

UIC Law Review

Volume 47
Issue 2 *Annual Kratovil Symposium on Real
Estate Law & Practice*

Article 7

Winter 2013

Funding Adaptation, 47 J. Marshall L. Rev. 657 (2013)

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FUNDING ADAPTATION

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I. INTRODUCTION

This Article assumes that climate change is going to cause human and property losses.¹ The Article does not seek to add to the extensive scholarship clearly indicating the need for adaptation (and mitigation).² Rather, it builds off of that scholarship and explores *how* we are going to pay for adaptation. Specifically, it examines the financing mechanisms that local governments have available to them to fund adaptation and whether those mechanisms can meet local needs. As the authors in this volume and others indicate, many climate-changing conditions

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1. In the final draft of *Climate Change 2013: The Physical Science Basis*, the Intergovernmental Panel on Climate Change (IPCC) makes it clear that we are trending towards dramatic climate-changing conditions. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS, SUMMARY FOR POLICYMAKERS 3 (2013), *available* at http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_All.pdf. The report details increases in land surface, air, troposphere, sea surface temperatures, and sea levels, as well as decreases in Arctic sea-ice, glacier mass, and northern hemisphere snow cover. *Id.* The United States is experiencing significant climate alterations as well, including some of the largest temperature anomalies in 2012 with 34,008 daily high records, AM. METEOROLOGICAL SOC'Y, STATE OF THE CLIMATE IN 2012 (Jessica Blunden & Derek S. Arndt eds., 2013), increased volume of rainfall in almost all areas, NAT'L CLIMATE ASSESSMENT & DEV. ADVISORY COMM., DRAFT CLIMATE ASSESSMENT REPORT 108-09, 168 (2013), and increases in the number of "extreme" weather events and billion-dollar disasters. AM. METEOROLOGICAL SOC'Y, *supra*, at 151. Climate models forecast a continuation of these dire climate patterns unless we considerably alter anthropomorphic choices. See INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* at 14.

2. See, e.g., *infra* note 5.

will have profound impacts on local governments³ and the infrastructure relevant to dozens of vital local services, such as the provision of potable water, waste disposal, and electricity.⁴ Recent climate events from hurricanes to heat waves have altered the economic and social vitality of communities by destroying capital improvements necessary to providing basic services, damaging critical downtown spaces, and threatening the human, environmental, and economic health of communities.⁵

Because we rely heavily on local services, the legal, operational, and moral responsibility to address and protect human health from many climate-changing conditions resides in

3. Carl J. Circo, *Using Development Financing Tools to Help Cover Costs of Adapting to Climate Change in Tornado Alley and Beyond*, 47 J. MARSHALL L. REV. 609 (2014). For purposes of this Article, “city”, “local government”, and “municipality” are used interchangeably and mean every general purpose incorporated subdivision that is self-governed, including towns, villages, counties (parishes), and special purpose or quasi-public entities (such as housing authorities). Because many municipal governments have moved their enterprise-type operations (utilities, for example) to special purpose districts, I include special purpose districts in the definition of “local governments” throughout the Article.

4. See, e.g., ICLEI, LOCAL GOVERNMENTS, EXTREME WEATHER, AND CLIMATE CHANGE 2012, available at http://www.resilientamerica.org/wp-content/uploads/2013/06/ICLEI_extreme_weather_cities_fact_sheet_2012.pdf (highlighting negative impacts of climate change on numerous local governments’ infrastructures and the actions they have taken in response); JEB BRUGMANN, ICLEI, FINANCING THE RESILIENT CITY: A DEMAND DRIVEN APPROACH TO DEVELOPMENT, DISASTER RISK REDUCTION, AND CLIMATE ADAPTATION 15 (2011), available at http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Frontend_user/Report-Financing_Resilient_City-Final.pdf (citing a 2010 World Bank report indicating that 80% of climate adaptation costs will be borne by urban areas); Evidence and Lessons from Latin America, *City-Level Climate Change Adaptation Strategies: The Case of Quito, Ecuador*, http://ella.practicalaction.org/sites/default/files/130225_ENV_CitAdaMit_BRIE_F1.pdf (“Climate change adaptation strategies at city-level are increasingly important for identifying and implementing adequate responses to climatic threats.”); Andrea Vittorio, *Community Leaders Tell White House What They Need to Foster Resiliency*, http://climate.bna.com/climate/summary_news.aspx?ID=256702 (Dec. 11, 2013) (“State and local entities are on the front lines in responding to the impacts of climate change.”).

5. See BRUGMANN, *supra* note 4, at 14 (“Catastrophic risks arise from the poor design and location of the built environment including infrastructure, and include vulnerabilities and losses associated with flooding, violent winds, temperature extremes, and sea level rise. . . . In New Orleans alone, the Hurricane Katrina disaster caused nearly 800 deaths, a loss of more than 90,000 jobs, and \$3 billion in lost wages in the first ten months after the disaster. It is generally accepted that total economic losses from the event exceeded \$200 billion. The 2011 flooding and landslides in cities of Rio de Janeiro and Sao Paulo left more than 800 dead and 20,000 homeless. In the same year in Australia, in assessing the damages caused by 2011 Cyclone Yasi, reinsurance broker Aon Benfield has estimated that the cyclone cost more than \$20 billion in losses due to flooding alone, a large percentage of this in urban areas.”).

large part with local governments. Local governments are and will be tasked with the responsibility of adapting local infrastructure to climate-changing conditions to ensure that critical services are not disrupted or are only minimally disrupted during climate-related events.⁶

Adapting local government infrastructure to climate change is going to cost an enormous amount of money. For example, New York City has proposed a plan to adapt to sea-level rises and related climate conditions that is estimated to cost nearly \$20 billion.⁷ This represents the costs to one city adapting primarily to sea-level rise. A 2013 study published in the *Proceedings of the National Academy of Sciences* estimated that 1,400 cities in the United States are threatened by sea-level rise, and each of these cities can expect significant costs associated with adapting to this threat.⁸ While New York City's plan may be more comprehensive and potentially more costly than other cities' plans, the total cost for 1,400 coastal communities to adapt to sea-level rise is going to be astronomical. In addition, hundreds of landlocked cities can expect enormous adaptation costs to protect against devastating climate events, such as fresh water floods, droughts, and tornados.

Notwithstanding the heavy price tag associated with adaptation, or perhaps because of it, very few adaptation plans set forth the necessary funding strategies to complete adaptation projects.⁹ There is very little data establishing how thousands of cities are going to raise billions, and potentially trillions, of dollars necessary to protect critical infrastructure relevant to key services. Typically, local governments assume the responsibility for funding

6. This is not to suggest that all projects seeking to adapt government services to climate change should or will involve local government infrastructure. This Article, however, is only focused on those large—and often critical and expensive—local infrastructure projects that require municipal financing. For examples of local government adaptation projects not directly related to infrastructure, see J.B. Ruhl & James Salzman, *Climate Change Meets the Law of the Horse*, 62 DUKE L.J. 975, 1020 (2013) (offering reduced building permits as a method of adaptation); Chris Duerksen, *Saving the World Through Zoning*, PLANNING (Jan. 2008), available at <http://www.clarionassociates.com/pdfs/duerksen-sustainable-code.pdf> (proposing a “sustainable community development code [to] directly address sustainability issues like energy conservation and production” through zoning).

7. CITY OF N.Y., PLANYC: A STRONGER, MORE RESILIENT NEW YORK 401 (2013), available at http://nytelecom.vo.llnwd.net/o15/agencies/sirr/SIRR_singles_Lo_res.pdf. The New York City plan includes levees, surge barriers, dune systems, bulkheads, and retrofitting of local infrastructure. *Id.* at 234-37. It does not include other infrastructure and climate change impacts relevant to utilities, telecommunications, and others. *See id.*

8. Benjamin H. Strauss, *Rapid Accumulation of Committed Sea-level Rise from Global Warming*, PROC. OF THE NAT'L ACAD. OF SCI. 2 (2013), available at <http://assets.climatecentral.org/pdfs/Strauss-PNAS-2013-v2.pdf>.

9. *Infra*, Part I.B.

public infrastructure projects related to the services they provide.¹⁰ In funding public infrastructure, local governments predominantly rely on the issuance of municipal bonds to update, expand, and protect local services. Municipal bonds are structured in a way that places almost all of the risk and cost of a given project on local governments. However, many local governments are experiencing an economic scenario that makes it highly unlikely they can assume sole responsibility for the massive costs associated with climate change adaptation.¹¹ And yet, the actual and potential risk of loss to local governments and the built environment is too great to not take action.¹² Faced with potential climate catastrophe and limited financial resources to mitigate the risk of a catastrophic event, local governments are beginning to search for possible alternatives to financing adaptation.

This Article sets the foundation to explore financing alternatives by examining the challenges facing local governments in the use of municipal bonds. Based on these challenges, the Article concludes by initiating a discussion on financing that incorporates public / private partnerships as a means of increasing available capital. In addition, the Article pursues alternative funding mechanisms that reconfigure the financing structure to account for externalities and ecosystem impacts in a way that helps build resilient communities and resiliency in investment.¹³

The Article begins by describing key local government services and sets forth some of the very limited data available on the actual and projected costs of adapting these services to climate change. Part II places the costs associated with adaptation in the context of the current fiscal challenges facing local governments and describes the traditional form of local government financing, noting the particular role that municipal bonds have played in

10. See Edward J. Sullivan & Isa Lester, *The Role of the Comprehensive Plan in Infrastructure Financing*, 37 URB. LAW. 53 (2005) (tracing the history of how local governments have financed infrastructure projects); CONG. BUDGET OFFICE, TRENDS IN PUBLIC INFRASTRUCTURE SPENDING 2 (1999), available at <http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/12xx/doc1256/infrastruct.pdf> (showing that about 75% of all public infrastructure dollars spent in the United States since the end of the 1980s have been spent by state and local governments).

11. See *infra* Part II (discussing current local financial stresses).

12. See, e.g., David R. Godschalk, *Urban Hazard Mitigation: Creating Resilient Cities*, 4 NAT. HAZARDS REV. 136, 136 (2003) ("Can sustainable development . . . be successful without taking into account the risks of natural hazards and their impacts? Can the planet afford to take the increasing costs and losses due to natural disasters? The short answer is no." *Id.* (quoting U.N. Commission on Sustainable Development (2001)).

13. Resiliency in investment "focuses investment on increasing a city area's overall ability to support a vibrant, healthy society and economy under a wide range of circumstances. . . . Rather than just being a risk-reduction cost, resilience investments aim to create an urban area's development premium." BRUGMANN, *supra* note 4, at 21.

fostering local development. Part III explores whether municipal bonds are capable of fully financing adaptation, given the economic status of cities and the high costs associated with adaptation. Part III also questions whether the structure of municipal bonds is suitable for financing adaptation projects. In particular, Part III notes that municipal bonds lack the ability to account for externalities and changes to ecosystem services relevant to climate change. They also do not provide a clear incentive to invest in adaptation.

The Article concludes by initiating further discussion on creative partnerships subnational governments and the private sector are forging. The Conclusion briefly explores the potential benefits of these partnerships and how they may increase access to capital by opening up private sector resources through collaboration, and how they may allow those who will be negatively affected by climate change to protect their investments. The structure of financing through some public / private partnerships could help local governments account for externalities relevant to climate change and impacts to ecosystem services, while capturing previously unrealized value in averting climate-related damages. Many local governments already understand that they simply cannot afford adaptation using the typical funding strategies. They must look to additional sources that shift from focusing solely on infrastructure improvements to a more integrated public / private approach that addresses not only adaptation needs, but the future of cities and sustainable communities.

