SETTING THE FOUNDATION: CLIMATE CHANGE ADAPTATION AT THE LOCAL LEVEL

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Climate change is here and with it a growing awareness of the need to adapt to impacts that are already occurring. At the same time, efforts to establish an international regulatory program to reduce or mitigate greenhouse gas (GHG) emissions have all but collapsed. This Article argues that climate change adaptation at the local level, particularly in urban areas, represents a logical step forward. In addition to managing risk, adaptation can stimulate a needed shift in emphasis towards a more pluralist or polycentric approach to climate regulation, laying the groundwork for future national and global regulatory regimes. Examining some of the strategies that local governments in the United States are undertaking to adapt to climate change, the Article identifies overlaps, as well as potential conflicts, between adaptation planning at the local level and broader environmental management objectives, including GHG mitigation. The United States could benefit greatly from national-level action to expand and strengthen local climate adaptation initiatives, and the Article concludes with a proposal for a national climate change adaptation fund.

I. INTRODUCTION	1222
II. ADAPTING TO A WARMER WORLD	1225
III. TOWARDS A POLYCENTRIC MODEL OF CLIMATE REGULATION	1228
A. Evolution of the Polycentric Model	1228
B. Adaptation in a Polycentric Model	1232
IV. ADAPTATION AND URBAN DEVELOPMENT	1235
A. Focus on the Urban Setting	1235
B. Strategies for Building the Resilient City	1239
V. CLIMATE CHANGE ADAPTION IN AMERICAN CITIES	1243
A. Urban Adaptation Planning in New York, Boston, and King County	1244
B. Top-Down Adaptation Planning: The Federal Role	1247
C. A National Climate Change Adaptation Fund	1250
VI. CONCLUSION	1253

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ENVIRONMENTAL LAW

I. INTRODUCTION

As the world grapples with the implications of rising temperatures for the next 100 years, the once taboo subject of climate change adaptation has taken center stage in environmental policy debate.¹ As of May 2011, developed countries had pledged several billion dollars to help developing countries adapt to climate change impacts, following through on pledges made in Copenhagen and formalized in Cancún.² National adaptation plans are assuming a central policy-making role in countries like the United Kingdom and the Netherlands.³ And in the United States, local governments in places like New York City, Boston, and Seattle are refining metropolitan adaptation plans that date back several years or decades.⁴ Policy makers hope that these plans will help to avoid wasted investment and pay ecological and economic dividends.

The stakes are high considering the projected costs of climate change, even under optimistic scenarios.⁵ One recent United Nations Framework Convention on Climate Change study pegs adaptation expenses at \$49 to \$171 billion per year by 2030 across the globe,⁶ while a recent World Bank report estimates that by 2050 a two degree Celsius temperature rise would require between \$70 to \$100 billion per year of adaptation investment.⁷ This includes substantial capital investment. For example, California state

³ See Mark Hertsgaard, Hot: Living Through the Next Fifty Years on Earth 61 (2011).

¹ See, e.g., Peter Hayes, *Resilience as Emergent Behavior*, 15 HASTINGS W.-NW. J. ENVTL. L. & POL'Y 175, 175 (2009) ("[T]he main game is now adaptation which renders mitigation no less urgent, but shifts the political equation in dramatic ways that cannot be ignored any longer."); Ileana M. Porras, *The City and International Law: In Pursuit of Sustainable Development*, 36 FORDHAM URB. L.J. 537, 593 (2009) ("Most climate change experts and policy-makers recognize that adaptation and mitigation are not mutually exclusive strategies but must, on the contrary be employed in tandem."); J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363, 433 (2010) ("[E]nvironmental law now recognizes mitigation and adaptation as being joined at the hip"); Thomas Lovejoy, *Mitigation and Adaptation for Ecosystem Protection*, 39 Envtl. L. Rep. (Envtl. Law Inst.) 10,072, 10,073 (Jan. 2009) ("The adaptation part of the climate change agenda is only just beginning to get attention, and needs much more right away."); *see also* Daniel H. Cole, *Climate Change, Adaptation, and Development*, 26 UCLA J. ENVTL. L. & POL'Y 1, 2 n.6 (2008); Robin Kundis Craig, "Stationarity is Dead"—Long Live Transformation: Five Principles for Climate Change Adaptation Law, 34 HARV. ENVTL. L. Rev. 9, 14 (2010).

² ATHENA BALLESTEROS ET AL., SUMMARY OF DEVELOPED COUNTRY FAST-START CLIMATE FINANCE PLEDGES (8th ed. 2011), *available at* http://pdf.wri.org/climate_finance_pledges_2011-05-09.pdf (displaying results in table updated as of May 9, 2011).

⁴ See infra Part IV.B.

⁵ Anastasia Telesetsky, *Insurance as a Mitigation Mechanism: Managing International Greenhouse Gas Emissions Through Nationwide Mandatory Climate Change Catastrophe Insurance*, 27 PACE ENVTL. L. REV. 691, 703 (2010) ("In 2008, the insurance industry recognized climate change as the number one threat to property and casualty insurance markets.").

⁶ MARTIN PARRY ET AL., ASSESSING THE COSTS OF ADAPTATION TO CLIMATE CHANGE: A REVIEW OF THE UNFCCC AND OTHER RECENT ESTIMATES 25 (2009), *available at* http://pubs.iied.org/pdfs/11501IIED.pdf.

⁷ WORLD BANK, THE ECONOMICS OF ADAPTATION TO CLIMATE CHANGE: A SYNTHESIS REPORT FINAL CONSULTATION DRAFT 10 (2010), *available at* http://siteresources.worldbank.org/EXTCC/ Resources/EACC_FinalSynthesisReport0803_2010.pdf.

SETTING THE FOUNDATION

1223

officials have estimated that "coastal armoring" to protect against flooding on the Pacific Coast and San Francisco Bay would require an initial investment of \$14 billion and recurring maintenance expenses of over \$1 billion dollars annually.⁸ But the greater burden of adaptation lies in directing government and private investment towards climate-resilient development. Often this is synonymous with better valuation of ecosystem services.⁹ In New York City, for example, where temperature increases are expected to make heat waves an increasing threat to public health, the city has embarked on a major tree planting campaign—"Greening the Bronx"—to combat urban heat island effect and severe ozone pollution on hot summer days.¹⁰ New York City also faces serious vulnerabilities to sea level rise, with conservative estimates indicating that a 1-in-100 year flood may become a 1in-15 year event over the next few decades,¹¹ and so the city has begun updating flood insurance rate maps in order to better guide zoning and construction policy.¹²

Climate change presents a serious obstacle to development and poverty reduction, and adaptation costs will hit hardest among those least able to afford them.¹³ In the words of Bangladeshi Prime Minister Begum Khaleda Zia, "[For some] the impacts might be lifestyle threatening, for others it is life threatening."¹⁴ In the United States, the experience of Hurricane Katrina

⁸ MATTHEW HEBERGER ET AL., THE IMPACTS OF SEA-LEVEL RISE ON THE CALIFORNIA COAST 3 (2009), *available at* http://www.pacinst.org/reports/sea_level_rise/report.pdf.

⁹ WALTER V. REID ET AL., ECOSYSTEMS AND HUMAN WELL-BEING SYNTHESIS: A REPORT OF THE MILLENNIUM ECOSYSTEM ASSESSMENT 40 (2005), *available at* http://www.maweb.org/documents/document.356.aspx.pdf (detailing services provided by environmental resources, such as food, climate regulation, and safeguarding water supplies)).

¹⁰ MICHAEL R. BLOOMBERG, N.Y.C., PLANYC: UPDATE APRIL 2011: A GREENER, GREATER NEW YORK 151 (2011), *available at* http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/ planyc_2011_planyc_full_report.pdf; JENNIFER PENNEY & IREEN WIEDITZ, CITIES PREPARING FOR CLIMATE CHANGE: A STUDY OF SIX URBAN REGIONS 42, 54 (2007), *available at* http://www.cleanairpartnership.org/pdf/cities_climate_change.pdf. Originally released in 2007 by Mayor Bloomberg, more than 25 agencies joined to prepare this PlaNYC addressing New York City's sustainability efforts with the anticipation of a population increase of 1 million residents. N.Y.C., *About PlaNYC*, http://www.nyc.gov/html/planyc2030/html/about/about.shtml (last visited Nov. 12, 2011).

¹¹ See BLOOMBERG, supra note 10, at 154 tbl. By the 2020s, the probability of a 1-in-100 year flood occurring in a given year will rise as high as 1-in-65, and by 2080, it may become a 1-in-15 year event. *Id.* The report's sea level, precipitation, and flood projections "represent the middle 67% of values from model-based probabilities" in "16 Global Climate Models (GCMs) (7 GCMs for Sea Level Rise) and three emissions scenarios." *Id.* At 154 nn.1–2. The estimates exclude, however, a "rapid ice-melt scenario" and the actual cost of protecting large portions of New York City from a rising sea remains to be determined. *See id.* at 154 n.5, 197 tbl.

¹² Id. at 155–56.

 ¹³ CAROLINE MOSER & DAVID SATTERTHWAITE, CLIMATE CHANGE AND CITIES DISCUSSION PAPER
3: TOWARDS PRO-POOR ADAPTATION TO CLIMATE CHANGE IN THE URBAN CENTRES OF LOW- AND MIDDLE-INCOME COUNTRIES 1 (2008), available at pubs.iied.org/pubs/pdfs/10564IIED.pdf.

¹⁴ MINISTRY OF ENV'T & FOREST, GOV'T OF THE PEOPLE'S REP. OF BANGL., NATIONAL ADAPTATION PROGRAMME OF ACTION (NAPA): FINAL REPORT, at i (2005), *available at* unfccc.int/resource/docs/napa/ban01.pdf. Examination of Bangladesh's National Adaption Programme of Action (NAPA) lends credence to this distinction. Rather than insurance rate maps, the Bangladesh plans focus on already precarious water scarcity problems wrought by

ENVIRONMENTAL LAW

[Vol. 41:1221

has lent credence to this distinction.¹⁵ Effective climate change adaptation, including better emergency preparedness, thus takes on an equitable dimension that should endear it to those concerned with the United States' growing inequality and the sinking fortunes of its poorest citizens.

In addition to greater equality, adaptation should increase public awareness of climate change.¹⁶ It should do so in a tangible way, because adaptation has an inherently local focus. Eventually, emerging adaptation institutions and policies may serve to re-orient climate regulation away from the top-down, unitary model of global regulation embodied in the Kyoto Protocol. This is critical, because at the local level, reducing greenhouse gas (GHG) emissions itself reaps no discernable local benefit.¹⁷ To be sure, mitigation strategies may coincide with policy solutions to other problems of local character, such as air or water pollution, but in many cases-e.g., a municipality's purchase of power from renewable sources rather than from downwind coal-fired plants-they will not. By contrast, adaptation policies inherently reap local benefits, and in many ways, align with climate change mitigation and help to build up the supporting governance structures for an effective mitigation regime.¹⁸ And by integrating reforms across a broad range of policy areas, from water management to land use planning to public health, adaptation aid can play a critical role in regions where government is already struggling to cope with basic needs.

The next Part of this Article begins with a brief description of climate change adaptation policy. Part III introduces the notion of polycentric climate change regulation. Part IV considers the specific climate challenges facing urban development, and puts forth the case for directing resources for adaptation to cities. The experience of adaptation planning in various cities in the United States provides helpful guidance on effective policy responses to climate change, and Part V takes a look at these and proposes policy reforms for expanding this work and eventually setting the foundation

salinity intrusion in the rivers and aquifers servicing major coastal settlements. *Id.* at 27. Indeed, adaptation is simply not an option for many communities in Bangladesh and across the world, thus creating a substantial climate change refugee crisis. *See, e.g.,* Sebastián Albuja & Isabel Cavelier Adarve, *Protecting People Displaced by Disasters in the Context of Climate Change: Challenges from a Mixed Conflict/Disaster Context,* 24 TUL. ENVTL. L.J. 239, 240–41 (2011).

¹⁵ See Lisa Grow Sun, *Disaster Mythology and the Law*, 96 CORNELL L. REV. 1131, 1179–82 (2011) (describing the bungled response to Hurricane Katrina and the tragedy that ensued, including the observation that when local authorities "purported to declare martial law in their jurisdictions," they encouraged "the egregious police misconduct that occurred following Katrina").

¹⁶ See, e.g., Edna Sussman et al., *Climate Change Adaptation: Fostering Progress Through Law and Regulation*, 18 N.Y.U. ENVTL. L.J. 55, 56 (2010) ("[R]ather than discouraging a commitment to mitigation, calling attention to adaptation can actually inspire a greater commitment to mitigation as the specter of future consequences is highlighted.").

¹⁷ See Jan Corfee-Morlot & Shardul Agrawala, *The Benefits of Climate Policy*, 14 GLOBAL ENVTL. CHANGE 197, 197 (2004), *available at* http://www.oecd.org/dataoecd/31/42/40132932.pdf; Press Release, Kathrin Happe, A Low Carbon Economy Should Be Good for Health and the Climate, Say Leading Scientists 1 (Nov. 26, 2010), *available at* http://www.leopoldina.org/fileadmin/user_upload/Politik/Empfehlungen/IAMP/IAMP_PRESS_RELEASE_25_nov_final.pdf.

¹⁸ See discussion infra Part IV.B.

SETTING THE FOUNDATION

1225

for a national climate change mitigation program. The Article concludes with a proposal for a national climate change adaptation fund to work toward these objectives.

