Proceedings of the 2010 Land Policy Conference

CLIMATE CHANGE AND LAND POLICIES

Edited by Gregory K. Ingram and Yu-Hung Hong

Climate Change and Land Policies

Edited by

Gregory K. Ingram and Yu-Hung Hong

LINCOLN INSTITUTE OF LAND POLICY
CAMBRIDGE, MASSACHUSETTS

Library of Congress Cataloging-in-Publication Data

Climate change and land policies /
edited by Gregory K. Ingram and Yu-Hung Hong.
p. cm.
Conference proceedings.
ISBN 978-1-55844-217-7
1. Land use, Urban—Congresses. 2. Climatic changes—Government
policy—Congresses. 3. Climatic changes—Environmental
aspects—Congresses. I. Ingram, Gregory K. II. Hong, Yu-Hung.
HD1391.C64 2011
333.73'13—dc22 2011003415

Designed by Vern Associates

Composed in Sabon by Achorn International in Bolton, Massachusetts.
Printed and bound by Puritan Press Inc., in Hollis, New Hampshire.
♻ The paper is Rolland Enviro100, an acid-free, 100 percent PCW recycled sheet.

MANUFACTURED IN THE UNITED STATES OF AMERICA

CONTENTS

6

Integrating Adaptation and Mitigation in Local Climate Change Planning

Elisabeth M. Hamin

Local and regional governments are the first line of defense in responding to the challenges of climate change. They set the terms by which land will be used, homes designed, buildings built, and ecosystem services preserved. They are also the first responders to disasters. One challenge in fulfilling this role is that, given the cumulative nature of greenhouse gas emissions, climate is changing whether we like it or not (IPCC 2007b). Because of their public safety responsibilities, local and regional governments need to prepare to adapt to changed conditions, whatever they may be for that region. Beyond public safety, local governments in conjunction with state and federal government and private industry invest billions of dollars in infrastructure; changing climate conditions could radically shorten the life of local infrastructure if left unanticipated (Rosenzweig et al. 2007; Stern 2007). For both public safety and fiscal reasons, local and regional governments need to plan ways to better accommodate a changing climate—they need to adapt. This does not replace local and regional responsibility to reduce greenhouse gas emissions; both must be done. And, in fact, the very urban nature of cities helps residents emit fewer greenhouse gases, so cities themselves need to be encouraged and supported as key mitigation opportunities. But adaptation and mitigation require very different policies. Both have spatial implications but in opposite directions, so it is essential that cities ensure that their policy choices do not unintentionally conflict.

The key goal of the current research was to provide a policy framework that would help make clear the connection between adaptation and mitigation. To test the framework, as well as to organize a selection of current case studies, evaluators examined seven leading municipal climate change plans to see what types of policies cities are proposing and whether these actions might serve as models for other policy makers. The specific research questions were as follows:

- In their statements of intent, do cities seem to prefer mitigation over adaptation or vice versa?
- What sorts of threats are leading municipal adaptation plans addressing?
- At the policy level, do the adaptive actions recommended conflict with mitigation in any significant ways?
- Is there a general approach that can be used to identify and prioritize adaptive actions that will not conflict with mitigation?

The findings based on these questions suggest that there may be less conflict between adaptation and mitigation than appeared in earlier studies, although the potential for conflict remains significant. The findings also suggest that characterizing policies in terms of whether they require significant urban space is a helpful, easy way to test for conflicts between adaptation and mitigation. The research identifies actions that local communities might adopt to maximize the dual goals of resilience in the face of climate change and emissions reductions. The good news that results from this analysis is that many of the adaptive actions that cities are taking also make them more pleasant places to live. Adaptive actions encourage livable cities; people living in cities emit fewer greenhouse gases on average than people in sprawling areas. Adaptation and mitigation done well can create a virtuous circle, each reinforcing the other.

