

STORMS AHEAD: CLIMATE CHANGE ADAPTATION CALLS FOR RESILIENT FUNDING

Janet E. Milne^{*†}

INTRODUCTION.....	819
I. THE GAP BETWEEN ADAPTATION COSTS AND RESOURCES	821
II. HURRICANE SANDY: A MICROCOSM OF THE FUNDING GAP	826
A. The Storm	827
B. The Governmental Response Framework.....	830
C. The Insurance Gap for Property Damage	832
D. Government Funding Gaps.....	836
III. THE SEARCH FOR NEW REVENUE TO FILL THE GAPS	839
A. A Disquieting Quiet on the New Revenues Front	839
B. Principles Guiding the Design of New Revenue Streams for Adaptation	842
1. Earmark the Revenue	842
2. Try to Place the Burden on the Polluter or Beneficiary, Even If Imperfectly	845
3. Match the Funding Responsibility for Adaptation to the Appropriate Level of Government	847
C. An Exploration of Potential Adaptation Taxes.....	848
1. Carbon Taxes.....	848
2. Dark Cloud Taxes.....	852
3. Adaptation Fees or Taxes on Impervious Surfaces	858
4. Real Estate Transfer Taxes.....	862
5. A Brief Synthesis	864
CONCLUSION	866

INTRODUCTION

The challenges of reducing greenhouse gas emissions have dominated international negotiations and national debates about climate change, often leaving the issue of adaptation to climate change in the shadows. The focus on mitigation is understandable, given the urgent need to take measures now to avoid greater future damage coupled with the fact that adaptation to climate change is a long-term undertaking with tangible, immediate demands on society that are now starting to emerge. Nevertheless, society is beginning to feel the impacts of climate change, underscoring the need to

* Professor of Law and Director of the Environmental Tax Policy Institute at Vermont Law School.

† The author thanks Nora Greenglass, Katherine Hambley, Alexis Peters, and Alessandra Wingerter for their valuable research assistance, Professor Patrick Parenteau for his thoughtful review, and Bradley Young for causing her to think about the environmental impacts of the cloud.

think more seriously about how to prepare for and minimize those impacts¹ and how to finance the measures that society should take. As a recent United States assessment found, “[d]espite emerging efforts, the pace and extent of adaptation activities are not proportional to the risks to people, property, infrastructure, and ecosystems from climate change.”²

This Article examines the role of environmental tax policy in addressing climate change adaptation, using the United States as a case study. To provide a concrete setting, it focuses on the challenges of adapting to extreme weather events.³ It draws in particular on the adaptation implications of Hurricane Sandy, which devastated the eastern United States in October 2012, flooded New York City’s subways and airports, left 8.5 million people without power,⁴ and prompted the United States Congress to appropriate \$51 billion in disaster funding.⁵ Whether or not the storm was linked directly to climate change, it illustrates the tremendous costs of extreme weather, the need to invest in resilience, and the challenges of financing efforts that will restore communities and protect them from future damage.

After exploring the gap between adaptation costs and funding in general (Part I) and in the case of Hurricane Sandy in particular (Part II), this Article considers how environmentally related taxes might help fill the gap between the costs of adaptation in the face of extreme weather events and available public resources (Part III). It highlights the need to earmark revenue for adaptation to ensure that adequate funds are available for short-term responses and long-term investments, and it explores, on an illustrative basis, several types of taxes that might generate new, dedicated revenue streams. Although countries with developed economies may be in a stronger position to find resources to build resilience than those with emerging economies, this case study underscores the fiscal challenge that

1. There is a direct relationship between mitigation and adaptation, given that the degree of mitigation will affect the level of climate change impacts and therefore the extent of adaptation. In addition, some mitigation measures, such as land use practices, can also serve adaptation purposes. However, this Article focuses solely on the adaptation side of the equation.

2. Rosina Bierbaum et al., *Adaptation*, in U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 671, 687 (Jerry M. Melillo et al. eds., 2014), available at <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>.

3. According to a recent European study, extreme weather events also are very likely to trigger adaptation actions, putting them center-front in the adaptation discussion. EUROPEAN ENV’T AGENCY, NATIONAL ADAPTATION POLICY PROCESSES IN EUROPEAN COUNTRIES—2014, at 23, 24 fig.2.1, 34 (2014).

4. NOAA, U.S. DEP’T OF COMMERCE, HURRICANE/POST-TROPICAL CYCLONE SANDY, OCTOBER 22–29, 2012, at iv (2013), available at <http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf>.

5. See *infra* Part II.D.

faces even developed economies and the potential role of environmentally related taxes in meeting that challenge.

I. THE GAP BETWEEN ADAPTATION COSTS AND RESOURCES

Both internationally and in the United States, reports acknowledge the difficulty of projecting the costs of adaptation and yet, even in the absence of hard numbers, recognize the lack of adequate financial resources to meet those needs. However, there is relatively little discussion about what types of new revenue might fill the gap between adaptation needs and currently available resources apart from international negotiations over the obligations of developed economies to help fund adaptation measures for developing countries.⁶

Adaptation, defined as the “process of adjustment to actual or expected climate and its effects,”⁷ will inevitably impose costs on society. Some adaptation costs will take the form of investments to reduce or avoid the adverse impacts of climate change (resilience costs), and some will involve the costs of responding to the impacts of climate change (reactive adaptation), such as the cost of disaster relief after climate-induced extreme weather events.⁸

The global costs, however, remain difficult to quantify.⁹ A World Bank report projected annual global adaptation costs ranging from \$70 billion to over \$100 billion by 2050, but a recent Intergovernmental Panel on Climate Change (“IPCC”) report on adaptation expressed low confidence in these

6. Two existing international programs are the Green Climate Fund and the Climate Investment Funds. For an overview of each, see generally RICHARD K. LATTANZIO, CONG. RESEARCH SERV., R41889, INTERNATIONAL CLIMATE CHANGE FINANCING: THE GREEN CLIMATE FUND (GCF) (2014) [hereinafter GREEN CLIMATE FUND], available at <http://fpc.state.gov/documents/organization/235012.pdf>, and RICHARD K. LATTANZIO, CONG. RESEARCH SERV., R41302, INTERNATIONAL CLIMATE CHANGE FINANCING: THE CLIMATE INVESTMENT FUNDS (CIFs) (2013) [hereinafter CLIMATE INVESTMENT FUNDS], available at <http://fpc.state.gov/documents/organization/210682.pdf>.

7. C.B. Field et al., *Summary for Policymakers*, in INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC), CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY, PART A: GLOBAL AND SECTORAL ASPECTS 1, 5 (C.B. Field et al. eds., 2014).

8. John Handmer et al., *Changes in Impacts of Climate Extremes: Human Systems and Ecosystems*, in IPCC, MANAGING THE RISKS OF EXTREME WEATHER EVENTS AND DISASTERS TO ADVANCE CLIMATE CHANGE ADAPTATION 231, 264–65 (C.B. Field et al. eds., 2012), available at https://www.ipcc.ch/pdf/special-reports/srex/SREX_FD_SPM_final.pdf. Note that some definitions of resilience include both pre-disaster mitigation and post-disaster recovery. *E.g.*, NAT’L RESEARCH COUNCIL, REDUCING COASTAL RISK ON THE EAST AND GULF COASTS 19–20 (2014), available at http://www.nap.edu/download.php?record_id=1881.

9. It is difficult to estimate the costs of the impacts of climate change for a variety of reasons. Douglas J. Arent et al., *Key Economic Sectors and Services*, in IPCC, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY, PART A: GLOBAL AND SECTORAL ASPECTS 659, 663 (C.B. Field et al. eds., 2014), available at <http://ipcc-wg2.gov/AR5/>.

and other numbers and noted the challenges facing cost studies.¹⁰ It identified the lack of full coverage of the adaptation costs of extreme weather events as one source of low confidence.¹¹

Even in the face of uncertain costs, authorities recognize a gap between anticipated costs and financial resources. In its recent survey of adaptation efforts, the IPCC found with high confidence that progress is being made on embedding adaptation into planning processes but that implementation is more limited,¹² in part due to the lack of financial resources.¹³ While noting the shortcomings in data about the costs of adaptation, it projected with medium confidence a gap between global adaptation needs and available funding.¹⁴ Other reports also cite the lack of financial resources to address adaptation.¹⁵

Despite acknowledgments of the cost-resource gap and suggestions that adaptation may yield benefits that are quadruple the cost,¹⁶ there seems to be relatively little overt discussion about how to raise the revenue that the public sector inevitably will need to play its role in addressing the consequences of climate change. The European Union has suggested that member states could commit part of the revenue from auctioning greenhouse gas emissions allowances to fund adaptation.¹⁷ On the whole, however, adaptation funding proposals have focused primarily on the international discussions about developed economies' obligations to finance adaptation in countries with developing economies that have occurred under the umbrella of the United Nations Framework Convention on Climate Change ("UNFCCC").¹⁸ An Organisation for Economic Co-

10. Muyeye Chambwera et al., *Economics of Adaptation, in IPCC, CLIMATE CHANGE 2014: IMPACTS, ADAPTATION, AND VULNERABILITY, PART A: GLOBAL AND SECTORAL ASPECTS* 945, 959 (C.B. Field et al. eds., 2014), available at <http://ipcc-wg2.gov/AR5/>.

11. *Id.* For a discussion of studies of adaptation costs for extreme climate events and disasters and the uncertainties in assessing costs, see Handmer et al., *supra* note 8, at 273–74.

12. Field et al., *supra* note 7, at 8.

13. *Id.* at 26.

14. *Id.* at 28.

15. See, e.g., Bierbaum et al., *supra* note 2, at 671 (citing “limited funding” as a key barrier to implementing adaptation); EUROPEAN ENV'T AGENCY, *supra* note 3, at 25 (citing “lack of financial/human resources” as one of “three most commonly reported barriers”).

16. ANDRIES HOF ET AL., PBL NETHERLANDS ENVTL. ASSESSMENT AGENCY, COSTS AND BENEFITS OF CLIMATE CHANGE ADAPTATION AND MITIGATION: AN ASSESSMENT ON DIFFERENT REGIONAL SCALES 14 (2014), available at http://www.pbl.nl/sites/default/files/cms/publicaties/PBL_2014_Costs_and_benefits_of_climate_change_adaption_and_mitigation_1198.pdf.

17. Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 Amending Directive 2003/87/EC So As to Improve and Extend the Greenhouse Gas Emissions Allowance Trading Scheme of the Community, 2009 O.J. (L 140) 63, 71–72, available at <http://faolex.fao.org/docs/pdf/eur88008.pdf>.

18. GREEN CLIMATE FUND, *supra* note 6, at 1; CLIMATE INVESTMENT FUNDS, *supra* note 6, at 1.

operation and Development (“OECD”) report cites several possible reasons why many OECD countries do not identify funding sources or the scale of funding required: funding numbers will emerge later in the planning process; speculations about cost may complicate discussions; attention to cost may make it more difficult to agree on policy objectives; and/or the issue is not raised because public funding is limited.¹⁹ While some reports look to economic instruments for their ability to create incentives for adaptation, such as pricing systems for water that encourage conservation in the face of climate-related shortages,²⁰ they generally do not focus on economic instruments’ potential to finance governmental adaptation measures.

The situation in the United States provides a concrete example of the IPCC’s findings about the status of adaptation efforts and the lack of financing. Adaptation efforts in the United States are “in a nascent stage.”²¹ In recent years, the federal government has included adaptation in its climate change agenda, but at most levels of government, the efforts are generally related more to the initial planning steps than to implementation.²² An analysis of the conservatively estimated \$77 billion in federal funding for climate change initiatives between fiscal year 2008 and fiscal year 2014 tentatively concluded that most federal agencies were devoting a low level of effort to adaptation and that their efforts typically were incremental additions to existing programs.²³

President Barack Obama has elevated the visibility of adaptation, giving it a place of note in *The President’s Climate Action Plan* released in

19. M. Mullan et al., *National Adaptation Planning: Lessons from OECD Countries* 61 (OECD Environment, Working Paper No. 54, 2013), available at <http://www.oecd-ilibrary.org/docserver/download/5k483jpfpsq1.pdf?expires=1421596783&id=id&accname=guest&checksum=235FEBF46FDDBD2727F78F064183069A>.

20. See, e.g., Chambwera et al., *supra* note 10, at 964; Samuel Fankhauser et al., *Economic and Policy Instruments to Promote Adaptation*, in ORG. FOR ECON. COOPERATION & DEV., ECONOMIC ASPECTS OF ADAPTATION TO CLIMATE CHANGE: COSTS, BENEFITS AND POLICY INSTRUMENTS 85, 85–133 (Shardul Agrawala & Samuel Fankhauser eds., 2008), available at <http://www.riesgoycambioclimatico.org/biblioteca/archivos/DC1082.pdf> (focusing on three economic implements and their ability to incent adaptive behavior).

21. Bierbaum et al., *supra* note 2, at 687.

22. *Id.* at 671.

23. JANE A. LEGGETT ET AL., CONG. RESEARCH SERV., R43227, FEDERAL CLIMATE CHANGE FUNDING FROM FY2008 TO FY2014, at 12 (2013), available at <http://fas.org/sgp/crs/misc/R43227.pdf>. Only the Department of the Interior explicitly reported its adaptation expenditures, making it difficult to calculate government-wide adaptation spending, and even the Department of Interior’s adaptation expenses amounted to under 1% of the climate change spending for all agencies in fiscal year 2013. *Id.*

2013.²⁴ Pursuant to the plan, the President directed federal agencies to engage in a number of adaptation activities and to consider the costs and benefits of improving adaptation and resilience with respect to their suppliers and capital investments in infrastructure.²⁵ He created the Council on Climate Change Preparedness and Resilience to facilitate interagency efforts and work with state, local, and tribal governments.²⁶ He also formed the State, Local, and Tribal Leaders Task Force on Climate Preparedness and Resilience to recommend how the federal government might better address climate impacts.²⁷ Both task forces reflect the federal recognition that adaptation requires actions at all levels of government²⁸ and that coordination is needed.

The current federal approach has been largely numberless. It is not built on comprehensive estimates of the economic and fiscal impacts of climate change or projections of the amount that governments in the United States will need to spend in order to implement adaptation measures. *The Third National Climate Assessment*, a federal report released in spring 2014,²⁹ conveys a message that echoes the IPCC study mentioned above.³⁰ It notes the lack of estimates of the total economic damage from climate change,³¹ and it recognizes the need for research to identify the costs of adaptation measures;³² but even without this information, it identifies “limited funding” as one of the barriers in its “key messages.”³³ The federal government’s 2014 UNFCCC *Climate Action Report* catalogues a sampling of adaptation actions at federal, state, and local levels of government,³⁴ but it also does not indicate funding levels beyond a discussion of U.S.

24. THE WHITE HOUSE, EXEC. OFFICE OF THE PRESIDENT, THE PRESIDENT’S CLIMATE ACTION PLAN 12 (2013) [hereinafter PRESIDENT’S CLIMATE ACTION PLAN], available at <http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf>.

25. Exec. Order No. 13,653, §§ 2, 5, 3 C.F.R. 330, 331, 333 (2014). Federal agencies have been charged since 2009 with developing adaptation assessments. Exec. Order No. 13,514, § 8(i), 3 C.F.R. 248, 255 (2010).

26. Exec. Order No. 13,653 § 6(a), (e), 3 C.F.R. 334, 335 (2014).

27. *Id.* § 7.

28. U.S. DEP’T OF STATE, UNITED STATES CLIMATE ACTION REPORT 2014, at 160 (2014) [hereinafter U.S. CLIMATE ACTION REPORT 2014], available at <http://www.state.gov/documents/organization/219038.pdf>.

29. U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT (Jerry M. Melillo et al. eds., 2014) [hereinafter THIRD NATIONAL CLIMATE ASSESSMENT], available at <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>.

30. See *supra* notes 9–10 and accompanying text.

31. THIRD NATIONAL CLIMATE ASSESSMENT, *supra* note 29, app. 6 at 826.

32. Bierbaum et al., *supra* note 2, at 687.

33. *Id.* at 671.

34. U.S. CLIMATE ACTION REPORT 2014, *supra* note 28, at 160–70; see also Bierbaum et al., *supra* note 2, at 672–80 (cataloging federal, state, tribal, and local adaptation measures).

international funding commitments,³⁵ nor does it discuss any new mechanisms to finance new adaptation activities.