II. ADAPTING TO A WARMER WORLD

References to climate change adaptation bring to mind large-scale infrastructure projects such as the Thames Barrier in London,¹⁹ or the relocation of entire villages threatened by melting permafrost and rising sea levels, as detailed in the Inuit Circumpolar Conference's landmark petition before the Inter-American Commission on Human Rights.²⁰ For the most part, however, climate change will simply make existing social and environmental problems worse.²¹ And the solutions to these problems consist in large part on building local government capacity. Specifically, local government capacity to address problems associated with water management, public health, and disaster response are paramount, including capabilities to identify climate change-related vulnerabilities, craft plans to address them, and implement those plans with adequate monitoring and enforcement.²² These capabilities also promote broader economic and social goals.²³

Adaptation presents the challenge of "mainstreaming" climate change planning into more general development goals.²⁴ In other words, plans and

²² See, e.g., U.N. Human Settlements Programme (UN-HABITAT), Climate Change Strategy 2010–2013 (2009), http://www.unhabitat.org/pmss/listItemDetails.aspx?publicationID=2861 (last visited Nov. 12, 2011) (click on "DOWNLOAD" to access PDF version); ALICE BALBO ET AL., ICLEI-LOCAL GOV'TS FOR SUSTAINABILITY, RESILIENT CITIES 2011: CONGRESS REPORT 7, 9 (drft. 2011) available at http://resilient-cities.iclei.org/fileadmin/sites/resilient-cities/files/Resilient_Cities_2011/RC2011_Congress_report_draft_20110922_www.pdf.

²³ See, e.g., WORLD BANK, 10 CITIES AND CLIMATE CHANGE: AN URGENT AGENDA 33 (2010), available at http://siteresources.worldbank.org/INTUWM/Resources/340232-1205330656272/ CitiesandClimateChange.pdf.

²⁴ "Mainstreaming" might also be referred to as "procedural" adaptation strategies. *See* Alejandro E. Camacho, *Adapting Governance to Climate Change: Managing Uncertainty Through a Learning Infrastructure*, 59 EMORY L.J. 1, 23 (2009) ("Though most commenters have

¹⁹ See Katherine M. Baldwin, Note, *NEPA and CEQA: Effective Legal Frameworks for Compelling Consideration of Adaptation to Climate Change*, 82 S. CAL. L. REV. 769, 777–78 (2009) (citing Thames Barrier design and contingency plan as an "incremental method" that societies may use to manage climate uncertainty).

²⁰ See Marguerite E. Middaugh, Comment, *Linking Global Warming to Inuit Human Rights*, 8 SAN DIEGO INT'L L.J. 179, 197 (2006) (explaining how under international law, the United States allegedly violated Inuit human rights by failing to take action on climate change).

²¹ See, e.g., Andreas Fischlin et al., *Ecosystems, Their Properties, Goods and Services, in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 211, 215 (M.L. Parry et al. eds., 2007), *available at* http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html (describing key vulnerabilities of global ecosystems); Tom Wilbanks et al., *Industry, Settlement and Society, in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 307: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra*, at 359, 361–63, 374 (noting that climate change may have beneficial and negative effects but conceding that rapid change is likely to have severe adverse effects).

ENVIRONMENTAL LAW

[Vol. 41:1221

policies for confronting climate risks cannot be developed in isolation. Rather, effective adaptation policy needs to draw on authorities across a broad spectrum of policy areas—public works, energy, water, transportation, public health—collaborating to integrate adaptation plans into their respective regulatory jurisdictions. A climate change adaptation program should thus represent a bundle of parallel initiatives—water management, emergency preparedness, land use planning—to respond to climate vulnerabilities facing a particular locality, and better align local economies with the ecologies that support them.²⁵ Mainstreaming has proven difficult, however, precisely because it involves a broad range of actors, including community groups and private sector developers.²⁶ Information regarding the actual impact of climate change at the local level, where impacts matter most, can be highly uncertain. This uncertainty frustrates efforts to link individual decisions to relevant climate data and projections.²⁷

Climate change poses an unprecedented challenge for human civilization. The projected speed and intensity of anticipated changes to the earth's temperature and atmospheric makeup resulting from anthropogenic GHG emissions will surpass those of any other period that mankind has ever witnessed.²⁸ According to the Intergovernmental Panel on Climate Change, climate change is causing and will continue to cause more frequent heat waves, more extreme storms and cyclones, an increase in the areas affected by drought, and a rise in sea levels, including a higher frequency of extreme storm surges.²⁹ These phenomena will have overlapping effects, producing feedback cycles and confounding models based on assumptions rooted in historical, typically linear trends. This carries important implications for managing food security, public health, urban infrastructure, and other

 26 See generally Gerald E. Frug, City Services, 73 N.Y.U. L. REV. 23, 23–96 (1998) (discussing the trend towards increasing privatization of city services).

²⁷ See Adger et al., *supra* note 25, at 717, 719, 721, 732–35.

focused on substantive strategies that seek to minimize or reverse the adverse effects of climate change on natural systems, the most crucial adaptations may take the more indirect form of procedural governmental strategies. Rather than focusing on directly managing the effects of climate change—or the natural systems or human conduct that may exacerbate such effects—this category is intended to encompass strategies that manage the regulatory programs and processes that develop more direct strategies.").

²⁵ See, e.g., W. Neil Adger et al., Assessment of Adaptation Practices, Options, Constraints and Capacity, in CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 21, at 717, 727–28, 732; JEB BRUGMANN, ICLEI-LOCAL GOV'TS FOR SUSTAINABILITY, FINANCING THE RESILIENT CITY: A DEMAND DRIVEN APPROACH TO DEVELOPMENT, DISASTER RISK REDUCTION, AND CLIMATE ADAPTATION: AN ICLEI WHITE PAPER 11–13, 20–24 (2011), *available at* http://www.iclei.org/fileadmin/user_upload/documents/Global/Publications/ Report-Financing_Resilient_City-Final.pdf.

²⁸ Neil Adger et al., *Summary for Policymakers, in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 21, at 7, 9.

²⁹ Neil Adger et al., *Technical Summary, in* CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 21, at 23, 40, 43–45, 50.

SETTING THE FOUNDATION

critical areas.³⁰ For example, rising sea levels and increased frequency of extreme storm surges will compromise water supplies as a result of salinity intrusion, increase the incidence of coastal flooding, and lead to permanent property loss in many areas.³¹ Increased temperatures and more frequent heat waves will diminish crop yields, increase urban "heat island" effects, worsen ground-level ozone smog and other air pollution problems, and increase the incidence of vector-borne diseases.³² The intensity of climate change impacts will vary from area to area, but adaptation policy may prove the most important determinant of which areas incur the greatest losses.³³

Unlike efforts to mitigate GHG emissions, adaptation policy does not fall neatly within the domain of pollution control or even environmental law.³⁴ Because climate change impacts will affect so many different aspects of human welfare, adaptation will have to take place across a wide range of jurisdictions and policy areas. The success of projects will largely depend on local conditions. More generally, the uncertainty of climate change impacts³⁵ translates into policy uncertainty at the point of implementation. Thus, unlike mitigation projects that might proceed relatively independent of local institutions, adaptation requires first and foremost more responsive local institutions. On the other hand, since adaptation gains accrue primarily to local residents,³⁶ unlike the dispersed global benefit of GHG reductions, local support for adaptation efforts may be more forthcoming than for mitigation projects.

This Article argues that adaptation should serve as the foundation for broader climate change regulation. Local adaptation plans in the United States typically entail land use and energy conservation measures that serve

1227

 $^{^{30}}$ Id. at 44–50.

³¹ MOSER & SATTERTHWAITE, *supra* note 13, at 3 tbl.1.

³² Id; see also Paul H. Brietzke & Carl Adrianopoli, *Climate Change in Cities of the Developing World*, 25 J. ENVTL. L. & LITIG. 85, 87 (2010).

³³ MOSER & SATTERTHWAITE, *supra* note 13, at 4. (noting that "the scale and nature of [climate-related] risk varies greatly between urban centres and also within them, between different population groups or locations"); *see also* Daniel A. Farber, *Adapting to Climate Change: Who Should Pay*, 23 J. LAND USE & ENVTL. L. 1, 18 (2007) ("The cost of adaptation may or may not be large in comparison with the total world economy, but that comparison will not be relevant to localities that need billions of dollars worth of expenditures for climate change adaptation.").

³⁴ Ruhl, *supra* note 1, at 379.

³⁵ See, e.g., NAT'L RESEARCH COUNCIL, NAT'L ACAD. OF SCIENCES, ADAPTING TO THE IMPACTS OF CLIMATE CHANGE 17 (2010) ("Adaptation to climate *variability* is nothing new to humanity, but it now seems very likely that climate conditions by the later part of the 21st century will move outside the range of past human experiences. Therefore, historical records and past experience are becoming incomplete guides for the future" (citations omitted)); NAT'L RESEARCH COUNCIL, NAT'L ACAD. OF SCIENCES, LIMITING THE MAGNITUDE OF FUTURE CLIMATE CHANGE 21 (2010) ("In choosing a specific goal for the United States, policy makers will have to deal not only with scientific uncertainties but also with ethical judgments.").

³⁶ See, e.g., Sussman et al., *supra* note 16, at 73–74 (noting that if the New York City Zoning Resolution were amended to allow the installation of sustainability devices (such as power substations, renewable energy resources, solar energy panels, small wind turbines, and neighborhood-oriented geothermal heat utilization) New York City could lessen its energy demands during the City's forecasted warming); *see also* discussion *infra* Part IV.B.

ENVIRONMENTAL LAW

[Vol. 41:1221

mitigation as well as adaptation purposes.³⁷ But while local action plans for reducing GHG emissions have become ubiquitous, only a few cities have undertaken serious adaptation planning.³⁸ As discussed further in Part IV, climate change adaptation policies can fulfill a critical educational role, focusing residents' attention to the problem of climate change and the consequences of inaction. But even ignoring the influence of adaptation work on voter preferences and broader norms, more resilient communities will also tend to be less carbon intensive. For example, water scarcity, intensified by climate change, suggests the need for more compact urban land-use patterns, which generate less storm water runoff pollution, and waste less on transporting water to far flung suburbs.³⁹ More generally, water scarcity supports better valuation of the ecosystem services provided by forests and wetlands.⁴⁰ These measures tend to promote higher density, fewer automobiles, less energy consumption, and a reduction of GHG emissions.⁴¹

This is not to say that adaptation initiatives should simply serve as a more politically palatable packaging for local mitigation efforts. Effective adaptation policies, such as providing poor residents with fans and air conditioning during a heat wave, may conflict with mitigation objectives.⁴² Conflating adaptation and mitigation objectives can create confusion and divert attention from a local government's most pressing adaptation needs, such as disaster preparedness.⁴³ But all adaptation policy should foster better understanding of climate change, better integration and coordination of local government services, and better long-term planning capacity. And these elements are conducive to pursuing GHG mitigation at the local level, and thus highlight a fundamental synchronicity between local climate change adaptation and mitigation.

III. TOWARDS A POLYCENTRIC MODEL OF CLIMATE REGULATION

A. Evolution of the Polycentric Model

An expanding body of commentary has taken to questioning the relevance of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the international negotiation framework

³⁷ See, e.g., BLOOMBERG, supra note 10, at 27-28.

³⁸ MOSER & SATTERTHWAITE, *supra* note 13, at 16 ("Even in the cities of high-income countries where there is the greatest awareness of climate change—and that have made substantial efforts to reduce emissions—there has been no move on adaptation.").

³⁹ Sussman et al., *supra* note 16, at 103, 105, 108–09; *see also* BLOOMBERG, *supra* note 10, at 66–67, 78–79, 151, 154 (explaining how New York City is seeking to improve its waterways system, including stormwater, watershed, and wetlands management, to help manage the impacts of climate change).

⁴⁰ See, e.g., BLOOMBERG, supra note 10, at 66–67.

⁴¹ Sussman et al., *supra* note 16, at 108–09.

⁴² See infra note 114 and accompanying text.

⁴³ MOSER & SATTERTHWAITE, *supra* note 13, at 16 n.9 (noting "considerable confusion between adaptation and mitigation" among local governments in low- and middle-income countries).

SETTING THE FOUNDATION

1229

that produced it.⁴⁴ Kyoto's defenders point out that it is the "only game in town,"⁴⁵ but for proponents of a pluralist or polycentric model of climate regulation, that perception represents part of the problem. The conventional, state-centric model of international relations, and of climate change regulation in particular, is ill-suited to incorporate and to build upon the relative success of national, state, and local initiatives, nor does it foster horizontal networks, such as the Cities for Climate Protection (CCP) campaign sponsored by the International Council for Local Environmental Initiatives (ICLEI).⁴⁶ These lower level actions are important as both support and guidance for an eventual global regime that effectively mitigates GHG emissions.⁴⁷ In the words of Elinor Ostrom, policymakers should "self-consciously adopt a polycentric approach to the problem of climate change in order to gain the benefits at multiple scales as well as to encourage experimentation and learning from diverse policies adopted at multiple scales."⁴⁸ The next Part takes a closer look at this idea and how climate

⁴⁵ Robert N. Stavins, *A Meaningful U.S. Cap-and-Trade System to Address Climate Change*, 32 HARV. ENVTL. L. REV. 293, 294 (2008) (quoting John Gummer, *Viewpoint: Kyoto—The Only Game in Town*, BBC NEWS, July 29, 2004, http://news.bbc.co.uk/2/hi/science/nature/3932947.stm (last visited Nov. 12, 2011)).