Adaptation Planning and Its Complexities

In 1992 the United Nations Framework Convention on Climate Change (UNFCCC) established two main categories of climate change responses: (1) mitigation, or actions designed to reduce greenhouse gas emissions; and (2) adaptation, which was not defined (United Nations Department of Economic and Social Affairs and Division for Sustainable Development 1993). Over time, however, and as solidified by the Intergovernmental Panel on Climate Change (IPCC), adaptation has come to mean policies that seek to adjust the built and social environment to minimize the negative outcomes of significant climate change (IPCC 2007a). Adaptation reduces vulnerability to the impacts of climate change (Smit et al. 2000), and thus builds urban resilience (Saavedra and Budd 2009).

Adaptation is not new, of course. Human settlements have been adjusting to changed weather patterns since their inception. As a result, it is helpful to differentiate two basic sorts of adaptation:

- Type I adaptation, without specific concern for climate change. These are actions that increase community resilience to known environmental risks such as hurricanes and droughts; and
- Type II adaptation, with specific concern for climate change (Burton 1997).

According to Burton (1997), Type I adaptation is the first step in overall climate change adaptation. Because adaptive actions are designed to make communities more resilient in the face of adversity, they tend to be supportive of social and economic development programs. In fact, for developing countries in particular, adaptation has come to be widely viewed as one component of development for communities that are at particular risk of disaster (Bicknell, Dodman, and Satterthwaite 2009; Girardet 2008; Wilby et al. 2009; Wilson and McDaniels 2007). The need for rural, resource-dependent communities to adapt to changing or increased environmental hazards is pressing. As a result, the literature on adaptation in rural areas of developing countries is more extensive than the literature on adaptation in urban areas of developed countries. However, the actual practice of urban adaptation in the developed world is more advanced than that in resource-challenged areas. The reasons for this situation are complex, but strongly related to the ability of developed countries to finance and sustain policy implementation.

There is a growing literature on the appropriate process for adaptation planning. The Pew Center on Global Climate Change, for instance, has a helpful brief on adaptation planning that outlines these main steps in the process:

1. Recognize that adaptation must happen at local and regional levels.
2. Identify key vulnerabilities.
3. Involve all key stakeholders.
4. Set priorities for action based on projected and observed impacts.
5. Choose adaptation options based on a careful assessment of efficacy, risks, and costs (Pew Center on Global Climate Change 2009).

The ICLEI approach (ICLEI 2007, 2008) is similar, but includes a final step of implementing policies and then checking their effectiveness, while the process supported by the Center for Clean Air Policy (CCAP) includes slightly different steps that lead to similar results (Center for Science in the Earth System et al. 2007). These general steps are familiar to anyone versed in traditional comprehensive planning. The focus on vulnerability is greater than in traditional planning, however, particularly because much of adaptation is managing disaster. One element that is very different from traditional planning is the need to deal explicitly with climate uncertainty. CCAP suggests examining projected climate impacts and "back casting" to identify what steps are necessary to reduce greenhouse gas emissions and build resiliency beginning now; they suggest 2050 as a good year to back-cast from for planning purposes (Lowe, Foster, and Winkelman 2009).

Adaptive actions must, most obviously, respond to the future climate, which means dealing with uncertainty. Broadly accessible ways to do this are still being developed, but they will clearly involve the use of possible scenarios. A further complicating factor, as Pizzaro (2009) strongly argues, is that urban design must respond to each city's specific climate conditions. For instance, he notes that higher-density, higher-floor development is helpful in hot, dry climates, as it creates shade on the street and in other buildings, but this type of development is not helpful in hot, humid climates, as it reduces the opportunity for wind cooling (Pizzaro 2009). Thus, any sort of generalized design recommendations for adaptation plans needs to be carefully reviewed for applicability to the conditions of a particular place.

Adaptation Practices

Processes and theories for adaptation are beginning to cohere into a theoretical framework. This is a big step forward. To date, however, there has been little empirical analysis of policies that specific communities have chosen to pursue, and even less analysis of implementation outcomes. Instead, current literature tends to be descriptive, reporting on practices community by community or focusing on climate risks that particular policies address. This early analytic stage is not surprising, given that adaptation plans are so new (Pew Center on Global Climate Change 2008, 2009). Evaluations of outcomes would be premature at this stage.