However, the Obama administration is moving toward a higher level of specificity, starting with a focus on the federal fiscal risks of inaction and the need for specific federal resilience programs. The Government Accountability Office in 2013 included the impacts of climate change on its list of areas where the federal government faces high fiscal risk.³⁶ In September 2014 the Director of the Office of Management and Budget accentuated the costs of climate change as a major threat to the federal budget and the American economy, focusing on the costs of coastal storms, wildfires, and droughts.³⁷ In February 2015 the White House budget proposal for fiscal year 2016 contained for the first time an assessment of the federal budget's exposure to climate risks³⁸ and described a portfolio of initiatives to start addressing resilience,³⁹ significantly underscoring the issue in the budget context and attaching numbers to the costs of requested programs.

In sum, from both the broad international perspective and the narrower U.S. perspective, there is a common recognition that, despite ambiguities about the cost of climate change and the cost of mitigation, society faces a gap between the needs that are emerging and the funding available. The challenge of how to fill that gap looms large.

To place adaptation funding challenges in a specific context, this Article considers the fiscal implications of the adaptation demands of extreme weather events⁴⁰—both in terms of reactive adaptation and

35. U.S. CLIMATE ACTION REPORT 2014, *supra* note 28, at 19–28, 173–94.

36. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-13-283, HIGH-RISK SERIES: AN UPDATE 61–74 (2013), available at <http://www.gao.gov/assets/660/652133.pdf>.

37. Lori Montgomery, *Forget the National Debt. The New Budget Threat Is Climate Change*, WASH. POST (Sept. 19, 2014), <http://www.washingtonpost.com/blogs/wonkblog/wp/2014/09/19/forget-the-national-debt-the-new-budget-threat-is-climate-change/>.

38. See OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, BUDGET OF THE UNITED STATES GOVERNMENT, FISCAL YEAR 2016, at 23–24 (2015) [hereinafter 2016 BUDGET], available at <https://www.whitehouse.gov/omb/budget/Overview> (citing, *inter alia*, that climate-related extreme weather events and fires cost the federal government \$300 billion over the past decade); OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, FISCAL YEAR 2016 ANALYTICAL PERSPECTIVES OF THE U.S. GOVERNMENT 353–57 (2015) (elaborating on the federal government's exposure to climate risks), available at https://www.whitehouse.gov/omb/budget/Analytical_Perspectives.

39. See 2016 BUDGET, *supra* note 38, at 19–25 (outlining the White House's proposals for federal programs to increase resilience).

40. A “climate extreme,” which includes extreme weather or climate events, is “[t]he occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable.” Simon K. Allen et al., *Summary for Policymakers*, in IPCC, MANAGING THE RISKS OF EXTREME EVENTS AND DISASTERS TO ADVANCE

building resilience—and, in particular, hurricanes. It draws on Hurricane Sandy, which devastated the eastern United States in 2012, as a specific case study. Although Hurricane Sandy has not been causally linked to climate change,⁴¹ it has been used as an example of the events that lie ahead⁴² and as a case study for how climate-related sea level rise exacerbates the frequency and severity of extreme weather events.⁴³ The need to adapt to climate change permeates the report issued by the federally created Hurricane Sandy Rebuilding Task Force.⁴⁴ The report mentioned President Obama's *Climate Action Plan* twenty-six times as it laid out plans for rebuilding after the storm and preparing for future resilience.⁴⁵

Extreme weather events provide a useful, concrete setting for considering the adaptation funding issues because the events are very specific and leave behind very tangible impacts with which the public and private sectors must contend. As the IPCC noted in its report, adaptation to climate change impacts depends on the specific context and place,⁴⁶ so the issues of need and fiscal responses, including the potential role for taxation, cannot be divorced from context. Nevertheless, exploring one particular set of adaptation needs and potential solutions can help illustrate the challenges we face in financing adaptation more generally.

II. HURRICANE SANDY: A MICROCOSM OF THE FUNDING GAP

Hurricane Sandy provides a vivid example of the challenges that governments at all levels confront when extreme weather wreaks its damage. The human, economic, and fiscal tolls are substantial and long-

CLIMATE CHANGE ADAPTATION 1, 5 Box SPM.1 (C.B. Field et al. eds., 2012), available at <http://ipcc-wg2.gov/SREX/report/>.

41. See *id.* at 9 (noting that, due to uncertainties in tropical cyclone modeling, ascribing any one weather event to climate change or human activity is “challenging”).

42. See, e.g., Barack Obama, President of the United States, Remarks at Hurricane Preparedness Briefing at FEMA Headquarters, Washington, D.C. (May 30, 2014), available at <http://www.whitehouse.gov/the-press-office/2014/05/30/remarks-president-hurricane-preparedness-briefing> (explaining the frequency and severity of storms like Hurricane Sandy that can be expected in the future).

43. William Sweet et al., *Hurricane Sandy Inundation Probabilities Today and Tomorrow*, 94 BULL. AM. METEOROLOGICAL SOC'Y (Explaining Extreme Events of 2012 From a Climate Persp.) S17, S17–20, available at <http://www.ametsoc.org/2012extremeeventsclimate.pdf>.

44. See, e.g., HURRICANE SANDY REBUILDING TASK FORCE, HURRICANE SANDY REBUILDING STRATEGY: STRONGER COMMUNITIES, A RESILIENT REGION 3, 33 (2013), available at <http://portal.hud.gov/hudportal/documents/huddoc?id=hsrebuildingstrategy.pdf>.

45. *Id.* at *passim*.

46. Field et al., *supra* note 7, at 22–23.

term. Even after significant governmental responses, the process of rebuilding continues today⁴⁷ and needs remain unmet.⁴⁸

A. The Storm

Hurricanes in the North Atlantic have increased in frequency, duration, and intensity over the past thirty years, in part due to warmer ocean surface temperatures, which in turn result from atmospheric warming driven by increased greenhouse gas emissions.⁴⁹ One U.S. study projects an annual cost of \$35 billion for hurricanes and other coastal storms along the east coast and the Gulf of Mexico over the next fifteen years, taking into account higher sea levels and storm surges.⁵⁰ Hurricane Sandy was the most recent major hurricane.

The deadliest hurricane to hit the east coast since 1972,⁵¹ Hurricane Sandy originated in the Caribbean and traveled north up the Atlantic Ocean, making landfall in New Jersey on October 29, 2012.⁵² Although it did not consistently sustain hurricane status and was a post-tropical cyclone once it made landfall, Sandy still covered 1.8 million square miles and its tropical force winds spanned 1,000 miles,⁵³ earning its description as one of the largest Atlantic storms ever recorded.⁵⁴ It impacted twenty-four states.⁵⁵ In blizzard conditions, two to three feet of snow covered parts of western Maryland, Virginia, North Carolina, and Tennessee a few hours after landfall hundreds of miles north.⁵⁶ Closer to the mid-Atlantic coast, twelve

47. See, e.g., Patrick McGeehan, *Repairs to New York Tunnel Will Limit Rail Service*, N.Y. TIMES (Oct. 2, 2014), <http://www.nytimes.com/2014/10/02/nyregion/repairs-to-new-york-tunnels-will-limit-rail-service.html> (reporting that Amtrak is sharply curtailing subway services in the tunnels leading in and out of New York City to repair damage from Hurricane Sandy); Liz Robbins, *After the Storm, 20 Months in Limbo*, N.Y. TIMES (June 20, 2014), <http://www.nytimes.com/2014/06/22/nyregion/after-the-storm-20-months-in-limbo.html> (reporting that many houses in pockets of the city, especially Brooklyn, remain storm-damaged).

48. See *infra* Part II.C, D.

49. John Walsh et al., *Our Changing Climate*, in U.S. GLOBAL CHANGE RESEARCH PROGRAM, CLIMATE CHANGE IMPACTS IN THE UNITED STATES: THE THIRD NATIONAL CLIMATE ASSESSMENT 19, 27 (Jerry M. Melillo et al. eds., 2014), available at <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>.

50. RISKY BUSINESS PROJECT, RISKY BUSINESS: THE ECONOMIC RISKS OF CLIMATE CHANGE IN THE UNITED STATES 3 (2014), available at http://riskybusiness.org/uploads/files/RiskyBusiness_PrintedReport_FINAL_WEB_OPTIMIZED.pdf.

51. NOAA, *supra* note 4, at 1.

52. *Id.* at iv.

53. *Id.* at 12.

54. *Id.*

55. *Id.* at 1.

56. *Id.* at 16.

inches of rain caused rivers and streams to flood.⁵⁷ The combination of astronomical high tides—some of the highest of the year—and Sandy’s high winds generated a storm surge along much of the east coast.⁵⁸ But the hardest hit areas were the coast of New Jersey, the most densely populated state in the country, and metropolitan New York, home to 19 million people and the source of 9.5% of the country’s GDP.⁵⁹ The most intense storm surge of ocean water occurred in the metropolitan New York area.⁶⁰ At the Battery at the southern end of Manhattan, nine feet of water covered low-lying areas.⁶¹

The storm left devastation in its wake. It directly caused seventy-two deaths in the United States (forty-eight in New York⁶² and forty-one from the storm surge⁶³) and at least seventy-five indirect deaths due to conditions during the evacuation and cleanup stages.⁶⁴ The storm damaged an estimated 650,000 houses and cut off power for 8.5 million customers, primarily from fallen trees.⁶⁵

In New Jersey and New York, flooding was a key cause of damage. Vivid images and statistics abound, with only a few mentioned here. In coastal New Jersey, the storm surge flooded entire communities, sweeping houses off foundations and carrying boats and cars inland,⁶⁶ and left some communities without power for months.⁶⁷ The storm surge flooded 17% of New York City’s landmass.⁶⁸ In New York City, the storm inundated over 23,000 businesses and nonprofit organizations, which employed 245,000 people and ranged from small businesses to major corporations,⁶⁹ as well as 88,700 buildings and more than 300,000 residential units.⁷⁰ Ten percent of the city’s population lived in the inundation area, where 80% of the housing

57. *Id.* at 1.

58. *Id.* at 13–14.

59. HURRICANE SANDY REBUILDING TASK FORCE, *supra* note 44, at 19–20. Metropolitan New York includes northern New Jersey. *Id.* at 19.

60. NOAA, *supra* note 4, at 1.

61. *Id.* at 13–14.

62. *Id.* at 1. The deaths occurred in eight states, with the majority in New York (forty-eight) but others ranging from West Virginia to New Hampshire. *Id.*

63. ERIC S. BLAKE ET AL., NAT’L HURRICANE CTR., TROPICAL CYCLONE REPORT: HURRICANE SANDY 14 (2013), available at http://www.nhc.noaa.gov/data/tcr/AL182012_Sandy.pdf.

64. NOAA, *supra* note 4, at 1.

65. *Id.* at iv.

66. *Id.* at 14.

67. *Id.* at 1.

68. CITY OF NEW YORK, A STRONGER, MORE RESILIENT NEW YORK 13 (2013) [hereinafter A STRONGER, MORE RESILIENT NEW YORK], available at <http://www.nyc.gov/html/sirr/html/report/report.shtml>.

69. *Id.* at 87.

70. *Id.* at 13.

was built before 1980—before the building code required consideration of flooding.⁷¹ The morning after landfall, over half the country’s daily public transit riders found themselves with no service—the worst public transit disaster in national history.⁷² Passenger train service along the northeast corridor did not return to full normal function for three weeks.⁷³ The New York City subway system, which closed from October 28 (in anticipation of the storm) to November 1, experienced flooding in eight tunnels.⁷⁴ Failures of wastewater treatment plants due to damage or loss of electricity sent billions of gallons of sewage into waterways.⁷⁵ Hospitals were damaged or affected; schools closed; and people were dislocated from their communities and jobs.⁷⁶ Immediately after the hurricane, over 23,000 people sought housing in temporary shelters.⁷⁷

Estimates of damage from Hurricane Sandy vary, depending perhaps on how one counts costs and on the knowledge available at any given time. According to one federal study, damage from the storm exceeded \$50 billion.⁷⁸ In November 2012 New Jersey Governor Chris Christie estimated that repair and recovery would cost \$36.9 billion for his state alone, and New York Governor Andrew Cuomo estimated \$42 billion, for a total of \$78.9 billion.⁷⁹ These amounts included \$7.4 billion⁸⁰ and \$9 billion⁸¹ for New Jersey and New York respectively to build resilience against future storms.⁸² One study projected economic damage to the New York/New

71. NYC RECOVERY, CITY OF NEW YORK ACTION PLAN INCORPORATING AMENDMENTS 1–7, at 11–12 (2014) [hereinafter NEW YORK ACTION PLAN], available at http://www.nyc.gov/html/cdbg/downloads/pdf/CDBG-DR-Action-Plan-incorporating-Amendments-1-7_12-04-14.pdf.

72. HURRICANE SANDY REBUILDING TASK FORCE, *supra* note 44, at 25.

73. *Id.* at 26.

74. *Id.* at 25.

75. *Id.* at 27. New York City estimated that failures in its wastewater systems resulted in 562 million gallons of sewage overflow. N.Y.C. DEP’T ENVTL. PROT., NYC WASTEWATER RESILIENCY PLAN: CLIMATE RISK ASSESSMENT AND ADAPTATION STUDY 5 (2013), available at http://www.nyc.gov/html/dep/html/about_dep/wastewater_resiliency_plan.shtml.

76. HURRICANE SANDY REBUILDING TASK FORCE, *supra* note 44, at 27–28.

77. FEMA, HURRICANE SANDY RECOVERY EFFORTS ONE YEAR LATER 1 (2013) [hereinafter HURRICANE SANDY RECOVERY EFFORTS ONE YEAR LATER], available at http://www.fema.gov/media-library-data/1382967173777-7411aa1b6d729a8a97e84dbba62083d8/FEMA+Sandy+One+Year+Fact+Sheet_508.pdf.

78. NOAA, *supra* note 4, at 1.

79. ECON. & STATISTICS ADMIN., U.S. DEP’T OF COMMERCE, ECONOMIC IMPACT OF HURRICANE SANDY: POTENTIAL ECONOMIC ACTIVITY LOST AND GAINED IN NEW JERSEY AND NEW YORK 17 (2013), available at <http://www.esa.doc.gov/sites/default/files/sandyfinal101713.pdf>; see also FRAN SUSSMAN ET AL., CLIMATE CHANGE: AN UNFUNDED MANDATE 11 (2013), available at <http://cdn.americanprogress.org/wp-content/uploads/2013/10/ClimateUnfundedMandate-REPORT.pdf> (breaking the New York cost estimate into several components).

80. ECON. & STATISTICS ADMIN., *supra* note 79, at 17 tbl.4.

81. SUSSMAN ET AL., *supra* note 79, at 11.

82. *Id.*

Jersey region between \$30 billion and \$50 billion,⁸³ although according to another study, long-term construction may yield net gains due to the positive effects for the construction industry if all the damage is repaired.⁸⁴ A 2014 study examined various resilience scenarios and projected that New York and New Jersey would need to spend between \$12 billion and \$24 billion to protect against flooding, depending on the assumptions.⁸⁵

B. The Governmental Response Framework

The events surrounding Hurricane Sandy illustrate the various types of government responses—both in terms of reactive adaptation (emergency response and recovery) and building resilience for the future—and the allocation of responsibilities and therefore costs among different levels of government. Although responsibility for handling disasters usually starts at the local level, the National Response Framework recognizes that response is often a partnership among communities, nongovernmental organizations, state governments, and the federal government.⁸⁶ The federal government serves as a significant backstop to provide important forms of assistance⁸⁷ and over the years has borne an increasing portion of the financial responsibility for coastal storms.⁸⁸ The governor of a state may request the President to declare a disaster if the governor believes that the circumstances are “beyond the capabilities” of the state and local governments and that federal assistance is therefore necessary.⁸⁹ In the wake of Hurricane Sandy, President Obama issued disaster declarations in twelve states plus the District of Columbia.⁹⁰ The declaration of a disaster allows the federal government to provide relief.⁹¹

83. HURRICANE SANDY REBUILDING TASK FORCE, *supra* note 44, at 24.

84. ECON. & STATISTICS ADMIN., *supra* note 79, at 24.

85. Jeroen C.J.H. Aerts et al., *Evaluating Flood Resilience Strategies for Coastal Megacities*, SCIENCE, May 2, 2014, at 473, 474, available at http://www.scor.com/images/stories/pdf/library/news_media/J2014Science344_EvaluatingFloodResilience.pdf.

86. U.S. DEP'T OF HOMELAND SECURITY, NATIONAL RESPONSE FRAMEWORK 8–9, 13–16 (2d ed. 2013), available at http://www.fema.gov/media-library-data/20130726-1914-25045-1246/final_national_response_framework_20130501.pdf.