⁴⁶ See supra Part II.

⁴⁸ Elinor Ostrom, A Polycentric Approach for Coping with Climate Change 32 (World Bank, Working Paper No. WPS5095, 2009), available at http://www-wds.worldbank.org/external/ default/WDSContentServer/IW3P/IB/2009/10/26/000158349_20091026142624/Rendered/PDF/WPS 5095.pdf.

⁴⁴ See, e.g., AMY SEIDL, FINDING HIGHER GROUND: ADAPTATION IN THE AGE OF WARMING 10 (2011) (characterizing Copenhagen as a "collective rock bottom" and noting that meeting the reduction goals of the 192 countries that participated would yield atmospheric GHG concentrations of "770 ppm, far and away beyond the limit of atmospheric carbon necessary to stabilize Earth's climate"); William Boyd, *Climate Change, Fragmentation, and the Challenges of Global Environmental Law: Elements of a Post-Copenhagen Assemblage*, 32 U. PA. J. INT'L L. 457, 464 (2010) ("The recent Copenhagen Accord, and now the Cancún Agreement, provide unambiguous confirmation that the existing United Nations process is limited, at best, and unlikely to be a major driver of climate governance in the coming years."); Daniel H. Cole, *From Global to Polycentric Climate Governance* 9, 16 (European Univ. Inst., Working Paper No. RSCAS 2011/30, 2011), *available at* http://www.eui.eu/Projects/GGP/Documents/Publications/WorkingPapers/RSCAS201130-DanHCole.pdf (characterizing the Kyoto Protocol as "at best, a tentative half-step in the direction of a functional and effective global climate regime," and suggesting that "participants in the global roving cocktail party known as the 'Conference of the Parties' seem to be under the misapprehension that they alone make climate policy").

⁴⁷ Colin Crawford, *Our Bandit Future? Cities, Shantytowns, and Climate Change Governance*, 36 FORDHAM URB. L.J. 211, 252 & n.183 (2009); Hari M. Osofsky & Janet Koven Levit, *The Scale of Networks?: Local Climate Change Coalitions*, 8 CHI. J. INT'L. L. 409, 430–32 (2008) (exemplifying Portland and Tulsa climate action plans as "bottom-up lawmaking" in which "localities are functional climate change 'practitioners'" and affect norms and laws in various ways that the state and federal governments do not); Judith Resnik et al., *Ratifying Kyoto at the Local Level: Sovereigntism, Federalism, and Translocal Organizations of Government Actors (TOGAs)*, 50 ARIZ. L. REV. 709, 711–12 (2008); Richard B. Stewart, *States and Cities as Actors in Global Climate Regulation: Unitary vs. Plural Architectures*, 50 ARIZ. L. REV. 681, 698 (2008) (arguing in favor of a plural model of climate regulation that allows for multiple regulatory systems to take advantage of the "fast-emerging international cooperation among cities on climate-related energy, housing, and transportation issues").

ENVIRONMENTAL LAW

[Vol. 41:1221

change adaptation in United States cities could help to advance it, but the limitations in the predominant policy approach should not escape scrutiny.

The conventional conception of climate change and its regulatory prognosis go hand-in-hand. As a global problem, fitting into the tragedy of the commons archetype, climate change requires a global solution of "mutual coercion, mutually agreed upon."⁴⁹ The need for a global solution implies the need for an international treaty among nation-states, and the Kyoto Protocol represents the most advanced expression of this in climate regulation, establishing a unitary regulatory structure among nations who have committed to limit emissions within their jurisdictions and comply with a set of trading and other rules agreed to under the Protocol.⁵⁰ This regulatory structure establishes a hierarchy, under which national, state, and local governments undertake the means to ensure compliance with the emissions reductions that the various political and industrial interests negotiate at the top. Increasingly, this structure and the associated conception of climate change regulation do not appear up to the task.⁵¹

Most would agree that climate change represents a huge collective action problem.⁵² But recent literature questions the associated global prognosis.⁵³ For one, while the standard exposition of collective action problems does well to describe *inaction* on climate change, it struggles to account for the numerous success stories, in which cooperation has prevailed to remedy an environmental or other collective action problem.⁵⁴ Treating climate change solely as a global collective action problem also ignores the multiple scales of externalities involved in climate regulation, such as air pollution in traffic clogged cities.⁵⁵

This is not to say that mutual coercion, mutually agreed upon, at the global level is not necessary to avert catastrophic climate change, but rather it is insufficient. Ostrom's polycentric approach and similar calls for pluralist regimes argue that the ultimate success of global action will rest on a set of

 53 Ostrom, supra note 48, at 31–32 (arguing against waiting for a single global solution to the climate change problem).

 54 Ostrom equates the "tragedy of the commons" problem with the game theory construct of the Prisoner's Dilemma, which provides the formal logic behind the "expectation of noncooperation leading to socially suboptimal outcomes in the regulation of shared natural resources." *Id.* at 7.

⁵⁵ *Id.* at 14–15 ("Efforts to reduce pollution levels in large metropolitan areas focus both on total energy use and on emissions of particulates and thus generate benefits at a metropolitan level as well as globally."). *But see* MOSER & SATTERTHWAITE, *supra* note 13, at 16, n.9 (noting confusion "between conventional urban environmental policies and climate change (for instance an assumption that controlling air pollution necessarily lowers [GHG] emissions)").

⁴⁹ Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243, 1247 (1968), *available at* http://www.sciencemag.org/site/feature/misc/webfeat/sotp/pdfs/162-3859-1243.pdf (articulating the now often-quoted description of the type of coercion that fosters collective responsibility).

 $^{^{50}}$ Stewart, supra note 47, at 682 (explaining the notion of unitary climate regulation architecture).

⁵¹ Boyd, *supra* note 44, at 457–58; *see* Cole, *supra* note 44, at 9–10.

⁵² See Ostrom, supra note 48, at 5; see also Paul G. Harris, *Collective Action on Climate Change: The Logic of Regime Failure*, 47 NAT. RESOURCES J. 195, 196 (2007) (noting the recognition by international governments of the need for global cooperation in addressing the problem of climate change).

SETTING THE FOUNDATION

1231

nested commitments and monitoring structures that go down to the household level.⁵⁶ In other words, an effective mitigation regime will require not just an international agreement but also national implementation legislation, sub-national monitoring and enforcement, local experimentation, community support, and most importantly, individual action.⁵⁷ A polycentric model of climate regulation seeks to broaden the analysis and assign a fuller role to actions at the sub-global level in climate regulation.⁵⁸ And to the extent that global action is bogged down in an ineffectual, largely dysfunctional regulatory regime, this shift of emphasis points to a way forward.

A key advantage of the overlapping, sometimes competing authority structure of a polycentric system lies in its ability to fit policy responses to scale.⁵⁹ Actors in a polycentric system do not simply operate in a hierarchy, implementing mandates from above which may be insensitive to local conditions. Rather, they "compete and cooperate, interact and learn from one another, and responsibilities at different governmental levels are tailored to match the scale of the public services they provide."⁶⁰ A polycentric model thus helps to differentiate between the issues that require international negotiations and action at the global level versus those which more appropriately fall within the domain of lower levels of government. Traditional local government power over zoning and building codes, for example, can shape constituents' preferences and behaviors, and curb underlying demand for carbon intensive development and activities, in ways that cap-and-trade regimes or carbon taxes imposed from above cannot.⁶¹

As with any regulatory design, a polycentric model must contend with inherent vulnerabilities as well. Perhaps most importantly, a decentralized authority structure runs the risk of regulatory fragmentation. Commentators have fingered a fragmented natural resources management structure in the United States as the culprit behind agency inaction, a lack of interagency learning, and neglect of climate change issues.⁶² At the local level, overreliance on technical climate planning specialists and weak ties between these specialists and other government officials hampered early adaptation

⁵⁶ Ostrom, *supra* note 48, at 39 (concluding that focusing at multiple levels, instead of just globally, will help build the necessary commitment to reducing individual emissions).

⁵⁷ See Cole, supra note 44, at 15–16.

⁵⁸ See Ostrom, supra note 48, at 4.

⁵⁹ Vincent Ostrom et al., *The Organization of Government in Metropolitan Areas: A Theoretical Inquiry*, 55 AMER. POL. SCI. REV. 831, 831, 835 (1961).

⁶⁰ Cole, *supra* note 44, at 10; *see also* Elinor Ostrom, *Nested Externalities and Polycentric Institutions: Must We Wait for Global Solutions to Climate Change Before Taking Actions at Other Scales?*, ECON. THEORY, at pt. 2 (2010), *available at* http://www.springerlink.com/content/723452714082113q/fulltext.pdf (noting that "[a] polycentric system exists when multiple public and private organizations at multiple scales jointly affect collective benefits and costs").

⁶¹ See, e.g., Katherine A. Trisolini, All Hands on Deck: Local Governments and the Potential for Bidirectional Climate Change Regulation, 62 STAN. L. REV. 669, 744–45 (2010).

⁶² Camacho, *supra* note 24, at 26; *see also* William W. Buzbee, *The Regulatory Fragmentation Continuum, Westway and the Challenges of Regional Growth*, 21 J.L. & POL. 323, 344–48 (2005) (describing various types of regulatory fragmentation).

ENVIRONMENTAL LAW

[Vol. 41:1221

efforts in Boston.⁶³ These problems underscore the importance of institutional linkages and bidirectional feedback loops in a polycentric model.⁶⁴ These linkages and feedback help to ensure that different jurisdictions streamline processes and do not repeat the same errors, but rather incorporate lessons from local experimentation.⁶⁵ Networks such as the CCP campaign have created value through horizontal transfers of policy, and through a bi-directional learning process between local and higher level governments, as well as with private institutions like the ICLEI.⁶⁶

Unfortunately, like Kyoto, action on climate change at the local level remains a largely nominal force in reducing GHGs,⁶⁷ despite some notable success stories. Ostrom argues that this results from the view of climate change as a global collective action quandary, for which individual- or community-level action is futile.⁶⁸ Shifting the emphasis to climate adaptation may therefore serve a critical function in reframing the popular conception of climate change, and what can be done about it at the local level. The experience of many United States cities' efforts to reduce GHG emissions suggests that stimulating more widespread action at the local level could reap considerable gains.⁶⁹ In Portland, Oregon, per capita GHG emissions have fallen by 12.5% during a period in which the rest of the United States per capita emissions have grown.⁷⁰ Such success stories reflect the unique opportunities for local governments to reduce GHG emissions, and the potential for scaling policy responses down.

B. Adaptation in a Polycentric Model

The local character of climate change impacts should serve as an advantage in stimulating ground-level support for adaptation. There is no reason to wait for the United Nations to act before diversifying the local

⁶⁸ Ostrom, *supra* note 48, at 15 ("Part of the problem is that 'the problem' has been framed so often as a global issue that local politicians and citizens sometimes cannot see that there are things that can be done at a local level that are important steps in the right direction.").

⁶⁹ See Trisolini, *supra* note 61, at 734–35 ("[O]ne of the few studies to review the collective impact of local climate change initiatives found in 2008 that if only the 684 signatories to the Mayors Agreement succeeded in reaching their GHG goals, they would reduce projected 2020 emissions by seven percent. Since 2008, over 300 more signatories have joined, cities have improved programs, and other networks have added members and iterated programs.").

⁷⁰ MARIA ROJO DE STEFFEY ET AL., A PROGRESS REPORT ON THE CITY OF PORTLAND AND MULTNOMAH COUNTY LOCAL ACTION PLAN ON GLOBAL WARMING 1 (2005), *available at* http://www.portlandonline.com/bps/index.cfm?a=112118&c=41917.

⁶³ See PENNEY & WIEDITZ, supra note 10, at 14–15.

⁶⁴ See J.B. Ruhl & James Salzman, *Climate Change, Dead Zones, and Massive Problems in the Administrative State: A Guide for Whittling Away*, 98 CALIF. L. REV. 59, 66, 90 (2010).

⁶⁵ See Cole, supra note 44, at 11.

⁶⁶ See MOSER & SATTERTHWAITE, supra note 13, at 22, 30–31.

⁶⁷ See, e.g., Heike Schroeder & Harriet Bulkeley, *Global Cities and the Governance of Climate Change: What Is the Role of Law in Cities?*, 36 FORDHAM URB. L.J. 313, 359 (2009) ("Given the gaps in action among the different levels of government, the role of law has been limited in urban climate governance to date. Emphasis has remained on governance by providing new energy infrastructure and enabling public-private partnerships to emerge that provide services that help reduce urban emissions.").

SETTING THE FOUNDATION

1233

water supply or updating flood maps. By virtue of association, however, climate change adaptation and mitigation efforts have tended to share the same regulatory architecture, as evidenced by the presentation of local climate change adaptation plans within larger mitigation or "green" plans.⁷¹

While adaptation work remains in its infant stages, it is important to avoid a "lock-in" effect whereby a globalist mentality becomes an impediment not just to solving the climate change problem but to dealing with its impacts as well. Specific adaptation policies often carry significant mitigation co-benefits but, as noted above, a focus on adaptation at the national, state, and local level may prove most valuable by establishing institutions and procedural frameworks that facilitate local GHG reduction plans. This is all the more true considering that the nonlinear rates of change associated with climate change impacts may, as concern grows, prompt a similarly abrupt global policy response that seeks to draw on a broad support structure of capable local governments.