II. CITIES AND THE COST OF ADAPTATION

A. *Risk to Local Government Services*

Local governments face a broad spectrum of challenges relative to climate change.¹⁴ The first column in Figure 1 below

14. See Jonathan Rosenbloom, *New Day at the Pool: State Preemption, Common Pool Resources, and Non-Place Based Municipal Collaborations*, 36 HARV. ENVTL. L. REV. 445, n.2 (2012) (citing PETER NEWMAN & ISABELLA JENNINGS, CITIES AS SUSTAINABLE ECOSYSTEMS: PRINCIPLES AND PRACTICES 33 (2008)) (listing local challenges as including “climate change, water supply disruptions due to global peaking in production, regional environmental damage, [and] loss of biodiversity”); Cameron Holley, *Removing the Thorn from New Governance’s Side: Examining the Emergence of Collaboration in Practice and the Roles for Law, Nested Institutions, and Trust*, 40 ENVTL. L. REP. NEWS & ANALYSIS 10656, 10656 (2010) (citing DAVID HELD ET AL., GLOBAL TRANSFORMATIONS: POLITICS, ECONOMICS, AND CULTURE 376–413 (1999)) (citing “loss of biodiversity, degraded land, diffuse air pollution, serious degradation to coast and oceans, and deteriorating water and soil quality” among the challenges resulting from “rapid environmental change”); Maïke Sippel & Till Jessen, *What about Local Climate Governance? A Review of Promise and Problems* 3 (Inst. of Energy Econ. and Rational Energy Use, Discussion Paper, 2009) available at <http://ssrn.com/abstract=1514334>

sets forth several key services local governments provide, including stormwater management, transportation, and the provision and distribution of electricity. For each of these services, local governments develop and maintain the relevant infrastructure. The cost involved with local infrastructure, including making outstanding bond payments, typically consumes a large part of municipal budgets and includes anything from making large capital improvements to day-to-day maintenance.¹⁵

The infrastructure necessary to provide many of the services in Figure 1 is vulnerable to several climate-related events, some of which are set forth in Column 2. The risks associated with these climate-related events may involve systemic risks in which temporal losses stem from slowly deteriorated infrastructure following repetitive climate stresses; or catastrophic risks in which losses arise from disastrous climate events.¹⁶ Examples of local governments experiencing damage from catastrophic events, which resulted from climate change include New Orleans during Hurricane Katrina (losing nearly 800 lives, more than 90,000 jobs, and \$200 billion in economic loss),¹⁷ New York City during Hurricane Sandy (estimated losses of \$65 billion),¹⁸ and Gilchrist, Texas during Hurricane Ike (all but a single home destroyed).¹⁹

("Emissions from energy use, transport, industrial processes or waste management are produced in cities, and urban planning, infrastructure and local emergency management are instrumental to build climate resilience."); John Herzfeld, *New York City Summer Air Quality Survey Links Higher Pollution, Heavier Traffic*, 162 DEN A-7, DAILY ENV'T REP. (Aug. 24, 2010); *Local Zeroes: Cities and States Are Facing Big Budget Deficits. It is Partly Their Own Fault*, THE ECONOMIST, Nov. 13, 2008, http://www.economist.com/world/unitedstates/displaystory.cfm?story_id=12608223.

15. Jason Grotto et al., *Broken Bonds*, CHICAGO TRIBUNE, Nov. 1, 2013, <http://apps.chicagotribune.com/bond-debt/> (in 2012, 12% of Chicago's budget went to payments on its general obligation debt). Local governments typically spend more on infrastructure, such as sewer and water systems, than state governments spend. See CENTER FOR ST. & LOC. GOV'T LEADERSHIP, GEORGE MASON U., LOCAL GOVERNMENT FISCAL CRISES: THE CRISIS FACING LOCAL GOVERNMENTS AND WHY IT MATTERS 3 (2013), available at http://s3.amazonaws.com/chssweb/documents/12810/original/GMU_Fiscal_Lit_Review.pdf?1379616883. In addition, most state government infrastructure funding goes to highways expenditures, as opposed to local utility or operational services. *Id.*

16. BRUGMANN, *supra* note 4, at 14.

17. *Id.*

18. *Billion-Dollar Weather/Climate Disasters*, NAT'L CLIMATIC DATA CENTER, <http://www.ncdc.noaa.gov/billions/events> (last visited Jan. 22, 2014).

19. Jason Hanna, *Their House Survived Ike, but It's the Only One Left*, CNN, <http://www.cnn.com/2008/US/09/18/ike.last.house.standing/index.html?iref=mpstoryemail> (Sept. 19, 2008, 1:49 PM); see also Audrey White, *Five Years After Ike, Galveston Is Still Picking Up the Pieces*, N.Y. TIMES, Apr. 25, 2013, <http://www.nytimes.com/2013/04/26/us/galveston-tex-picking-up-the-pieces-5-years-after-hurricane-ike.html?pagewanted=all&r=0> (noting that Hurricane Ike was responsible for 103 deaths and damages totaling over \$50 billion).

Figure 1
At-Risk Local Government Services

Column 1	Column 2	Column 3
Potable water Provision & distribution of energy Fire fighting Transportation Waste removal Emergency medical Airports Policing Stormwater Management Housing Parks Libraries Prisons & jails	<ul style="list-style-type: none"> • Flood • Drought • Hurricane • Heat wave • Snow storm • Tornado • Wild fires 	Risk of Damage to Local Infrastructure

Catastrophic climate events such as these stress local governments' ability to provide key services.²⁰ For example, several climate events have made it difficult for local governments to provide the proper quality and quantity of fresh water.²¹ The 2013 floods in Colorado resulted in local governments' temporarily closing one water treatment plant, losing capacity in another as a main waterline burst, and issuing several boil water alerts.²² Similarly, floods in Central Iowa consistently strain the Des Moines Water Works ("Water Works"), the primary water treatment facility serving approximately 500,000 customers. In 1993, the Water Works was rendered inoperable following a 500-year flood along the Raccoon and Des Moines Rivers, the primary sources of potable water, which experienced the 500-year flood again in 2008.²³ The Raccoon and Des Moines Rivers also

20. NAT'L ASS'N OF METRO. WATER AGENCIES, *CONFRONTING CLIMATE CHANGE: AN EARLY ANALYSIS OF WATER AND WASTEWATER ADAPTATION COSTS* 3 (2009), available at <http://www.amwa.net/galleries/climate-change/ConfrontingClimateChangeOct09.pdf>.

21. *Id.* at 3–5.

22. Yesenia Robles, *Colorado Floods: Water-treatment Plants Struggle to Keep Up*, DENVER POST, Sept. 14, 2013, http://www.denverpost.com/news/ci_24093109/floods-stressing-water-treatment-issues-could-still-loom; see generally Monte Whaley, *All Flood-damaged Colorado Roads To Open before Dec. 1 Repair Deadline*, DENVER POST, Nov. 20, 2013, http://www.denverpost.com/breakingnews/ci_24565807/all-flood-damaged-colorado-roads-open-before-dec (noting that \$450 million in federal funds is being allocated to repair roads damaged in the flood).

23. *500 Year Flood Submerges Iowa*, ENV'T NEWS SERV., June 16, 2008,

experienced the 100-year flood in 2007, 2008 and 2010. During each flood, the Water Works was overwhelmed adding costs and reducing services.²⁴

While these floods directly affect whether local governments can provide services, many climate-changing conditions indirectly affect other services. For example, drought conditions may directly impact local government services, by, among other things, reducing the availability of water, energy, and emergency services. The combination of droughts followed by floods, however, may also have indirect effects. In 2012, major parts of the United States experienced some of the worst drought conditions since the Dust Bowl.²⁵ Eighty-one percent of the contiguous United States suffered from abnormally dry conditions, wreaking havoc on croplands, cattle, and shipping, and having a profound effect on local economic activity. The federal government paid \$14 billion in federal crop insurance, passing the prior record set in 2011 at \$11.3 billion.²⁶

Ironically, while a taskforce of experts assembled by Iowa Governor Terry Brandstad was contemplating how to address the drought conditions in spring 2013, more rain soaked the state than any year since 1892.²⁷ With a total rainfall of over 19 inches from January to May 2013, the quick shift in moisture led to multiple

<http://www.ens-newswire.com/ens/jun2008/2008-06-16-01.asp>.

24. See Perry Beeman, *Record Nitrate Levels in Raccoon, Des Moines Threaten Des Moines-area Tap Water*, DES MOINES REGISTER (May 10, 2013, 12:55 PM),

<http://blogs.desmoinesregister.com/dmr/index.php/2013/05/10/record-nitrate-levels-in-raccoon-des-moines-threaten-des-moines-area-tap-water/article>.

25. David Schaper, *This Drought's No Dry Run: Lessons of the Dust Bowl*, NPR (Aug. 4, 2012, 5:51 AM),

<http://www.npr.org/2012/08/04/158119458/soaked-in-drought-lessons-from-the-dust-bowl>. The 2012 drought does not seem to be an aberration. Since 2002, when another severe drought hit the Rocky Mountains and the Midwest, large parts of the country have been under some drought conditions, costing billions of dollars. See *Climate of 2002: Annual Review*, NAT'L OCEANIC AND ATMOSPHERIC ADMIN. (Jan. 23, 2003),

<http://www.ncdc.noaa.gov/oa/climate/research/2002/ann/paleo-drought.html>;

Rick Grow, *Historic U.S. Drought Will Continue Into Spring and Summer, Experts Say*, WASH. POST: POST LOCAL BLOG (Feb. 22, 2013, 1:10 PM),

http://www.washingtonpost.com/blogs/capital-weather-gang/post/historic-us-drought-will-continue-into-spring-and-summer-experts-say/2013/02/22/7f0da2f2-7d0e-11e2-9a75-dab0201670da_blog.html (noting that the current drought being experienced throughout much of the country "started in the 2000s, and . . . could remain a big issue . . . in the years to come").

26. *It's Official: 2012 Drought Cost Taxpayers a Record \$14 Billion*, TAXPAYERS FOR COMMON SENSE (Jan. 16, 2013),

<http://www.taxpayer.net/library/article/2012-drought-cost-taxpayers-a-record-14-billion>.

27. Dar Danielson, *Wettest Spring in 141 Years of Records*, RADIO IOWA (May 30, 2013), <http://www.radioiowa.com/2013/05/30/wettest-spring-in-141-years-of-records/>.

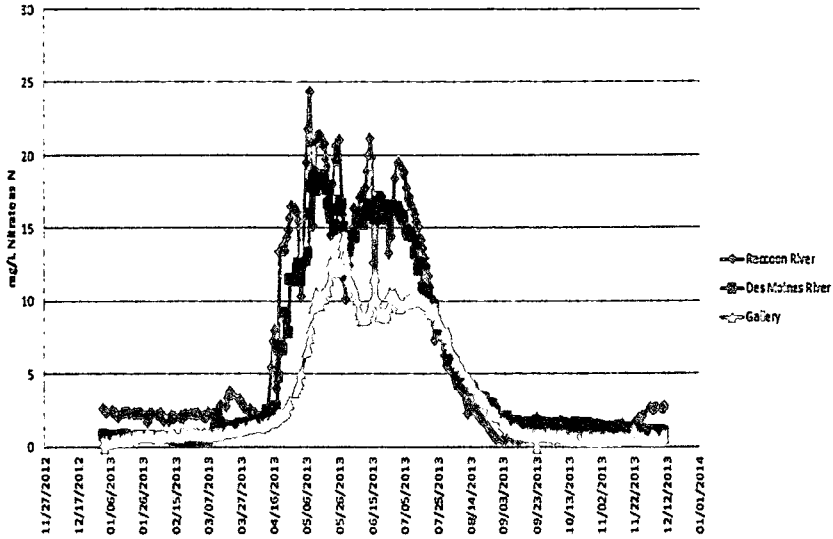
flash floods, straining water facilities, utilities, and emergency medical services.²⁸ In Iowa and other states, it also led to an unexpected and indirect consequence of a spike in nutrient, such as nitrates and phosphates, run-off.²⁹ Figure 2 below illustrates the drastic increase in nitrates measured at the Water Works.³⁰ Nitrates entering the Water Works from mid-April to late-July exceeded 10 milligrams per liter (mg/L)—the U.S. Environmental Protection Agency maximum load. Because of the spike, the Water Works was required to treat the water through one of the world's most sophisticated reverse osmosis nitrate removal systems at an additional cost of about \$7,000 a day, costing approximately \$900,000.³¹

28. Perry Beeman, *State Has 'Long Way to Go' on Flood Prevention, Mitigation*, DES MOINES REGISTER, June 23, 2013, <http://www.desmoinesregister.com/article/20130623/NEWS/306230049/State-has-long-way-go-flood-prevention-mitigation>.

29. A 2013 Report by the Minnesota Pollution Control Agency found that 70% of nitrates in surface waters originate from cropland run-off and heavy rain events can increase nutrient run-off loads by 51%. MINN. POLLUTION CONTROL AGENCY, NITROGEN IN MINNESOTA SURFACE WATERS 13, 16 (2013), available at <http://www.pca.state.mn.us/index.php/view-document.html?gid=19623>.

30. Beeman, *supra* note 28.

31. *Id.*; *Tragedy of the Commonsenseless: Why Voluntary-Based Efforts to Curb Nonpoint Source Pollution Fail and How a Regulatory Structure Can Be Built to Succeed* (2014) (citing William G. Stowe, CEO and General Manager, Des Moines Water Works, Panel Discussion at the Annual Conference of the Iowa Environmental Council: An Extraordinary Year; An Extraordinary Need for Action (Oct. 11, 2013)) on file with author. At one point, the treated water, post-reverse osmosis, tested at 9.6 mg/L, greatly straining Des Moines Water Works' ability to provide potable water once again. Sadly, after the Des Moines Water Works withdraws the nitrates (albeit a small amount compared to the total nitrates in the rivers), it discharges the extracted nitrates back into the river, which makes its way to the Mississippi River, downstream to others cities, such as St. Louis, Memphis, Baton Rouge, and New Orleans, before contributing to hypoxia in the Gulf of Mexico. *See generally* NAT'L OCEANIC AND ATMOSPHERIC ADMIN., U.S. DEP'T OF COMMERCE, DEAD ZONES: HYPOXIA IN THE GULF OF MEXICO 1 (2009) ("Seventy percent of nutrient loads [in Mississippi] that cause hypoxia are a result of agricultural runoff.").