When it comes to organizing adaptation policies, several research schemes have been proposed, depending on the goal of the analysis. Wheeler, Randolph, and London (2009) briefly categorize adaptive responses as structural, meaning seawalls and other large-scale investments, and nonstructural, primarily regulatory and incentive-based instruments such as floodplain zoning. Howard (2009) begins with the principle that adaptive actions must not reduce a region's ability to mitigate greenhouse gases. He uses this principle to frame a matrix of potential adaptive actions according to the risk they address and their fit with mitigation, where mitigation is generally understood to require higher-density development and public transit use. Pizzaro (2009), as noted above, is concerned with adapting urban form to actual and projected climate conditions, and so he organizes adaptive actions according to their fit with climate type and associated risks. And the cities themselves tend to organize their plans along the lines of what risk a particular policy is addressing. As cities develop adaptation plans, a key issue is how these policies fit with mitigation policies, to which the section below turns.

Mitigation and Urban Form

Research and logic provide fairly persuasive arguments that urban form influences per capita average greenhouse gas emissions. Norman, McLean, and Kennedy (2006) found that the per capita energy consumption and greenhouse gas emissions of low-density areas were 2 to 2.5 times higher than those of high-density areas. Ewing and Rong (2008) found that a change in land use approach alone could reduce emissions by up to 10 percent and that additional reductions could result from employing other strategies, such as investing in mass transit and increasing fuel prices and parking charges. The likely reductions in emissions from more density are highly contested; a recent report by the Transportation Research Board found that even if 25 percent of all new residential housing units were built with double the density of the U.S. average, fuel use and CO_2 emissions would be reduced by only between 1 and 2 percent (National Research Council 2009). Stone, Mednick et al. (2007), in contrast, found that for Midwestern metropolitan statistical areas, a 10 percent increase in tract-level density would bring a 3.5 percent reduction in vehicle miles traveled. One point of some agreement is that to be effective, density increases need to occur within a framework of careful urban design (Campoli and MacLean 2007). Trip length and the number of trips taken are highly influenced by destination accessibility and other design issues (Ewing et al. 2008). In this chapter, the term *density* is used to refer to that broad spectrum of design and policy interventions needed to create cities that encourage reductions in greenhouse gas emissions.

According to Condon, Cavens, and Miller (2009), the first way that density (as broadly construed in the above paragraph) can reduce greenhouse gas emissions in urban areas is through public transportation and alternative mobility. Issues that need to be considered when trying to achieve a more walkable, bikeable, and bus-friendly environment include the price of gasoline and parking; the speed of buses versus cars; the aesthetic experience of walking, biking, and busing; and the cultural implications of promoting public transportation.

The second key way that density can reduce emissions is by providing more shared walls. Multifamily homes, such as apartment buildings and town houses, lose much less heating and cooling to the environment and thus in most cases are more energy efficient. But shared walls can also mean less natural cooling in the summer, less airflow, and thus more need for air conditioning. This exemplifies a density-related mitigation/adaptation conflict: designs that reduce energy use (shared walls) also can have a countereffect of increasing energy use (air conditioning) (Condon, Cavens, and Miller 2009).

The third key way that density can support mitigation is by providing district heating and cooling systems. This element is often cited in planning literature, but is less well documented outside of technical studies. Researchers generally find that district heating and cooling systems are much more efficient than individual systems and can allow for the provision of combined heat and power, which is very efficient, but does require advance planning, as homes must be connected via steam pipes (Condon, Cavens, and Miller 2009; see also Grimmond 2007).