What legal designs will enable this support structure, install an effective system of regulatory checks and balances at multiple levels, create value through experimentation, identify and curb regulatory failures, transmit and adapt successful strategies, and provide adequate and predictable funding? An extensive body of literature seeks answers to these and other quandaries.⁷² One promising approach, detailed by J.B. Ruhl, is to apply the same principles that guide the development of resilient ecosystems and adaptive built environments to envision the attributes of "resilient and adaptive climate change adaptation law."⁷³

Ruhl's analysis favors flexibility and dynamism in adaptation policy, since the impacts of climate change at the local level are fraught with uncertainty.⁷⁴ Conventional environmental regulatory models, such as environmental assessments under the National Environmental Policy Act (NEPA),⁷⁵ tie an assessment of climate change and other environmental conditions to some discrete regulatory or permitting decision under what Ruhl terms "assumptions of stationarity."⁷⁶ Such static decision frameworks serve as poor guides to climate change adaptation policy, however, because of the rapidly changing information, nonlinear feedback loops, and wide scope of impacts that characterize climate change.⁷⁷ Instead, adaptation should draw on an ongoing updating process that incorporates public input, monitoring of past project impacts, and newly available data and technology to inform policymakers.⁷⁸ In a similar vein, an overlapping, polycentric model

⁷¹ See, e.g., BLOOMBERG, *supra* note 10, at 3, 150.

⁷² See, e.g., sources cited *supra* note 1.

⁷³ J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems—with Applications to Climate Change Adaptation*, 89 N.C. L. REV. 1373, 1393 (2011).

⁷⁴ See id. at 1397–98.

⁷⁵ National Environmental Policy Act of 1969, 42 U.S.C. §§ 4321–4347 (2006).

⁷⁶ Ruhl, *supra* note 73, at 1396.

⁷⁷ See id. at 1394–95.

⁷⁸ See id. at 1396; see also Daniel A. Farber, Adaptation Planning and Climate Impact Assessments: Learning from NEPA's Flaws, 39 Envtl. L. Rep. (Envtl. Law Inst.) 10,605, 10,605 (July 2009).

ENVIRONMENTAL LAW

[Vol. 41:1221

of governance should rely on a breadth of policy instruments, from "hard" mandates to "soft" incentives and information sharing tools, in order to make progress on multiple fronts. Ruhl also endorses increased reliance on "transgovernmental networks" to share information and identify best practices without the need for going through formal hierarchies and with fewer institutional constraints.⁷⁹

These policy prescriptions, while straightforward in theory, have proven elusive in practice. The few examples of national-level action to address climate change adaptation in the United States, such as the Climate Ready Estuaries Program of the United States Environmental Protection Agency, and the joint federal Climate Change Science Program, have been limited in scope and lacked a long-term presence around which to foster the linkages and information sharing critical to adaptation policy.⁸⁰ On the other hand, various local experiences suggest some possible avenues for designing a polycentric adaptation model and point to where some of the deficiencies may lie in the current regulatory structure.⁸¹

Adaptation to climate change cannot occur in a vacuum. It relates to specific places and contexts.⁸² A country might build its resilience to climate change by improving its disaster preparedness, or establish technical capacity at the national level to guide adaptation planning,⁸³ but the actual drought, storms, flooding, forest fires, heat waves, coastal erosion and inundation, disease epidemics, and myriad other challenges will occur in particular places and contexts. Their resolution and management will depend to a great extent on local government. National policies in the United States have only weakly influenced critical land use and resource management decisions made at the local level.⁸⁴ And as local conditions

1234

⁷⁹ Ruhl, *supra* note 73, at 1399 & n.105; Janet Koven Levit, *A Bottom-Up Approach to International Lawmaking: The Tale of Three Trade Finance Instruments*, 30 YALE J. INT'L L. 125, 182 (2005).

⁸⁰ Camacho, *supra* note 24, at 59–63.

⁸¹ See Daniel A. Farber, *Climate Change, Federalism, and the Constitution*, 50 ARIZ. L. REV. 879, 914 (2008); *see also infra* Part V.A, notes 85–87, 149–52 and accompanying text.

⁸² BRUGMANN, *supra* note 25, at 43 ("Adaptation and the development of resilience are by definition local processes. They require unique solutions for unique, context-specific conditions."); Elizabeth C. Black, *Climate Change Adaptation: Local Solutions for a Global Problem*, 22 GEO. INT'L ENVTL. L. REV. 359, 360 (2010) ("Unlike mitigation, adaptation efforts largely involve local decision-making"); Craig, *supra* note 1, at 23 ("[A] global legal response is insufficient to deal with the localized details of climate change impacts, which will require legal reforms at the national, state, and local levels as well."); Robert L. Glicksman, *Climate Change Adaptation: A Collective Action Perspective on Federalism Considerations*, 40 ENVTL. L. 1159, 1164 (2010) ("[T]he effects of climate change will vary by location, requiring different strategies.").

⁸³ See, e.g., RED CROSS / RED CRESCENT CLIMATE CENTRE, HOW TO ENGAGE IN THE POLICY DIALOGUE ON CLIMATE CHANGE ADAPTATION IN YOUR COUNTRY? 1, Annex 1 (2011), available at http://www.climatecentre.org/downloads/File/advocacy/National%20CCA%20policy%20dialogue %20_version%20february%202011.pdf.

 $^{^{84}}$ This is not to say that in the future local policy-making authority should not be more diffused. *E.g.*, Farber, *supra* note 81, at 914 ("Traditionally, state and local governments have been the major regulators of land use and urban development. Responding to climate change may result in changes to this tradition. Given the national and international scope of climate

SETTING THE FOUNDATION

1235

become increasingly volatile, mirroring the uncertainty surrounding the earth's climate, the federal government's ability to craft flexible, context-sensitive policy responses will be subject to more strain.

This local character of climate adaptation may seem banal, but it implicates important policy considerations. Climate change will primarily exacerbate existing social and environmental problems. George W. Bush and the Federal Emergency Management Administration (FEMA) rightly received condemnation for their inept response to Hurricane Katrina.⁸⁵ But local officials in New Orleans, particularly local law enforcement, might have averted much of the tragedy.⁸⁶ Adaptation efforts should seek to identify these types of institutional vulnerabilities, and wherever possible, tap into local expertise for managing local problems that climate change exacerbates. National governments may take action in the event of an emergency, or partially regulate an area's natural resources through air and water pollution statutes, or through the operation of specific resource management jurisdictions, but "[e]xperience ... shows that local government is the key locus for action on adaptation."⁸⁷

IV. ADAPTATION AND URBAN DEVELOPMENT

A. Focus on the Urban Setting

Climate change is both a symptom and an increasingly important cause of a broader disjunction between economic growth and the natural resources upon which economic activity depends. Urban development is the quintessential manifestation of this conventional economic growth,⁸⁸ and in order to adapt the economic growth process to the pressures of climate change, urbanization will need to adapt.⁸⁹ Hence, focusing adaptation resources on cities makes sense. It also makes sense because climate change will affect different places in different ways, and so the specific policies to manage impacts must respond to local conditions. These policies tend to fall within the gambit of traditional local government powers zoning, water and waste management, emergency response—and so adaptation aid can help local governments, as well as non-governmental

change, the need for an integrated national strategy for controlling emissions and planning adaptation is strong.").

⁸⁵ See, e.g., Pam Fessler, *Report Slams Homeland Response to Katrina*, NPR, Apr. 14, 2006, http://www.npr.org/templates/story/story.php?storyId=5343126 (last visited Nov. 12, 2011).

⁸⁶ See, e.g., Grow Sun, *supra* note 15, at 1178, 1185–87, 1197–98, 1201, 1203.

⁸⁷ MOSER & SATTERTHWAITE, *supra* note 13, at 14 ("Urban populations in high-income nations take for granted that a web of institutions, infrastructure, services and regulations protects them from extreme weather/floods, and keep adapting to continue protecting them.").

⁸⁸ See, e.g., JAMES HOWARD KUNSTLER, THE GEOGRAPHY OF NOWHERE: THE RISE AND DECLINE OF AMERICA'S MAN-MADE LANDSCAPE 147–73 (1993).

⁸⁹ Porras, *supra* note 1, at 542 ("That cities North and South are disproportionate contributors to global ecological dysfunction and, not coincidentally, the sites of a significant proportion of economically productive activity is not in dispute.").

ENVIRONMENTAL LAW

[Vol. 41:1221

organizations, community groups, and local businesses,⁹⁰ to exercise these powers in a way that steers economic growth and urban development towards more sustainable practices. This is not to say that "cities alone can deliver" a solution to climate change and all of the other ecological problems that stem from conventional economic development.⁹¹ But cities must figure prominently in the eventual solution, and action now at the local level can facilitate that solution.

Another reason that cities matter is that most people now live in a city,⁹² and even more are projected to do so in the future. Some seventy-one percent of GHG emissions are attributable to urban areas, according to a recent World Bank estimate, and this share is expected to rise.⁹³ The global population is urbanizing rapidly, and while today just over half of the world lives in cities, at current rates, the global urban population is projected to come to represent three-quarters of the entire global population by 2050.⁹⁴ Perhaps more daunting, between 1990 and 2000, "the annual growth rate of urban land cover was twice that of the urban population," meaning that "urban land cover will double in only 19 years" if trends persist.⁹⁵ Modern urbanization is thus a story of both mass migration to cities, and the expansion of cities to encompass once rural locations.

To be sure, the most rapid declines in urban density have occurred in the developing world,⁹⁶ and the authors of the Lincoln Land Use Institute study, cited above, are quick to point out that living conditions in ultra-high-density slums, such as those in the Kowloon Walled City in Hong Kong during the 1980s, or New York City's lower east side in the late 1800s, pose public health hazards and implicate basic human rights that justify this trend in many areas of the world.⁹⁷ But the decline in urban density is occurring in almost every urban area on the planet, even in places like Europe that have comparatively restrictive urban growth laws.⁸⁸ What accounts for this "very

1236

⁹⁰ See MOSER & SATTERTHWAITE, *supra* note 13, at 1, 13–14, 15 tbl.2 ("A substantial part of adaptive capacity relates to the ability of local communities to make demands on local governments and, wherever possible, to work in partnership with them.").

⁹¹ Porras, *supra* note 1, at 543 (noting that cities may have difficulty pursuing global sustainable development objectives because city governance is increasingly privatized, environmental impacts extend beyond their jurisdictions, and local notions of sustainable development may conflict with responses to climate change).

⁹² According to a recent study published by the Lincoln Institute of Land Policy, "[t]he world urban population is expected to increase from 3 billion in 2000 to 5 billion in 2030 and to 6.4 billion in 2050." SHLOMO ANGEL ET AL., LINCOLN INST. OF LAND POLICY, MAKING ROOM FOR A PLANET OF CITIES 45 (2011), *available at* http://www.citiesalliance.org/ca/sites/citiesalliance.org/files/CA_Images/Making%20Room%20for%20a%20Planet%20of%20Cities.pdf.

⁹³ WORLD BANK, A CITY-WIDE APPROACH TO CARBON FINANCE 1 (2010) available at http://siteresources.worldbank.org/INTCARBONFINANCE/Resources/A_city-wide_approach_to_carbon_finance.pdf.

 $^{^{94}}$ *Id.* at 5.

 $^{^{95}\,}$ Angel et al., supra note 92, at 3.

⁹⁶ On average, cities in developing countries house four times as many people per square mile than urban areas in North America, and they are undergoing both the most rapid increase in urban population and the most rapid decline in urban density. *See id.*

⁹⁷ Id. at 24–25.

⁹⁸ Id. at 20, 25–27.

SETTING THE FOUNDATION

1237

powerful and sustained global tendency for urban densities to decline"?⁹⁹ So called "infill" development¹⁰⁰ must confront challenges that grow out of various property rights, place-based dependencies, and claims and preferences of the local community. These challenges "are a primary reason why the property development industry, and the financial industry that supports it, show preference for new-build or 'greenfield' projects which in turn result in the urban sprawl that is a worldwide urban growth phenomenon."¹⁰¹ Put simply, current regulatory structures make constructing new urban development cheaper, more predictable, and more profitable than investing in existing areas.

For various reasons, auto-centric urban sprawl performs poorly as a system in the face of climate change. In addition to its carbon intensive nature,¹⁰² the sheer scale of the transportation and other infrastructure needed to sustain growth centered on ownership of private automobiles is already becoming an economic liability in places like Texas, where recent droughts have caused significant damage to roads and water infrastructure.¹⁰³ Projections of increasing heat and drought intensity, as a result of climate change, mean that the costs of expansive road and water line networks will go up along with the costs of repairing similar damages.¹⁰⁴ Moreover, the conventional pollution problems associated with these inefficiencies, such as stormwater runoff pollution, ozone and particulate matter pollution in the air, and habitat fragmentation, are intensified by climate change impacts like flooding, heat waves, and ecological stress.¹⁰⁵ Consequently, as climate change intensifies, many investments in sprawl growth development may be lost or require significant retrofits.

However disquieting, the global character of urban sprawl suggests that policy solutions for managing it in the United States, where the phenomenon

⁹⁹ *Id.* at 27.

 $^{^{100}}$ *Id.* at 11 (defining "infill" development as "all new development that occurred between two time periods within all the open spaces in the city footprint of the earlier period excluding exterior open space").

¹⁰¹ BRUGMANN, *supra* note 25, at 33.