Figure 2.: Nitrate Levels Des Moines Water Works³²

Similar to the provision of potable water, the provision of electricity and production of energy is constantly at risk of damage from several climate-changing conditions. Huge storms, such as Hurricane Sandy, which left approximately eight million people without power from Indiana to Virginia to Maine, strain local services and cost local governments billions.³³ Power outages, however, are only part of the story. In addition to straining water treatment facilities, the 2008 flood in Iowa damaged three coal-fired power plants, leaving thousands without power until the plants could be repaired.³⁴ Most Chicagoans will remember the

32. Reprinted with the permission of the Des Moines Water Works. The image shows spikes from the two primary drinking water sources, the Raccoon and Des Moines Rivers (the third, the "Gallery," is a 3-mile long underground infiltration water source, it is partially protected by a park owned by Water Works). For more information on why the Gallery experiences lower nitrate levels than the two river sources see Christopher S. Jones, Dennis Hill & Gordon Brand, *Use a Multifaceted Approach to Manage High Source-Water Nitrate*, OPFLOW, June 2007, at 20, available at <http://www.dmw.com/upl/documents/water-quality/lab-reports/lab-studies/use-of-multifaceted-approach-to-manage-high-source-water-nitrate.pdf>.

33. *Superstorm Sandy: More than 7 Million Without Power*, CBS NEWS (October 30, 2012), <http://www.cbsnews.com/news/superstorm-sandy-more-than-7-million-without-power/>; See also *Behemoth Storm Blankets Northeast with 2 Feet of Snow, Darkens 650,000 Homes, Businesses*, FOX NEWS (Feb. 9, 2013), <http://www.foxnews.com/us/2013/02/09/behemoth-storm-blankets-northeast-with-2-feet-snow-darkens-650000-homes/>.

34. *Flooding Shuts 3 Iowa Power Plants*, REUTERS, Jun. 13, 2008, available at <http://www.reuters.com/article/2008/06/14/us-utilities-operations-alliant-iowa-idUSN1347818320080614>.

1995 heat wave, which over the course of two weeks put extreme pressures on energy utilities, emergency medical services, and other services.³⁵

Cities can expect these types of climate events to continue.³⁶ The IPCC's 2013 report noted increased frequency of heavy rain events, storm intensity, sea-level rise, flooding, and heat waves.³⁷ In addition, a 438-page report initiated by the City of New York indicated that the City can expect three times as many days above 89 degrees before 2050, with heat waves that threaten the public health, power system, and infrastructure.³⁸ The report also indicated an increase in rainfall with rain events consisting of more than two inches to almost double.³⁹ Other projections indicate that heat-related deaths are likely to quadruple by 2050 and that an event like the deadly 1995 heat wave could occur three times a year.⁴⁰

B. *The Costs of Local Adaptation*

The examples set forth above concerning potable water and electricity, illustrate the vulnerability of local government services and infrastructure to climate-changing conditions. How we adapt

35. NAT'L OCEANIC AND ATMOSPHERIC ADMIN., U.S. DEPT OF COMMERCE, NATURAL DISASTER SURVEY REPORT: JULY 1995 HEAT WAVE (1995), available at <http://www.nws.noaa.gov/om/assessments/pdfs/heat95.pdf> (attributing 1000 deaths nationwide to the heat wave). Other recent heat waves have had similar impacts, such as the July 1998 heat wave in Arizona, Florida, and Colorado, estimated to cause \$3.7 billion in damages and killing 117 people, and the July 1999 heat wave in the Upper Midwest killing 257 people, and the 2010 heat wave and drought in Europe led to almost 70,000 deaths and \$13.8 billion in damages.

36. See Strauss, *supra* note 8, at 1; See Anders Levermann et al., *The Multimillennial Sea-level Commitment of Global Warming*, 110 PROC. OF THE NAT'L ACAD. OF SCI. 13745 (2013), available at <http://www.pnas.org/content/110/34/13745.full.pdf>; Alice Kaswan, *Seven Principles for Equitable Adaptation*, 13 SUSTAINABLE DEV. L. & POLY 41 (2012-2013).

37. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 1, at 3.

38. CITY OF N.Y., *supra* note 7, at 27-28.

39. *Id.* (noting a 2.5 foot rise in sea-level by 2050).

40. U.S. GLOBAL CHANGE RESEARCH PROGRAM, GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 91 (2009), available at <http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf>; *Climate Hot Map: Global Warming Effects Around the World*, UNION OF CONCERNED SCIENTISTS, <http://www.climatehotmap.org/global-warming-locations/chicago-il-usa.html> (last visited Jan. 23, 2014); Katharine Hayhoe et al., *Climate Change, Heat Waves, and Mortality Projections for Chicago*, 36 J. GREAT LAKES RES. 65 (2010); Katharine Hayhoe & Donald Wuebbles, CLIMATE CHANGE AND CHICAGO: PROJECTIONS AND POTENTIAL IMPACTS (2008), available at http://www.chicagoclimatereaction.org/filebin/pdf/report/Chicago_climate_impact_s_report_Executive_Summary.pdf; Katherine Hayhoe et al., *Regional Climate Change Projections for Chicago and the Great Lakes*, 36 J. GREAT LAKES RES. 7 (2010).

to these conditions will undoubtedly cost money. How much money is difficult to say, not only because adaptation is heavily localized,⁴¹ but, more importantly, because there is insufficient data concerning what adaptation projects are needed and how much those projects will cost. That said, some of the numbers we have are staggering. In 2009, the United Nations estimated the yearly spending for adaptation—not post-catastrophic event damage due to a climate-changing event—to be between \$49 and \$171 billion a year.⁴² Since that report, scientists have put the figure at up to three times that amount.⁴³

Cities setting forth their adaptation plans have projected similarly high costs to adapt local infrastructure and protect local investment. Venice, where floods in 2012 were the worst in its history, has designed an adaptation plan involving a significant above and underwater project involving inflatable gates to stop flooding.⁴⁴ The plan is projected to cost about \$9 billion dollars.⁴⁵ The barriers across the Inner Harbor Navigation Canal in New Orleans are estimated to cost \$14 billion.⁴⁶ New Orleans recently released a separate storm water adaptation plan estimated to cost \$6.2 billion.⁴⁷ London's flood risk management plan for the Thames River is projected to cost the city \$2.3 billion.⁴⁸ The U.S. Army Corps of Engineers estimates its flood risk reduction project on the Red River of the North in North Dakota and Minnesota to

41. See NAT'L ASS'N OF METRO. WATER AGENCIES, *supra* note 19, at 4–5 (setting forth specific geographic factors relevant to adaptation and water).

42. MARTIN PARRY ET AL., *ASSESSING THE COSTS OF ADAPTATION TO CLIMATE CHANGE 9* (2009), available at <http://pubs.iied.org/pdfs/11501IIED.pdf>. For a discussion on whether subnational, national, and international funding has failed to reach the necessary funding levels, see BRUGMANN, *supra* note 4, at 17.

43. See WORLD BANK, *WORLD DEVELOPMENT REPORT 2010, GENERATING THE FUNDING NEEDED FOR ADAPTATION AND MITIGATION 1* (2010), available at <http://siteresources.worldbank.org/INTWDR2010/Resources/5287678-1226014527953/Chapter-6.pdf> (“In developing countries mitigation could cost \$140 to \$175 billion a year over the next 20 years (with associated financing needs of \$265 to \$565 billion).”).

44. *MOSE Project, Venice, Venetian Lagoon, Italy*, WATER-TECHNOLOGY.NET, <http://www.water-technology.net/projects/mose-project/> (last visited Jan. 23, 2014).

45. *Id.*

46. Bob Marshall, *Funding Crisis Looms for \$14 Billion Hurricane Protection System*, THE LENS (Feb. 14, 2013, 3:23 PM), <http://thelensnola.org/2013/02/14/a-cadillac-flood-defense-but-now-comes-the-hard-part-paying-for-it/>.

47. Press Release, Caitlin Berni, Greater New Orleans Inc. Reg'l Econ. Dev., *Greater New Orleans Urban Water Plan Released* (Sept. 6, 2013), available at <http://gnoinc.org/news/publications/press-release/greater-new-orleans-urban-water-plan-released/>.

48. Maria Gallucci, *6 of the World's Most Extensive Climate Adaptation Plans*, INSIDE CLIMATE NEWS (Jun. 20, 2013), <http://insideclimateneeds.org/news/20130620/6-worlds-most-extensive-climate-adaptation-plans> (in the first 25 years).

be \$1.8 billion.⁴⁹ An estimate in 2006 to protect the seawalls in Massachusetts was more than \$600 million.⁵⁰ “This \$600 million would only repair the walls; it would not be sufficient to expand their length or raise their height to protect against sea level rise and the increased intensity expected from future storms. For that, more than \$1 billion would be required.”⁵¹ Each of these examples represents just *one city’s* attempt to adapt to *one* climate-changing condition.

In 2009, the National Association of Clean Water Agencies (NACWA) estimated the cost of adapting water utilities to climate change in the U.S. to be between \$448 billion and \$944 billion.⁵² The report states that NACWA based its estimates on the IPCC’s 2007 report and expects changes upon a review of the now-released IPCC 2013 report, which shows significantly more severe climate changing impacts.⁵³ NACWA’s report is nonetheless telling, as it provides a uniquely comprehensive estimate of the costs to adapt a single local government service.⁵⁴

In terms of actual costs, implementation of Quito, Ecuador’s strategy has thus far required \$350 million in adaptation funds.⁵⁵ In an attempt to protect itself and its inhabitants from floods, heat, and landslides, Quito has been phasing in adaptation plans since 1997, beginning with a hillside management plan.⁵⁶ Quito’s adaptation plan includes infrastructure investment in water supply, waste, and hillside management programs to help avert future landslide losses.⁵⁷ St. Petersburg, Russia recently completed a 15-mile storm surge barrier across the Neva Bay in

49. U.S. GOV’T ACCOUNTABILITY OFFICE, GAO-14-23, CLIMATE CHANGE: FEDERAL EFFORTS UNDER WAY TO ASSESS WATER INFRASTRUCTURE VULNERABILITIES AND ADDRESS ADAPTATION CHALLENGES 33 (2013), available at <http://www.gao.gov/assets/660/659024.pdf>.

50. ANNE SIDERS, COLUMBIA LAW SCH., CENTER FOR CLIMATE CHANGE LAW, MANAGED COASTAL RETREAT: A LEGAL HANDBOOK ON SHIFTING DEVELOPMENT AWAY FROM VULNERABLE AREAS 76 (2013), available at https://web.law.columbia.edu/sites/default/files/microsites/climate-change/files/Publications/ManagedCoastalRetreat_FINAL_Oct%2030.pdf.

51. *Id.*

52. NAT’L ASS’N OF METRO. WATER AGENCIES, *supra* note 19, at 1.

53. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 1.

54. *Id.*

55. Gallucci, *supra* note 48.

56. Evidence and Lessons from Latin America, *supra* note 4, at 3, 5; J. Fernandez, *Flooding and Landslide Risk Reduction in Quito*, <http://emi.pdc.org/soundpractices/Quito/SP2-Quito-Flooding-and-Landslide-RR.pdf> (last visited March 17, 2014). The cost of adaptation in Quito is a fraction of the economic costs stemming from the damages caused by a 1987 earthquake that killed 1,000 people and resulted in \$700 million in damages due to landslides. Evidence and Lessons from Latin America, *supra* note 4, at 3, n.4. While the earthquake may not be tied to climate change, climate conditions deteriorated the hillsides protecting Quito, making it vulnerable.

57. *Id.* at 5, fig.3.

the Baltic Sea. The cost of the project was \$6.4 billion.⁵⁸ In 2012, the barrier was closed and successfully protected St. Petersburg from the fourth highest flood waters on record.⁵⁹ Grand Forks, North Dakota has spent \$171 million to purchase real property lots and turn the lots into a greenway along the Red River of the North, which experienced massive flooding and catastrophic losses in 2009 and 2011.⁶⁰

III. MUNICIPAL BONDING: THE TRADITIONAL INFRASTRUCTURE FINANCING APPROACH

The examples set forth in Part I.A above highlight local infrastructure vulnerability to climate-changing conditions. The sample adaptation costs set forth in Part I.B begin to depict the enormous amount of money it will cost to adapt local infrastructure to those conditions. Even though the cost of adaptation is likely to be extraordinarily expensive, very few adaption plans set forth the necessary funding strategies to complete the projects.⁶¹ As one author stated, “few . . . cities have outlined specific actions or provided concrete details on how government agencies should . . . *pay for them.*”⁶²

Typically, local governments assume the responsibility of paying for infrastructure projects and are given wide discretion to determine the proper funding means.⁶³ Funding tools available to local governments can be categorized under two general headings: 1) local governments can raise revenue and pay for the project with upfront funds, or 2) as is common in most large scale infrastructure projects, they can borrow money by issuing municipal bonds. Both raising revenue and borrowing are limited by state constitutional and statutory caps. For example, state constitutions may limit the amount a city may increase tax rates

58. Alex Marshall, *The \$5.9 Billion Question*, METROPOLIS MAG., Feb. 2013, <http://www.metropolismag.com/February-2013/The-5.9-Billion-Question/>.