Bringing all these elements together, Pizzaro summarizes the most energy-efficient urban form for mitigation in this way:

> an urban form that encourages walking, bicycling, and mass-transit systems; a compact urban form that saves on infrastructure costs and energy requirements (i.e., less mileage of pipes and cables, less travel distance for fire trucks, police, delivery of parcels, and so on); the provision of com-

> bined heat and power (CHP) for urban districts as well as energy systems reliant on solar energy; and rooftop and community gardens to save on the transportation of food. (2009, 42–43)

When Mitigation and Adaptation Blend

In land use discussions, the question of whether reducing greenhouse gas emissions or the potential impacts of climate change on local residents should be the priority policy goal is the source of much debate. If reducing the latter is the primary goal, then attention to urban form is even more important.

Urbanization itself causes warming and other changes in the regional climate, regardless of the intermediate function of global atmospheric changes, which provides an opportunity and reason for environmentally responsible design (Grimmond 2007). According to Stone:

> Due to the long atmospheric residence times of greenhouse gases, a reduction in current emissions through technological controls would be unlikely to yield measurable results for many decades. In contrast, changes to the physical characteristics of cities can produce cooling benefits at the time of implementation. (2005, 23)

This chapter is concerned with climate change, including increased climate hazards and variability, not just urban warming, so for the sake of clarity, we will keep the simple distinction between mitigation (greenhouse gas reductions) and adaptation (measures to address the impacts of climate change), while acknowledging that the relationship is more complex than that.

When Mitigation and Adaptation Conflict

A key question is whether adaptation and mitigation policies support or conflict with each other. There are some obvious conflicts, such as using residential air conditioners, which consume great amounts of energy, on very hot days. But there are also some less obvious conflicts that are of more interest to planners. The primary issue here is spatial form. As Gurran and I argued:

> A key point of adaptation is that many actions, although certainly not all, require more land left in open space, and/or a less dense built environment. Current approaches to floodwater management suggest less piping and more natural infiltration; bioswales require space that pipes do not. More water to manage often means more space needed to manage it. Similarly, adding (or not removing) space-using greenery is an important step in preventing or treating urban heat island effects (Stone 2005). Buildings

> that are more moderate in height and placed to enable ventilation between individual dwellings provide adaptation to higher temperatures, but tend to reduce density. While there is little adaptation benefit from low density, sprawling development, under adaptation it appears that moderate density with significant fingers of green infrastructure running through the city may be the most effective form. (Hamin and Gurran 2008, 241)

At the time of that research, it was not possible for us to use adaptation plans per se. Instead, we conducted a content analysis of local comprehensive and special-purpose municipal plans in Australia, and to a lesser extent the United States, which included policies with clear adaptive value. Because that study focused on "amenity" or "sea change" communities—nonurban or rapidly growing communities and less dense cities—we found that quite a few of the recommended adaptive actions would conflict with mitigation.

> Some of the key actions that [Australian] communities are undertaking for adaptation include changing infrastructure and disaster plans to include forecasts for climate change[,] . . . planning for larger river floodplains and protecting wetlands in areas likely to see increased severe storm events from climate change (as undertaken by Noosa Shire in Australia's south east), providing corridors for species' movement as climate changes and species ranges need to change (Port Stephens Shire in New South Wales [NSW] has proclaimed a koala habitat plan of management for this purpose), and changing building codes to reflect the need for more natural cooling/less contribution to the heat island effect (see Queensland's Gold Coast Design for Climate Policy). (Hamin and Gurran 2008, 241)

Other researchers have been working on the same issue. Laukkonen et al. (2009), working from Shaw, Colley, and Connell (2007), found the following:

> While high densities in urban areas minimize commuter distances and provide opportunities to incorporate common energy schemes that can reduce emissions; they also contribute to urban heat island, can increase the likelihood of urban flooding, and additionally, a dense-built environment can reduce the incorporation of urban green or tree cover which helps reduce the need for cooling aids. (Laukkonen et al. 2009, 289)

More generally, it is clear that when it comes to density, design matters a great deal. Better design makes higher density much more pleasant and environmentally matched to the conditions of the site (Campoli and MacLean 2007).