 $^{^{102}}$ The carbon-intensive character of sprawl has been well documented and is fairly intuitive. SIERRA CLUB, GLOBAL WARMING: SPRAWLING ACROSS THE NATION, *available at* http://www.sierraclub.org/sprawl/globalwarming.pdf. The further apart housing, school, employment, and shopping are located, the more residents must travel, usually by automobile. As a result, the Sierra Club estimates that in North America, locating new development within already built areas on average yields 50% less $\rm CO_2$ emissions on the basis of driving reductions alone. *Id.*

¹⁰³ Ari Auber, *Drought Effects Extend Far Beyond Water Restrictions*, N.Y. TIMES, Aug. 4, 2011, http://www.nytimes.com/2011/08/05/us/05ttdrought.html (last visited Nov. 12, 2011) ("In cities like Houston and Fort Worth, clay soil is drying up because of the blistering summer heat, bursting water pipelines, buckling house foundations and splitting asphalt roads.... The new cracks are opening as city workers continue to mend fissures in the streets from the 2009 drought.").

¹⁰⁴ See Ann E. Drobot, Transitioning to a Sustainable Energy Economy: The Call for National Cooperative Watershed Planning, 41 ENVTL. L. 707, 772–74 (2011).

¹⁰⁵ John M. Anderies et al., A Framework to Analyze the Robustness of Social-Ecological Systems from an Institutional Perspective, 9 ECOLOGY & SOC'Y 2 (2004), available at http://www.ecologyandsociety.org/vol9/iss1/art18/print.pdf.

ENVIRONMENTAL LAW

[Vol. 41:1221

largely originated,¹⁰⁶ could reverberate abroad. Current projections identify damage to urban infrastructure and associated crises as the single most costly impact of climate change.¹⁰⁷ Therefore, policies for both directing new urban growth and retrofitting existing urban areas to less carbon intensive uses in the United States can help to construct a sorely needed alternative model of urban growth.

Adapting cities and urban growth will require policymakers to view cities within the context of their specific ecologies, including food production systems and other local ecological services. The ICLEI's definition of "resilience" turns on this systemic emphasis,¹⁰⁶ in the tradition of Jane Jacobs,¹⁰⁹ and "proposes a reframing of the adaptation challenge from its primary focus on risk reduction to a broader focus on increasing the performance of the area or system in which the investment is to take place."¹¹⁰ Toward this end, procedural reforms to mainstream climate considerations into the development decision-making process—updating flood plain maps and building regulations, for example—may prove more valuable than capital improvement projects, such as a seawall, simply because the level of private investment in urban infrastructure dwarfs that of public expenditures.¹¹¹

¹⁰⁷ See BRUGMANN, supra note 25, at 15 (noting that "[i]n spite [of] their variances in cost estimates, the top-down models share one clear conclusion: that the dominant portion of future adaptation costs will be in infrastructure and urban areas").

¹⁰⁶ See Michael Lewyn, Sprawl in Europe and America, 46 SAN DIEGO L. REV. 85, 112 (2009) (comparing European and American experiences with sprawl to argue that "affluent societies need not be as suburbanized and automobile dependent as the United States."); Michael Lewyn, *You Can Have It All: Less Sprawl and Property Rights Too*, 80 TEMP. L. REV. 1093, 1095, 1097 (2007) (discussing the history of sprawl in the United States and noting that "[a]s late as the 1940s, most American cities were booming," but "America became far less pleasant for nondrivers during the second half of the twentieth century").

 $^{^{108}}$ *Id.* at 11.

 $^{^{109}\;}$ See Jane Jacobs, The Death and Life of Great American Cities 3–4, 7, 50 (1961).

¹¹⁰ BRUGMANN, *supra* note 25, at 11 (emphasis omitted); *see also* Sheila R. Foster, *The City as an Ecological Space: Social Capital and Urban Land Use*, 82 NOTRE DAME L. REV. 527, 533 (2006) ("Reformers' focus on physically redesigning existing urban space to create social capital is ironically inattentive to existing social ties and networks. [A]ccounting for the integrated relationship between decisions about physical urban space and impacts on a community's social capital necessarily requires rethinking how we manage and regulate the urban commons." (emphasis omitted)).

¹¹¹ To take an example from abroad, in Chinese cities alone, one recent analysis estimates that investment in urban fixed asset expenditures will top \$46 trillion in the period between 2005 and 2020, or over \$2 trillion per year. BRUGMANN, *supra* note 25, at 17. This is 20 times more than the \$100 billion per year by 2020 that was pledged in Copenhagen. United Nations Framework Convention on Climate Change, Copenhagen, Den., Dec. 7–19, 2009, *Report of the Conference of the Parties on its Fifteenth Session, Held in Copenhagen from 7 to 19 December 2009: Addendum: Part Two: Action Taken By the Conference of the Parties at its Fifteenth Session, U.N. Doc. FCCC/CP/2009/11/Add.1, 7 (Mar. 30, 2010). Unfortunately, in practice, a demand for tangible benefits from adaptation aid may distort these policy options, with the Red Cross noting that "often the 'hardware' (concrete visible measures like seawalls) tend to dominate the 'software' (like capacity building of the most vulnerable people, [disaster risk reduction] and health programmes)." RED CROSS / RED CRESCENT CLIMATE CENTRE, <i>supra* note 83, at 3.

SETTING THE FOUNDATION

1239

Directing this private investment towards better performance of the city as a system thus presents a valuable leveraging opportunity.

B. Strategies for Building the Resilient City

United States cities are taking important steps to adapt to climate change, from disaster planning to transit-oriented development to renewable electricity generation. As discussed below, these policies are mutually reinforcing, with many opportunities for "no regrets" policies that serve both economic and environmental interests.¹¹² For example, buildings less susceptible to hurricanes or typhoons are often more energy efficient and cost effective as well.¹¹³ But conflicts are inevitable between adaptation strategies, and between adaptation and mitigation objectives.¹¹⁴ The mix of strategies should reflect local conditions and priorities, taking into account the specific climate change vulnerabilities that a community faces. A closer look at some of the local-level adaptation strategies that are already being adopted across the United States gives an idea of this dynamic.

More frequent natural disasters may represent the most universal threat of climate change. And for many local governments, developing emergency response preparedness remains a top priority. The increased frequency of extreme weather events also requires more prospective loss avoidance strategies.¹¹⁵ Local governments can use their authority to dictate how and where to construct buildings and infrastructure to undertake flood planning and control, strengthen buildings to withstand major storm events, and prevent ridgeline development susceptible to landslides.¹¹⁶ The tools for undertaking this planning are the basic stuff of local government administration—"comprehensive plans, floodplain regulations, zoning, building codes, overlay zones, and stormwater regulations."¹¹⁷ These tools also play a fundamental role in broader environmental protection and GHG mitigation initiatives, such as wetlands preservation.¹¹⁸

Related to flood control, wetland preservation also ranks as an important urban climate change adaptation strategy. Wetlands provide a critical buffer against storm surges in coastal areas, and also help to control

¹¹² See infra text accompanying note 186.

¹¹³ See Evan Mills, Climate Change, Insurance and the Buildings Sector: Technological Synergisms Between Adaptation and Mitigation, 31 BUILDING. RES. & INFO. 257, 271 (2003).

¹¹⁴ See, e.g., Sussman et al., *supra* note 16, at 154 (noting that "siting a new facility above a future floodplain may require users today to travel long distances in GHG-emitting transit modes").

¹¹⁵ Margaret E. Byerly, A Report to the IPCC on Research Connecting Human Settlements, Infrastructure, and Climate Change, 28 PACE ENVIL. L. REV. 936, 982 (2010).

¹¹⁶ Id.

¹¹⁷ Id.

¹¹⁸ See Trisolini, *supra* note 61, at 675 (discussing local government efforts to address climate change and the efficacy of zoning and building codes and other municipal tools).

ENVIRONMENTAL LAW

[Vol. 41:1221

water quality and flood management in inland areas.¹¹⁹ Section 404 of the Clean Water Act¹²⁰ gives the United States Army Corps of Engineers limited authority over activities to fill or otherwise destroy wetlands,¹²¹ but in practice, local land use decisions largely determine wetlands preservation.¹²² To respond to the need for wetlands preservation in the face of coastal erosion and rising sea levels, some local governments have instituted "rolling easements" that automatically adjust as sea levels advance, creating opportunities for new wetlands creation and accommodating coastal property owners, while encouraging them to plan on the basis of sea level rise projections.¹²³

In many areas, climate change will stress already scarce freshwater supplies.¹²⁴ Local government can exercise authority over wetlands, stormwater runoff, solid waste management, and even the location of water supply facilities,¹²⁵ in order to build resilience to water supply disruptions. In the United States, state governments have traditionally retained a great deal of authority over water allocation decisions, and much debate surrounds the extent to which state and local officials are capable of making these allocation decisions, with many arguing for a larger federal role in arbitrating the various competing interests across jurisdictions.¹²⁶ Selfinterested local government action, however, can also create positive spillover effects at the regional or basin-wide level. For example, urban forestry initiatives can help to bolster water supplies, and measures to reduce stormwater runoff can both ease the pressure on local wastewater treatment infrastructure and improve freshwater supplies for jurisdictions downstream.¹²⁷ Other measures, such as safeguarding sewage and water supply infrastructure against flooding,¹²⁸ may require external financing but nonetheless fall within the gambit of local authorities.¹²⁹ As the ICLEI points out in its adaptation planning guide for cities, such capital improvements

¹²⁸ Sussman et al., *supra* note 16, at 106.

¹¹⁹ See, e.g., Glicksman, *supra* note 82, at 1184 (storm buffers); Fred Bosselman, *Swamp Swaps: The "Second Nature" of Wetlands*, 39 ENVTL. L. 577, 587, 617 (2009) (discussing usefulness of wetlands in enhancing water quality and providing flood abatement).

¹²⁰ Federal Water Pollution Control Act, 33 U.S.C. § 1251–1387 (2006). Section 404 is at 33 U.S.C. § 1344 (2006).

¹²¹ *Id.* § 1344(a).

¹²² See, e.g., Paula J. Schauwecker, *Shifting the Focus of Wetlands Protection to State and Local Governments*, 22 NAT. RES. & ENV'T, WINTER 2008, at 66, 67. ("Local governments play a critical role in wetlands protection and restoration.").

¹²³ See Sussman et al., supra note 16, at 71–72.

¹²⁴ See Drobot, *supra* note 104, at 736–37.

¹²⁵ See, e.g., Byerly, *supra* note 115, at 984 ("Iowa City relocated its water supply facility to higher ground following severe floods in 1993. This prevented another disruption in the city's drinking water during serious flooding in 2008.").

 $^{^{126}}$ See, e.g., Glicksman, supra note 82, at 1184 (discussing allocation of water from the Colorado River in the face of climate change impacts).

¹²⁷ See *id.* at 1187 (describing adaptation measures that create environmental benefits that extend beyond the originating jurisdiction).

¹²⁹ See *id.* 135–53 (discussing the different financing opportunities available at the federal, state, and municipal level, while noting that local authorities are the best situated to implement climate change adaptation measures).

SETTING THE FOUNDATION

should be undertaken with a long-term planning perspective in order to identify opportunities for adding value.¹³⁰ For example, a municipality may decide to "piggyback" a reclaimed water system onto a wastewater treatment facility expansion.¹³¹ Some cities, such as Delray Beach, Florida, have even integrated their wastewater treatment operations with conservation efforts to create popular wildlife reserves.¹³²

Water scarcity also implicates an overlap between climate change adaptation and mitigation in the area of energy policy.¹³³ As a recent analysis of adaptation in the New York City metropolitan area explains, climate change will impact energy supplies because of the "inextricable link between energy and water."¹³⁴ It will also introduce scarcity, and favor less centralized power generation, because flooding and heat waves tend to stress energy transmission infrastructure.¹³⁵ This dynamic points to two quintessential local government functions—building regulation and transportation planning—as key drivers of resilience.

Improving the energy efficiency of buildings can help to avoid blackouts during heat waves and ease the impacts of energy shortages during emergencies. It also represents low-hanging fruit as a mitigation strategy, producing financial gains over the lifetime of a building in most cases, while achieving significant reductions in GHG emissions.¹³⁶ Obstacles to making buildings more energy efficient include poor information about existing mature technologies, a focus on short-term costs versus long-term energy savings, and agency problems arising out of landlord-tenant relationships.¹³⁷ Many local governments have overcome these obstacles through green building codes and policies. These include both mandates, such as requirements that municipal, or in some cases new commercial and residential buildings, meet LEED (Leadership in Energy and Environmental Design) standards, as well as less coercive incentives "including options such as fee waivers or reimbursements, subsidized LEED fees, discounted energy star appliances, property tax abatement, awards, green loan funding, training, and permit fee reductions."138 While local governments often rely on external standards to guide building codes and permitting, these functions are well-suited to smaller scale government because "construction design tends to be site-specific."139

Simply removing some building and zoning codes would go a long way towards improving resilience in many cities. For example, zoning ordinances in most United States jurisdictions require developers to include a certain

¹³⁰ AMY K. SNOVER ET AL., PREPARING FOR CLIMATE CHANGE: A GUIDEBOOK FOR LOCAL, REGIONAL, AND STATE GOVERNMENTS 28 (2007).

¹³¹ Id.

¹³² Diane Ackerman, Op-Ed., *Emerald Cities*, N.Y. TIMES, Aug. 16, 2011, at A19.

¹³³ Drobot, *supra* note 104, at 756–57.

 $^{^{134}}$ Sussman et al., *supra* note 16, at 105.

¹³⁵ See Drobot, supra note 104, at 736–37.