87. FRANCIS X. MCCARTHY & JARED T. BROWN, CONG. RESEARCH SERV., R41981, CONGRESSIONAL PRIMER ON RESPONDING TO MAJOR DISASTERS AND EMERGENCIES 5 (2014), available at <https://www.fas.org/sgp/crs/homesecc/R41981.pdf>.

88. NAT'L RESEARCH COUNCIL, *supra* note 8, at 1, 19.

89. 42 U.S.C. § 5170 (2012).

90. HURRICANE SANDY REBUILDING TASK FORCE, *supra* note 44, at 19.

91. FEMA, A GUIDE TO THE DISASTER DECLARATION PROCESS AND FEDERAL DISASTER ASSISTANCE 2 (2014), available at http://www.fema.gov/media-library-data/20130726-1536-20490-8240/dec_proc.pdf.

After a disaster declaration, the Federal Emergency Management Agency (FEMA) can draw on the Disaster Relief Fund.⁹² Through the Fund, FEMA can provide individual assistance (for example, to help individuals when a storm damages or destroys residences by offering temporary shelter, repairs, and rebuilding assistance), public assistance (for example, to repair damage to public infrastructure or help government remove debris impairing public rights-of-way), and hazard mitigation assistance (to fund projects that will reduce the risk of future damage, such as retrofitting properties or buying out at-risk properties).⁹³ Other federal agencies also can provide financial assistance. These include the Small Business Administration, the Department of Transportation through its Emergency Relief Program, and the Department of Housing and Urban Development through its Community Development Block Grant Program.⁹⁴ Rules govern the extent to which federal funding requires some state or local cost-sharing, but the federal government's financial role is significant.⁹⁵

The federal government also steps in to provide personnel in the event of a disaster. For example, in the immediate response to Hurricane Sandy, the U.S. Army Corps of Engineers removed 150 million gallons of water from tunnels and subway systems in the greater metropolitan New York area (the equivalent of 227 Olympic-sized pools),⁹⁶ and 17,000 federal responders, including more than 5,000 FEMA employees, addressed storm issues.⁹⁷ In the longer term, FEMA was still staffing recovery offices in New York and New Jersey as of February 2015.⁹⁸

The storm spawned special commissions to help mobilize government efforts. Given the amount of damage from the storm, President Obama in December 2012 established the Hurricane Sandy Rebuilding Task Force,⁹⁹ composed of representatives of a wide range of federal agencies and led by

92. *Id.*; NAT'L RESEARCH COUNCIL, *supra* note 8, at 48.

93. MCCARTHY & BROWN, *supra* note 87, at 7; *see generally* NAT'L RESEARCH COUNCIL, *supra* note 8, at 45–49 (explaining FEMA's role in disaster relief).

94. MCCARTHY & BROWN, *supra* note 87, at 7–8.

95. *Id.* at 3.

96. HURRICANE SANDY RECOVERY EFFORTS ONE YEAR LATER, *supra* note 77, at 2.

97. *One Year Later: Examining the Ongoing Recovery from Hurricane Sandy: Hearing Before the Comm. on Homeland Sec. & Governmental Affairs and Subcomm. on Emergency Mgmt., Intergovernmental Relations & the D.C.*, 113th Cong. (Nov. 6, 2013) (written Testimony of Craig Fugate, Administrator, FEMA), available at http://www.fema.gov/media-library-data/1387208691195-dda79568fbb827633b3e095d61fa9f7a/11-6-2013_ONE%20YEAR%20LATER_EXAMINING%20THE%20ONGOING%20RECOVERY%20FROM%20HURRICANE%20SANDY.pdf.

98. *Sandy Recovery Office*, FEMA, <http://www.fema.gov/sandy-recovery-office> (last visited Apr. 11, 2015).

99. Exec. Order No. 13,632 § 1, 3 C.F.R. 328, 328 (2013).

the Secretary of the Department of Housing and Urban Development.¹⁰⁰ The task force was charged with helping to coordinate the rebuilding efforts, improving regional resiliency, and presenting a long-term rebuilding plan.¹⁰¹ The plan, issued in August 2013, contains a wide array of recommendations.¹⁰² Two months after the storm, New York City created its Special Initiative for Rebuilding and Resiliency, which presented a plan for short- and long-term recovery in June 2013.¹⁰³ Also relevant to long-term adaptation, the State of New York had previously created a task force to address the problem of rising sea levels, which issued a report in late 2010 containing a variety of recommendations.¹⁰⁴

In sum, as illustrated by Hurricane Sandy, adaptation involves multi-level governmental responses, both in terms of reactive adaptation and building resilience. A major event focuses attention on the need for action at all levels. Within this framework, however, significant funding gaps remain.

C. The Insurance Gap for Property Damage

As indicated above, Hurricane Sandy left New York and New Jersey with the task of recovering from damage and with costs in the \$50 billion to \$70 billion range. Insurance coverage did not adequately cover the private sector costs for property damage, causing the private sector to look for relief from the public sector. Globally, insurance tends to fall far short of covering losses from extreme weather events: Insurance covered only about one-quarter of the total costs of extreme weather events around the world between 1980 and 2004 (\$1.4 trillion).¹⁰⁵ Coverage was higher for Hurricane Sandy but still fell short of what was needed to compensate for the losses. According to Swiss Re's 2013 estimates, about half of the \$70 billion in economic losses from Sandy was covered by insurance.¹⁰⁶ Private

100. *Id.* § 2.

101. *Id.* §§ 3, 5(a)(ii).

102. See HURRICANE SANDY REBUILDING TASK FORCE, *supra* note 44, at 39–159 (offering sixty-nine recommendations on policy priorities for funding and offering strategies to rebuild, as well as methods for prevention and recovery from future flood related disasters).

103. The plan is embodied in the report, A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68.

104. NEW YORK STATE SEA LEVEL RISE TASK FORCE, REPORT TO THE LEGISLATURE (2010), available at http://www.dec.ny.gov/docs/administration_pdf/slrffinalrep.pdf.

105. Handmer et al., *supra* note 8, at 269.

106. Swiss Re's *Sigma on National Catastrophes and Man-made Disasters in 2012 Reports USD 77 Billion in Insured Losses and Economic Losses of USD 186 Billion*, SWISS RE (March 27, 2013), http://www.swissre.com/media/news_releases/nr_20130327_sigma_natcat_2012.html.

insurance picked up the tab for \$20 to \$25 billion, and between \$10 to \$15 billion fell on the Federal National Flood Insurance Program (NFIP).¹⁰⁷

Perhaps not surprisingly, large commercial firms were better protected than smaller firms and households. Based on a post-Sandy study of New York City, very large commercial firms tend to obtain comprehensive private insurance coverage, including flood insurance coverage.¹⁰⁸ The private insurance market generally offers more selective coverage to other types of property owners.¹⁰⁹ For homeowners and small businesses, the primary potential source of coverage for flood insurance is through the Federal NFIP.¹¹⁰

Started in 1968,¹¹¹ NFIP provides insurance for policyholders who own property in flood-prone areas, including property in the high-risk area where the risk of flooding is 1% (the 100-year flood plain).¹¹² Communities may elect to participate, in which case their residents are eligible for insurance, provided that the community follows specific land use guidelines designed to reduce risk.¹¹³ Purchase of insurance is not mandatory unless the property owner obtains a mortgage from a federally regulated lender or receives federal disaster relief funding for rebuilding a damaged property.¹¹⁴ NFIP also finances mitigation measures, particularly for repetitive-loss properties, by helping to cover the cost of raising, moving, or taking down buildings,¹¹⁵ a program that can be very important to building resilience.

107. *Id.* According to another report, \$15.9 billion of these payments centered on New York and New Jersey, and the majority (\$9 billion) covered commercial property owners. ECON. & STATISTICS ADMIN., *supra* note 79, at 7. Approximately half of the claims paid by private insurance were covered by reinsurance. *Id.*

108. LLOYD DIXON ET AL., RAND CORP., FLOOD INSURANCE IN NEW YORK CITY FOLLOWING HURRICANE SANDY 17, 87–88 (2013), *available* at http://www.rand.org/content/dam/rand/pubs/research_reports/RR300/RR328/RAND_RR328.pdf (estimating 80% to 90% coverage for New York City both inside and beyond the then-mapped floodplain for large firms that pay more than \$500,000 in premiums per year).

109. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 15; ECON. & STATISTICS ADMIN., *supra* note 79, at 7. Private insurers' commercial and residential policies generally exclude flooding, requiring people to seek a separate policy if they want to insure against risk, and premiums for catastrophic coverage are likely to be high. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 94–95.

110. DIXON ET AL., *supra* note 108, at 13, 18.

111. National Flood Insurance Act, Pub. L. No. 90-448, 82 Stat. 572 (1968) (codified at 42 U.S.C. §§ 4011–33).

112. 42 U.S.C. § 4011 (2012).

113. *Id.* §§ 4012a, 4106.

114. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-09-20, FLOOD INSURANCE: OPTIONS FOR ADDRESSING THE FINANCIAL IMPACT OF SUBSIDIZED PREMIUM RATES ON THE NATIONAL FLOOD INSURANCE PROGRAM 12–13 (2008) [hereinafter U.S. GOV'T ACCOUNTABILITY OFFICE, FLOOD INSURANCE], *available* at <http://www.gao.gov/assets/290/283427.pdf>.

115. FEMA, HAZARD MITIGATION ASSISTANCE UNIFIED GUIDANCE 23–24 (2013), *available* at http://www.fema.gov/media-library-data/15463cb34a2267a900bde4774c3f42e4/FINAL_Guidance_

These mitigation measures serve NFIP's financial interests. Repetitive loss properties constitute 1% of the insured properties but generate 30% of NFIP's insured losses.¹¹⁶

Although flood insurance coverage was available through NFIP, New York City estimates that less than 20% of the residential buildings that were inundated in the storm were covered by NFIP policies.¹¹⁷ The coverage was low for several reasons. Half of the homes lay outside of the 100-year floodplain identified on FEMA's outdated maps¹¹⁸ and were not on notice of risk. The inundated area exceeded the floodplain marked on FEMA's maps by 53%.¹¹⁹ For the half within the mapped flood zone, numerous properties did not have mortgages requiring NFIP coverage or did not comply with the insurance requirement for federally backed mortgages.¹²⁰ In terms of commercial structures, only 1,400 NFIP policies were in effect for commercial properties even though over 26,000 small businesses were inundated.¹²¹ Even for properties covered by insurance, NFIP caps the benefits and limits the coverage for certain elements, such as basements, which were hit hard by Sandy's flooding.¹²² Hence, in both the private insurance market and through NFIP, insurance did not adequately cover the costs of private losses. Those losses then must either fall on the private sector as uncompensated losses or fall on the public sector when the government offers assistance.

081213_508.pdf. FEMA will provide up to 100% of the cost of mitigating severe repetitive loss properties and 90% of the cost of repetitive loss properties, provided the state or tribal government has a FEMA-approved mitigation plan that addresses repetitive losses. *Id.* at 89–90

116. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-11-297, FEMA: ACTION NEEDED TO IMPROVE ADMINISTRATION OF THE NATIONAL FLOOD INSURANCE PROGRAM 54–55 (2011), available at <http://www.gao.gov/new.items/d11297.pdf>.

117. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 97.

118. The flood insurance rate map for New York City showing high-risk areas in the 100-year floodplain was based on data and modeling that was thirty years old. DIXON ET AL., *supra* note 108, at 7.

119. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 13.

120. *Id.* at 15, 97. For example, in New York City, 55% of the one-to-four family buildings, which comprise 88% of the residential structures in the then-mapped high-risk area, had NFIP coverage. DIXON ET AL., *supra* note 108, at 13–14 & tbl.2.5. Of those with mortgages, only 65% had coverage, and for those without mortgages, only 21% had coverage. *Id.* at 16 tbl.2.6. The average annual premium for these types of structures was about \$1,800 for properties that predated the FEMA maps and almost \$1,000 for those built after the initial maps; outside the then-mapped floodplain, the premiums were in the neighborhood of \$500. *Id.* at 18, 19 tbls.2.7 & 2.8.

121. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 97. One study suggests that only 5% to 10% of small businesses in New York City purchased flood insurance, regardless of whether they were inside or outside the floodplain, and when they did, they tended to rely on NFIP policies. DIXON, *supra* note 108, at 17–18.

122. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 96–97. NFIP caps the coverage, for example, at \$250,000 for a single-family residence plus \$100,000 for contents and at \$500,000 for a commercial property plus \$500,000 for contents. *Id.* at 95.

Moreover, NFIP insurance premiums have not been adequate to fund NFIP's growing nationwide coverage obligations with recent extreme weather events, causing the federal government to step in to fill the gap by authorizing NFIP to borrow from the Treasury. In recent years NFIP has been financially unsustainable due to subsidized insurance premium rates and a rising number of claims.¹²³ Properties in high-risk areas that were built before the first flood risk maps are eligible for subsidized insurance rates,¹²⁴ and the number of subsidized policies has risen due to increased participation and better enforcement of mandatory mortgage requirements.¹²⁵ In addition, major flooding in 2005 caused heavy claims records. As of early 2013, the program had acquired \$18 billion in debt from the Treasury, in large part due to claims from the massive Hurricane Katrina that devastated New Orleans and the Gulf Coast in 2005.¹²⁶ It then faced an additional projected \$12 to \$15 billion in NFIP claims from Hurricane Sandy.¹²⁷ Thus, even when property owners obtain flood insurance, NFIP has not allocated the full cost of insurance to those who assume the risk of living in the floodplain.¹²⁸ To ensure that NFIP would be able to pay its anticipated claims post-Sandy, Congress, in January 2013, authorized an additional \$9.7 billion in NFIP's borrowing authority.¹²⁹

123. See generally RAWLE O. KING, CONG. RESEARCH SERV., R40650, NATIONAL FLOOD INSURANCE PROGRAM: BACKGROUND, CHALLENGES, AND FINANCIAL STATUS (2012), available at <https://www.fas.org/sgp/crs/misc/R40650.pdf> (analyzing the NFIP and its current financial status).

124. *Id.* at 18; see also NAT'L RESEARCH COUNCIL, *supra* note 8, at 49 (accounting for the high percentage (19%) of discounted policies by noting that houses built before flood-risk maps were eligible for subsidy).

125. U.S. GOV'T ACCOUNTABILITY OFFICE, FLOOD INSURANCE, *supra* note 114, at 11–13.

126. WILLIAM L. PAINTER & JARED T. BROWN, CONG. RESEARCH SERV., R42869, FY2013 SUPPLEMENTAL FUNDING FOR DISASTER RELIEF 20 (2013), available at <https://www.fas.org/sgp/crs/misc/R42869.pdf>. The storms of 2005 caused the federal government to raise the NFIP's borrowing authority in several steps, from \$3.5 billion in 2005 to \$20.725 billion in 2006. *Id.* As of November 2012, NFIP had paid \$16.3 billion in claims from Hurricane Katrina. RAWLE O. KING, CONG. RESEARCH SERV., R42850, THE NATIONAL FLOOD INSURANCE PROGRAM: STATUS AND REMAINING ISSUES FOR CONGRESS 6 tbl.1 (2013) [hereinafter KING, R42850], available at <https://www.fas.org/sgp/crs/misc/R42850.pdf>.

127. KING, R42850, *supra* note 126, at 5. As of January 2013, NFIP had processed over 140,000 claims (\$1.7 billion). *Id.*

128. Legislation passed in 2012 attempted to address the deficit situation by adjusting rates and mandating the creation of a reserve to avoid borrowing from the Treasury, but the ability to raise rates was partially curtailed by legislation in early 2014 that resulted from concerns about rapidly increasing rates. NAT'L RESEARCH COUNCIL, *supra* note 8, at 49–50.

129. See Pub. L. No. 113–1, 127 Stat. 3 (2013) (codified as amended at 42 U.S.C. § 4016(a)) (increasing NFIP's borrowing authority from \$20.725 billion to \$30.425 billion).

D. Government Funding Gaps

The significant gap between insurance coverage and the need to repair and rebuild areas affected by Hurricane Sandy put pressure on the federal government for financial assistance.¹³⁰ FEMA's Disaster Relief Fund and other federal programs had to step in to provide relief, transferring the financial pressure from the private sector and from state and local governments to the federal government and its taxpayers.¹³¹ But existing federal resources were not adequate to address the magnitude of the short-term response and long-term recovery and resilience.¹³² Congressional action was necessary to authorize additional funds.