59. Mark Fischetti, *Russian Flood Barrier Is a Model for New York City*, SCIENTIFIC AM., June 10, 2013, <http://www.scientificamerican.com/article/russian-flood-barrier/>.

60. SIDERS, *supra* note 50, at 115.

61. See, e.g., CAL. NATURAL RES. AGENCY, 2009 CALIFORNIA CLIMATE ADAPTATION STRATEGY (2009), *available at* http://resources.ca.gov/climate_adaptation/docs/Statewide_Adaptation_Strategy.pdf; MD. COMM'N ON CLIMATE CHANGE ADAPTATION AND RESPONSE WORKING GROUP, COMPREHENSIVE STRATEGY FOR REDUCING MARYLAND'S VULNERABILITY TO CLIMATE CHANGE (2009); see also Vittorio, *supra* note 4 (noting a White House task force on adaptation consists of four subgroups involving state and local governments, none of the four pertain directly to funding).

62. Gallucci, *supra* note 48 (emphasis added).

63. Bauman & William H. Ethier, *Development Exactions and Impact Fees: A Survey of American Practices*, 50 LAW & CONTEMP. PROBS. 51, 51 (1987).

to raise revenue, such as those rates relevant to property taxes.⁶⁴ States may also place substantive and procedural restrictions on local borrowing, such as limiting debt payments to a certain percentage of the annual budget (a substantive limitation),⁶⁵ or requiring a public referendum prior to borrowing (a procedural limitation).⁶⁶

The money necessary to fund climate adaptation and the need to take immediate steps limit the availability of many revenue-raising options. Revenue-raising options, such as assessments, fees, and taxes, are well-suited to provide funds to pay interest and principal on bonds because they provide a steady stream of income, but they are not well-suited to provide upfront funding for large infrastructure adaptation projects. By the time municipalities collect the necessary upfront capital to fully fund many adaptation projects (such as \$20 billion in the case of New York City's plan), they could very well experience the catastrophic

64. See, e.g., Cal. Const. art. XIII (also known as Proposition 13, limiting tax rates and property assessments); see also *Nordlinger v. Hahn*, 505 U.S. 1 (1992) (upholding Proposition 13).

65. See, e.g., Haw. Const., Art. VII, §13 (limiting local debt to 15% of assessed property values); Ky. Const. § 158 (same, except limiting percentage to 2–10%). State and local officials, however, have crafted a number of mechanisms for circumventing the revenue and borrowing restrictions. On the revenue side, local governments have increasingly looked to fees and special assessments that are not subject to constitutional and statutory restrictions on taxes. See, e.g., *McNally v. Township of Teaneck*, 379 A.2d 446 (N.J. 1977) (holding that a special assessment is not subject to constitutional taxation limitations because “[t]he purpose of a special assessment is to reimburse the municipality . . . for a particular expenditure . . . not to raise funds for revenue purposes”); see also *Bolt v. City of Lansing*, 587 N.W.2d 264 (Mich. 1998) (finding the city's storm water service charge, imposed on each property, to be a tax requiring approval by referendum). On the borrowing side, local governments have turned to the special fund doctrine and special purpose districts. See *Lonegan v. State*, 819 A.2d 395 (N.J. 2003) (holding statutes authorizing appropriations-backed debt do not violate the constitutional debt limitations clause); *Schulz v. State*, 639 N.E.2d 1140, 1150 (N.Y. 1994) (upholding a bond issue for transportation improvements where the bond would be repaid from a Tax Fund fed by various taxes and fees collected by the Metropolitan Transportation Authority); Phillip J.F. Geheb, *Tax Increment Financing Bonds as “Debt” Under State Constitutional Debt Limitations*, 41 URBAN LAW. 725, 741 (2009) (“A ‘special fund’ is a segregated account within a local government that receives revenue raised from a source separate from the state or local government's general tax revenues, in particular, ad valorem property taxes. Revenue bonds backed by a special fund, rather than by the government's full faith and credit, are exempt from debt ceilings and referenda requirements because a bondholder's only recourse is against the special fund itself and not against the local government.”)

66. See, e.g., Iowa Const. art. XI, § 3 (requiring public referendum); see also Jonathan Rosenbloom, *Can a Corporate Analysis of Public Authority Administration Lead to Democracy?*, 50 N.Y.L. SCH. L. REV. 851, 852 (2006) (discussing public authorities' ability to “avoid many state and local regulations,” such as the ability to “issue debt without having to seek a public referendum”).

disasters they are trying to address. Municipalities simply do not have the time to fully capitalize adaptation projects before moving forward with protecting the local infrastructure.

Because local governments may access capital quickly through the borrowing process and because of the high cost of adaptation, local governments are more likely to fund large infrastructure projects with municipal bonds. The municipal bond market helps local governments procure capital for anything from bridges to airports and is commonly used for local infrastructure projects.⁶⁷ Municipal bonds allow local governments to borrow money and spread the cost of a given project among multiple generations. While there are dozens of municipal bond variations and a number of local government entities permitted to issue bonds,⁶⁸ municipal bonds typically offer investors a federal income tax exemption, as well as a state and local exemption.⁶⁹

The intricacies of how local governments structure and repay the bonds can be quite convoluted.⁷⁰ It may involve a number of public and quasi-public entities, multiple accounts, and leasebacks.⁷¹ Relevant for these purposes, most bond issuances follow a basic structure, although that structure can be highly complicated. As set forth in Figure 3, local governments issue bonds directly to the capital market. Investors purchase the bonds, forwarding capital to the local governments, which then use the funds to construct the infrastructure project. In return, investors receive interest payments (the coupon) and ultimately the return of their investment (the principal).

67. *Municipal Bond Market*, MUN. SEC. RULEMAKING BD., <http://www.msrb.org/Municipal-Bond-Market.aspx> (last visited Jan. 24, 2014); see also MARINER WEALTH ADVISORS, ECONOMIC AND CAPITAL MARKETS: WEEKLY COMMENTARY (2013), available at http://www.marinerwealthadvisors.com/uploads/Commentary/MWA-Market%20Commentary_print_101413.pdf (noting that \$3.2 trillion of the \$3.7 trillion represents local government debt).

68. General obligation and revenue bonds are typical methods used by local governments to finance local infrastructure. General obligations bonds are secured by the full faith and credit of the local governments and are typically paid from the local government's general coffers. Revenue bonds in which payment is secured by revenues derived from some type of fee, charge, or projected tax revenue are generally issued by special authorities, such as the Port Authority of New York and New Jersey. For a discussion of public authority bonding practices see Jonathan Rosenbloom, *supra* note 66, at 851–67.

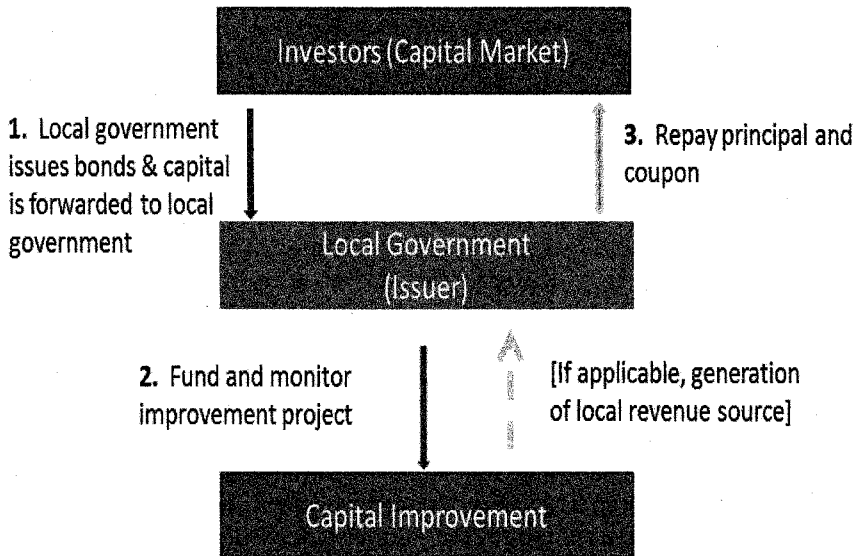
69. See Patrick Manchester, Note, *Be Kind to Your Investor Friends*, 98 GEO. L.J. 1823, 1829–30 (2010) (discussing the history of tax exemptions for municipal bonds). Some municipal bonds do not offer a Federal tax exemption when those bonds are not issued for a general public purpose. See *id.*

70. See generally Christine Sgarlata Chung, *Municipal Securities: The Crisis of State and Local Government Indebtedness, Systemic Costs of Low Default Rates, and Opportunities for Reform*, 34 CARDOZO L. REV. 1455 (2013).

71. See generally *id.*; see also William L. Vallee, Jr., *Sale-Leaseback Transactions by Tax-exempt Entities and the Need for Congressional Guidelines*, 12 FORDHAM URB. L.J. 349, 352–71 (1984).

Figure 3.: Skeletal Diagram of Municipal Bonding

Traditional Bonding



From an investor's perspective, there are a number of risks involved in municipal bonds, including the possibility that the local government may default on its principal and/or interest payments, that interest rates may rise resulting in a lower yield relative to newly issued bonds and altering the market value of the bond, and that the local government may "call" the bond and repay the investors prior to the maturity date (permitted by some bonds).⁷² Notwithstanding these risks, the primary risk of repayment on municipal bonds is almost exclusively the responsibility of the local government.⁷³ Local governments that issue bonds are, depending on the bond structure, exclusively responsible to bondholders for the principal and interest.⁷⁴

72. See *Investor Bulletin: Municipal Bonds*, U.S. SEC. & EXCH. COMM'N, <http://www.sec.gov/investor/alerts/municipalbonds.htm> (last modified Jun. 15, 2012).

73. Municipal bond insurers also bear risk relevant to municipal bonds and whether they will be repaid. This Article is principally concerned with local government risk relative to bond investor risk and not municipal bond insurers' risk.

74. See, e.g., *Flushing Nat'l Bank v. Mun. Assistance Corp. for the City of N.Y.*, 358 N.E.2d 848, 851 (N.Y. 1976) (discussing the New York state

Although the legal obligations and the extent to which the entity must pay the bonds back may change depending on whether the bonds were secured by the full faith and credit, the local government that issued the bonds is contractually obligated to pay the principal and interest.⁷⁵

Local governments also bear the risk of loss for any inefficiency in the project. For example, if a new water treatment facility is over budget or does not perform to the projected optimum level, the relevant local government is responsible for raising the additional funds to cover the full costs and for ensuring that the water exiting the plant is in quantity and quality that meets federal and state standards. An argument could be made that bond investors assume some risk relative to the project's performance, particularly in the case of revenue bonds where payment to the bondholders is based on revenues generated from the project. Most bonds, however, are specifically structured to disassociate risk of payment from risk stemming from the project itself. Bondholders rarely have involvement with the project. They almost never have oversight or review authority, and are usually unconcerned with the project and its development. If the project fails or does not achieve its stated goals, the public entity that issued the bonds is obligated to pay the bondholders. Even in the case of revenue bonds, the bondholders are entitled to their full principal and interest payment as local governments may not avert their bond obligations based on a project's failure. While the dedicated funding stream may be insufficient to pay bondholders, they are still entitled to receive payment, which, of course, may come from the city's general coffers. Further, as noted in several judicial opinions, general purpose governments, such as cities and counties, often come to the aid of special purpose districts to ensure that they do not miss bond payments even when general purpose governments are not legally obligated to make the payments.⁷⁶ When the dedicated revenue source is deficient, general purpose governments tap into alternative resources, such as the general tax revenues, to ensure that a default does not

constitutional requirement that a local government may not issue bonds unless it has pledged its "full faith and credit" to repayment of both principal and interest).

75. While general purpose local governments, such as cities and counties, may legally insulate themselves from bondholders by having a special purpose district issue bonds not backed by the full faith and credit of the general purposes entity, the special purpose district—a local government—is still legally obligated to pay the bondholders.

76. See, e.g., *Dykes v. N. Va. Transp. Dist. Comm'n*, 411 S.E.2d 1, 11 (Va. 1991) (Stephenson, J., dissenting) ("Is anyone so naïve that they truly believe that the County, in reality, is not compelled to make annual appropriations until the bonds are retired? What are some of the consequences if the County ceases to make the appropriations? Obviously, the bondholders would have no recourse, and their bonds would be worthless. Quite obviously, also, the County's credit would be seriously impaired, if not destroyed.").

occur.