¹³⁶ Trisolini, *supra* note 61, at 699.

¹³⁷ *Id.* at 700.

¹³⁸ Id. at 705.

¹³⁹ Glicksman, *supra* note 82, at 1189.

ENVIRONMENTAL LAW

[Vol. 41:1221

number of parking spaces based on the size of a planned structure.¹⁴⁰ Some municipal governments have offered relief from these ordinances as an incentive for green building plans.¹⁴¹ Nevertheless, the enduring presence of parking and setback ordinances underscores the key role that local government has played in promoting sprawl growth in the United States through interconnected land use and transportation policies. By the same token, it points to local government's potential for directing growth in a new direction.

Transit-oriented development or "Smart Growth" alternatives to conventional urban development are typically thought of as GHG mitigation strategies.¹⁴² But the environmental and quality of life benefits that accrue from smart growth policies make these strategies an important climate adaptation strategy as well.¹⁴³ Smart growth aims to concentrate growth in developed city centers and to enable residents to access employment, schools, shopping, and other services by transit or alternatives to driving.¹⁴⁴ Successful smart growth strategies depend both on land use and transportation policies.¹⁴⁵ Land use includes issues such as the setback and parking requirements cited above and single-use versus multi-use zoning,¹⁴⁶ while transportation policies include decisions regarding how much to spend on transit versus highways (or repairs versus new capacity),¹⁴⁷ the design of the overall transportation network, the speed limits on central district streets, and the availability of sidewalks and pedestrian crossings.¹⁴⁸

Many local governments are taking action to structure growth around transit and invest in city centers, while preserving valuable watersheds and agricultural production in city surroundings.¹⁴⁹ Urban containment strategies,

1242

¹⁴⁰ See Trisolini, supra note 61, at 706.

¹⁴¹ *Id*. ("Cities may offer similar incentives through other aspects of zoning codes by allowing developers to exceed limits on building height, ratio of floor space to lot size, or by reducing the amount of required parking.").

 ¹⁴² See CHRIS PYKE ET AL., ADAPTING TO CLIMATE CHANGE THROUGH NEIGHBORHOOD DESIGN 8,
11 (2007), available at http://www.ctg-net.com/content/upload/publications/3/pyke%20etal%
20adapting%20to%20climate%20change%20051807.pdf.

¹⁴³ See U.S. Envtl. Prot. Agency, Smart Growth: Smart Growth and Climate Change, http://www.epa.gov/smartgrowth/climatechange.htm (last visited Nov. 12, 2011).

¹⁴⁴ See U.S. Envtl. Prot. Agency, Smart Growth: About Smart Growth, http://www.epa.gov/smartgrowth/about_sg.htm (last visited Nov. 12, 2011); U.S. Envtl. Prot. Agency, Smart Growth: Smart Growth and Transportation, http://www.epa.gov/smartgrowth/ topics/transportation.htm (last visited Nov. 12, 2011) (discussing the need to develop around transit centers).

¹⁴⁵ See U.S. Envtl. Prot. Agency, Smart Growth: About Smart Growth, supra note 144.

¹⁴⁶ See U.S. Envtl. Prot. Agency, Smart Growth: Smart Growth and Transportation, supra note 144.

¹⁴⁷ Local governments have considerable discretion over how federal transportation funding is used. *See* Keith Bartholomew, *Cities and Accessibility: The Potential for Carbon Reductions and the Need for National Leadership*, 36 FORDHAM URB. L.J. 159, 208 (2009).

¹⁴⁸ See U.S. Envtl. Prot. Agency, Smart Growth: Smart Growth and Transportation, supra note 144; U.S. Envtl. Prot. Agency, Smart Growth: Smart Growth Streets and Emergency Response, http://www.epa.gov/smartgrowth/topics/streets.htm (last visited Nov. 12, 2011).

 $^{^{149}}$ Ironically, many redevelopment initiatives are currently being concentrated in areas prone to high flooding and other natural disaster risks. Lisa Grow Sun, Smart Growth in Dumb

SETTING THE FOUNDATION

1243

such as in Portland, Oregon, have received a great deal of attention, but more modest policies can have a significant impact as well.¹⁵⁰ In the United States, "geographically and demographically diverse efforts" to implement zoning and land use codes based on smart growth principles have flourished in cities including "El Paso, Louisville, and Miami—not jurisdictions usually associated with Berkeley-style environmentalism."¹⁵¹ Similarly, "complete streets" policies have been widely adopted across the United States, forcing planners to design roads with the interests of pedestrians and other non-drivers in mind.¹⁵²

Local government exercises many other important functions that can build resilience—developing renewable energy resources, managing the local electric grid, disposing of solid waste, cleaning up hazardous waste, and maintaining telecommunications infrastructure.¹⁵³ Part V offers just a few illustrative examples from the growing literature to illustrate the policy overlaps between adaptation and mitigation. Beyond specific policies, however, the most important tool for reducing GHG emissions may simply lie in the institutional capacity that adaptation efforts foster at the local level. Just as climate adaptation implicates a broad range of local government functions, so too do the challenges of mitigation and directing urban development that complements, rather than impedes, local ecological services. The following cases give an idea of how that capacity can evolve.

V. CLIMATE CHANGE ADAPTION IN AMERICAN CITIES

In the United States, various studies have sought to shed light on climate change impacts at the national, 154 state, 155 and local 156 levels. At the

¹⁵¹ Trisolini, *supra* note 61, at 715.

¹⁵² See Nat'l Complete Streets Coal., Complete Streets: Homepage, http://www.completestreets.org (last visited Nov. 12, 2011).

 153 See Sussman et al., supra note 16, at 110–19 (discussing examples and opportunities for variety of local regulations).

¹⁵⁵ See, e.g., AMY LYND LUERS & SUSANNE C. MOSER, CAL. CLIMATE CHANGE CTR., No. CEC-500-2005-198-SF, PREPARING FOR THE IMPACTS OF CLIMATE CHANGE IN CALIFORNIA: OPPORTUNITIES AND CONSTRAINTS FOR ADAPTATION, at v, 10 (2006), *available at*

Places: Sustainability, Disaster, and the Future of the American City 1, 14, 26 (Apr. 1, 2011) (unpublished manuscript) (on file with author), *available at* http://papers.ssrn.com/sol3/ Delivery.cfm/SSRN_ID1918386_code1442156.pdf?abstractid=1918386&mirid=1 (noting a "need to broaden the current conversation about sustainability to include discussion of disaster risk").

¹⁵⁰ See REID EWING ET AL., GROWING COOLER: THE EVIDENCE ON URBAN DEVELOPMENT AND CLIMATE CHANGE § 1.7.3 (2007), *available at* http://postcarboncities.net/files/SGA_GrowingCooler9-18-07small.pdf; KELLY KOLAKOWSKI ET AL., URBAN GROWTH BOUNDARIES: A POLICY BRIEF FOR THE MICHIGAN LEGISLATURE 1–2 (2010) *available at* http://www.ippsr.msu.edu/publications/arurbangrowthbound.pdf.

¹⁵⁴ See, e.g., JOEL B. SMITH, ENVIRONMENT: A SYNTHESIS OF POTENTIAL CLIMATE CHANGE IMPACTS ON THE U.S., at ii–iii, 10–17 (2004), *available at* http://www.pewclimate.org/docUploads/ Pew-Synthesis.pdf (summarizing national impacts of climate change on different societal and natural sectors, including agriculture, water resources, coastal communities, human health, terrestrial ecosystems, forestry, and aquatic ecosystems); U.S. Global Change Research Program, *What We Do: The National Climate Assessment*, http://www.globalchange.gov/what-we-do/assessment (last visited Nov. 12, 2011).

ENVIRONMENTAL LAW

[Vol. 41:1221

local level, climate change initiatives have tended to focus on GHG mitigation and other sustainable development goals.¹⁵⁷ The scope of these efforts is substantial, with dozens of cities working through networks such as the ICLEI, the Mayors Climate Protection Center, and C40, to inventory emissions and develop climate action plans.¹⁵⁸ As of October 2011, more than 600 United States cities were members of ICLEI.¹⁵⁹ As with climate regulation in general, for climate adaptation, "the largest U.S. cities are among the most engaged,"¹⁶⁰ and New York City, Boston, and King County, Washington have a relatively long experience in honing adaptation policy.¹⁶¹ This Part looks at these metropolitan areas' plans and potential federal roles for expanding on their efforts.

A. Urban Adaptation Planning in New York, Boston, and King County

Several United States municipal governments have taken steps to identify and adapt to climate change, but New York, Boston, and King County have among the most advanced—and well-documented—adaptation initiatives in the United States.¹⁶² A closer examination of how these programs evolved, and where they are now, offers some lessons for other local governments. In particular, they illustrate the importance of linkages between different branches of local government authority.

In many ways, King County exemplifies how mainstreaming climate change adaptation into urban policy can produce better outcomes across a wide range of measures. King County, which encompasses Seattle, began some of the earliest efforts to prepare for climate change at the local level.¹⁶³

¹⁵⁸ Id.

http://www.energy.ca.gov/2005publications/CEC-500-2005-198/CEC-500-2005-198-SF.PDF (examining opportunities in California for managing climate change impacts, including storm-resistant coastal and floodplain development, improved warning systems for heat extremes, and water conservation measures); Minn. Pollution Control Agency, *Climate Change*, www.pca.state.mn.us/hot/globalwarming.html (last visited Nov. 12, 2011).

¹⁵⁶ PAUL KIRSHEN ET AL., INFRASTRUCTURE SYSTEMS, SERVICES AND CLIMATE CHANGE: INTEGRATED IMPACTS AND RESPONSE STRATEGIES FOR THE BOSTON METROPOLITAN AREA (2004), *available at* http://www.pewtrusts.org/uploadedFiles/wwwpewtrustsorg/Reports/Global_ warming/040813Climate_Change_Boston.pdf (presenting results of the Climate's Long-term Impacts on Metro Boston (CLIMB) project, this report is also known as the CLIMB Final Report); A.K. SNOVER ET AL., CLIMATE IMPACTS GRP., UNCERTAIN FUTURE: CLIMATE CHANGE AND ITS EFFECTS ON PUGET SOUND (2005), *available at* http://www.cses.washington.edu/db/pdf/ snoveretalpsat461.pdf.

 $^{^{157}\,}$ See Trisolini, supra note 61, at 679.

¹⁵⁹ ICLEI-Local Gov'ts for Sustainability USA, *FAQ: About ICLEI-Local Governments for Sustainability*, http://www.icleiusa.org/about-iclei/faqs/faq-about-iclei-local-governments-for-sustainability (last visited Nov. 12, 2011).

¹⁶⁰ Trisolini, *supra* note 61, at 679.

¹⁶¹ See PENNEY & WIEDITZ, supra note 10, at ix.

 $^{^{162}}$ In particular, a comparative analysis of these metropolitan areas' adaptation plans, along with those of Halifax, Vancouver, and London was conducted in 2007 in conjunction with the Clean Air Partnership. *Id.* at ix, 45–50.

¹⁶³ King Cnty., *Past King County Climate Action*, http://www.kingcounty.gov/environment/ climate/legacy.aspx (last visited Nov. 12, 2011).

SETTING THE FOUNDATION

In 1988, then King County Councilmember Ron Sims proposed an ordinance to establish a county office of global warming.¹⁶⁴ Sims later became the Executive for King County, and passed various executive orders aimed at reducing GHG emissions.¹⁶⁵ In 2005, the County held a conference, entitled "The Future Ain't What It Used to Be," in order to foster collaboration between city and regional officials from a broad range of regulatory areas.¹⁶⁶ Following the conference, a "Global Warming Team" was formed with representatives from all of the city's major offices—budget, environmental services, parks, transportation, economic development, and others—to guide adaptation as well as mitigation efforts.¹⁶⁷

These efforts have led to significant reforms. The County's wastewater treatment, for example, now includes a program to make reclaimed water available for industrial and irrigation uses, thus relieving pressure to draw water from local rivers, where climate change impacts are stressing salmon and other wildlife.¹⁶⁸ The city has also undertaken a flood buyout and home elevation program to avoid property losses in flood zones.¹⁶⁹ The County revised its Comprehensive Plan and Shoreline Master program to integrate climate change projections, which included specific policies to raise awareness of climate change impacts,¹⁷⁰ assess and plan for flooding and sea level rise,¹⁷¹ update disaster preparedness plans,¹⁷² evaluate climate change impacts on biodiversity,¹⁷³ and reform salmon and other wildlife conservation plans to reflect climate change stresses on habitat.¹⁷⁴ These policies illustrate both the breadth of adaptation policy and its potential for realizing environmental and economic co-benefits.

New York City's adaptation planning started early as well. In 1997, the federal government initiated a National Assessment of Climate Change Impacts on the United States, divided into eighteen regional assessments.¹⁷⁵ More than any other region, the Metropolitan East Coast (MEC) Assessment¹⁷⁶ focused on urban issues.¹⁷⁷ The MEC Assessment set the

¹⁶⁷ PENNEY & WIEDITZ, *supra* note 10, at 57.

 $^{^{164}}$ Id.

¹⁶⁵ Id.

¹⁶⁶ King Cnty., 2005 King County Climate Change Conference: The Future Ain't What It Used to Be, http://www.kingcounty.gov/environment/climate/legacy/2005-climate-changeconference.aspx (last visited Nov. 12, 2011).

¹⁶⁸ King Cnty., *supra* note 163.

¹⁶⁹ PENNEY & WIEDITZ, *supra* note 10, at 54–55.