In December 2012, the White House requested that Congress appropriate \$60.4 billion in supplemental funding in response to Hurricane Sandy¹³³ and, in doing so, clearly linked the relief programs with climate change and adaptation. The request sought funding in part “[t]o build a more resilient Nation prepared to face both current and future challenges, including a changing climate,”¹³⁴ and it proposed allocating \$13 billion (over 20%) to programs that would mitigate the effect of future disasters,¹³⁵ indicating a clear presidential emphasis on resilience.

In January 2013, Congress passed a supplemental appropriation of \$50.7 billion largely for post-Sandy response and resilience.¹³⁶ Although allocated to twenty-one federal agencies,¹³⁷ the lion's share of the funding went to the Department of Housing and Urban Development's Community Development Fund (\$16 billion) for unmet housing, economic development, and infrastructure needs; to FEMA for the Disaster Relief Fund (\$11.5 billion); to the Department of Transportation's Federal Transit Administration for the Public Transportation Relief Program (\$10.9 billion); and to the Army Corps of Engineers for construction (\$3.5 billion) and flood control and coastal emergencies (\$1 billion),¹³⁸ totaling

130. See, e.g., Letter from Jeffrey D. Zients, Deputy Dir. for Mgmt., Office of Mgmt. & Budget, Exec. Office of the President, to the Honorable John Boehner, Speaker of the H. Reps. 1 (Dec. 7, 2012), available at http://www.whitehouse.gov/sites/default/files/supplemental_december_7_2012_hurricane_sandy_funding_needs.pdf (requesting funding and explaining that insurance does not cover “a significant amount of damage” from Hurricane Sandy).

131. *Id.* at 2.

132. *Id.*

133. *Id.* at 1.

134. *Id.* app. at 1

135. *Id.* app. at 64

136. Disaster Relief Appropriations Act, 2013, Pub. L. No. 113–2, 127 Stat. 4 (2013).

137. PAINTER & BROWN, *supra* note 126, at 1–3, 4–8 tbl.1.

138. The supplemental funding allowed the Army Corps of Engineers to proceed with projects that were previously authorized but unfunded. NAT'L RESEARCH COUNCIL, *supra* note 8, at 62.

approximately \$43 billion.¹³⁹ To create a sense of fiscal scale, Congress approved on average \$1.1 billion between 1989 and 2010 in routine appropriations for the Disaster Relief Fund, but Congress appropriated \$116 billion during the same period in emergency supplemental appropriations for the Fund in response to specific disasters.¹⁴⁰ The pattern of business with extreme weather has been to respond to specific crises after the event on a debt-financed basis, not to build funds in anticipation.

The recovery and resilience plans that state and local governments presented to demonstrate their need for federal funds provide snapshots of the multi-faceted state and local efforts underway and the yawning chasms of their unmet needs.¹⁴¹ Particularly at a time when many communities suffered from weakened tax bases as a result of the storm,¹⁴² the federal government played a crucial role. Under the “routine” disaster framework, the federal government would have responded through its disaster relief programs. With a storm of Sandy’s magnitude hitting densely populated areas, however, the state and local governments looked more desperately to the federal government, and the federal government had to take emergency measures to provide significant funding for short- and long-term needs. Even still, a gap remains.

New York City’s recovery and resilience plan illustrates the financial scope of the task, the extent to which the city relies on federal funding to achieve its goals, and the remaining gap. The 2013 plan, *A Stronger, More Resilient New York*, contains a wide array of measures to rebuild and to

139. *Id.* at 4–8 tbl.1. Congress did not consistently distinguish among immediate response, rebuilding, and resilience. PAINTER & BROWN, *supra* note 126, at 41–42.

140. BRUCE LINDSAY & JUSTIN MURRAY, CONG. RESEARCH SERV., R40708, DISASTER RELIEF FUNDING AND EMERGENCY SUPPLEMENTAL APPROPRIATIONS 6, 7 tbl.1 (2011), *available at* <http://fas.org/sgp/crs/misc/R40708.pdf>. Budget requests are based on: unspent, authorized funds; the five-year rolling average for “normal” disasters (with costs less than \$500 million); and amounts still needed for past catastrophic events. *Id.* at 5. Hence they do not try to anticipate catastrophic events, such as Hurricane Sandy.

141. For example, in its Action Plan seeking \$1.8 billion in federal Community Development Block Grant funds, the State of New Jersey identified \$31.8 billion in needs for housing, business, and infrastructure purposes, of which \$29.7 billion had not yet been met by other sources. N.J. DEP’T OF CMTY. AFFAIRS, COMMUNITY DEVELOPMENT BLOCK GRANT DISASTER RECOVERY ACTION PLAN 2-2 tbl.2.1 (2013), *available at* <http://www.state.nj.us/dca/announcements/pdf/CDBG-DisasterRecoveryActionPlan.pdf>. New York City identified \$17.2 billion in unmet needs in the course of seeking \$3 billion from the Block Grant Program. NEW YORK ACTION PLAN, *supra* note 71, at 34 tbl. The Block Grant program allocated \$5.4 billion of the newly appropriated \$16 billion to the first round of funding for the region; additional allocations will be made over time. N.J. DEP’T OF CMTY. AFFAIRS, *supra*, at 1-1.

142. N.Y. STATE HOMES & CMTY. RENEWAL, OFFICE OF CMTY. RENEWAL, STATE OF NEW YORK ACTION PLAN FOR COMMUNITY DEVELOPMENT BLOCK GRANT PROGRAM DISASTER RECOVERY 59 (2013), *available at* <http://www.nysher.org/Publications/CDBGActionPlan.pdf>.

make the city more resilient to climate change in the future.¹⁴³ Estimating the cost of projects that can be completed within ten years, the plan concluded that the public cost will be approximately \$19.5 billion—\$14 billion for resiliency investments and \$5.5 billion for private and public housing recovery, business recovery, and the city agencies' costs of immediate response to the storm.¹⁴⁴ It estimated that the federal government will fund \$8.8 billion, the city will finance \$5.5 billion through its capital budget (plus \$40 million (with philanthropies) for small businesses and mold removal programs), and utility ratepayers will fund about \$1 billion of the improvements.¹⁴⁵ Closing the remaining gap, estimated at \$4.5 billion, will require other strategies, including the possibility of seeking an additional supplemental appropriation from Congress.¹⁴⁶

Thus, Hurricane Sandy illustrates how an extreme weather event creates the immediate need for emergency response, and it demonstrates the magnitude of the long-term investments in recovery and resilience. At the same time, it shows that insurance does not adequately cover private property damage. With pressure on government to protect the immediate public health, safety, and welfare, and to finance repairs to both public sector and private sector property, state and local governments look intensely to the federal government for human and financial assistance. Yet the federal government is not immediately equipped to respond in full magnitude but must instead dig deep into its pocket (and therefore the federal taxpayers' pockets) to produce special appropriations. Even with those appropriations, gaps remain and state and local governments continue to seek other sources of revenue, including the federal government. With repeated events of this nature, governments at all levels increasingly need to think about their fiscal capacity to respond—and potential sources of new revenue.

Hurricane Sandy also stands as a stark reminder of the need to invest in building resilience *before* extreme weather events wreak their havoc. Communities need to prepare themselves in advance of disaster in order to reduce the harm to people and property and the financial, human, and ecological cost of that damage. Adaptation involves not only reactive

143. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68. For other reports addressing New York City's needs and rebuilding strategies, see CITY OF NEW YORK, PLANYC: PROGRESS REPORT 2014 (2014); NEW YORK ACTION PLAN, *supra* note 71; and N.Y.C. DEP'T ENVTL. PROT., *supra* note 75.

144. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 401–02.

145. *Id.* at 402–04.

146. *Id.* at 401–06. Note that the city estimates that the housing recovery alone will cost \$2.5 billion, \$100 million of which will come from private insurance and philanthropy, *id.* at 401, again indicating how much of the burden falls on the government.

adaptation through response but also building resilience over the long term in anticipation of the consequences of climate change.

III. THE SEARCH FOR NEW REVENUE TO FILL THE GAPS

A. A Disquieting Quiet on the New Revenues Front

In the face of the United States' increasing needs to address adaptation, both in its reactive and prospective senses, there are still relatively few concrete proposals for funding sources actively on the table, and there is no coherent national strategy for funding. The following examples of adaptation discussions illustrate the sparse proposals for new sources of revenue, even after the loud wakeup call that Sandy and other storms have sounded.

The State, Local and Tribal Leaders Task Force on Climate Preparedness and Resilience, created by executive order in November 2013¹⁴⁷ pursuant to President Obama's *Climate Action Plan*,¹⁴⁸ was charged with recommending how the federal programs can increase their attention to resilience and support state, local, and tribal efforts.¹⁴⁹ However, its charge did not explicitly address the issue of the need to find new or larger sources of revenue to fund programs. The Task Force's November 2014 report highlighted a number of initiatives, such as regulatory reforms, better governmental coordination, technical assistance, and increased attention to resilience in the course of making expenditure decisions.¹⁵⁰ Financing issues maintained a very low profile. Perhaps not surprisingly, in light of the Task Force's charge, the report did not discuss the need for new sources of federal tax revenue that could assist state, local, and tribal governments. It instead framed the federal government's role in finding new revenue in terms of its potential to serve as an incubator of ideas. Without supplying details, it recommended that the government explore and pilot "innovative financing strategies," citing as examples public-private partnerships, bonds, and special districts that could finance investments that would yield lower

147. Exec. Order No. 13,653, § 7, 3 C.F.R. 330, 335–36 (2014).

148. PRESIDENT'S CLIMATE ACTION PLAN, *supra* note 24, at 13.

149. PRESIDENT'S STATE, LOCAL, & TRIBAL LEADERS TASK FORCE ON CLIMATE PREPAREDNESS & RESILIENCE, RECOMMENDATIONS TO THE PRESIDENT, at i (2014), available at http://www.whitehouse.gov/sites/default/files/docs/task_force_report_0.pdf.

150. *See, e.g., id.* at 6–8 (proposing overarching principles that can be advanced across the federal government that will support communities as they prepare for climate change).

insurance premiums in the future, as well as the possibility of private sector funding for resilience investments.¹⁵¹

In the context of Hurricane Sandy, publicly available governmental analyses of new funding sources appear to be limited. The sixty-nine recommendations in the federal Hurricane Sandy Rebuilding Task Force's 2013 report focused largely on ways to harness existing federal programs to improve recovery and long-term resiliency efforts and improve coordination among federal, state, and local governments.¹⁵² Although the report generally did not highlight the need for new funding sources or propose any new federal funding, it showed some interest in exploring other revenue sources, citing the Task Force's efforts to help states consider how to finance resilience for energy infrastructure through customer fees or other revenue streams, the possibility of using public-private partnerships to leverage federal rebuilding funds, and the potential for an increased role of philanthropies and other non-profit organizations in rebuilding efforts.¹⁵³

New York State's 2010 pre-Sandy report on the need to address rising sea levels recommended that the State explore mechanisms to fund adaptation. It suggested potential tax or fee approaches, such as taxes on new construction of buildings with values of \$1 million or more, a "coastal users' tax" on hotels and vacation rental properties, and increased or new permitting fees on construction in the coastal risk management zone, as well as non-tax mechanisms and further pursuit of federal funding.¹⁵⁴ The stated two-year timeframe for this exploration has now passed, and it does not appear that these suggestions have been enacted or officially proposed. A post-Sandy New York State commission charged with studying the resilience of the State's infrastructure recognized the need for funding but did not target a specific source of revenue, instead recommending that the

151. *Id.* at 35; *see also id.* at 40 (recommending that the government work with the private sector to develop "innovative funding platforms"). In July 2014, President Obama announced some federal initiatives that the Task Force inspired, but they appear to draw on existing funding mechanisms. *See* Press Release, Office of the Press Secretary, The White House, Fact Sheet: Taking Action to Support State, Local, and Tribal Leaders as They Prepare Communities for the Impacts of Climate Change (July 16, 2014), *available at* <http://www.whitehouse.gov/the-press-office/2014/07/16/fact-sheet-taking-action-support-state-local-and-tribal-leaders-they-pre> (enumerating various agency funding opportunities, but not pointing to new funding sources for any).

152. HURRICANE SANDY REBUILDING TASK FORCE, *supra* note 44, at 18, 39.

153. *Id.* at 65, 95, 140. A New York City plan for resiliency post-Sandy indicates the city's support for \$1 billion of investments in utilities that could be recovered through utility rates but assumes that any adjustments to rates would be minimal given capital funding already in the rates, modifications of priorities, and savings. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 404-05.

154. NEW YORK STATE SEA LEVEL RISE TASK FORCE, *supra* note 104, at 75-76, 79.

State identify “the widest possible range of revenue sources, including Federal grants, taxes, user fees, and targeted programs.”¹⁵⁵

New York City’s 2013 post-Sandy resiliency plan contemplated the possibility of applying a modest per-square-foot assessment to buildings in the financial district to finance a flood protection system consisting of permanent landscaping and deployable floodwalls, but it concluded that the likely opposition would render the concept “relatively speculative.”¹⁵⁶ It also urged New York to consider an advocacy group’s proposal for a toll system for access to the central business district.¹⁵⁷ Although that idea predated Sandy and related primarily to transit issues, the report noted the policy nexus between vehicle usage and climate change mitigation and suggested the toll could help fund resiliency.¹⁵⁸ The city’s subsequent April 2014 report on rebuilding and resilience efforts post-Sandy stated that the Office of Recovery and Resiliency would “explor[e] alternative financing mechanisms for recovery and resiliency investments” but provided no elaboration.¹⁵⁹

To a significant extent, the paucity of specific, legislatively active proposals for new sources of state or local revenue is understandable. Raising new revenue is difficult in the contentious, anti-tax environment that has dominated U.S. political discussions in recent years, an environment exacerbated by a sluggish economy sensitive to price increases. In addition, the \$50 billion supplemental appropriation by Congress following Hurricane Sandy helped satisfy a number of immediate needs, and revenues from that appropriation are still working their way through the spending pipeline.

155. NYS 2100 COMM’N, RECOMMENDATIONS TO IMPROVE THE STRENGTH AND RESILIENCE OF THE EMPIRE STATE’S INFRASTRUCTURE 166 (2013), available at <http://www.governor.ny.gov/sites/governor.ny.gov/files/archive/assets/documents/NYS2100.pdf>. The report also recommended the creation of an infrastructure bank that might draw on a wide range of potential sources of revenue, including user fees and revenue from special assessment districts. *Id.* at 163. For a discussion of infrastructure banks, see *infra* Part III.C.1. Two other post-Sandy state commissions also recognized significant needs for improvements in response and preparation for extreme weather events, but their recommendations largely sidestep funding questions. See generally NYS READY & NYS RESPOND COMM’NS, SUMMARY OF RECOMMENDATIONS & PROGRESS UPDATE (2013), available at http://www.governor.ny.gov/sites/governor.ny.gov/files/archive/assets/documents/NYS-Ready-Respond-Update_10282103.pdf.

156. A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 406.

157. *Id.*

158. *Id.*

159. WILLIAM GOLDSTEIN, AMY PETERSON & DANIEL A. ZARRILLI, ONE CITY, REBUILDING TOGETHER: A REPORT ON THE CITY OF NEW YORK’S RESPONSE TO HURRICANE SANDY AND THE PATH FORWARD 28–29 (2014), available at http://www1.nyc.gov/assets/home/downloads/pdf/reports/2014/sandy_041714.pdf.

Nonetheless, it is important to heed Hurricane Sandy's lessons about the magnitude of the need for revenue to respond and build resiliency, and to start seriously exploring mechanisms that can help ensure adequate funding for climate change adaptation in the future. Revenue from new taxes is obviously not the only path toward achieving adaptation goals. For example, regulations can demand higher standards for construction practices; government may require recipients of federal funds to follow certain adaptation-friendly practices; and government can raise general tax rates or issue bonds to provide the funds needed to invest in disaster response and more resilient infrastructure. This Article, however, focuses on the potential role of new environmental taxes and fees that could help finance adaptation beyond current levels of funding. It cannot claim to provide a comprehensive set of proposals but instead is designed to present some specific ideas to illustrate the types of policy and design considerations that might influence the development of a more comprehensive funding plan.

B. Principles Guiding the Design of New Revenue Streams for Adaptation

Before delving into possible measures that could fund adaptation, it is useful to think briefly about propositions or principles that might guide the choice and design of specific tax measures and the choice of the level of government at which they will operate. Every new tax (or fee) proposal requires decisions about what to tax, who should pay the tax, and where the revenue should be directed. Those decisions define the character of the tax.