Beyond the potential for spatial conflict between adaptation and mitigation, there is the question of cost-benefit analysis over the short and long terms. Specifically, as noted by Howard (2009), the benefits of mitigation (minimizing greenhouse gas emissions) are global and quite long-term. In contrast, the benefits of adaptation (resilience in the face of environmental disasters such as flooding) are local and more short-term. Thus, there is likely to be a tendency for communities to prioritize investment in adaptation over mitigation. This can be a significant problem because adaptation alone cannot protect any community from the likely climate outcomes of uncontrolled greenhouse gas emissions. Thus, for the long term, mitigation is the best adaptation, taken globally. We can conceptualize this as a classic problem of collective action (Olson 1971), in which localities are unwilling to invest in long-term actions whose benefits are shared globally, but whose costs may be incurred locally.[1] In practice, however, there is little information available as to whether the preference for adaptation over mitigation actually occurs. Part of the goal of the current research was to empirically test this.

Research Method

To get a sense of the state of municipal practice when it comes to adaptation, I selected seven leading examples of cities with Web-published adaptation plans that include concrete policy actions. An initial universe of cases was developed by reviewing two major reports that list local adaptation plans (Ligeti 2007; Perkins, Ojima, and Corell 2007), and also undertaking a general Web search looking for cities with adaptation plans. Final selection of each case study rested on whether the plan (or part of the plan) was clearly identifiable as having significant spatial practices embedded in it, as opposed to recommending processes for developing such practices or recommending primarily infrastructure changes. This requirement excluded some leading plans for specific projects, such as Boston's Deer Island infrastructure project (Kirshen, Ruth, and Anderson 2008) and a New York City plan (PlaNYC) that includes climate change in a broader planning framework (Rosenzweig et al. 2007), although both of these plans are important examples of appropriate actions.

Also to be noted is that the research addressed recommended actions, without concern for whether they were prioritized, funded, or actually implemented. Future research that characterizes and evaluates actual implementation will be important. The final case study list includes plans for four global cities (London, Melbourne, Chicago, and Toronto) that have the sophistication and resources to be cutting-edge, one medium-sized metropolitan area that is well known in the United States for its progressive planning (King County, Washington, which is the home of Seattle). Two less obvious choices are Halifax, Nova Scotia, a Canadian regional center, and Keene, New Hampshire, a small town, both chosen for the quality of their plans. (See table 6.1.) (The plans reviewed are City of

1. Neoclassical economic theory, as well as game theory, suggests that municipalities should strongly prefer adaptation over mitigation on this basis, because in adaptation the benefits are local, while the costs (e.g., federal funding for infrastructure) may be spread out more broadly (Olson 1971). But as Elinor Ostrom has demonstrated, a variety of social organization issues can change this calculus (Ostrom 1991; Ostrom et al. 1999), particularly when it comes to climate change (Ostrom 2009).

Table 6.1
Plans Reviewed and Climate Change Threats, by City

City/Region	Year of Plan	Plan Name	Author	Key Climate Threats Identified in Plan
London	2010	The Draft Climate Change Adaptation Strategy for London, Public Consultation Draft	Mayor of London	Floods; drought; heat waves
Melbourne	2009	City of Melbourne Climate Change Adaptation Strategy	City of Melbourne	Drought and reduced rainfall; intense rainfall and wind events; extreme heat waves and bushfires; sea-level rise
Chicago	2008	Chicago Climate Action Plan (esp. Chapter 6)	Chicago Climate Task Force	Hotter summers; more frequent and intense heat waves; heavy rains and snows more frequent in winter and spring; drier summers; changing species and biodiversity
Toronto	2008	Ahead of the Storm . . . Preparing Toronto for Climate Change	Toronto Environment Office, in collaboration with the City of Toronto Climate Adaptation Steering Group and the Clean Air Partnership	Rising temperatures; shorter and warmer winters; increase in extreme weather; changing precipitation patterns; lowering of inland lakes and streams; sea-level rise
Halifax, NS[a]	2007	Climatesmart: Climate Change Risk Management Strategy for Halifax Regional Municipality	Halifax Regional Municipality	Increase in mean temperature; more and hotter heat-wave days; fewer days below –10°C (14°F); longer frost-free season; increase in precipitation and rainfall intensity; sea-level rise; increase in peak winds associated with tropical cyclones; introduction of new and exotic pests