¹⁷⁰ KING CNTY., KING COUNTY COMPREHENSIVE PLAN 2008: WITH 2010 UPDATE 4-16 (2010), *available at* http://www.kingcounty.gov/property/permits/codes/growth/CompPlan/2008_ 2010update.aspx (click on "Chapter Four-Environment" to access either PDF or MS Word version).

¹⁷¹ Id.

 $^{^{172}}$ Id. at 4–17.

¹⁷³ Id.

¹⁷⁴ Id.

¹⁷⁵ PENNEY & WIEDITZ, *supra* note 10, at 18.

¹⁷⁶ Metro. E. Coast Assessment, *Climate Change and a Global City: An Assessment of the Metropolitan East Coast Region*, http://metroeast_climate.ciesin.columbia.edu/ (last visited Nov. 12, 2011).

¹⁷⁷ PENNEY & WIEDITZ, *supra* note 10, at 18.

ENVIRONMENTAL LAW

[Vol. 41:1221

foundation for New York City's climate change adaptation plan, and eventually, the establishment of a separate departmental adaptation program in the city's Department of Environmental Protection.¹⁷⁸ Currently, New York's PlaNYC includes a major adaptation project to shore up the city's water supply in the face of expected drought, and a tree-planting program— "Greening the Bronx"—designed to reduce urban heat island effect.¹⁷⁹ These projects, however, represent the end results of an ongoing process to build awareness and educate policymakers, assess risks and identify vulnerabilities, and evaluate appropriate courses of action.¹⁸⁰ In its initial assessment, New York City planners identified six urban systems susceptible to climate change impacts: coasts, water, energy, infrastructure, transportation, and health.¹⁸¹ They then held a series of workshops with midlevel officials from corresponding departments over a period of several years to encourage those agencies to mainstream climate change adaptation into their planning and operational decisions.¹⁸² At the same time, the city has launched websites and other marketing efforts to win public support for the program.¹⁸³

The greater Boston area illustrates some of the obstacles to adaptation planning. Compared to King County and New York City, technical specialists took a greater role at the assessment stage and established weaker ongoing ties with a wide variety of stakeholders.¹⁸⁴ As a result, the Boston initiative, which spent more money than most other jurisdictions on a highly technical and comprehensive adaptation assessment report, did not develop the same level of institutional mechanisms for incorporating adaptation options into broader policies for transportation, water management, and other affected areas.¹⁸⁵ This is not to say that Boston area officials are ignoring climate change. Future sea level rise projections led the Massachusetts Water Resources Authority, for example, to change the site of a sewage treatment plant built in 1998, and the city has undertaken a major forestry initiative, a prime example of a "no regret" adaptation policy.¹⁸⁶ But while King County and New York City appear to have moved beyond the assessment and policy evaluation stages of adaptation planning to more concrete actions, including major infrastructure projects, the 2011 update to Boston's Climate Action Plan identifies the need to "[d]evelop an adaptation plan" and "[r]equire

¹⁷⁸ *Id.* at 47–48.

¹⁷⁹ BLOOMBERG, *supra* note 10, at 79–85; PENNEY & WIEDITZ, *supra* note 10, at 42, 54.

¹⁸⁰ BLOOMBERG, *supra* note 10, at 3–14.

¹⁸¹ PENNEY & WIEDITZ, *supra* note 10, at 25.

¹⁸² See id.

¹⁸³ *Id.* at 7–12.

¹⁸⁴ See id. at 17–18.

 $^{^{185}}$ Id. at 17–18, 49–50 (noting the CLIMB Final Report discussing Boston's impacts cost more than \$800,000 and took almost five years to complete, yet it was "less effective in motivating action" than a comparable London study that cost approximately \$100,000 and took two years to complete).

¹⁸⁶ *Id.* at 7, 43–44; *see, e.g., Boston Mayor Menino Announces Urban Forestry Initiative*, BOSTON/SF, May 21, 2007, http://bostonsf.com/ME2/dirmod.asp?sid=&nm=&type=Publishing& mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=40F 254DE25A643B5BA3C07A83D5E496E (last visited Nov. 12, 2011).

SETTING THE FOUNDATION

1247

every municipal department and agency to undertake a formal review of consequences of climate change," suggesting that the city has some catching up to do.¹⁸⁷

The experiences of Boston, New York City, and King County reflect unique local contexts, but they provide some insights into how climate change adaptation can succeed. The experiences underscore the importance of linkages between climate and environmental specialists on the one hand, with officials from other areas of local and regional government, such as transportation or solid waste management. The studies also underscore the importance of raising public awareness, and fostering public support. In this respect, King County's focused attention to salmon fisheries is unsurprising. Perhaps most importantly, the cities' experiences attest to a common process for mainstreaming climate considerations into municipal operations, which begins with identifying climate change impacts and disseminating that information broadly in a way that stimulates communication flows in both directions, then building on those linkages to craft policy strategies, and eventually, undertaking coordinated action to build resilience.¹⁸⁸

B. Top-Down Adaptation Planning: The Federal Role

Federal initiatives on climate change adaptation should provide an important source of finance, expertise, and political incentives for local policymakers. By bringing climate change adaptation into the limelight, moreover, the federal government can boost public awareness and educate individuals regarding climate change. A highly visible, national climate change adaptation fund could serve these purposes well, and help to make up for lost ground. For now, the federal government's climate change adaptation work is neither very visible nor very effective.¹⁸⁹

Federal action on climate change adaptation has proceeded slowly. On October 5, 2009, President Obama issued Executive Order 13514¹⁹⁰ requiring federal agencies to undertake various measures to reduce GHG emissions and to identify adaptation strategies in conjunction with the interagency Climate Change Adaptation Task Force.¹⁹¹ Pursuant to the Order, all federal

¹⁹¹ *Id.* at 249. The Climate Change Adaptation Task Force is co-chaired by the White House Council on Environmental Quality (CEQ), the Office of Science and Technology Policy (OSTP),

¹⁸⁷ PENNEY & WIEDITZ, *supra* note 10, at 54, 64; CLIMATE ACTION LEADERSHIP COMM. & CMTY. ADVISORY COMM., SPARKING BOSTON'S CLIMATE REVOLUTION 11 (2010), *available at* http://www.cityofboston.gov/Images_Documents/Sparking%20Bostons%20Climate%20Revolutio n%20Summary%20Report_tcm3-16527.pdf.

¹⁸⁸ See Climate Action Leadership Comm. & Cmty. Advisory Comm., supra note 187, at 5–8, 11.

¹⁸⁹ See Camacho, supra note 24, at 26 ("[M]ost existing state and federal regulatory programs are ill-prepared to adapt to the direct effects of climate change."); Glicksman, supra note 82, at 1163 ("Despite the critical need for the development of adaptive responses to climate change, the federal government has done little to stake out its turf on adaptation policy or to coordinate the responses of lower levels of government."); Ruhl, supra note 1, at 412 ("[T]he United States has compiled close to zero in the way of coordinated anticipatory adaptation policy for managing the risk in the United States of climate change catastrophe and crisis.").

¹⁹⁰ Exec. Order No. 13514, 3 C.F.R. 248 (2009).

ENVIRONMENTAL LAW

[Vol. 41:1221

agencies were required to issue "an agency-wide climate change adaptation policy statement . . . that commits the agency to adaptation planning to address challenges posed by climate change to the agency's mission, programs, and operations," by June 2011.¹⁹² This process has highlighted important deficiencies. For example, the United States Department of Transportation (DOT) report concedes that "[c]osts and benefits resulting from climate change impacts are currently not addressed or quantified in DOT evaluation processes."¹⁹³ DOT has pledged to incorporate consideration of climate adaptation into planning processes and investment decisions,¹⁹⁴ but its success in doing so will depend in no small part on state and local transportation partners' policy. Unfortunately, thus far federal initiatives have done little to stimulate adaptation planning in American cities.¹⁹⁵

This lack of coordination poses a clear challenge to establishing an effective polycentric governance structure for dealing with climate change. On the one hand, the weak federal policy fails to encourage, or even inhibits, the horizontal transmission of policy successes and best practices established in jurisdictions like King County and New York City. At the same time, where federal agencies have developed policies to incorporate climate change considerations into their operations and planning, disengaged local policymakers are largely free to override these considerations. For example, under NEPA, agencies are increasingly documenting climate change impacts in Environmental Impact Statements (EISs), but because the NEPA process does not inform so much as authorize decisions after the fact,¹⁹⁶ even dramatic evidence of climate change vulnerabilities may be ignored or rationalized in environmental assessments.¹⁹⁷

and the National Oceanic and Atmospheric Administration (NOAA). Council on Envtl. Quality, *Climate Change Adaptation Task Force*, http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation (last visited Nov. 12, 2011).

 $^{^{192}}$ COUNCIL ON ENVTL. QUALITY, INSTRUCTIONS FOR IMPLEMENTING CLIMATE CHANGE ADAPTATION PLANNING IN ACCORDANCE WITH EXECUTIVE ORDER 13514, at § I(A)(2) (2011), available at http://www.whitehouse.gov/sites/default/files/microsites/ceq/adaptation_final_implementing_instructions_3_3.pdf.

¹⁹³ U.S. DEP'T OF TRANSP., STRATEGIC SUSTAINABILITY PERFORMANCE PLAN 23 (2010), *available at* http://www.dot.gov/sustainability/sspp_2010.pdf.

 $^{^{194}}$ Id. at 58.

 $^{^{195}\,}$ See Camacho, supra note 24, at 26; Glicksman, supra note 82, at 1163; Ruhl, supra note 1, at 412 .

 $^{^{196}}$ Farber, *supra* note 78, at 10,609 ("U.S. Supreme Court decisions have allowed agencies to use the EIS as an end-of-process disclosure document rather than an integral part of the agency's decisionmaking.").

¹⁹⁷ In one particularly egregious example, the EIS for a proposed bridge project to the Outer Banks of North Carolina took the position that projected sea level rise actually favored building a second bridge to a barrier island, because the road linking the area around the proposed project and the existing bridge on the other side of the island would be under water. U.S. DEP'T OF TRANSP. ET AL., ADMINISTRATIVE ACTION DRAFT ENVIRONMENTAL IMPACT STATEMENT: MID-CURRITUCK BRIDGE STUDY 3-64 to -65 (2010), *available at* http://www.ncdot.gov/projects/midcurrituckbridge/download/midcurrituck_DEIS_Draft_EIS.pdf; *see also* Farber, *supra* note 78, at 10,613–14 (discussing the need to reform NEPA in order to respond to climate change challenges).

SETTING THE FOUNDATION

1249

In order to support climate adaptation planning at the national level, federal government should play a larger role in fostering local adaptation efforts and engaging local policymakers. The National Oceanic and Atmospheric Administration (NOAA) has proposed a reorganization to create a national Climate Service, which is a good first step, filling an important coordinating role by centralizing federal sources of information on climate change adaptation and mitigation strategies.¹⁹⁸ This type of information sharing role is one of the least intrusive possible relationships between federal and local governments on climate change adaptation.¹⁹⁹ That has not stopped congressional Republicans from targeting NOAA's revenueneutral reorganization in recent spending bills and cutting off funding to the Climate Service through September of 2011.²⁰⁰ Other NOAA initiatives, however, such as the Coastal Services Center Coastal Climate Adaptation website and information clearinghouse, continue to operate and in the past have provided substantial support for local initiatives such as the Boston, New York City, and King County initiatives discussed above.²⁰¹

Increased federal financial support for state and local efforts to compile their own information and planning processes could be helpful, too. The means of structuring such financial assistance could take the form of grant or loan programs specifically aimed at adaptation planning, or at financing infrastructure improvements linked to adaptation planning. The federal finance program for sewage treatment plants has been offered as one template for such a program.²⁰² Another proposal would seek to condition federal transportation, energy, and other funding on compliance with

 201 See, e.g., SIUSLAW ESTUARY P'SHIP, CLIMATE CHANGE REPORT 38 (2011), available at http://www.siuslawwaters.org/shop/images/climate_

¹⁹⁸ Examining NOAA's Climate Service Proposal: Hearing Before the H. Comm. on Sci., Space, & Tech., 112th Cong. 1–3 (2011) (statement of Jane Lubchenco, Administrator, National Oceanic and Atmospheric Administration), *available at* http://science.house.gov/ sites/republicans.science.house.gov/files/documents/hearings/062211_lubchenco.pdf (describing NOAA's proposal for a national Climate Service).

¹⁹⁹ *See* Glicksman, *supra* note 82, at 1167.

²⁰⁰ Press Release, H. Comm. on Sci., Space, and Tech., Republicans Raise Concerns with NOAA Climate Service, EPA Science Activities (Mar. 10, 2011) http://science.house.gov/press-release/republicans-raise-concerns-noaa-climate-service-epa-science-activities (last visited Nov. 12, 2011). The creation of NOAA's Climate Service was to coincide with a \$56.8 million decrease in the Agency's budget, according to the Obama Administration's proposal, however, the Department of Defense and Full-Year Continuing Appropriations Act of 2011, Pub. L. No. 112-10, § 1348, 125 Stat. 38, 124, provides that "[n]one of the funds made available by this division may be used to implement, establish, or create a NOAA Climate Service as described in the 'Draft NOAA Climate Service Strategic Vision and Framework' published at 75 Federal Register 57,739 (September 22, 2010)."

change_report_apr_11_2011.pdf (noting that the NOAA Coastal Services Center website is a "primary resource for coastal managers"); Univ. of Wis. Sea Grant, *National GIS Programs and Data Websites* http://aqua.wisc.edu/cpr/Default.aspx?tabid=85 (last visited Nov. 12, 2011) (listing the website as a resource and noting "the NOAA Coastal Services Center is devoted to serving the nation's state and local coastal resource management programs").