1. Earmark the Revenue

The first proposition for purposes of this Article is that government needs new streams of tax revenue that are dedicated solely to adaptation programs, regardless whether they are aimed toward reactive adaptation or building resiliency.¹⁶⁰ As a preliminary matter, one should note that a tax instrument designed for earmarking is in large part driven by its revenue-raising function, unlike a classic Pigouvian environmental tax, which

160. Others have called for dedicated revenue streams. See Thomas M. Gremillion, *Setting the Foundation: Climate Change Adaptation at the Local Level*, 41 ENVTL. L. 1221, 1250–53 (2011) (calling for a federal adaptation fund); Yee Huang et al., *Climate Change and the Puget Sound: Building the Legal Framework for Adaptation*, 2 CLIMATE L. 299, 310 (2011) (stating that adaptation must be “sufficiently funded with dedicated, guaranteed resources”).

obtains its *raison d'être* from the behavioral impact of the tax itself.¹⁶¹ The tax rate will depend primarily on the amount of revenue needed, not the cost of the taxed activity's externalities. This is not to say that the tax rate may not also influence behavior as a co-benefit; the behavioral impact will depend on how high the tax rate is.

The Hurricane Sandy case study illustrates the need for substantial amounts of new revenue to meet adaptation needs, but it also suggests that government could benefit from having earmarked funds on hand to respond immediately to disasters and to build resiliency in the longer term. Earmarked funds would allow government to avoid the potential pitfalls of the normal, annual budgetary process. Although the earmarking technique is controversial in the public finance field because it can limit budgetary flexibility and build entrenched fiefdoms,¹⁶² earmarking may offer a significant benefit both when government faces a high risk of unpredictable, costly events that will demand a time-sensitive response and when government needs to start setting aside assets for large, future investments.

In terms of the immediate demands after a disaster, Hurricane Sandy demonstrates the need to have ready access to funds to ensure a timely response and the difficulty in meeting this need through routine budgetary processes—both reasons for earmarking tax revenue. The federal government has a long history of under-funding disaster relief as part of the routine budgetary process. FEMA's annual appropriations for its Disaster Relief Fund in the normal budgetary course between 2001 and 2011 ranged from \$800 million in 2003 to a high of \$2.2 billion in 2002.¹⁶³ Yet demand for greater federal disaster relief had been increasing during that period as the number of natural disasters escalated.¹⁶⁴ As a result, Congress had to issue supplemental appropriations to respond to demand in all but two years and even enacted three supplemental appropriations in 2005 and again in

161. For a discussion of Pigouvian taxes, see Janet E. Milne & Mikael Skou Andersen, *Introduction to Environmental Tax Concepts and Research*, in HANDBOOK OF RESEARCH ON ENVIRONMENTAL TAXATION 15, 15–18 (Janet E. Milne & Mikael Skou Andersen eds., 2012).

162. See generally Claudia Dias Soares, *Earmarking Revenues from Environmentally Related Taxes*, in HANDBOOK OF RESEARCH ON ENVIRONMENTAL TAXATION 102, 102–21 (Janet E. Milne & Mikael Skou Andersen eds., 2012).

163. BRUCE R. LINDSAY, CONG. RESEARCH SERV., R43537, FEMA'S DISASTER RELIEF FUND: OVERVIEW AND SELECTED ISSUES 8–9 tbl.2 (2014), available at <https://www.fas.org/sgp/crs/homesecc/R43537.pdf>.

164. The number of natural disasters in the United States costing \$1 billion from 1996 to 2012 rose to ninety disasters, double the forty-six disasters for the preceding fifteen-year period (1980–1995). Jennifer Daniel, *Rising Tide*, BLOOMBERG BUSINESSWEEK (Nov. 1, 2012), <http://www.businessweek.com/articles/2012-11-01/rising-tide>.

2008.¹⁶⁵ Between 2001 and 2011, Congress authorized over \$80 billion in supplemental funding for the Disaster Relief Fund, including \$43 billion in 2005 when storms punished the Gulf of Mexico.¹⁶⁶

This shift away from the routine appropriations process is understandable, given the desire to adjust the size of the relief to the unpredictable magnitude and timing of disasters.¹⁶⁷ However, Hurricane Sandy illustrates how supplemental post-disaster relief can fall prey to larger, contemporaneous political issues. President Obama's \$60.4 billion supplemental appropriation proposal, submitted in early December 2012, was caught in the political crossfire over limits on federal spending and the looming fiscal cliff that had brought Democrats and Republicans to loggerheads.¹⁶⁸ A modified \$50.7 billion proposal finally passed Congress on January 27, 2013, ninety-one days after Sandy hit.¹⁶⁹ The emergency relief approach also tends to rely on deficit financing,¹⁷⁰ further heightening the tensions over whether to authorize relief. A reliable, earmarked revenue stream would allow government to build a reserve in anticipation of future needs, bypass the political brinksmanship and potential delays of emergency legislation, and avoid the risk of using deficit financing to fund the needs.¹⁷¹

The principle of earmarking new revenues is not limited to meeting the demands for immediate response to disaster: Government needs dedicated funding to build resilience on a prospective basis, even in the absence of dramatic events. The benefits of adaptation reportedly are four times the cost, suggesting that long-term investment in resilience is money well spent.¹⁷² However, the rationale for earmarking funds for long-term

165. LINDSAY, *supra* note 163, at 5 tbl.1.

166. *Id.* at 8–9 tbl.2.

167. *Id.* at 12.

168. Raymond Hernandez & Peter Baker, *Obama Asks Congress for \$60.4 Billion to Help States Recover from Storm*, N.Y. TIMES (Dec. 7, 2012), <http://www.nytimes.com/2012/12/08/nyregion/obama-proposes-hurricane-recovery-bill.html>; Raymond Hernandez, *Senate Passes \$60.4 Billion for Storm Aid; Bill's Fate in House Is Unclear*, N.Y. TIMES (Dec. 28, 2012), <http://www.nytimes.com/2012/12/29/nyregion/senate-approves-hurricane-aid-bill-fate-in-house-is-uncertain.html>.

169. Disaster Relief Appropriations Act, 2013, Pub. L. No. 113-2, 127 Stat. 411 (2013); *see also* Raymond Hernandez, *Congress Approves \$51 Billion in Aid for Hurricane Victims*, N.Y. TIMES (Jan. 28, 2013), <http://www.nytimes.com/2013/01/29/nyregion/congress-gives-final-approval-to-hurricane-sandy-aid.html> (reporting on the bill's passage).

170. LINDSAY, *supra* note 163, at 12.

171. *Id.* at 13 (exploring a rainy-day fund for disaster relief).

172. HOF ET AL., *supra* note 16, at 14 (citing KELLY DE BRUIN ET AL., OECD, ECONOMIC ASPECTS OF ADAPTATION TO CLIMATE CHANGE: INTEGRATED ASSESSMENT MODELING OF ADAPTATION COSTS AND BENEFITS, OECD ENVIRONMENT WORKING PAPERS NO. 6 (2009); Andries F.

investments in climate resilience differs from that for saving for immediate disaster response. Building new public physical infrastructure or fortifying existing infrastructure, such as roads, bridges, seawalls, or stormwater management facilities, will often require significant governmental investment. At a time when national infrastructure is already in need of major improvements,¹⁷³ adaptation to climate change only increases the urgency and the cost. New streams of dedicated revenue can help ensure that governments build the funding necessary to accomplish these purposes in the long term. Otherwise, short-term demands that are immediately pressing and apparent may trump long-term needs, leaving the latter underfunded.¹⁷⁴

Although one should always be healthily wary of building dedicated funds that can subvert the normal, democratic budgeting process, unpredictable emergency needs and high-cost, long-term investments can justify earmarking. This Article does not delve into the important substantive and procedural issues of how to administer disbursements from earmarked funds, but that omission is not meant to diminish the significance of those issues.

2. Try to Place the Burden on the Polluter or Beneficiary, Even If Imperfectly

A second proposition is that the burden for adaptation measures should fall, as much as possible, on the polluters who contribute to the need for adaptation and/or are the beneficiaries of adaptation. As discussed below,

Hof et al., *The Effect of Different Mitigation Strategies on International Financing of Adaptation*, 12 ENVTL. SCI. POLICY 832 (2009)).

173. See, e.g., NAT'L ECON. COUNCIL & PRESIDENT'S COUNCIL OF ECON. ADVISERS, THE WHITE HOUSE, AN ECONOMIC ANALYSIS OF TRANSPORTATION INFRASTRUCTURE INVESTMENT 3 (2014), available at http://www.whitehouse.gov/sites/default/files/docs/economic_analysis_of_transportation_investments.pdf (noting that in the United States 65% of the major roads are rated at less than good condition, 25% of the bridges require significant repair or are inadequate for present traffic levels, and 45% of the population lacks access to transit); BEN CHOU ET AL., NATURAL RES. DEF. COUNCIL, ISSUE PAPER 14-06-A, USING STATE REVOLVING FUNDS TO BUILD CLIMATE-RESILIENT COMMUNITIES 5 (2014), available at <http://www.nrdc.org/globalwarming/files/state-revolving-funds-IP.pdf> (exploring the idea of using a revolving fund to pay for infrastructure); Adam Nagourney, *Infrastructure Cracks as Los Angeles Defers Repairs*, N.Y. TIMES (Sept. 1, 2014), <http://www.nytimes.com/2014/09/02/us/pipes-roads-and-walks-crack-as-los-angeles-defers-repairs.html> (describing the dilapidated state of Los Angeles's infrastructure).

174. See NAT'L RESEARCH COUNCIL, *supra* note 8, at 66-67, 133, 142 (discussing people's tendency to accept the risks of natural disasters and to favor investments with immediate benefit rather than long-term risk-reducing investments).

and as others have concluded,¹⁷⁵ it can be difficult to precisely match polluters or beneficiaries with the adaptation problems. The need for adaptation in large part arises from the polluters of the past, many now long gone and who were spread around the globe. The present and future beneficiaries may not always be easy to identify,¹⁷⁶ and choosing beneficiaries raises significant equity issues.¹⁷⁷ However, some rough justice correlation may help build a stronger rationale for a new tax and help justify the dedication of the revenue. The alternative is to place the burden on taxpayers as a whole through a general tax and—under the earmarking rationale—to dedicate some portion of the general revenue to adaptation. Diverting a stream of general tax revenue into an earmarked fund, however, tends to run counter to tax traditions in the United States.¹⁷⁸

Linking the adaptation payment obligation, where possible, to a class of polluters or beneficiaries is likely to mean that the tax base (what is being taxed) will bear environmentally related features. If the polluters are paying for adaptation, the tax should be keyed to the polluting activities. If the beneficiaries are paying for the value they receive from the adaptation activity, the payment is likely to be based on an inherently environmental benefit.

This proposition does not preclude using general revenues for adaptation purposes. For example, it may be entirely appropriate to fund some amount of federal disaster relief from the general budget, as has happened in the past. The nation as a whole has a commitment to take care of its own in times of severe need, so base-level emergency funding from the general budget can be justified. As argued above, however, the magnitude and potential unpredictability of disasters relating to climate change and the cost of building resiliency warrant special measures that the general budget may not be able to sustain.

175. See Daniel A. Farber, *Adapting to Climate Change: Who Should Pay*, 23 J. LAND USE & ENVTL. L. 1, 26–34 (2007) [hereinafter Farber, *Adapting to Climate Change*] (outlining four frameworks for allocating the costs of climate change adaptation); Orr Karassin, *Mapping the Gap: Knowledge and Need in Regulating Adaptation to Climate Change*, 22 GEO. INT'L ENVTL. L. REV. 383, 423–28 (2010) (drawing on Farber's principles).

176. Farber, *Adapting to Climate Change*, *supra* note 175, at 28.

177. J.B. Ruhl & James Salzman, *Climate Change Meets the Law of the Horse*, 62 DUKE L.J. 975, 1021–23 (2013).

178. Legislatures, of course, can dedicate tax revenue to long-term funds through their normal appropriations procedures, as happens with the Disaster Relief Fund. See, e.g., Disaster Relief Appropriations Act, 2013, Pub. L. No. 113–2, 127 Stat. 4 (appropriating funds for Hurricane Sandy relief). Automatically earmarking a percentage or dollar share of a general stream of tax revenue to a fund would represent a very different and unusual situation, quite unlike the earmarking of revenue from a specific tax, such as earmarking the federal gas tax to the Highway Trust Fund. See 26 U.S.C. §§ 4081(a)(1)(A), 9503(a), (b)(1)(D) (2012).

3. Match the Funding Responsibility for Adaptation to the Appropriate Level of Government

When thinking about new taxes, a basic design question is which level of government should impose the tax. One ideally would match the type of public interest at stake for any given adaptation goal with the level of government.¹⁷⁹ The type of public interest relevant to adaptation taxes is reflected in how the revenue would be spent. For example, the cost of building the resilience of local infrastructure might best be paired with local taxes, consistent with the U.S. tradition of using local taxes to finance local water and local road systems. The cost of fortifying assets of national significance, such as the integrity of the interstate highway system and the electricity grid, may warrant federal funding (in keeping with the longstanding practice of using federal taxes on gasoline to help fund the highway system).

Admittedly, it can be difficult to neatly separate federal, state, and local public interests. Some ostensibly localized interests, such as the uninterrupted functioning of Wall Street for the sake of New York City's economy, have significant national implications. A seawall that can protect New York City against flooding has direct local benefits, but it also protects the economy of the region and the well-being of major national institutions and markets.¹⁸⁰ Hence, matching the type of public interest to the level of government provides only rough guidance subject to wide discretion.

History also creates presumptions about which level of government will assume responsibility for the costs. As illustrated by the Hurricane Sandy case study, the federal government played a major role in providing immediate disaster relief—a role that presumably will only expand as climate change provokes more extreme weather events. Given this tradition, it seems unlikely in the near term that this responsibility will entirely shift back to state and local governments, rendering it necessary to find new sources of revenue for federal disaster relief. Nor should the responsibility necessarily move away from the federal government. As suggested above,

179. This Article cannot fully address the issues of the appropriate allocation of responsibility for adaptation across the various levels of government in the United States. For more comprehensive discussions, see generally Daniel A. Farber, *Climate Adaptation and Federalism: Mapping the Issues*, 1 SAN DIEGO J. CLIMATE & ENERGY L. 259 (2009) [hereinafter Farber, *Climate Adaptation and Federalism*], and Robert L. Glicksman, *Climate Change Adaptation: A Collective Action Perspective on Federalism Considerations*, 40 ENVTL. L. 1159 (2010).

180. See Aerts et al., *supra* note 85, at 474–75 (noting that New York City, New York State, the federal government, and the private sector could share the costs of protecting New York City, since they would all benefit from the investment).

the federal government has an enlightened self-interest in assisting in times of significant need even if the effects are localized.

The nature of the tax base may also influence the choice of the level of government. For example, if the tax is directed at emissions from industries that operate nationwide, a federal tax may be more appropriate as a matter of environmental and economic policy. If the targeted activities are more local in nature, a state or local tax may be more suitable. Relatedly, certain levels of government traditionally have relied more heavily on certain types of tax bases than others, creating a tradition that can inform the use of new environmentally related taxes. For example, local governments rely heavily on local property taxes to fund municipal services, given the local nature of the tax base and the direct correlation between real property and the benefits that municipal services provide.

The remainder of this Article explores four possible sources of increased revenue. The proposals below are offered as a means of considering, on an illustrative basis, how taxes can fund adaptation and how the propositions outlined above might apply. They do not purport to create a detailed policy agenda but rather to inspire other thoughts about measures that might fill the gap between adaptation needs and resources. Nor are they filtered through the screen of political reality. However, it is important nonetheless to start thinking about how to conduct the search for new revenue.

C. An Exploration of Potential Adaptation Taxes

1. Carbon Taxes

Given that the need for climate change adaptation is driven in large part by greenhouse gas emissions, it is logical to consider imposing part of the cost of adaptation on those emissions under a “polluter-pays” approach. As others have noted, a carbon tax does not perfectly match the tax base and taxpayers with the use of the revenue—funding adaptation. The cost ideally would be imposed largely on past emissions, which are the source of current and future adaptation needs, but it is both administratively and politically challenging to impose liability retroactively.¹⁸¹ However, present and future emissions will continue to contribute to the need for adaptation.