(continued)

Table 6.1
(continued)

City/Region	Year of Plan	Plan Name	Author	Key Climate Threats Identified in Plan
Keene, NH	2007	Adapting to Climate Change: Planning a Resilient Community	City of Keene and ICLEI	More frequent and severe flooding; changes in annual snowfall; infestations of nonnative plant and animal species; increase in total number of high-heat-index days; more numerous poor-quality-air days
King County, WA	2007	King County Climate Plan (esp. Chapter 6B)	City Hall, King County, Washington	Warmer average temperatures; some sea-level rise in Puget Sound; likely increase in flooding frequency in fall and winter; lower stream flow in summer and early fall; impacts to precipitation and windstorm potential "less well known"

[a]The Halifax plan is a set of options for treating particular hazards, but these options have been run through a fairly rigorous multi-stage screening process already and so are similar in specificity and likelihood of implementation to policies listed in other plans.

Keene, New Hampshire, and ICLEI [2007]; City of Melbourne [2009]; City of London [2010]; Halifax Regional Municipality [2007]; King County Washington [2008]; Toronto Environment Office [2008].) There is an obvious bias toward English-speaking cities in the developed world. Future research on cities in other parts of the world would be helpful.

Within each plan, a research assistant and I identified policy recommendations that were intended to affect the built form and excluded process-oriented policies (data or mapping plans; community outreach or education programs). We then categorized the policies into analytic matrices. Intercoder reliability was increased by having two people code each plan. Not surprisingly, given the length of the documents and the need for interpretation, there were coding differences.

Resolution required a third review of each plan and in several cases the addition of categories to the matrices to accurately reflect the plans' contents.

Results of Analysis

A preliminary question was why these cities decided to undertake adaptation planning. In answering this question, it was first helpful to understand the differences between mitigation and adaptation, as explored earlier in this chapter. A second helpful approach was thinking of disasters as either fast-onset (typhoon, hurricane, wildfire) or slow-onset (sea level or temperature rise). Brody et al. (2008), for instance, report that cities are more likely to undertake mitigation planning if they have recently experienced a climate-related trauma (i.e., a fast-onset disaster). Considering the difference between adaptation and mitigation, this finding appears counterintuitive: the connections between local reductions in greenhouse gases and local climate catastrophe are minimal. Thus, the question of whether the cities in the current study had fairly recent environmental disasters was of interest.

In 2003 London had a significant climate-related event when a heat wave resulted in 2,091 deaths (Kovats, Johnson, and Griffiths 2006). Preparing for another such heat wave is mentioned as a key motivation for the city's adaptation plan. Also in 2003, Halifax was hit by Hurricane Juan, which caused seven fatalities and C$300 million in damages.[2] Again, this is explicitly mentioned as a motivation for the city's plan. Melbourne is in the midst of a drought that started in 1997. It experienced its highest urban temperature on record, 46.4°C (115.5°F), in February 2009, and both the heat and the drought contributed to wildfires in the state of Victoria that decimated nearly 200,000 hectares (500,000 acres) of bushland, destroyed more than 2,000 homes, and killed 210 people in early 2009.[3] The political will for these plans appears to be largely in response to these fast-onset, clearly identifiable disasters. Further back in time, Chicago had a heat wave in 1995 that killed more than 700 people (Klinenberg 2002).

Toronto, Keene, and King County did not have any obvious recent climate catastrophes, and one could argue that global warming may actually have some benefits for Toronto and perhaps Chicago through longer growing cycles and milder winters (IPCC 1997). The motivation for these communities to create adaptation plans appears to have been to preempt fast-onset disasters and reduce the effects of slow-onset ones that climate change may bring.