IV. CHALLENGES FACING MUNICIPAL BONDING IN THE CONTEXT OF ADAPTATION

This Part sets forth two challenges facing local governments when employing municipal bonds to finance adaptation projects. First, when juxtaposed with the current precarious fiscal state of local governments and the high cost of adapting local infrastructure, municipal bonds become a limited funding option. Second, missing from the municipal bond structure are components that could help policymakers account for externalities in the context of adaptation. Municipal bonds are structured in a way that fails to capture value embedded in climate-related impacts to ecosystems services. The goals of traditional infrastructure projects include growth and population increases; and the structure of municipal bonding supports these goals.⁷⁷ Growth, however, is not a goal of adaptation. Rather, equity, resiliency (and aversion of catastrophic loss), and sustainability are adaptation goals, which work with ecosystems. In the process of achieving equity, resiliency, and sustainability, adaptation projects provide an unprecedented savings in designated portions of the private sector that are not realized when using municipal bonds. As set forth below, this savings represents an actual and real value that has a corresponding cost not captured when using the municipal bond structure.

A. *Current State of Municipal Fiscal Affairs*

Even at \$3.7 trillion dollars (approximately \$365 billion in bonds were issued in 2012), the municipal bond market would have to multiply several times to assume the potential costs of adaptation.⁷⁸ While the cost of adaptation will be enormous, the current state of local government finances makes it additionally unlikely that local governments will be able to finance adaptation with municipal bonds. Local governments are not currently in a position to assume more debt through municipal bonding, much less the debt obligations necessary to adapt to climate change.⁷⁹ Local governments have been losing revenue and experiencing increased costs.⁸⁰ As stated by the State and Local Government

77. Edward J. Sullivan & Isa Lester, *The Role of the Comprehensive Plan in Infrastructure Financing*, 37 URB. LAW. 53, 58 (2005).

78. Press Release, Sec. Indus. & Fin. Markets Ass'n, SIFMA Issues 2013 Municipal Bond Issuance Survey (Dec. 21, 2012), available at <http://www.sifma.org/news/news.aspx?id=8589941274>.

79. Some, such as ICLEI, have suggested that the traditional funding strategies will fail to "marshal sufficient funds relative to the scale of the required financing." BRUGMANN, *supra* note 4, at 18.

80. *Road To Financial Distress in Varies by City in U.S.: Report*, REUTERS, Sept. 19, 2013, available at <http://www.reuters.com/article/2013/09/20/us-usa-cities-fiscal-stress-idUSBRE98J00220130920>.

Leadership Center at George Mason University, “[l]ocal governments are confronting perhaps the greatest fiscal challenges in at least a century.”⁸¹

The single largest source of local government income is derived from property taxes.⁸² Most property taxes are calculated based on assessed property values and property tax rates. As values drop, property tax revenues drop. When the housing market collapsed, almost every county in the U.S. experienced some drop in property tax revenue, making it more difficult for local governments to make their current bond payments.⁸³ For example, while the number remains small, there are several local governments that have missed bond payments and a couple dozen that have filed for bankruptcy, including large local governments, such as Detroit at \$18.5 billion and Jefferson County, Alabama at \$4 billion.⁸⁴

The drop in tax revenues makes it uncertain that local

81. CENTER FOR ST. & LOC. GOV'T LEADERSHIP, *supra* note 15. Local governments are receiving less federal and state funds, compounding their fiscal challenges. *Id.* at 2.

82. Christine R. Martell & Adam Greenwade, *Profiles of Local Government Finance*, in 178 OXFORD HANDBOOK OF STATE AND LOCAL GOVERNMENT FINANCE (Robert D. Ebel & John E. Petersen, eds., 2012).

83. CENTER FOR ST. & LOC. GOV'T LEADERSHIP, *supra* note 15, at 2. A loss in property tax revenue due to a drop in the property tax assessment can be off-set by an increase in the property tax rate (so long as permitted under state law). Raising property tax rates, however, has a number of ramifications, including making the prospect of borrowing less likely, as there is less flexibility to find revenue streams to pay for the new bond payments and making it more expensive to borrow as the bonds may be rated more poorly and thus carry a higher coupon rate. In addition, there are a number of societal impacts connected to raising the property tax rate that may hurt a local government. *See, e.g.*, *Edgewood Indep. Sch. Dist. v. Kirby*, 777 S.W.2d 391, 393 (Tex. 1989) (“Property-poor districts are trapped in a cycle of poverty from which there is no opportunity to free themselves. Because of their inadequate tax base, they must tax at significantly higher rates in order to meet minimum requirements for accreditation; yet their educational programs are typically inferior.”).

84. *Bankrupt Cities, Municipalities List and Map*, GOVERNING: THE STATES AND LOCALITIES, <http://www.governing.com/gov-data/municipal-cities-counties-bankruptcies-and-defaults.html> (last visited Jan. 25, 2014). Other local governments that have filed for bankruptcy include City of San Bernardino, California; Town of Mammoth Lakes, California (dismissed); City of Stockton, California; City of Harrisburg, Pennsylvania (dismissed); City of Central Falls, Rhode Island; and Boise County, Idaho (dismissed). *Id.* According to the S&P Municipal Bond Index 46 of 20,307 bond deals and 30 of 20,802 bond deals in 2011 and 2012, respectively, defaulted. S&P DOW JONES INDICES, FIXED INCOME UPDATE: 2013 MUNICIPAL BOND DEFAULT RATE FALLS TO 0.107% (2014); *see also*, C. TYSON SCHOBACK & MICHAEL P. TAYLOR, COLUMBIA MGMT., AGENCY RATING VOLATILITY: MUNICIPAL RECALIBRATION AND BEYOND: ARE THE RATING AGENCIES SHIFTING THE GOALPOSTS (AGAIN)? (2013), available at https://www.columbiamanagement.com/content/columbia/pdf/AGENCYRATING_WHITEPAPER.PDF.

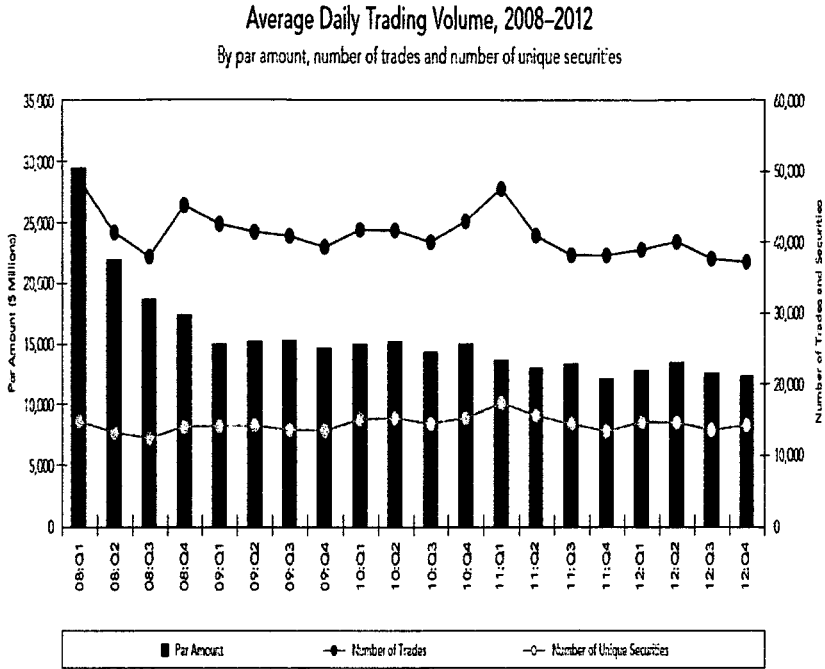
governments will have funds available to make new bond payments. This realization affects local governments' decision to issue new bonds. As set forth in Figure 4, the total par amount (face value of the bonds) traded on the municipal bond market dropped by nearly 50% between 2008 and the end of 2012.⁸⁵ A further indication of the current state of the bond market is that there was a "\$65 billion outflow of investor money from bond funds last year."⁸⁶ Further, as Figure 4 indicates, the last several years have trended toward less municipal borrowing. If local governments are already reducing the amount of debt they assume and issue, it is logical to assume that local governments will not be willing or able to borrow the necessary amount to cover adaptation costs under their current fiscal constraints.⁸⁷

85. MUN. SEC. RULEMAKING BD., 2012 FACTBOOK 38 (2012), available at http://msrb.org/msrb1/pdfs/MSRB-FactBook-2012_WEB.pdf.

86. Penelope Lemov, *Will the 2014 Muni Market Be Good for Issuers?*, GOVERNING.COM (Jan. 30, 2014), <http://www.governing.com/topics/finance/gov-2014-municipal-bond-market-good-issuers.html>.

87. See, e.g., Greg Botelho, *Atlanta Mayor Says Price To Keep Braves in City Limits Was Too Steep*, CNN (Nov. 13, 2013, 1:12 PM), <http://www.cnn.com/2013/11/12/us/atlanta-braves-move/> (discussing Atlanta mayor Kasim Reed's decision not to incur between \$150 million and \$250 million in additional debt for "extensive public investments" for Turner Field and the surrounding area requested by the Atlanta Braves, resulting in the Braves choosing to leave Atlanta for suburban Cobb County where they were offered a reported \$450 million in public financing).

Figure 488



Source: Municipal Securities Rulemaking Board.

The financial bad news continued at the end of 2013, when both Moody's and Fitch stated that they expect more municipal bond rating downgrades than upgrades in 2014.⁸⁹ Typically, a downgrade in a municipal bond rating makes it more expensive for local governments to raise cash, as they must pay a higher rate of interest to entice investors to accept the riskier offering. In their respective statements, Moody's noted that the "number of junk-rated public finance issuers has grown by 27% since 2008 [junk rated' refers to high risk, high yield bonds that are non-investment grade; each rating agency sets a standard and anything below that standard is considered "junk"]."⁹⁰ Similarly, Fitch noted:

[E]vidence of management's failure to prioritize debt service payments in a limited number of bankruptcy cases is troubling. . . . If pending bankruptcy rulings demonstrate that pensions take priority over general obligation debt service, or require debt restructuring along with benefit adjustments, more cities may be

88. MUN. SEC. RULEMAKING BD., *supra* note 85, at 38.

89. Michael Aneiro, *More Municipalities Face Downgrades, Junk Ratings*, BARRON'S INCOME INVESTING BLOG (Dec. 3, 2013, 4:23 PM), <http://blogs.barrons.com/incomeinvesting/2013/12/03/more-municipalities-face-downgrades-junk-ratings/>.

90. *Id.*

encouraged to take this path. Fitch would likely re-evaluate the strength of the general obligation pledge in states where benefits are clearly placed ahead of [local government] debt.⁹¹

The connection between rating downgrades, fiscal distress, and the inability to borrow is evident from the example of Stockton, California. In 2010, Moody's rated Stockton, California's bonds for its pension obligations an A1 (a secure rating for municipal bonds).⁹² Over the next two and one-half years, Moody's downgraded Stockton's rating seven times, rating the obligations a Caa3 (a very low, "junk" rating) by the middle of 2012.⁹³ Three months later, Stockton was unable to reissue its bonds and filed for bankruptcy.⁹⁴ It is hard to imagine cities, especially those in fiscal distress, such as Stockton, having the ability to assume the debt necessary to fund adaptation when they can barely cover their current obligations. The current state of local government budgets is such that issuing additional municipal bonds would place an enormous burden on an already overwhelmed system.

B. Matching Adaptation Goals with Funding Goals

Municipal bonding may be insufficient to fully finance adaptation because the structure in which municipal bonds are issued can be incompatible with the goals of adaptation. Municipal bonding has traditionally been used in conjunction with projects designed to facilitate economic development and growth.⁹⁵ Its structure and process reflect a desire to promote economic development and growth with the ultimate goal of increasing long-term tax revenues.⁹⁶ Tax increment financing (TIF) through TIF bonds (one form of municipal bonds) and TIF districts provides a good illustration of bonds being used to facilitate economic growth and enhance local revenues.⁹⁷ Typically, funds generated from issuing TIF bonds are used to improve a designated geographic area (the TIF district) through projects such as the construction of new roads, schools, and water services.⁹⁸ The local government

91. *Id.* But see Detroit Bankruptcy case (refusing to give priority to pensions in the pending bankruptcy).

92. SCHOBACK & TAYLOR, *supra* note 84, at 3.

93. *Id.*

94. *Bankrupt Cities, Municipalities List and Map*, *supra* note 84.

95. Sullivan & Lester, *supra* note 77 (quoting Laurie Reynolds, *Living with Land Use Exactions*, 11 YALE J. ON REG. 507, 508 (1994)) ("community growth was seen as a 'stimulus to population increases and economic growth through higher real estate values'").