One practical solution is to forgive the sins of the past but impose a tax on the emitters of the present and future, particularly given that many

181. See Farber, *Adapting to Climate Change*, *supra* note 175, at 29–35 (discussing benefits of an “Emitter Pays” approach and possible challenges to implementation); Karassin, *supra* note 175, at 424–26 (discussing benefits of and objections to “polluter-pays” model).

emitters (including all of us during our lives) have also contributed to the emissions in the past. By dedicating the revenue to adaptation purposes through an earmarked fund, present and future emitters can build an adaptation endowment that will help address the needs of the future. Apart from not imposing retroactive liability, a tight policy correlation exists between the pricing mechanism and the use of the revenue. If the sole purpose of the tax is to fund adaptation needs, the tax rate would be set according to estimates of need, not according to Pigouvian internalization principles, but a tax of any magnitude might nonetheless serve mitigation as well as adaptation goals. To provide a sense of scale of the potential revenue, a tax of just \$5 per ton of greenhouse gas emissions, adjusted upward slightly each year, would generate about \$200 billion in the first ten years.¹⁸²

The co-existence of regulatory regimes that limit greenhouse gas emissions does not preclude the additional imposition of a carbon tax inspired by adaptation needs.¹⁸³ Because regulations do not create a ban on emissions, it is appropriate to impose a tax on the remaining emissions to recognize their environmental consequences and their contribution to the need to adapt in the future.¹⁸⁴ An adaptation carbon tax could also be one component of a larger carbon tax.

Such a tax is suited to the federal level. As illustrated above, the federal government needs revenue to fund national interests in disaster relief and to build the resilience of infrastructure of national significance. It makes sense to link this revenue need to a carbon tax; emissions occur and

182. The Congressional Budget Office has estimated that a \$25 per ton tax on most greenhouse gas emissions, with a 2% annual inflation adjustment, would generate \$1.06 trillion between 2014 and 2023. CONG. BUDGET OFFICE, CONG. OF THE U.S., *OPTIONS FOR REDUCING THE DEFICIT: 2014 TO 2023*, at 176 (2013), available at <https://www.cbo.gov/sites/default/files/cbofiles/attachments/44471-OptionsForReducingDeficit-3.pdf>. The \$200 billion figure above assumes for sake of simplicity that a \$5 tax rate would generate one-fifth of the Congressional Budget Office's estimate for a \$25 tax rate.

183. For example, in 2014 the EPA proposed regulations reducing greenhouse gas emissions from existing power plants. Carbon Pollution Emissions Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 34,830 (proposed June 18, 2014) (to be codified 40 C.F.R. pt. 60). For a general overview of the proposed rule's provisions, see JAMES E. MCCARTHY ET AL., CONG. RESEARCH SERV., R43572, *EPA'S PROPOSED GREENHOUSE GAS REGULATIONS FOR EXISTING POWER PLANTS: FREQUENTLY ASKED QUESTIONS* (2014), available at <http://www.fas.org/crs/misc/R43572.pdf>.

184. Note, however, that emitters in California who must purchase emissions allowances to cover their emissions, see CAL. CODE REGS. tit. 17, §§ 95801, 95811, 95856 (2015), can argue that they are already paying for their emissions and should not also owe a tax. In that case, the rationale for the tax would turn on its adaptation function. In California, the proceeds from auctions of allowances are used only for mitigation purposes. John A. Pérez California Global Warming Solutions Act of 2006: Greenhouse Gas Reduction Fund, Assemb. B. 1532, Reg. Sess., chs. 4.1, 807 (Cal. 2012) (enacted).

travel nationwide.¹⁸⁵ Using a federal carbon tax to generate revenue would create a more uniform price signal than would state-specific emissions taxes. Moreover, taxing emissions nationally provides a relatively equitable distribution of the burden of adaptation across the nation. Although it is possible that a carbon-intensive region might pay a share of the tax that does not align perfectly with the benefits it will receive from the use of the revenue, the consequences of the emissions reach far beyond that region. In addition, the regional equity issues may diminish when one considers the full range of adaptation challenges, including river flooding and tornadoes in the Midwest and forest fires in the West.¹⁸⁶

The idea of attaching a price to greenhouse gas emissions that can help fund adaptation is not novel. The European Union's Emissions Trading Scheme for greenhouse gas emissions has moved toward increased auctioning of emissions allowances, and the European Union has indicated that member states should use at least half of the revenue for climate change purposes, including adaptation.¹⁸⁷ In the United States, a bill calling for a federal "carbon pollution fee" would dedicate the revenue from fees on imported carbon-intensive goods (in effect, the revenue from a border tax adjustment) in large part to state and local adaptation programs.¹⁸⁸ Although emissions are global in nature, this proposal's matching of international emissions with domestic adaptation shifts the adaptation cost overseas, creating a somewhat awkward policy nexus. As another example, an advocacy organization that grew out of Hurricane Sandy's effects on New Jersey has called for Congress to create an Extreme Weather Relief and Protection Fund financed through carbon pricing, although it has not specified any details about the pricing mechanism.¹⁸⁹ However, it is time to start considering the concept in the United States on a more mainstream basis.

While defining the specific uses of a new federal fund for adaptation and designing its administrative structure lie beyond the scope of this Article, two general points are worth considering. First, the dedicated

185. See Farber, *Climate Adaptation and Federalism*, *supra* note 179, at 273 (noting that spillover effects of pollution are the strongest argument for federal funding of adaptation).

186. See, e.g., *Obama's Climate Task Force Meets in Des Moines*, WASH. TIMES (May 13, 2014), <http://www.washingtontimes.com/news/2014/may/13/presidents-climate-task-force-in-des-moines/print/> (quoting mayor of Des Moines, Iowa, saying "[a] lot of the focus sometimes around country looks at what's happening in coastal regions. I want to tell you it is here").

187. Directive 2009/29/EC, *supra* note 17, at 63; see also Decision No. 377/2013/EU, 2013 O.J. (L. 113) (EU) (recalling that revenue from auctioning aviation allowances should be dedicated to climate change, including adaptation, in EU and third countries, particularly developing countries).

188. Climate Protection Act of 2013, S. 332, §§ 196(a), 197(a), (b)(2)(A)(i)(I) (as introduced Feb. 14, 2013 by Sen. Bernie Sanders).

189. CURTIS FISHER & IAN T. SHEARN, EXTREME WEATHER EXTREME COSTS 30–31 (2013).

revenue stream could address both the immediate response to extreme weather, supplementing existing programs, and longer-term recovery and resilience programs, perhaps building new initiatives.

Second, although a federal adaptation fund could be available in large part for direct spending programs, it could also be used to finance programs that leverage other dollars, such as through the creation of an infrastructure bank. An infrastructure bank could provide a pool of capital that regional, state, and local interests could draw upon to invest in resiliency infrastructure projects. This approach would give the federal government an appropriate role as a source of capital, while not saddling it with the ultimate cost of the projects, which might be more appropriately borne by non-federal entities.

The infrastructure bank concept is gaining momentum. The European Investment Bank is already funding water and transportation adaptation projects in Europe and elsewhere, such as a flood barrier to protect St. Petersburg¹⁹⁰ and resilient transportation infrastructure in the Port of Rotterdam.¹⁹¹ In the United States, President Obama has proposed a national infrastructure bank for a wide range of federal and regional infrastructure projects to address the needs of water, transportation, and energy infrastructure.¹⁹² Although not yet explicitly encompassing adaptation, the proposal could handily be used to incorporate resiliency projects. New Jersey recently created an energy resilience infrastructure bank using federal funding for Hurricane Sandy relief,¹⁹³ and New York

190. EUROPEAN INV. BANK, FINANCING WATER AND CLIMATE CHANGE ADAPTATION 2 (2011), available at http://www.eib.org/infocentre/publications/all/financing_water_and_climate_change_adaptation.htm.

191. EUROPEAN INV. BANK, PROMOTING CLIMATE ACTION 4 (2013), available at http://bookshop.europa.eu/pt/promoting-climate-action-pbQH3011054/downloads/QH-30-11-054-EN-C/QH3011054ENC_002.pdf;pgid=y8dIS7GUWMDSR0EAlMEUUsWb00003oHTmfqX;sid=zcuSgjnA-O-Sj2qKjQMMJVvlgKiM8HSj07k=?FileName=QH3011054ENC_002.pdf&SKU=QH3011054ENC_PDF&CatalogueNumber=QH-30-11-054-EN-C.

192. *E.g.*, OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, BUDGET OF THE UNITED STATES GOVERNMENT, FISCAL YEAR 2015, at 21 (2014). For other discussions of a national infrastructure bank, see DEP'T OF THE TREASURY & COUNCIL OF ECON. ADVISERS, A NEW ECONOMIC ANALYSIS OF INFRASTRUCTURE INVESTMENT 5–6 (2012), available at <http://www.treasury.gov/resource-center/economic-policy/Documents/20120323InfrastructureReport.pdf>, and KEITH MILLER ET AL., CTR. FOR AM. PROGRESS, CREATING A NATIONAL INFRASTRUCTURE BANK AND INFRASTRUCTURE PLANNING COUNCIL (2012), available at <http://cdn.americanprogress.org/wp-content/uploads/2012/09/InfrastructureBankReport.pdf>. Although the White House proposal has not yet been enacted, the Obama administration has launched a \$10 billion rural infrastructure fund. News Release, USDA, White House Rural Council Announces \$10 Billion Private Investment Fund to Finance Job-Creating Infrastructure Projects in Rural America (July 24, 2014), available at <http://www.usda.gov/wps/portal/usda/usdahome?contentid=2014/07/0158.xml>.

193. Press Release, New Jersey Board of Public Utilities, NJ Energy Resilience Bank Now Accepting Applications: Critical Facilities Can Begin Process to Secure Resilience Grant Funds (Oct.

Governor Cuomo has announced his intention to establish an infrastructure bank.¹⁹⁴ Regardless of the level of government that creates and holds the bank, the infrastructure bank concept would be well-suited to funding projects that will generate their own stream of revenue, such as through tolls or consumer fees, to repay the bank over the course of time.

2. Dark Cloud Taxes

The American and global economies are undergoing a technological revolution in which communications and the means of doing business are increasingly dependent on electronic, Internet-based resources. For example, the “cloud,” recently novel, is growing fast. “‘Most enterprises no longer look at [the] cloud as an if,’ said Tom Kershaw, director of Google’s cloud platform, ‘They look at it as a when.’”¹⁹⁵ Cloud services encompass data centers, networks that connect the data centers to consumers, and the consumers’ end-user devices.¹⁹⁶ They have been defined as services “provided to computers and other end-user devices as a utility over a

20, 2014), available at http://www.state.nj.us/bpu/newsroom/announcements/pdf/20141020_erb_press.pdf.

194. ANDREW M. CUOMO, MOVING THE NEW NEW YORK FORWARD 31–32 (2014), available at <http://andrewcuomo.com/wp-content/uploads/sites/44/2014/10/Moving-the-New-NY-Forward-by-Andrew-M-Cuomo.pdf>; Governor Cuomo Announces Launch of Build NY Initiative to Redefine State’s Approach to Upgrading Vital Infrastructure, NEW YORK STATE (Oct. 6, 2014), <http://www.governor.ny.gov/news/governor-cuomo-announces-launch-build-ny-initiative-redefine-states-approach-upgrading-vital>. Although not specifically targeted to post-Sandy adaptation projects, the proposal logically follows from the infrastructure bank recommendation contained within the post-Sandy 2100 Commission’s report. NYS 2100 COMM’N, *supra* note 155, at 166. Both the governor’s proposal and the 2100 Commission’s report look to a broad range of sources of revenue to fund the infrastructure bank, *see id.*; CUOMO, *supra*, but the Governor’s proposal includes one-time sources, such as settlements with banks. CUOMO, *supra*. The Cuomo Administration is pursuing the bank-settlement tact. Greg Farrell et al., *New York Officials Jockey as Bank Settlements Create Windfall*, BLOOMBERGBUSINESS (Dec. 4, 2014, 5:00 AM), <http://www.bloomberg.com/news/articles/2014-12-04/new-york-officials-jockey-as-bank-settlements-create-windfall>.

195. Shira Ovide & Clint Boulton, *Flood of Rivals Could Burst Amazon’s Cloud*, WALL ST. J. (July 25, 2014), <http://www.wsj.com/articles/storm-clouds-over-amazon-business-1406328539>.

196. GREENHOUSE GAS PROTOCOL, GHG PROTOCOL PRODUCT LIFE CYCLE ACCOUNTING AND REPORTING STANDARD: ICT SECTOR GUIDANCE 7 (2013) (draft), available at <http://www.ghgprotocol.org/files/ghgp/GHGP-ICT-Cloud-v2-6-26JAN2013.pdf>. Clouds’ physical locations have been dubbed “server farms,” which are massive data centers. *Down on the Server Farm*, ECONOMIST (May 22, 2008), <http://www.economist.com/node/11413148>. Shifting away from Silicon Valley, these server farms are often located in rural parts of the country, where security is fairly easy to maintain, natural disasters are rare, energy is cheap, and generous state tax incentives are in place. *See* David Lumb, *How Microsoft’s “Project Mountain” Stacks Up Against Data Centers from Google, Apple, and Facebook*, FAST CO. LABS (June 26, 2013, 4:45 PM), <http://www.fastcolabs.com/3013493/how-microsofts-project-mountain-stacks-up-against-data-centers-from-google-apple-and-facebook>; Shira Ovide & Mark Peters, *Why Data Centers Collect Big Tax Breaks*, WALL ST. J. (Nov. 14, 2014), <http://www.wsj.com/articles/why-data-centers-collect-big-tax-breaks-1416000057>.

network, using shared infrastructure that includes data centers, hardware, software and other infrastructure.”¹⁹⁷ By providing on-demand access to computer resources over an external network, cloud services are a significant step away from the tradition of maintaining IT services installed and managed on site.¹⁹⁸ By 2012, the New York Stock Exchange used a third-party data center to handle and store the 2,000 gigabytes (or four trillion bytes) of data it generates each day,¹⁹⁹ and by 2013, the majority of businesses in the United States used shared or private clouds for their digital needs.²⁰⁰

E-sports represent just one example of the rampant growth in consumer-oriented products that rely on cloud services. In October 2013, a streamed e-tournament of League of Legends drew 8.5 million simultaneous online viewers, equivalent to the viewers of the decisive game in the Stanley Cup hockey competition.²⁰¹ Twitch, a video-streaming company that gamers use, was founded in 2011 and bought by Amazon in 2014 for almost \$1 billion.²⁰² With 55 million unique users in July 2014, Twitch was the fourth-largest user of Internet bandwidth in the United States and had invested in at least fifteen data centers.²⁰³ In terms of email alone, a 2014 report found that every sixty seconds, 204 million emails are exchanged globally.²⁰⁴ And retail sales increasingly occur over the Internet. The same 2014 report stated that Amazon sells \$272,000 of merchandise every minute through its virtual salesroom.²⁰⁵

197. GREENHOUSE GAS PROTOCOL, *supra* note 196, at 6.

198. See generally Jack Newton, *Is Cloud Computing Green Computing?*, GPSOLO, Dec. 2010, at 28, 29–30.

199. James Glanz, *Power, Pollution and the Internet*, N.Y. TIMES (Sept. 22, 2012), <http://www.nytimes.com/2012/09/23/technology/data-centers-waste-vast-amounts-of-energy-belying-industry-image.html>.

200. Reuven Cohen, *The Cloud Hits the Mainstream: More than Half of U.S. Businesses Now Use Cloud Computing*, FORBES (Apr. 16, 2013, 9:23 AM), <http://www.forbes.com/sites/reuvencohen/2013/04/16/the-cloud-hits-the-mainstream-more-than-half-of-u-s-businesses-now-use-cloud-computing>.

201. Nick Wingfield, *In E-Sports, Virtual Gamers Draw Real Crowds and Big Money*, N.Y. TIMES (Aug. 30, 2014), <http://www.nytimes.com/2014/08/31/technology/esports-explosion-brings-opportunity-riches-for-video-gamers.html>.

202. *Id.*

203. David Carr, *Amazon's Bet on Content in Deal for Twitch*, N.Y. TIMES (Aug. 31, 2014), <http://www.nytimes.com/2014/09/01/business/media/amazons-bet-on-content-in-a-hub-for-gamers.html>. The 55 million users reportedly watched 155 billion minutes of gaming. *Id.*

204. JOSH WHITNEY, ANTHESIS, & PIERRE DELFORGE, NATURAL RES. DEF. COUNCIL, ISSUE PAPER 14–08–A, DATA CENTER EFFICIENCY ASSESSMENT 9 (2014), available at <http://www.nrdc.org/energy/files/data-center-efficiency-assessment-IP.pdf>.