---

2. Information about Hurricane Juan is available at http://www.ec.gc.ca/ouragans-hurricanes/default.asp?lang=En&n=F0E43FF7-1.

3. Information about Melbourne's drought is available at http://drought.melbournewater.com.au/content/history_of_drought.asp and http://www.ncdc.noaa.gov/sotc/index.php?report=hazards&year=2009&month=feb.

Adaptation or Mitigation? Which Gets Preference?

As mentioned earlier, theory suggests that communities may prefer adaptation over mitigation because adaptation provides more local benefits. Is there evidence of this in the plans reviewed? To address this issue, I identified statements in the plans that explain the authors' perspectives on adaptation versus mitigation. The City of Toronto, for instance, is taking a comprehensive approach to climate change, as this excerpt from its plan shows:

> Toronto Council unanimously approved a comprehensive strategy to respond to climate change, known as the Climate Change, Clean Air and Sustainable Energy Action Plan. The City of Toronto's overall strategy is to focus on:
>
> 1. activities that reduce greenhouse gas emissions and help to prepare for climate change (Mitigation and Adaptation);
> 2. activities that reduce greenhouse gas emissions (Mitigation); and
> 3. activities that help prepare for climate change (Adaptation). (Toronto Environment Office 2008, 4)

Similarly, the London plan includes this statement in its executive summary: "Preparing for changes to our climate is not an alternative strategy to reducing greenhouse gas emissions, but a parallel and complementary one" (City of London 2010, 1).

Melbourne's plan may best reflect the policy community's sense of *why* adaptation is necessary. According to their introductory statement:

> Cities responding early to climate change are likely to better withstand its impacts and maintain a platform for health and prosperity (IPCC 2007) . . . Rising awareness and concern regarding potential climate change impacts has seen many policy responses and programs aimed at reducing greenhouse gas emissions (GHG) to previous levels. GHG mitigation initiatives are important to long term climate stabilisation, however scientists warn of the time it takes for the climate system to respond to GHG reductions. Regardless of future emissions, the GHG concentrations already in the atmosphere commit us to a likely range of climate change impacts in the near future. (City of Melbourne 2009, 1)

In contrast, the Chicago and King County plans call primarily for mitigative actions, each devoting only one chapter to adaptation. It may also be helpful to remember that all of the cities had mitigation plans that preceded their adaptation plans.

Based on this sample, there appears to be little cause for concern that cities prefer to invest in adaptation rather than mitigation. The issue nevertheless bears watching as more cities develop increased awareness of the need for adaptation and as the funding and implementation of programs begin, thus allowing a much more realistic assessment of actual outcomes.

Table 6.2
Adaptation Actions Recommended in Each Plan, by Condition Treated

	Water Management					
	Revised Engineering Standards (e.g., larger storm pipes)	On-Site Stormwater Treatment	Permeable/ Porous Pavement	Restoration/ Expansion of Natural Floodplains and Other Waterways	Zoning Changes to Limit Development in Vulnerable Areas	Design for Flooding or Seawall Improvements
London (2010)	1	1	1	1	1	
Melbourne (2009)	1	1	1	1		1
Chicago (2008)		1	1			
Toronto (2008)	1	1	1	1		
Halifax (2007)	1				1	
Keene (2007)	1	1		1	1	
King County (2007)	1	1	1		1	1
Total	6	6	5	4	4	2

Types of Policies Proposed

Based on their plans, these cities clearly see stormwater management as the most pressing, or at least the most addressable, issue (see table 6.2). Favored policies include changing engineering standards to meet climate change forecasts, enabling more on-site stormwater treatment, and allowing or encouraging porous pavement to be used in appropriate areas. Other concerns include floodplain restoration and management, zoning changes, and designing for flooding or seawall improvements in flood-prone areas. Three policies clearly address both water and heat management: increased urban greening/forests, which help slow stormwater flow and provide cooling; the use of green roofs and walls, which serve similar purposes, perhaps less effectively (Stone 2005) but without requiring much, if any, extra space; and revised design guidelines and building codes to encourage, for instance, LEED[4] standards, which address a range of climate change issues (e.g., reducing stormwater runoff, encouraging self-cooling, and designing in higher tolerances for flooding). The most popular practices that focus on urban heat reduction alone are albedo lightening (such as requiring heat-reflective roofs) and designing public spaces for cooling (such as adding misting stations). Two other

4. LEED stands for Leadership in Energy and Environmental Design. It is a green building program developed by the U.S. Green Building Council.