96. *See id.*

97. For a description of TIF bonds generally see James R. Paetsch & Roger K. Dahlstrom, *Tax Increment Financing: What It Is and How It Works*, in FINANCING ECONOMIC DEVELOPMENT: AN INSTITUTIONAL RESPONSE (Richard D. Bingham et al. eds., 1990).

98. For examples of projects financed with TIF bonds see N.Y.C. Indep. Budget Office, *Learning from Experience: A Primer on Tax Increment Financing*, FISCAL BRIEF, Sept. 2002, at 3,

investment in the TIF district is intended to incentivize private sector investment in the district. The combination of the TIF funds and private sector investment are believed to result in an increase in property values in the district—the tax increment. The tax increment represents funds above a pre-set frozen amount that are deposited into a special fund that are then used to pay off the bonds. By intertwining success of the infrastructure project to bond payments, TIF bonds make the project dependent upon economic development. If the project is successful, tax revenues will increase and provide the funds necessary to make bond payments—if the project fails, there will be insufficient tax increment to pay bondholders.

Economic development and growth are not primary goals of adaption and are not part of many adaptation projects. Adaptation and its associated projects seek to preserve or improve—and not necessarily grow—existing infrastructure. Adaptation involves: 1) “safeguarding equity”; 2) “reducing vulnerability”; and 3) “ensuring resiliency”.⁹⁹ The following three subparts explore in more detail whether municipal bonds are structured in a way that supports these three adaptation goals.

1. Equity

Equity in adaptation “ensure[s] that the benefits of promoting resilience and reducing vulnerability are distributed fairly.”¹⁰⁰ Municipal bonds are principally funded through either the general coffers (predominantly comprised of the property tax), or a special fund, such as a TIF, in which the bonds are paid back from growth in property tax revenues.¹⁰¹ As scholars have repeatedly stated, reliance on the property tax framework results in inequities among local jurisdictions and tends to favor wealthier communities.¹⁰² For decades, economically depressed local governments have sought a more equitable solution for funding among local jurisdictions.¹⁰³ Challenges to the property tax structure claim that basing revenues and available services on the property tax allows wealthier jurisdictions to provide better and more services, such as in educational opportunities.¹⁰⁴ Wealthier

<http://www.ibo.nyc.ny.us/iboreports/TIF-Sept2002.pdf>.

99. Ruhl & Salzman, *supra* note 6, at 975.

100. *Id.* at 1021.

101. Bauman & Ethier, *supra* note 63, at 51-52.

102. Laurie Reynolds, *Skybox Schools: Public Education as Private Luxury*, 82 WASH. U.L.Q. 755, 756-57 (2004); U.S. GEN. ACCOUNTING OFFICE, SCHOOL FINANCE: STATE EFFORTS TO EQUALIZE FUNDING BETWEEN WEALTHY AND POOR SCHOOL DISTRICTS 2 (1998).

103. See *Serrano v. Priest*, 487 P.2d 1241 (Cal. 1971).

104. See *San Antonio Indep. Sch. Dist. v. Rodriguez*, 411 U.S. 1 (1973); *Sheff v. O'Neill*, 678 A.2d 1267 (Conn. 1996); *Rose v. Council for Better Educ.*, 790 S.W.2d 186 (1989); *Edgewood Indep. Sch. Dist. v. Kirby*, 777 S.W.2d 391 (Texas 1989).

communities have access to more tax revenues through higher property tax assessments, providing their communities with better services.¹⁰⁵ Relatedly, because they have higher property tax assessments, they are also able to have lower tax rates, encouraging more economic growth. As one court noted in a case involving the property tax and inadequate funding for education, distressed communities are caught in a vicious cycle in which any attempt by a local government to raise the property tax rate to improve schools and other services will result in people leaving the jurisdiction, leading to a lower property tax assessment.¹⁰⁶

Similar to basing educational services on the property tax, basing the opportunities to protect vital local infrastructure from climate damage on the property tax will likely to lead to further inequities.¹⁰⁷ Distressed cities will have less opportunity to issue municipal bonds due to their fiscal conditions, and therefore, they will have less opportunity to adapt to climate-changing conditions. Economically distressed cities may also pay a higher cost for borrowing because their bonds may carry higher risk, and thus a higher interest rate.¹⁰⁸ As discussed above, a higher interest rate translates into a higher cost to the city in paying back the bonds. Thus, those cities that are least able to afford issuing bonds may have to pay more for similar projects, further disincentivizing them from taking the necessary adaptation steps.¹⁰⁹

Distressed cities may also find it difficult to find investors as the bonds may be considered too risky. Failing to find investors for a bond issuance is an expensive endeavor for local governments. A bond issuance can cost millions. If it fails (in that the city is unable to find bond investors), the money spent on the issuance is gone and has produced no reciprocal compensation. Last year, for example, Richmond, California's failed bond attempt cost the city \$4 million.¹¹⁰ A failed bond attempt is a possibility that may

105. See Ronald F. Ferguson, *Paying for Public Education: New Evidence on How and Why Money Matters*, 28 HARV. J. ON LEGIS. 465 (1991); but see Eric A. Hanushek, *When School Finance "Reform" May Not Be Good Policy*, 28 HARV. J. ON LEGIS. 423, 425 (1991) (arguing that "there is no systematic relationship between school expenditures and student performance").

106. *Kirby*, 777 S.W.2d at 393.

107. Municipal bonding also results in unhealthy competition among municipalities, often to the detriment of economically distressed communities. This competition is routed in the desire to lure private sector investment to one community over another. Often it is the wealthier communities that may offer more incentives (for example, property tax abatements) as they have more available tax revenues. See generally Laura A. Reese, *Municipal Fiscal Health and Tax Abatement Policy*, 5 ECON. DEV. Q. 23 (1991).

108. See *supra* notes 89-94 and accompanying text for a discussion of added costs on higher risk bonds.

109. See *supra* notes 89-94.

110. See Carolyn Said, *Eminent Domain Plan May Have Spooked Investors*, SFGATE (Aug. 29, 2013, 11:00 PM), <http://www.sfgate.com/realestate/article/Eminent-domain-plan-may-have-spooked-investors-4773720.php>.

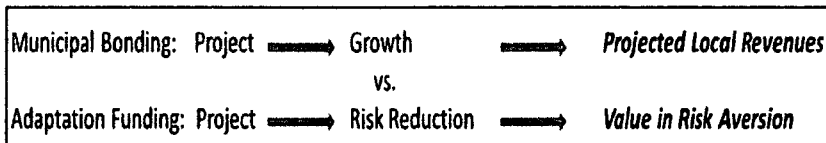
further dissuade economically distressed communities from attempting to issue bonds for critical adaptation projects.

2. Incentivizing Investment

In the context of adaptation, the structure in which municipal bonds are issued results in a misallocation of risk and reward. One of the primary beneficiaries of projects funded through municipal bonding is the local government. The projected growth facilitated by municipal bonding is believed to be captured in long-term local revenues for the city. As such, local governments benefit as they can provide better and more services. Although bondholders may gain a profit from purchasing municipal bonds, the city is the primary beneficiary, as it is making an investment to increase its long term revenue.

As shown in Figure 5, the beneficiaries and the value received by those beneficiaries differ between projects traditionally funded with municipal bonds and adaptation projects. Where municipal bonds help infrastructure projects create value based on growth and economic development, adaptation projections create value based on risk aversion. The risk aversion value is the amount of money local communities avoid having to pay by averting a climate-related disaster. It is a value not captured in the municipal bond structure and, as discussed in the next Section, a structure that can help incentivize private sector investment.

Figure 5.



In the context of adaptation, the municipal bond structure separates many of the private sector beneficiaries from any rights of oversight and from any risk of performance. Private sector parties, however, stand to lose from climate change and gain from adaptation projects.¹¹¹ For some insurers, reinsurers, utility

111. For a discussion of reinsurers' role in adaptation see Sean B. Hecht, *Insurance*, in *THE LAW OF ADAPTATION TO CLIMATE CHANGE* 525–26 (Michael B. Gerrard & Katrina Fischer Kuh eds., 2012). “Yet despite widespread recognition of the effects climate change will likely have on extreme events, few insurers were able to articulate a coherent plan to manage the risks and opportunities associated with climate change.” CERES, *CLIMATE RISK DISCLOSURES BY INSURERS: EVALUATING INSURER RESPONSES TO THE NAIC CLIMATE DISCLOSURE SURVEY 5* (2011), available at http://www.ceres.org/resources/reports/naic-climate-disclosure/atresource_view; see also SIDERS, *supra* note 50, at 97 (noting that “[i]n Isla Vista, California, in 2004, five large apartment complexes, worth almost \$20 million were condemned due to cliff erosion that had made the

companies, and owners and developers of real estate, adaptation investment may provide a possibility to protect their investment. As one individual noted,

Climate change remains a material risk for a majority of investors and, in many cases, it is increasingly influencing their investment activities. . . . About 81 percent of asset owners and 68 percent of asset managers said they view climate change as a material risk across their entire investment portfolio in the third annual Global Investor Survey on Climate Change.¹¹²

Under the municipal bond structure, investors have little opportunity to oversee efficient adaptation. Because municipal bonds are structured so that investors have little oversight or connection to the projects, those with climate risks have less motivation to invest in adaptation and ensure that adaptation projects are meeting the necessary threats.

3. Resiliency

The process of municipal bonding may also not be suitable to achieve the adaptation goal of ensuring resiliency. Ensuring resiliency helps insulate local governments from climate changing impacts and expedites recovery when climate impacts occur.¹¹³ Resiliency is a form of adaptation that incorporates sustainable development.¹¹⁴ The incorporation of resiliency into infrastructure projects is designed to increase the projects' performance by going beyond simple risk-reduction and looking at creating vibrant communities.¹¹⁵ Resiliency simultaneously protects from climate

homes uninhabitable”).

112. Andrea Vittorio, *Investors See Climate Change as Risk That Influences Decisions: Report*, BLOOMBERG, Aug. 6, 2013, available at <http://www.bloomberg.com/news/2013-08-06/investors-see-climate-change-as-risk-that-influences-decisions-report.html>; see GLOBAL INVESTOR COAL. ON CLIMATE CHANGE, GLOBAL INVESTOR SURVEY ON CLIMATE CHANGE: 3RD ANNUAL REPORT ON ACTIONS AND PROGRESS (2013), available at <http://www.ceres.org/resources/reports/global-investor-survey-on-climate-change-2013/view>.

113. Ruhl & Salzman, *supra* note 6, at 1021.

114. See Godschalk, *supra* note 12, at 137 (defining resilient cities: “Their lifeline systems of roads, utilities, and other support facilities are designed to continue functioning in the face of rising water, high winds, shaking ground, and terrorist attacks. Their new development is guided away from known high hazard areas, and their vulnerable existing development is relocated to safe areas. Their buildings are constructed or retrofitted to meet code standards based on hazard threats. Their natural environmental protective systems are conserved to maintain valuable hazard mitigation functions. Finally, their governmental, nongovernmental, and private sector organizations are prepared with up-to-date information about hazard vulnerability and disaster resources, are linked with effective communication networks, and are experienced in working together.”).

115. See BRUGMANN, *supra* note 4, at 11 (defining resilience as more than simply a risk mitigation strategy but as focusing on “the overall performance of the relevant area as a functioning urban unit.”).

losses and mitigates future climate changes by creating a community harmonious with ecosystems.¹¹⁶ As one report stated:

Strictly speaking, ‘adaptation’ focuses development on mitigation of specific risk factors without a clear connection to the overall performance of the relevant area *as a functioning urban unit*. . . . From an urban property and infrastructure development perspective, ‘resilience upgrading’ is implementing a set of financially justified risk reduction measures that increase the reliability of investment returns and asset values under a wider range of circumstances.¹¹⁷

Resilient adaptation projects are designed to accommodate changes in the climate by leveraging ecosystem capacities and working with ecosystems.¹¹⁸ Ecosystems provide services—and a corresponding value—that result from the “physical, chemical and biological activities that influence the flows, storage, and transformation of materials and energy within and through ecosystems.”¹¹⁹ An ecosystem services management approach accounts for the value stemming from ecosystem services, which are “combine[d] with manufactured and human capital services to produce human welfare.”¹²⁰ For example, instead of building new

116. *Id.*

117. *Id.*; see Vittorio, *supra* note 4 (Hoboken, New Jersey Mayor Dawn Zimmer stated following her meeting with a White House task force on adaptation that “her priority . . . was ‘to make sure that cities in the future are rebuilt in a much more resilient way.’”).

118. For a brief history of an ecosystem services approach to governance, see J.B. Ruhl & James Salzman, *The Law and Policy Beginnings of Ecosystem Services*, 22 J. LAND USE & ENVTL. L. 157, 157 (2007). For alternative perspectives and criticism of an ecosystem services approach see Nancy E. Bockstael et al., *On Measuring Economic Values for Nature*, 34 ENVIRON. SCI. & TECH. 1384 (2000); David Pearce, *Auditing the Earth*, 40 ENVIRONMENT 23, 23–28 (1998); COMMITTEE ON ASSESSING AND VALUING THE SERVICES OF AQUATIC AND RELATED TERRESTRIAL ECOSYSTEMS, NAT’L RESEARCH COUNCIL, VALUING ECOSYSTEM SERVICES: TOWARD BETTER ENVIRONMENTAL DECISION-MAKING 189 (Nat’l Academies Press 2004).