205. *Id.*

Cloud services may seem invisible to businesses and consumers, who are often unaware that they are even using the cloud,²⁰⁶ but the cloud nonetheless leaves an environmental footprint. One study reports, for example, that transporting one gigabyte of data over a network requires the energy contained in one pound of coal.²⁰⁷ To create a sense of scale, one wireless provider estimates that two gigabytes a month allows a user to spend fifteen minutes a day streaming music and ten minutes a day watching a video.²⁰⁸ Greenpeace has found that, “[i]f the cloud were a country, it would have the fifth largest electricity demand in the world.”²⁰⁹ In 2013, U.S. data centers, which constitute just one element of the cloud in one country, consumed 91 billion kilowatt-hours of electricity—enough to power all the households in New York City for two years.²¹⁰ While major cloud companies such as Amazon, Apple, and Google have committed to increasing their use of renewable energy sources,²¹¹ they represent only a very small percentage of global data center capacity.²¹²

It is difficult to precisely assess the emissions profile of the cloud.²¹³ Federally mandated reporting requirements fall on the primary emitters, such as power plants and manufacturers,²¹⁴ although voluntary protocols are being developed to help those who choose to identify the emissions

206. Tony Danova, *Most People Are Still Confused About Cloud Storage, and No One Service Is Winning the Race to Educate and Acquire Users*, BUSINESS INSIDER (Aug. 22, 2014), <http://www.businessinsider.com/people-use-the-cloud-and-dont-even-realize-it-2014-7>.

207. MARK P. MILLS, *THE CLOUD BEGINS WITH COAL: BIG DATA, BIG NETWORKS, BIG INFRASTRUCTURE, AND BIG POWER: AN OVERVIEW OF THE ELECTRICITY USED BY THE GLOBAL DIGITAL ECOSYSTEM* 38 (2013), available at http://www.tech-pundit.com/wp-content/uploads/2013/07/Cloud_Begins_With_Coal.pdf.

208. Anna Bernasek, *Two Countries, Two Vastly Different Phone Bills*, N.Y. TIMES (Aug. 24, 2014), <http://www.nytimes.com/2014/08/24/business/two-countries-two-vastly-different-phone-bills.html>.

209. GARY COOK, GREENPEACE INT’L, *HOW CLEAN IS YOUR CLOUD?* 10 (2012), available at <http://www.greenpeace.org/international/Global/international/publications/climate/2012/iCoal/HowCleanisYourCloud.pdf>.

210. WHITNEY & DELFORGE, *supra* note 204, at 5.

211. Ehren Goossens, *Amazon Joins Apple Using Clean Energy at Cloud Data Centers*, BLOOMBERGBUSINESS (Jan. 20, 2015, 11:55 AM), <http://www.bloomberg.com/news/articles/2015-01-20/amazon-joins-apple-using-clean-energy-at-cloud-computing-centers>; see also COOK, *supra* note 209, at 6, 7 tbl., 26 (ranking Google and Yahoo highest in prioritizing reliance on renewable energy and noting Facebook’s commitment to renewable energy).

212. WHITNEY & DELFORGE, *supra* note 204, at 5. Data centers at the largest “consumer-facing” companies constitute only an “estimated 5 to 7 percent of the total installed base of servers globally.” *Id.*

213. *But see* COOK, *supra* note 209, app. at 1 (providing a statistical analysis of the extent of reliance on renewable electricity by data centers operated by major cloud-computing facilities, such as Amazon, Apple, Facebook, and Google).

214. See Alexandra L. Pichette, *Becoming Positive About Being Carbon Neutral: Requiring Public Accountability for Internet Companies*, 14 VAND. J. ENT. & TECH. L. 425, 435–37 (2012).

associated with data centers, networks, and consumer devices.²¹⁵ However, even if the cloud's emissions are indirect, it may still be advisable to hold cloud services and their users responsible for those emissions.

This Article does not explore the question whether electronic ways of doing business leave a smaller carbon footprint than traditional methods. That question involves complex calculations. For example, using the cloud to listen to one song requires less energy than the manufacture and shipping of a CD, but streaming a high-definition movie one time requires more energy than making and distributing a DVD.²¹⁶ This Article instead accepts the premise that e-services are part of the global economic and social fabric and are here to stay, regardless of the relative carbon merits of a traditional economy and the new digital economy of cloud-based services. The analytical baseline is not the emissions associated with the old economy but rather expectations for the new economy. This Article also assumes that cloud services will only increase in the years to come, given the growing appetite for instant communications. As one researcher noted, “[t]hat’s what’s driving that massive growth—the end-user expectation of anything, anytime, anywhere.”²¹⁷ More efficient computing capabilities only increase the level of traffic.²¹⁸

Why not tax the externalities of the new, digital way of doing business from the start, both to start building the endowment that will help society adapt to future environmental consequences and to inform behavior? Instead of responding to the impacts of fully developed industries after the fact, as would happen with a traditional carbon tax on industry, policymakers could plan prospectively and design policies that would impose responsibility from the point of technological infancy; they could consider what this Article will dub “dark cloud taxes.”

Dark cloud taxes could impose on present and future polluters their share of adaptation costs. As in the case of the carbon tax discussion above, the match is not perfect. Some adaptation is attributable to the generations of emissions that resulted from the “old” economy, but that flaw in alignment should not excuse contributions from new polluters for their share of present and future responsibility.

Dark cloud taxes logically would fall within the domain of the federal government. The ability of states to tax the cloud is riddled with legal

215. GREENHOUSE GAS PROTOCOL, *supra* note 196, at 5.

216. MILLS, *supra* note 207, at 39.

217. Glanz, *supra* note 199 (quoting David Cappuccio at Gartner, a technology research firm).

218. MILLS, *supra* note 207, app. B.

complexities,²¹⁹ but more fundamentally, federal taxes synchronize with the boundary-less nature of cloud services and the advisability of having a consistent, nationwide approach to the cloud. Moreover, the boundary-less cloud logically could contribute to some of the geographically expansive adaptation problems. For example, revenue might be especially appropriate for federal investments in building the resilience of the electricity and telecommunications grids, upon which the cloud is so dependent. Dark cloud taxes may, in some instances, thus serve to implement both a polluter-pays approach and a beneficiary-pays approach.

Dark cloud taxes might target different components of cloud services in different ways. For example, data centers could be taxed based on the carbon profile of their energy consumption, thus imposing a higher tax on centers heavily dependent on electricity produced from coal than on those that draw more on renewable energy. This form of dark cloud tax would link directly to the environmental consequences of increased dependence on data centers. It could not only secure funding for long-term adaptation needs but also raise awareness of data centers' emissions profiles, influence choices about energy sources, and highlight the need for greater energy efficiency.²²⁰

Alternatively, purchasers of network services could be subject to a tax correlated to usage as a proxy for emissions. This approach would target the actual carbon footprint less precisely, given the potential difficulty of precisely matching upstream actual emissions profiles with consumers' actual downstream network usage. However, until such time as clean energy sources predominantly fuel the cloud, it could provide some rough justice allocation of future adaptation costs. Although some might perceive a tax as imposing an inappropriate burden on access to an important engine of communication and the economy,²²¹ the tax would assign responsibility

219. For a discussion of the challenges facing state-level taxes on cloud services, see generally Walter Hellerstein & John Sedon, *State Taxation of Cloud Computing: A Framework for Analysis*, 117 J. TAXATION 11, 11 (2012).

220. A recent report underscores the need to reduce the carbon footprint of data centers and to improve their energy efficiency. See generally WHITNEY & DELFORGE, *supra* note 204. When data centers operate on a multi-tenant basis, the efficiency incentive would be more effective when the tenant, who is the user of the energy, is directly responsible for the tax based on the tenant's energy usage. *Id.* at 20. In many multi-tenant situations, however, the data center owner pays the utility directly based on space and power block, and the lease arrangements do not call for a per-kilowatt-hour pricing. *Id.* As a result, the arrangements do not create an incentive to reduce energy usage along to the tenant. *Id.* at 6, 20. The report recommends moving toward actual usage terms, *id.* at 25, a recommendation that would increase the behavioral impact of a dark cloud tax.

221. A proposed Internet tax in Hungary sparked protests. Rick Lyman, *Hungary Drops Internet Tax Plan After Public Outcry*, N.Y. TIMES (Oct. 31, 2014), <http://www.nytimes.com/2014/11/01/world/europe/hungary-drops-internet-tax-plan-after-surge-of-protests.html>.

for emissions and send an educational signal that might encourage energy conservation and reliance on renewable resources.

Either approach would serve as a surrogate for a carbon tax on the primary emitters. As a result, dark cloud taxes would remain viable only if the government does not fully execute the adaptation carbon tax option described above—or if a broader carbon tax or some other carbon pricing mechanism does not fully internalize environmental costs of climate change, including adaptation.

It is important also to note that this dark cloud tax concept is fundamentally different from other cloud tax issues that have been discussed in policy and academic circles, such as whether states should tax network services or products sold over the Internet and how to tax income generated by cloud services for income tax purposes.²²² Those tax issues do not rest on the cloud's environmental footprint; the distinguishing feature of the dark cloud tax concept is that it focuses on the environmental implications of the cloud.

While this Article can only introduce the general concept of environmental cloud taxes on a preliminary, tentative basis, the next step would be to explore design details. One of the critical issues for further analysis is which services and products would be taxed. There is, of course, the foundational question whether to focus on data centers or network services, but other issues exist as well. For example, would a tax be limited to cloud services or also include non-cloud data centers and internal networks—and how do tax and environmental policy rationales influence those decisions?²²³ Emissions accounting protocols under development may help inform the development of design details, both in terms of identifying the most environmentally appropriate tax base (what would be taxed) and

222. See generally Vlad Frants, *The Evolution of Cloud Computing Taxation: Characterizing and Sourcing Cloud Computing Payments in an Uncertain World*, AM. BAR ASS'N, http://www.americanbar.org/groups/young_lawyers/publications/the_101_201_practice_series/the_evolution_of_cloud_computing_taxation.html (last visited Apr. 11, 2015); Hellerstein & Sedon, *supra* note 219; Stephan J. Lusch, *State Taxation of Cloud Computing*, 29 SANTA CLARA COMPUTER & HIGH TECH. L.J. 369 (2012); Orly Mazur, *Taxing the Cloud*, 103 CAL. L. REV. 1 (2015); David J. Shakow, *The Taxation of Cloud Computing and Digital Content*, 140 TAX NOTES 333, 350–52 (2013).

223. Under equal protection principles, one would want to ensure that there is a rational basis for imposing a tax on some activities but not others. See, e.g., *Regan v. Taxation With Representation of Wash.*, 461 U.S. 540, 547 (1983) (noting that most equal protection challenges to taxation provisions only require extremely deferential rational basis review). Taxing some cloud services but not all digital services that use energy, or taxing cloud services but not all economy-wide demands on electricity, might be justified as a rational first step. See *Williamson v. Lee Optical of Okla.*, 348 U.S. 483, 489 (1955) (“[T]he reform may take one step at a time, addressing itself to the phase of the problem which seems most acute to the legislative mind. . . . The prohibition of the Equal Protection Clause goes no further than the invidious discrimination.”).

administratively feasible points of taxation.²²⁴ There is also the possibility that dark cloud taxes might be integrated into a broader tax linked to other features of the cloud, such as e-waste and the need to fund cybersecurity measures.

For purposes of this Article, however, the basic point is that policymakers could consider the idea of taxing a burgeoning activity that will generate additional emissions in the future and contribute to adaptation demands. Dark cloud taxes could generate earmarked revenue to help cover those costs. In addition to funding adaptation, the mere imposition of the taxes could help change behavior. The taxes could create a financial incentive for data centers to focus on the carbon profile of electric utilities and energy efficiency, not just on the cost of electricity.²²⁵ Importantly, they could also raise consumer awareness that the cloud is neither invisible nor clean as our electronic appetite grows. Accelerated usage will add environmental costs, many of which will be borne by the generations of the future.

3. Adaptation Fees or Taxes on Impervious Surfaces

One of the consequences of extreme storm events is heightened levels of intense precipitation and resulting flooding. Impervious surfaces accelerate the amount of stormwater runoff because they reduce the landscape's natural ability to absorb rainfall, and they contribute to flash flooding.²²⁶ According to one report, an acre of parking lot generates sixteen times more runoff than an acre of meadow.²²⁷ As a result, adaptation to climate change calls for coping with increased runoff, reducing the amount of impervious surfaces, and using green infrastructure measures to improve the landscape's ability to assimilate precipitation and runoff. A tax or fee on impervious surfaces could both provide funding to finance gray and green infrastructure measures and create an incentive to minimize impervious surfaces.

224. For example, development in data center infrastructure management systems and software can provide information about energy usage. WHITNEY & DELFORGE, *supra* note 204, at 13, 20. One could explore whether that type of data could be used in the implementation of a dark cloud tax.

225. Data centers are energy-intensive and therefore sensitive to the price of energy. MILLS, *supra* note 207, at 36.

226. PETER FLINKER, THE NEED TO REDUCE IMPERVIOUS SURFACE COVER TO PREVENT FLOODING AND PROTECT WATER QUALITY 3 (2010), available at <http://www.dem.ri.gov/programs/bpoladm/suswshed/pdfs/imperv.pdf>.

227. *Id.* at 5; see also Lance Frazer, *Paving Paradise: The Peril of Impervious Surfaces*, 113 ENVTL. HEALTH PERSPS. A457, A458 (2005) (reporting that an acre of pavement generates runoff ten to twenty times the amount from an acre of grass).

Although the ultimate polluters are those who generate the greenhouse gas emissions that provoke the need for adaptation, landowners and managers who rely heavily on impervious surfaces are also implicated in that they contribute to the need for adaptation. They are also the beneficiaries of government services that deal with the consequences of their pollution. Hence, fees or taxes on impervious surfaces link to the polluter-pays and beneficiary-pays principles and reduce the need to place costs on the general public.

For several decades, the United States has regulated stormwater runoff to control flooding²²⁸ and more recently to protect water quality under the federal Clean Water Act.²²⁹ In the context of climate change adaptation, the focus is more directly on water quantity than water quality, but increased flows of stormwater inevitably invoke issues of water quality as well. Heavy downpours can overwhelm wastewater systems, causing flooding and the release of untreated stormwater and wastewater into water bodies.²³⁰ Although the federal government can incorporate stormwater quantity considerations into its Clean Water Act programs and funding mechanisms,²³¹ climate change is very likely to exacerbate the gap between currently available funding for water infrastructure projects and future needs.²³² Furthermore, the responsibility for implementing stormwater

228. COMM. ON REDUCING STORMWATER DISCHARGE CONTRIBUTIONS TO WATER POLLUTION, NAT'L RESEARCH COUNCIL OF THE NAT'L ACADS., *URBAN STORMWATER MANAGEMENT IN THE UNITED STATES* 47 (2009) [hereinafter *URBAN STORMWATER MANAGEMENT IN THE UNITED STATES*], available at <http://www.nap.edu/catalog/12465/urban-stormwater-management-in-the-united-states>. For a history of federal flood control policy, see Debbie M. Chizewer & A. Dan Tarlock, *New Challenges for Urban Areas Facing Flood Risks*, 40 *FORDHAM URB. L.J.* 1739, 1746–54 (2013).

229. *URBAN STORMWATER MANAGEMENT IN THE UNITED STATES*, *supra* note 228, at 47. See generally CTR. FOR WATERSHED PROTECTION, *THE VALUE OF STORMWATER FEES IN MARYLAND* 1–2 (2014), available at www.cwp.org/images/stories/PDFs/SW%20Utility%20Fact%20Sheet2.pdf (describing the history of stormwater fees that focus on flood control and water quality requirements from the 1970s to the 1990s).

230. See, e.g., A STRONGER, MORE RESILIENT NEW YORK, *supra* note 68, at 212 (summarizing the risks of increased precipitation from climate change to New York's wastewater systems and categorizing increased precipitation and heavy downpours as causing “moderate” risk by 2050); N.Y.C. DEP'T ENVTL. PROT., *supra* note 75, at 5 (reporting that 562 million gallons of wastewater overflowed treatment facilities during Hurricane Sandy and entered local waterways).

231. See Robin Kundis Craig, *Climate Change Comes to the Clean Water Act: Now What?*, 1 *WASH. & LEE J. ENERGY, CLIMATE & ENV'T* 9, 30 (2010) (explaining that state implementation plans under the Clean Water Act could help manage increased stormwater); BEN CHOU ET AL., *supra* note 173, at 5 (indicating that Clean Water State Revolving Funds provide grants to repair and strengthen wastewater infrastructure, including grants to New York and New Jersey after Sandy).