²⁰² Glicksman, *supra* note 82, at 1167 ("Under the Clean Water Act, for example, the United States Environmental Protection Agency (EPA) has administered a program of grants and loans to state and local governments for the construction of sewage treatment plants.").

ENVIRONMENTAL LAW

[Vol. 41:1221

prescribed adaptation planning objectives, following the example of Dutch law makers. $^{\scriptscriptstyle 203}$

As a first step, reducing the role of federal funding as a driver of poorly adaptive urban development could have a significant impact. Some tentative steps have been taken in this direction. For example, as part of the federal stimulus bill in 2009, DOT's Transportation Investment Generating Economic Recovery (TIGER) grant program targeted funding on the basis of performance measures, including the environmental impacts and GHG emissions associated with proposed transportation infrastructure projects.²⁰⁴ These criteria have since been largely incorporated into the ongoing Transportation Infrastructure Finance and Innovation Act (TIFIA) loan program,²⁰⁵ and could help to shift its investment mix away from its current focus on highways and toll roads.²⁰⁶ The criteria fall short of any hard and fast requirements for sustainability, nor do they even mention climate change adaptation, but they move closer to a system in which federal transportation and other funding is awarded on the basis of performance. Eventually, such a performance-based system could provide important incentives to local governments.

C. A National Climate Change Adaptation Fund

A sizable population in the United States continues to believe that climate change is not an important problem, and that its impacts and the need for an aggressive policy response remain far in the future.²⁰⁷ So

²⁰³ See Damien Leonard, Directed Note, *Raising the Levee: Dutch Land Use Law as a Model for U.S. Adaptation to Climate Change*, 21 GEO. INT'L ENVTL. L. REV. 543, 561 (2009) (noting that "the federal government could require that each new federally-funded state or local project must conduct an analysis of potential impacts due to climate change and methods for mitigating those impacts within the larger context of the state-wide plan").

²⁰⁴ Interim Notice of Funding Availability for Supplemental Discretionary Grants for Capital Investments in Surface Transportation Infrastructure Under the American Recovery and Reinvestment Act, 74 Fed. Reg. 23,226, 23,230 (May 18, 2009).

²⁰⁵ Notice of Funding Availability for Applications for Credit Assistance Under the Transportation Infrastructure Finance and Innovation Act (TIFIA) Program, 76 Fed. Reg. 4408, 4410 (Jan. 25, 2011) ("Listed in order of relative weight, the TIFIA selection criteria are as follows: . . . (iii) The extent to which the project helps maintain or protect the environment. This includes sustainability: Improving energy efficiency, reducing dependence on oil, reducing [GHG] emissions, and reducing other transportation-related impacts on ecosystems"); "The [TIFIA] program provides Federal credit assistance in the form of direct loans, loan guarantees, and standby lines of credit to finance surface transportation projects of national and regional significance." Fed. Highway Admin., Dep't of Transp., *TIFIA*, http://www.fhwa.dot.gov/ipd/tifia/ (last visited Nov. 12, 2011).

²⁰⁶ TIFIA has 19 ongoing projects, of which only one is transit, three are "intermodal" stations, and 15 are highway. Fed. Highway Admin., Dep't of Transp., *Projects & Project Profiles*, http://www.fhwa.dot.gov/ipd/tifia/projects_project_profiles/tifia_portfolio.htm (last visited Nov. 12, 2011).

²⁰⁷ See, e.g., YALE PROJECT ON CLIMATE CHANGE COMMC'N & GEORGE MASON UNIV. CTR. FOR CLIMATE CHANGE COMM., PUBLIC SUPPORT FOR CLIMATE AND ENERGY POLICIES IN MAY 2011, at 2 (May 1, 2011), available at http://www.climatechangecommunication.org/images/files/ PolicySupportMay2011.pdf [hereinafter YALE & GEORGE MASON UNIV. CLIMATE CHANGE]

SETTING THE FOUNDATION

1251

messaging is important. This gives appeal to the creation of a national climate change adaptation fund to finance adaptation planning at the local level.

A "national climate change adaptation fund," under that name, could serve a variety of purposes. Simply conveying meaning could be the most important. There are some Americans who believe that climate change is a hoax.²⁰⁸ But the more powerful force against reducing GHG emissions is neither so extreme nor unreasonable.²⁰⁹ Most American policymakers, whether they care to admit it, are concerned about climate change, but remain unpersuaded that it represents a very immediate threat.²¹⁰ This sentiment is encouraged by classical economic analysis. For example, Steven Levitt's Superfreakonomics claims that bioengineering provides a more economically efficient means of addressing climate change than reducing emissions now.²¹¹ In a similar vein, Bjorn Lomborg's *Cool It* argues that the money required for a major climate change mitigation program would be better spent on priorities like reducing malaria.²¹² Unfortunately, the scientific literature on climate change discredits these economic arguments and paints an increasingly dire picture of what will be needed to avoid catastrophic global tipping points, such as the melting of the Greenland ice sheet.²¹³ Conventional economic analyses of climate change also tend to understate more immediate costs, such as soaring food prices, that have resulted from climate change triggering dispersed, localized tipping points of ecological degradation.²¹⁴

²¹⁰ In recent years, many American policymakers, particularly Republicans, have conceded that the climate is changing, but disputed an anthropogenic cause. *See, e.g.*, Ashley Parker, *Day After Fed Uproar, Perry Tones It Down*, N.Y. TIMES, Aug. 18, 2011, at A12 (quoting Governor Rick Perry of Texas).

²¹¹ See Steven D. Levitt & Stephen J. Dubner, Superfreakonomics: Global Cooling, Patriotic Prostitutes, and Why Suicide Bombers Should Buy Life Insurance 195 (2009).

²¹² BJORN LOMBORG, COOL IT: THE SKEPTICAL ENVIRONMENTALIST'S GUIDE TO GLOBAL WARMING 162 tbl.2, 163 (2007).

²¹³ See Neil Adger et al., Summary for Policymakers, in CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY: CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, supra note 21, at 19; Suzanne Goldenberg, Greenland Ice Sheet Faces "Tipping Point in 10 Years", GUARDIAN, Aug. 10, 2010, http://www.guardian.co.uk/environment/2010/aug/10/greenland-ice-sheet-tipping-point (last visited Nov. 12, 2011).

²¹⁴ In 2007 to 2008, global food prices spiked and motivated several countries to implement export restrictions that further fueled the crisis. United Nations, *UN Issues Policy Guide for Countries Hit Hard by High Food Prices*, UN NEWS CENTRE, Jan. 26, 2011, http://www.un.org/apps/news/story.asp?NewsID=37384 (last visited Nov. 12, 2011). Since then, food prices have continued to climb, with real prices 17% higher than in 2008, as of June 2011. Food & Agric. Org. of the United Nations, *World Food Situation: FAO Food Price Index*, http://www.fao.org/

⁽showing that in 2011, 30% of Americans polled thought global warming should be a low priority for the president and Congress).

²⁰⁸ E.g., Arlette Saenz, Rick Perry Picks Up Endorsement of Sen. Jim Inhofe, Climate

Change Skeptic, ABC NEWS, Aug. 29, 2011, http://abcnews.go.com/Politics/rick-perry-picks-endorsement-sen-jim-inhofe-climate/story?id=14407804 (last visited Nov. 12, 2011).

²⁰⁹ See YALE & GEORGE MASON UNIV. CLIMATE CHANGE, *supra* note 207, at 11–14 (indicating that a majority of Americans oppose a variety of small fees to support programs that would reduce GHG emissions).

ENVIRONMENTAL LAW

[Vol. 41:1221

As the reality of the science sinks in, concern in the United States and abroad may force political tipping points²¹⁵ accompanied by more aggressive policy at the global²¹⁶ and national level on mitigation and adaptation. But as Ostrom and others point out, such aggressive policy at the top cannot be implemented without a support structure of local and ultimately individual action.²¹⁷ Simply familiarizing residents of many American cities with the fact that climate change already requires an adaptive response could go a long way towards building that support structure. And, of course, a national adaptation fund would provide incentives for the local planning and policies that ease the transition to a world of climate disruptions and carbon constraints.

Consistent with the principles of adaptive law, discussed above, a national adaptation fund should rely on a broad range of policy instruments, some more coercive than others. In the context of transportation, for example, the fund could award grants for projects to better integrate transportation, land use and natural resource planning, helping local governments to phase out antiquated travel demand models and make realistic assessments of how planned development will affect the local water supply and air shed as the climate changes.²¹⁸ It could also fund capital improvement projects, or federal reinsurance. Conditions on funding might include reform of local governance structures, such as consolidating multiple Metropolitan Planning Organizations in a single metropolitan

Our argument shows that the leading economic models of climate change's impacts are methodologically limited in ways that systematically skew toward an understatement of costs. The models understate some impacts because of their optimistic assumptions about the rate and magnitude of warming and fail to account for certain categories of impacts that are difficult to quantify. In addition, leading models tend to adopt a myopic single economy view that does not account for international spillover effects.

 215 For an interesting discussion of this concept as it applies to global climate change negotiations, see Geoffrey Heal & Howard Kunreuther, *Tipping Climate Negotiations* 1–2 (Risk Mgmt. & Decision Processes Ctr., Working Paper No. 2011-02, 2011), *available at* http://opim.wharton.upenn.edu/risk/library/WP2011-02_GH,HK_TippingClimateNegotiations.pdf.

²¹⁶ For example, as I have argued in a previous article, administrative realities and the value of certain areas as bulwarks against climate change-induced ecological stress could support the issuance of carbon offset credits, or even transfer payments, to foreign governments that agree to forego exploitation of fossil fuel resources in areas of high biodiversity. *See* Thomas M. Gremillion, *Reducing Carbon Emissions Through Compensated Moratoria: Ecuador's Yasuní Initiative and Beyond*, 41 Envtl. L. Rep. (Envtl. Law Inst.) 10641 (July 2011).

²¹⁷ Ostrom, *supra* note 48, at 4, 27.

worldfoodsituation/wfs-home/foodpricesindex/en/ (last visited Nov. 12, 2011) (highlighting "FAO Food Price Index fell for the third consecutive month" in the monthly release of June 2011). For a general discussion of the limits of economic analyses of climate change, see Jody Freeman & Andrew Guzman, *Climate Change and U.S. Interests*, 41 Envtl. L. Rep. (Envtl. Law Inst.) 10,695, 10,711 (Aug. 2011):

²¹⁸ California has taken a step in this direction with Senate Bill 375, "which requires the state's [Metropolitan Planning Organizations] to include as part of their long-range transportation plans a 'sustainable communities strategy' that is designed to meet greenhouse gas reduction targets set by the state Air Resources Board." Bartholomew, *supra* note 147, at 209 (citing 2008 Cal. Adv. Legis. Serv. 728 (LexisNexis)).

SETTING THE FOUNDATION

area,²¹⁹ or revising zoning codes to relax requirements such as parking setbacks. Such reforms are often difficult for local policymakers to undertake because of local opposition, and so the enticement of federal funding could provide political cover. The prospect of creating jobs could also win support from local partners, with an adaptation fund possibly financing new staff positions in local government, and boosting employment through capital improvement and other projects as well.

Clearly, creating a new federal spending program with "climate change" in the title will encounter opposition.²²⁰ But compared to the challenges of cap-and-trade, a climate change adaptation fund poses a less direct threat to powerful special interests, and has a common sense, better-safe-than-sorry appeal. The various efforts at the agency level to craft climate adaptation plans demonstrate that such a fund aligns with existing federal policy. But local adaptation planning, which can identify and address specific vulnerabilities to climate change, should not depend on federal expertise to trickle down. It should receive a direct stimulus now.

VI. CONCLUSION

Ultimately, adapting to climate change must include a stop to its underlying cause. Avoiding more than a two degree Celsius rise in average world temperature will require a Herculean effort at every level of action, from international negotiating bodies to neighborhood coalitions. It will require linkages between climate specialists and a diverse body of policymakers and stakeholders, and it will require public awareness and the assumption of individual responsibility. Unfortunately, few policymakers appear inclined to embark upon this Herculean effort anytime soon. Local climate adaptation initiatives, with support from above, can help to set the stage for action when the political winds change. As the value of local initiatives like those of King County and New York City become more evident, other cities are sure to follow with their own assessments of vulnerabilities and action plans. Federal policy should encourage cities to undertake these initiatives and to continue developing those already in progress, setting the institutional foundation for tackling climate change head on.

1253

²¹⁹ To cite one particularly fragmented example, four metropolitan planning organizations and two rural planning organizations share authority over transportation planning in the Charlotte metro area. Mecklenburg-Union Metro. Planning Org., *Fast Facts*, http://www.mumpo.org/about-us/fast-facts (last visited Nov. 12, 2011).

²²⁰ See, e.g., Kate Sheppard, *The CIA's Weather Underground: Are Republicans Putting the Intelligence Community's Climate Projects on Ice?*, MOTHER JONES, Aug. 10, 2011, http://motherjones.com/environment/2011/08/cia-climate-change-national-security (last visited Nov. 12, 2011) (describing Republican opposition to military and intelligence programs to study climate change, including a budget amendment by Sen. John Barraso (R-Wyo.) to curtail the Central Intelligence Agency's Center on Climate Change and National Security).