119. DAVID GOODSTEIN, OUT OF GAS: THE END OF THE AGE OF OIL 32–33 (2004); see also Millennium Ecosystem Assessment, *Ecosystems and Human Well-being: Synthesis v* (2005) (defining “ecosystem services” as “the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling.”). Costanza et al. identified seventeen ecosystem services: gas regulation, climate regulation, disturbance regulation, water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, biological control, refugia (habitat), food production, raw materials, genetic resources, recreation, and cultural. Robert Costanza et al., *The Value of the World’s Ecosystem Services and Natural Capital*, 387 NATURE 253, 254 tbl.1 (1997).

120. *Id.* at 254 (stating that “[e]ach form of capital stock generates, either autonomously or in conjunction with services from other capital stocks, a flow of services that may be used to transform materials . . . to enhance the welfare

and wider roads, many cities, such as London, Stockholm, and Singapore, are enhancing traffic flows through smart sensors and mass transit.¹²¹ The closing of several storm barriers in the Netherlands, as another example, led to a drastic reduction in shellfish and seals and a change in salination, altering the ecosystem almost entirely.¹²² Learning from these unintended adverse outcomes, the Netherlands has started considering wetlands and other natural remedies to absorb storm surges.¹²³

One cannot begin to understand flood control . . . without realizing the impact of widespread wetland destruction on the ecosystem service of water retention; nor can one understand water quality without recognizing how development in forested watersheds degrades the service of water purification. The costs from degradation of these services are high, and suffered in rich and poor countries alike.¹²⁴

Resiliency in investment “focuses investment on increasing a city area’s overall ability to support a vibrant, healthy society and economy under a wide range of circumstances. . . . Rather than just being a risk-reduction cost, resilience investments aim to create an urban area’s development premium.”¹²⁵ Building for resiliency may provide a “resilience investment opportunity” in protecting existing infrastructure *and* in increasing the overall performance and value of urban areas.¹²⁶ Incorporating sustainable development into designs through techniques such as smart growth, for example, may provide investment opportunities in reducing the upfront cost of infrastructure, reducing the cost for ongoing services, and creating increased property values, and therefore, increased tax revenues.¹²⁷ Including sustainable development as part of adaptation plans incorporates a market-driven solution that serves the local community’s needs. If an investor cannot find value in adaption and sustainable development, including improving the community’s conditions, it is questionable whether the government should invest in protecting the infrastructure and it is questionable whether the community will benefit from the investment.

of humans.”).

121. Marshall, *supra* note 58.

122. *Id.*

123. *Id.*

124. DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 11 (4th ed. 2010) (citing MILLENNIUM ECOSYSTEM ASSESSMENT, LIVING BEYOND OUR MEANS: NATURAL ASSETS AND HUMAN WELL-BEING 5, 16–22 (2005)).

125. BRUGMANN, *supra* note 4, at 21.

126. *Id.* at 15.

127. SMART GROWTH AM., BUILDING BETTER BUDGETS: A NATIONAL EXAMINATION OF THE FISCAL BENEFITS OF SMART GROWTH DEVELOPMENT 4–8 (2013), available at <http://www.smartgrowthamerica.org/documents/building-better-budgets.pdf>.

There are no obvious components embedded in municipal bonds that incentivize resiliency in investments by helping policymakers account for externalities stemming from the use of ecosystems.¹²⁸ Municipal bonds are not structured to internalize externalities pertaining to local adaptation projects.¹²⁹ Municipal bonds do not have a means of capturing ecosystems' value and utilizing that value to pay bondholders. This is not to suggest that some adaptation projects will require an almost exclusively protectionist approach to avoid grave harm. However, it is to suggest that the funding of adaptation projects may be made easier if the projects consider more than just avoiding a current risk and, instead, also incorporate factors that can create a resilient city and enhance value.¹³⁰

V. CONCLUSION: THE FUTURE OF FUNDING ADAPTATION

The fiscal challenges facing local governments and the risk of catastrophic and systemic loss may provide sufficient motivation to encourage local governments to look for creative means to finance adaptation projects.¹³¹ Successfully funding adaptation projects will require additional access to capital and new ways of capturing value to incentivize the funding adaptation projects. Outside the context of adaptation, local governments are taking steps to diversify funding options. Many of these options have the potential to help local governments raise the capital necessary to adapt to climate change while promoting resilient, sustainable communities. Several of these methods incorporate public / private partnerships, account for externalities, capture value in ecosystem services, and promote resiliency in investment.¹³²

128. Keith H. Hirokawa, *Sustaining Ecosystem Services Through Local Government Environmental Law*, 28 PACE ENVTL. L. REV. 760, 786 (2011).

129. See generally Blake Hudson, *Federal Constitutions: The Keystone of Nested Commons Governance*, 63 ALA. L. REV. 1007, 1021–23 (2012).

130. BRUGMANN, *supra* note 4, at 18 (“[F]ocusing specifically on risk reduction rather than the broader, revenue-generating opportunity for investment, little incentive is created to attract private investment into adaptation and other risk reduction projects.”). Seattle’s Elliot Bay Seawall employs a variety of ecosystem services to protect the built environment, while making an aesthetically pleasing place to lure people. WATERFRONT SEATTLE, <http://www.waterfrontseattle.org/> (last visited Jan. 25, 2014). Elliot Bay Seawall includes restored kelp forest, permeable promenade, native shoreline, storm way gardens. *Id.* See Ruhl & Salzman, *supra* note 6, at 984 (“Adapting to the impacts of climate change will vary depending on each location’s geography and vulnerabilities.”).

131. Sridhar Vedachalam, David L. Kay & Susan J. Riha, *Capital Investment and Privatization: Public Opinion on Issues Related to Water and Wastewater Infrastructure*, PUB. WORKS MGMT. POL’Y, Oct. 8, 2013, at 11 (“The fiscal situation in many municipalities has forced communities across the U.S. to look at alternative ways of financing.”).

132. For a discussion of public / private partnerships see Eduardo Engel, Ronald Fischer & Alexander Galetovic, *The Economics of Infrastructure Finance: Public-Private Partnerships versus Public Provision*, 15 EIB PAPERS

The public / private partnerships are designed to open new sources of capital and incentivize private sector investment in sustainable development to accelerate adaptation.¹³³ The partnerships reallocate the risk of loss from climate-related events among the relevant public and private sector parties by internalizing costs and capturing an ecosystem services value. The public / private partnerships also allow the parties to capitalize on and capture a risk aversion value embedded in ecosystem services that more accurately responds to adaptation needs. “[I]f it can be established that climate or disaster risks are directly lowering property values, then value capture mechanisms should in principle be available to finance the measures to reduce these risks, and thereby increase those values.”¹³⁴ In addition, adaptation projects generally “are particularly suited for providing the capital for the long-term environmental infrastructure required to build a low-carbon, climate-resilient economy. The extra upfront investments are often balanced by much lower operating costs, particularly in the building, energy, industrial and transport sectors.”¹³⁵ By capturing value in risk aversion and efficiency, the partnerships provide opportunities to incentivize private sector investment in adaptation projects.

There are a number of public / private financing methods that reconfigure the public and private sectors’ roles to account for ecosystem services impacts and to leverage each party’s strengths, including human and financial capital.¹³⁶ The reconfigurations assume different forms from minimal private sector input and involvement to minimal public sector input and involvement,¹³⁷ and include infrastructure trusts,¹³⁸ Property Assessed Clean

40, 40–69 (2010).

133. See Randy Rogers, *Bayonne Uses Private Investment to Address Water Woes*, SUSTAINABLE CITY NETWORK (Dec. 11, 2013, 3:47 PM), http://www.sustainablecitynetwork.com/topic_channels/water/article_41ae3c24-62b8-11e3-ba08-001a4bcf6878.html (“In the nearly universal struggle to improve and maintain crumbling infrastructure, local governments are increasingly turning to private investors to pay for and manage public services.”).

134. BRUGMANN, *supra* note 4, at 39.

135. CLIMATE BONDS INITIATIVE, *BONDS AND CLIMATE CHANGE: THE STATE OF THE MARKET IN 2013*, at 2 (2013), available at http://www.climatebonds.net/wp-content/uploads/2013/08/Bonds_Climate_Change_2013_A4.pdf.

136. Vedachalam, Kay & Riha, *supra* note 131, at 11.

137. See, e.g., Caroline Cournoyer, *Portland’s Testing a Greener Kind of P3*, GOVERNING (Nov. 2013), <http://www.governing.com/topics/transportation-infrastructure/gov-portland-testing-greener-p3.html> (setting forth a proposed Gateway Green project that involves almost full private sector upfront funding through crowd funding).

138. Trusts originate with private sector funding and may include investors who would benefit from a reduced risk of loss from climate change, such as reinsurers or utility companies. For an example of a recently initiated Trust see Ryan Holeywell, *Dauphin County Launches Infrastructure Bank*,

Energy (PACE),¹³⁹ Kyoto Protocol's Clean Development Mechanism (CDM),¹⁴⁰ Green Banks,¹⁴¹ and the Morris [County,

GOVERNING (May 30, 2013), <http://www.governing.com/blogs/view/gov-pennsylvania-county-debuts-infrastructure-bank.html>. The funding is used to improve environmental performance in local infrastructure projects. *See, e.g.*, Press Release, Office of the Mayor of the City of Chicago, Mayor Rahm Emanuel Announces Chicago Infrastructure Trust to Invest in Transformative Projects (Mar. 1, 2012), *available at* <http://www.cityofchicago.org/content/dam/city/depts/mayor/Press%20Room/Press%20Releases/2012/March/3.1.12Infrastructure.pdf>. Critically, the money saved in preventative and efficiency measures is used to pay the investors. Several trusts are in existence around the world including two in the U.S.—with one being the yet-untested Chicago infrastructure trust. *See id.* Only the K-Green Trust in Singapore is specifically dedicated to environmentally focused infrastructure, such as a waste-to-energy plant and a new water treatment facility partially powered by solar. *Senoko Waste-to-Energy Plant, K-GREEN TRUST*, http://www.kgreentrust.com/senoko_WTE_plant.html (last visited Jan. 25, 2014). Trusts differ as to whether the final project is public or privately owned. For example, K-Green Trust owns the project and local governments enter into a long-term provider contract with the Trustee. *See* Press Release, K-Green Trust, K-Green Trust Unaudited Results for the Full Year Ended 31 December 2013 (Jan 20, 2014). Other trusts, such as the proposed Chicago plan, would result in the public partially or fully owning the project. *See* CHICAGO INFRASTRUCTURE TRUST, CHICAGO INFRASTRUCTURE TRUST CONTRACTING MANUAL (2013), *available at* <http://www.shapechicago.org/wp-content/uploads/2013/04/CIT-Contracting-Manual-7-19-131.pdf>.

139. PACE financing and bonds require the local government to issue municipal bonds to raise upfront capital. *About Pace*, PACE NOW, <http://pacenow.org/about-pace/> (last visited Dec. 20, 2013); CLIMATE BONDS INITIATIVE, *supra* note 135, at 7 (“33 states now have enabling legislation in place with 7 states facilitating 16 different PACE programs, mainly focusing commercial buildings”). That money is then loaned to individual property owners, who are assessed an annual payment on their property tax bill. The assessment is equal to the principle and interest one the loan amortized over a set period (typically, 15–20 years). *About Pace, supra*. For an example of a recently initiated PACE program see Kevin Duchscher, *St. Paul Port Authority Can Now Issue Bonds to Finance PACE Projects* (Aug. 23, 2013), <http://blog.cleantechies.com/2013/08/23/st-paul-port-authority-can-now-issue-bonds-to-finance-pace-projects/>.