232. One study found that the United States will need to invest between \$123 and \$252 billion in wastewater systems by 2050 just to address climate change adaptation, not taking into account upgrades and replacements of existing systems. ASS'N OF CLEAN WATER AGENCIES & ASS'N OF METRO. WATER AGENCIES, *CONFRONTING CLIMATE CHANGE: AN EARLY ANALYSIS OF WATER AND*

control measures rests largely with the states and therefore with local governments.²³³ The increased level of funding that will be necessary and the emphasis on local-level control over stormwater management each create a logical match between local responsibilities and local funding mechanisms, such as fees or taxes.

A large number of local governmental bodies or water authorities around the United States—over 1,400 in 2013—are already using fees on impervious surfaces to help finance stormwater control measures under a system called “stormwater utilities.”²³⁴ The “utility,” which is usually more in the nature of a financing mechanism than a service-providing utility, collects the fees and disperses the revenue for stormwater programs.²³⁵ For example, the State of Maryland recently required counties and municipalities subject to the Clean Water Act’s stormwater discharge requirements to impose a fee on impervious surfaces, the revenue from which must be dedicated to the implementation of stormwater management plans.²³⁶ The legislation allows each governmental body to design the structure and rate of the fee, including relief when landowners implement advanced stormwater management practices or use stormwater management facilities.²³⁷

Nationwide, about 80% of the stormwater utilities base their fees on units of impervious area (known as “Equivalent Residential Units”), creating a “you pave, you pay” system that operates regardless of the relative proportion of impervious and pervious surfaces on the property.²³⁸ Others base the fee on the percentage of impervious area relative to the whole (known as the “Intensity of Development” system) or on the basis of runoff from both impervious and pervious areas, with lower rates for the pervious areas (known as the “Equivalent Hydraulic Area”).²³⁹ As of 2013,

WASTEWATER ADAPTATION COSTS 3–10 (2009), available at <http://www.amwa.net/galleries/climate-change/ConfrontingClimateChangeOct09.pdf>.

233. *Stormwater Homepage*, EPA, <http://water.epa.gov/polwaste/npdes/stormwater/index.cfm> (last updated Jan. 21, 2015).

234. C. WARREN CAMPBELL, WESTERN KENTUCKY UNIVERSITY STORMWATER UTILITY SURVEY 2013, at 1 (2014), available at http://www.wku.edu/engineering/civil/fpm/swsurvey/western_kentucky_university_swu_survey_2013.pdf.

235. EPA, FUNDING STORMWATER PROGRAMS 3 (2009), available at <http://water.epa.gov/infrastructure/greeninfrastructure/upload/FundingStormwater.pdf> (using the terms “stormwater fees” and “stormwater utilities” interchangeably, and classifying both as funding mechanisms).

236. See generally DEP’T OF LEGIS. SERVS., STORMWATER REMEDIATION FEES IN MARYLAND: LOCAL IMPLEMENTATION OF HOUSE BILL 987 OF 2012 (2013) (explaining Maryland’s stormwater utility fee plan).

237. MD. CODE ANN., ENVIRONMENT § 4–202.1(e), (f) (LexisNexis 2014).

238. EPA, *supra* note 235, at 3.

239. *Id.* at 3–4.

the three states hit hardest by Hurricane Sandy—New York, New Jersey, and Connecticut—did not have any fee-based stormwater utilities.²⁴⁰

The stormwater utility concept could be readily expanded to cover the need to adapt to higher levels of stormwater associated with climate change. Existing stormwater utilities could adjust their rates to provide the financing necessary to invest in higher levels of protection against runoff, and local or county governments without existing programs could institute fees, provided they either have or obtain the state legal authority to impose fees. Such an approach would maximize the co-benefits of improving water quality and coping with current and increased quantities of stormwater. It could also change behavior by creating a financial incentive for landowners to both minimize impervious surfaces and invest in green infrastructure or stormwater reduction measures. One would, of course, need to coordinate the fees with other programs that create incentives. For example, New York City offers a one-year property tax abatement for the construction of a green roof.²⁴¹ If New York City were to create a stormwater utility and impose a fee on impervious surfaces, it might instead want to provide a fee-reduction for green roofs.

The revenue from fees or taxes on impervious surfaces could be used to invest in measures that help control flooding and reduce runoff, including investments in green infrastructure. If structured as a fee, the relationship between the cost imposed on properties and the mitigation or treatment benefit provided by the use of the funds would need to be sufficiently reasonable to avoid a legal challenge that the fee is instead a tax.²⁴² A local jurisdiction would, of course, need to be sure that it has the legal authority to impose these measures.

One might also consider the use of this technique at levels of government higher than the municipal or county level. For example, it might be possible to create a stormwater utility on a multi-jurisdictional watershed basis, provided that upstream payers receive some benefit from downstream investments if the utility imposes a fee. In addition, one would

240. The lack of stormwater utilities does not mean that state and local governments are not subject to federal regulations concerning stormwater; it only means that they are financing regulatory investments in other ways, such as through general tax revenues or bonds. Note that bills authorizing the use of stormwater fees in New Jersey have failed in recent years. MICKENZIE ROBERTS-LAHTI, *NEW JERSEY FUTURE, STORMWATER UTILITIES: A FUNDING SOLUTION FOR NEW JERSEY'S STORMWATER PROBLEMS* 8–9 (2014), <http://www.njfuture.org/wp-content/uploads/2014/09/New-Jersey-Future-Stormwater-Utilities-Report.pdf>.

241. NYC BUILDINGS, *NYC GREEN ROOF PROPERTY TAX ABATEMENT PROGRAM 1* (2010), available at http://www.nyc.gov/html/dob/downloads/pdf/green_roof_tax_abatement_info.pdf.

242. *See, e.g., City of Lewiston v. Gladu*, 2012 ME 42, ¶¶ 24–26, 40 A.3d 964 (holding that an impervious-surface-based stormwater fee was a fair approximation of cost and benefit and that the charge was a fee and not a tax).

consider the relationship to existing environmental regulatory regimes. Where environmental regulatory regimes create regional water quality standards, such as in the multi-state Chesapeake Bay area,²⁴³ a regional or state-level approach might be attractive. Expanding the use of fees or taxes on impervious surfaces is not necessarily politically easy. As Maryland found, it is easy for opponents to call the fees a “rain tax,”²⁴⁴ artfully invoking both antipathy toward taxes and the thought that people are paying for something that falls from the heavens over which they have no control.

4. Real Estate Transfer Taxes

Another source of revenue for climate change adaptation might be real estate transfer taxes. Real estate transfers in themselves do not generate greenhouse gas emissions, but they arguably bear some links to the need for extreme weather adaptation measures. As indicated in the discussion of impervious surfaces, the built environment contributes to stormwater runoff, creating secondary polluter status. It also can place people in locations where they are at risk of flooding or storm surges, where they may be beneficiaries in need of assistance. Even transfers of undeveloped land can embody a linkage because transfers often lead to new development. Although modest increases in real estate transfer taxes are not likely to significantly change behavior,²⁴⁵ they can provide funding to help finance ameliorating adaptation measures. For example, they could help fund stormwater control programs under the polluter-pays approach, such as the purchase of open space or financing of green streets, or measures that would protect vulnerable areas against storm surges under the beneficiary-pays approach, such as water walls or restoring natural shorelines.

As in the case of stormwater utilities, some jurisdictions in the United States have a history of using real estate transfer taxes to fund environmental purposes. The State of New York, for example, imposes a \$2 tax on every \$500 of sales price,²⁴⁶ the proceeds of which are deposited in

243. DEP'T OF LEGIS. SERVS., *supra* note 236, at 3–4.

244. *See, e.g.*, Travis H. Brown, *When it Rains, it Pours Tax Dollars in Maryland*, FORBES (Jan. 3, 2014, 8:00 AM), <http://www.forbes.com/sites/travisbrown/2014/01/03/when-it-rains-it-pours-tax-dollars-in-maryland> (referring to the Maryland Stormwater Management-Watershed and Restoration Program as a “rain tax”).

245. Note, however, that the 1% “mansion tax” in New Jersey and New York State, which applies to sales of residences for over \$1 million, pushed prices below the \$1 million threshold and depressed sales. Janet Novack, *Mansion Tax Kills Some Million Dollar Home Sales, Study Concludes*, FORBES (May 7, 2014, 11:54 AM), <http://www.forbes.com/sites/janetnovack/2014/05/07/mansion-tax-kills-some-million-dollar-home-sales-study-concludes>.

246. N.Y. TAX LAW § 1402(a) (Consol. 2014).

its Environmental Protection Fund.²⁴⁷ Money in the Fund is allocated by the annual state budget to a variety of purposes including open space protection.²⁴⁸ In 2014, over 100 environmental groups asked the State to increase allocations to the Fund to help ““municipalities to become more resilient and reduce risks from storm impacts.””²⁴⁹ When authorized by state legislation, local communities can also impose dedicated transfer taxes, as has happened in the Peconic Bay area of Long Island, New York.²⁵⁰ Using the funds specifically for adaptation purposes may require revisions in the enabling legislation.²⁵¹

Investment of the revenue in adaptation can also produce co-benefits. For example, using funds to protect open space that can help reduce stormwater runoff or protect populations from storm surges and flooding can yield other ecological benefits, such as habitat preservation and protection of groundwater recharge areas. At the same time, the investment decisions should consider the role of other programs. For example, local funds that might be used to move current development out of the floodplain should be coordinated with FEMA’s Hazard Mitigation Fund, which can help finance the removal of vulnerable structures from high-risk flooding areas.

Real estate transfer taxes are not the only way to associate the costs of adaptation with the development that exacerbates the need for adaptation or that needs protection from climate change impacts. Stormwater utilities could achieve some of the same goals, as described above. Exaction fees imposed at the time of new development can contribute to necessary green and gray public infrastructure, although those fees do not apply to existing development. Local governments also have the opportunity to create special assessment districts, which can impose the cost of new, protective infrastructure on those directly benefiting.²⁵² Real estate transfer taxes, however, offer the benefit of generally occurring when money is changing hands in the course of transactions. They may also provide greater

247. *Id.* § 1421; N.Y. STATE FINANCE LAW § 92-s (Consol. 2014).

248. STATE FIN. § 92-s(1), (6).

249. Sarah Crean, *Environmentalists See Mixed Bag in Cuomo Budget*, GOTHAM GAZETTE (Feb. 18, 2014), <http://www.gothamgazette.com/index.php/environment/4866-environmentalists-see-mixed-bag-in-cuomo-budget>.

250. N.Y. TAX. LAW § 1449-bb (Consol. 2014) (authorizing Peconic Bay towns to use transfer taxes); N.Y. TOWN LAW § 64-e(2) (requiring deposit of transfer taxes into Peconic Bay region community protection funds).

251. *See* S. Assemb. A5939A-2013, Reg. Sess. 2013–2014 (N.Y. 2013) (codified as amended at N.Y. TOWN LAW § 64–e) (proposing an amendment to the enabling legislation to allow the Peconic Bay Community Preservation Fund to be used to preserve shorelines “at significant risk of coastal flooding due to projected sea level rise and future storms”).

252. Farber, *Adapting to Climate Change*, *supra* note 175, at 27.

flexibility over the use of the revenue than the tighter burden-to-benefit linkage underlying exactions and special assessment districts.

It is appropriate to consider the use of real estate transfer taxes at the state and local level, rather than at the federal level. While the federal government and many states tax the gains generated by the sale of property, states have traditionally maintained control over real estate transfer taxes, applying a percentage tax to the sales price. Adjusting real estate transfer tax rates and purposes to address adaptation would follow this traditional allocation of taxation practices. As the New York transfer taxes illustrate, the taxes could operate at the state or local levels, subject to how taxing authority is distributed in any particular state. State or regional level taxes create the opportunity to coordinate adaptation funding goals on a broader watershed perspective than municipal taxes might allow.

5. A Brief Synthesis

The following chart captures some of the analytical highlights of these proposals.

Table 1: Possible Adaptation Taxes for Extreme Weather Events (Storms)

Tax	Level of government	Linkage between adaptation needs and taxpayer/tax base	Use of revenue
Carbon tax	Federal	Present and future emitters pay for collective sins of the past, assume responsibility for their emissions, and invest in future resilience	Immediate disaster relief; infrastructure investments of national significance; funding for infrastructure bank
Dark cloud taxes	Federal	Present and future emitters contribute to future adaptation needs from start of new technology's growth	Investments in e-related adaptation measures, such as resilience of grid
Impervious surface taxes and fees	Local or regional	Contributors to runoff pay for measures to reduce or control	Resilience of local water systems; investments in green infrastructure
Real estate transfer taxes	State, regional, local	Built environment contributes to exposure to climate change risks	Investments in defensive systems; relocation projects; land conservation

The suggestions above serve as examples of possible fiscal instruments that could fund adaptation. They share similarities but also illustrate differences. They all bear some attributes of a polluter-pays and/or a beneficiary-pays approach, linking either responsibility or benefit to the obligation to pay. They all fall short of pure cost-internalization standards under a Pigouvian ideal. Therefore they may not influence behavior in the optimal fashion under economic theory, but they nonetheless can send an informational message about the linkage between human activities and climate change that may help change attitudes in a more subtle fashion. They all create dedicated funding sources that would be used for adaptation. In doing so, they offer the policymakers and administrators who design the programs flexibility to determine the most cost-effective and prudent forms of adaptation investments—although the details of implementation lie beyond the scope of this Article. They differ in terms of the level of government at which they would operate, determined in accordance with the level of government most involved with the adaptation activities on which the new revenue would be spent and in light of traditional and legal differentiations of taxing authority among different levels of government. The carbon and cloud taxes would constitute new taxes; the taxes or fees on impervious surfaces and real estate transactions build on systems that already exist and therefore may be politically easier to implement.

Each of these proposals and others that might be included in Table 1 must be judged against a much more sophisticated matrix of funding alternatives than this Article allows. Such a matrix would start with a more detailed analysis of the existing funding programs for various types of adaptation measures at all levels of government in order to identify the existing policy infrastructure and gaps in both coverage and levels of funding. It would incorporate the full range of government financing options, such as current-year financing through the use of general revenue, bond financing, grants from various levels of government, and resources from the philanthropic sector. The merits of new fiscal instruments that finance dedicated funds must be examined against the alternatives. The matrix would also include ways in which governments can prepare for adaptation without direct spending, such as use of their regulatory power and, in particular, their land use planning authority.

A fundamental part of the analysis of alternatives inevitably will involve the question whether it is appropriate to create new streams of revenue for a dedicated purpose—adaptation. A dedicated revenue source will at least partially remove adaptation from the political jockeying that inherently accompanies the annual budget-making process at all levels of government when multiple priorities must compete for limited dollars. That

removal may be particularly important for adaptation measures, given the public health and safety at stake and the need for investments that may be disproportionately large in relation to normal budgetary demands. However, the creation of dedicated funds of any magnitude represents a substantial reorientation of customary governmental budgetary procedures. It also brings center-front the policy question of how a society with limited dollars should allocate its resources between mitigation and adaptation. This Article has argued that governments need to start setting aside funds for increased investment in adaptation, but it recognizes that adaptation alone is not sufficient. The matrix for considering policy instruments that promote adaptation must also include current and potential climate change mitigation measures. Those measures will not only affect the analysis of future adaptation needs but also allocation of costs across the public and private sectors of society. The question of who should pay for adaptation, and how much, cannot be divorced from the question of who bears the cost of mitigation.

CONCLUSION

As Hurricane Sandy illustrates, extreme weather poses tremendous fiscal challenges for federal, state, and local governments. With relatively few dedicated funds on hand, they must scramble to try to meet the immediate need to respond and rebuild. The insurance market offers only limited assistance in covering losses. Governments also need the resources to invest in building resilience against future threats even if they have not yet experienced disaster. Governments at all levels should look for new sources of tax revenue to dedicate to adaptation to extreme weather events—and to the full range of adaptation needs. Hurricane Sandy serves as a microcosm of a much larger universe of adaptation needs.

The tax and fee proposals portrayed above are far from an all-inclusive list of the potential to use environmentally related taxes or fees to provide funding for climate change adaptation. They serve only to illustrate the potential role of green taxes and some of the conceptual issues that might arise. The particular taxes that one might use for any particular adaptation need will depend on the type of adaptation action, an assessment of who most logically should bear the cost, and the appropriate level of government that should serve as the tax collector and dispenser of funds. There is no one right set of answers, given the breadth of policy and political questions involved. However, the time has arrived to start seriously considering the funding options in light of the significant gaps we face between the need for adaptation and the resources currently at hand.