140. The CDM “allows emission-reduction projects in developing countries to earn certified emission reductions (CERs), each equivalent to one tonne of CO₂. CERs can be traded and sold, and used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol.” Press Release, United Nations Climate Change Clean Dev. Mechanism, Kyoto Protocol's Clean Development Mechanism Reaches Milestone at 7,000 Registered Projects 2 (July 8, 2013), *available at* http://cdm.unfccc.int/filestorage/6/u/extfile-20130708093620767-2013-8.7-Release-7000_projects.pdf/2013-8.7-Release-7000%20projects?t=YlR8bXFleDg5fDB9HpAQw0nZ4Q03BVwguJNy. An emission-reduction project is a project in which the developer generates the CERs by reducing CO₂ “compared to a baseline scenario in which a higher emission technology would have been used.” DOROTHEE TEICHMANN, THE ROLE OF PUBLIC-PRIVATE PARTNERSHIPS IN LOCAL INFRASTRUCTURE: THE CASE OF CARBON OFFSET PROJECTS 30 (2011), *available at* <http://www.cdclimat.com/IMG/pdf/12-01->

New Jersey] Model.¹⁴²

As an example, performance-based bonds or social bonds are built around a public / private model that makes additional capital accessible by incentivizing private sector investment, while helping communities adapt. The basic structure of performance-based bonds is set forth in Figure 6. When issuing performance-based bonds, local governments agree to repay investors based on a sliding scale that is dependent upon performance.¹⁴³ The process begins with an intermediary originating in the private sector.¹⁴⁴ The intermediary is an equity partner, who generates profit from successfully developing and managing the capital project and its performance.¹⁴⁵ The intermediary assembles investors and contracts with entities, such as contractors, who are necessary to fulfill the project's objectives.¹⁴⁶ The intermediary also monitors the contractors' performance. As the contractors achieve certain pre-determined goals, the local government forwards funds to the intermediary to make bond payments.¹⁴⁷ The amount of each

17_these_dorothee_teichmann_version_finale-2.pdf. Typically, a CDM involves a public or private entity in a developing country (one without obligations under Kyoto) that obtains CERs and sells them to a developing country (one that does have emission reduction obligations under Kyoto). *What is the Clean Development Mechanism?*, THE GUARDIAN (July 26, 2011), <http://www.guardian.co.uk/environment/2011/jul/26/clean-development-mechanism>. For case studies summarizing CDM projects and how they were funded see UNITED NATIONS ENVIRONMENT PROGRAMME, GUIDEBOOK TO FINANCING CDM PROJECTS (2007), available at <http://www.cd4cdm.org/Publications/FinanceCDMprojectsGuidebook.pdf>.

141. *What Is a Green Bank?*, COAL FOR GREEN CAPITAL, <http://www.coalitionforgreencapital.com/whats-a-green-bank.html> (last visited Jan. 25, 2014). Governor Andrew Cuomo proposed a Green Bank in his 2013 State of the State address. *NY Green Bank*, GOVERNOR ANDREW M. CUOMO, <http://www.governor.ny.gov/NYGreenBank> (last visited Jan. 25, 2014). The Bank would function similarly to the Kyoto Protocol's Clean Development Mechanisms, however, these require the commoditizing of un-used greenhouse gas emissions—something currently beyond local home rule authority.

142. CLEAN ENERGY & BOND FIN. INITIATIVE, CLEAN ENERGY BOND FINANCE MODEL: MORRIS MODEL (2013), available at <http://www.cdfa.net/cdfa/cdfaweb.nsf/ordredirect.html?open&id=cebfi-model-morris.html>. In this form, the local government (here, Morris County, N.J.) enters into a long-term lease with a developer who finances the project. *Id.* at 2. In Morris County the project concerned energy efficiency. *Id.* The local government planned to pay the developer from money saved in increased efficiencies. *Id.* The developer was able to secure a long-term steady cash flow through the lease agreement. *Id.*

143. Jeffery B. Liebman, CENTER FOR AMERICAN PROGRESS, SOCIAL IMPACT BONDS: A PROMISING NEW FINANCING MODEL TO ACCELERATE SOCIAL INNOVATION AND IMPROVE GOVERNMENT PERFORMANCE 1–2 (2011), available at http://www.americanprogress.org/issues/2011/02/pdf/social_impact_bonds.pdf.

144. *Id.*

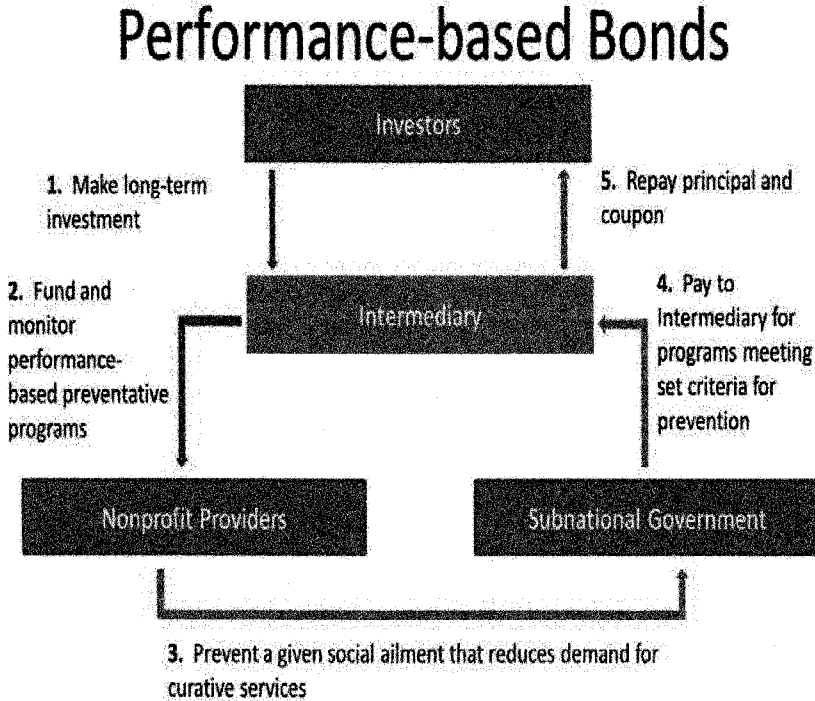
145. *Id.*

146. *Id.*

147. *Id.*

payment is based on projected costs the local government avoids by implementing the project.¹⁴⁸

Figure 6.



In the first set of social bonds issued in the U.S., New York City agreed to make payments to the intermediary and, ultimately, to the contractors so long as there was a pre-determined drop in recidivism among adolescents (i.e. fewer adolescents released from jail or prison returning to jail or prison).¹⁴⁹ With funds forwarded from investors, the intermediary provided working capital to nonprofits to run adolescent

148. *Id.*

149. While there are no doubt details to be worked out with these bonds, they have shown some success in New York City and London, and are now being used in Massachusetts and Utah. See SOCIAL FINANCE, PETERBOROUGH SOCIAL IMPACT BOND (2011), available at http://www.socialfinance.org.uk/sites/default/files/SF_Peterborough_SIB.pdf; Kristina Costa & Jitinder Kohli, *Social Impact Bonds: New York City and Massachusetts to Launch the First Social Impact Bond Programs in the United States*, CENTER FOR AM. PROGRESS (Nov. 5, 2012), available at <http://www.americanprogress.org/issues/economy/news/2012/11/05/43834/new-york-city-and-massachusetts-to-launch-the-first-social-impact-bond-programs-in-the-united-states>; Press Release, United Way of Salt Lake, United Way of Salt Lake Announces Results-based Financing for Low-income Preschool Students (June 13, 2013), available at http://www.uw.org/news-events/media-room/news-releases/uw_resultsbasesfinancingnr.pdf.

behavioral programs. Upon achieving a certain level of success, the city paid the intermediary, who re-paid the investors. As shown in Figure 7, if the re-admission rate of adolescents dropped by 10%, the city would pay investors \$9.6 million, the amount they invested, giving them a 0% return. However, if the rate dropped by 20% or more, the city would pay investors \$11.7 million, a return of 22%. The investors' profit was based on a sharing of the projected savings that the City would net by adopting a preventative approach as opposed to a curative approach—something directly in line with climate adaptation. The upfront costs in both the New York City project and adaptation projects are balanced by a lower loss of future damage. Performance-based bonds help capture a value in social and adaptation projects—a value not captured when utilizing municipal bonds. The performance-based bonding, however, requires “considerable predictability that 1) a group of agencies have established the capacity to implement reliable measures to reduce the risk e.g. of re-offense [and] 2) at a cost that is less than the cost of the risk event.”¹⁵⁰

150. BRUGMANN, *supra* note 4, at 41.

Figure 7.¹⁵¹

Reduction in Re-Admission Rate	Projected Long Term City Net Savings	City Payments to Investors	Investor Return
≥ 20.0%	\$20,500,000	\$11,712,000	22.0%
≥ 16.0%	\$11,700,000	\$10,944,000	14.0%
≥ 13.0%	\$7,200,000	\$10,368,000	8.0%
≥ 12.5%	\$6,400,000	\$10,272,000	7.0%
≥ 12.0%	\$5,600,000	\$10,176,000	6.0%
≥ 11.0%	\$1,700,000	\$10,080,000	5.0%
≥ 10.0%	≥ \$1,000,000	\$9,600,000	0.0%
≥ 8.5%	≥ \$1,000,000	\$4,800,000	-50.0%

Performance-based bonds and similar financing structures could facilitate the implementation of local adaptation projects by providing access to additional funding sources and by maintaining a focus on performance-based preventative measures.¹⁵² The bonds would simply alter the criteria to focus on key environmental conditions likely to indicate reduced climate risks. Instead of measuring recidivism rates, payment would be based on a number of ecosystem-based criteria relevant to climate adaptation. While the specific climate-related criteria would depend on the local needs, for some projects it may be based on “sound financial evaluation of risk profiles and of the related contribution of different measures to reduce [climate-based] risks.”¹⁵³

A public / private funding approach aims to encourage private sector investment in at least two ways. First, it seeks to capture value in risk aversion. Many private sector entities, such as insurers, reinsurers, and private utility companies, can expect losses stemming from climate-related events. Adaptation projects are designed to minimize the risk of loss, and thus, assume a preventative approach analogous to performance-based bonds. Restructuring the financing for adapting projects captures value in risk aversion to incentivize private sector investment. The return on investment, for example, could be based on or tied to a portion of the damages that a neighboring community which has not invested in adaptation suffers in future weather events. It also provides those in the private sector who stand to lose from climate-related events with an opportunity to invest in infrastructure that

151. *Social Impact Bonds—Useful to Achieve Social Change?*, SOC. ENTER. ASSOCS., <http://www.socialenterprise.net/blog/SIB.html> (last visited Jan. 25, 2013).

152. Relatedly, Con Edison, a private entity, recently agreed to spend \$1 billion for adaptation and resiliency projects. *Con Edison Improves Storm Resiliency of Energy Systems*, WATER ENV'T FED'N STORMWATER REPORT, <http://stormwater.wef.org/2014/01/con-edison-improves-storm-resiliency-energy-systems/> (last visited Jan. 25, 2014).

153. BRUGMANN, *supra* note 4, at 36.

protects their investment. In addition to providing a return on investment, restructuring financing could evolve investors from passive participants in which they lend money and passively await repayment to active participants in which they are involved with oversight and performance regulation. Because repayment of performance-based bonds is attached to a pre-set standard, the investors have a stake in whether the project meets the anticipated standard. Performance-based bonds offer the private sector the opportunity to actively fund and oversee projects that may help them avoid future losses.¹⁵⁴

A difficult question beyond the scope of this Article is how the incentives designed to encourage private sector investment will impact consumers, such as rates for insurance policy holders or utility users. For example, if an insurance company invests in creating a wetland to absorb tidal rise to reduce losses, who is going to bear that cost and what should the cost be? The insurance company has to be able to forecast a profit from its capital expenditure, but what does that translate into for purposes of rates? A further complication arises when a new customer purchases into the protected zone and has a different insurance company. This may alter the expected cash flow and challenge the parties' ability to match long-term liability (created by the financing) with cash flows to pay back investors. Additionally, identifying the proper criteria to calculate repayment obviously requires a significant amount of consideration in terms of understanding key indicators relative to climate adaptation.¹⁵⁵ Obtaining the information and choosing the proper performance indicators, however, may provide local governments and the private sector with a better understanding of the climate-relevant risks they face.

An alternative to incentivizing private sector investment in adaptation may be to create a regulatory environment. State insurance regulators, for example, could impose a policy that in order to underwrite in the state an insurance company must make measurable remediation efforts that will reduce losses as a result of climate change. The system would be similar to the carbon taxes imposed on European utilities. The state regulator would have to develop metrics to measure remediation and would allow remediation credits to be traded between insurers. This would encourage insurers to participate in projects with public entities. It also would allow some companies to buy extra credits and other companies without remediation options to simply buy credit, offering some flexibility. Of course, this would require additional regulation, which public and private entities are often hesitant to adopt.

Notwithstanding the concerns set forth above, public / private

154. See Hecht, *supra* note 111.

155. BRUGMANN, *supra* note 4, at 41.

partnerships help bring together key parties in the battle to protect cities. They strategically leverage the benefits of collaboration while enhancing the long term viability of public infrastructure. They provide additional avenues to access capital by opening up more resources at the private level than are available at the public level. They also allow those who will be negatively affected to support large infrastructure projects and protect their investments by capturing and distributing a risk aversion value that more accurately responds to adaptation needs. It is unlikely that we will be able to fully fund adaptation with the current municipal bond mechanisms. The public / private funding options are presented as innovative funding alternatives that re-think the role of the public and private sectors in protecting and sustainably growing local governments.