Combined Water and Heat Management			Heat Management		Species and Habitats		Agriculture and Energy	
Significant New Urban Greening/ Forests	Green Roofs and Walls	Revised Design Guidelines (LEED, building code, etc.)	Albedo Lightening	Public Space Design for Cooling	Revised Planting Lists	Habitat Corridors to Preserve Migration Routes	Increased Urban Agriculture and Food Security	Distributed/ Renewable Energy
1	1	1	1	1		1		
1	1	1	1	1				
1	1		1		1			
1	1	1	1	1	1			1
					1			
1	1	1				1	1	1
1		1				1	1	
6	5	5	4	3	3	3	2	2

sets of adaptive actions are also prescribed. The first set focuses on natural resources, including changing suggested planting lists to encourage hardier species that better match future climate zones and designating habitat corridors. The second set includes practices, such as urban agriculture and zoning for distributed and renewable energy, that cross over into mitigation. Not surprisingly, these practices are less common in the cities examined here, perhaps because the issues addressed may seem less relevant or pressing and the actions less feasible.

Spatial Implications: Conflicts and Cobenefits of Adaptation and Mitigation

As noted earlier, typical mitigation measures require a denser urban environment, while adaptation tends to require space and thus work against density in the urban form. This may lead to conflict between the two types of policies. How real is this conflict? That is, are cities prescribing actions that will significantly reduce their density? The findings in this study suggest that with the exception of on-site stormwater management, the cities are not calling for such practices (see table 6.3). And even in regard to stormwater, it is not clear whether the prescriptions require larger lots or call for the conversion of what would have been lawns or paved areas to wetlands. It also is not clear how much new space would

Table 6.3
Adaptation Actions Recommended in Each Plan, by Spatial Implication

	No New Space Required = 33							
	Revised Engineering Standards (e.g., larger storm pipes)	Permeable/ Porous Pavement	Green Roofs and Walls	Revised Design Guidelines (LEED, flooding, etc.)	Albedo Lightening	Revised Planting Lists	Design for Flooding or Seawall Improvements	Public Space Design for Cooling
London (2010)	1	1	1	1	1			1
Melbourne (2009)	1	1	1	1	1		1	1
Chicago (2008)		1	1		1	1		
Toronto (2008)	1	1	1	1	1	1		1
Halifax (2007)	1					1		
Keene (2007)	1		1	1				
King County (2007)	1	1		1			1	
Total	6	5	5	5	4	3	2	3

be required to meet the urban forestry recommendations in several of the plans. Some of the greening would result from planting trees along streets or in existing lawns and yards.[5] Conflict likely would occur if urban forests were prescribed for vacant, and presumably redevelopable, lots. Further research on implementation and the subdivision and zoning requirements associated with each of these plans would be needed to ascertain the trade-off of urban density for urban greening and its potential for conflict.

Several of the plans reflect the need for actions to serve both mitigation and adaptation. The Chicago plan, for instance, prioritizes nonspatial actions and those that address both mitigation and adaptation, even in the adaptation chapter. As the plan notes:

> Many of these actions to adapt to climate change serve a dual purpose: They also reduce greenhouse gas emissions. Green roofs, for instance, cool the city as temperatures rise and retain water during storms (adaptation), while they also help increase the energy efficiency of buildings (mitigation). Increasing the size of the Chicago urban forest canopy can provide shade to mitigate the urban heat island effect (adaptation) and reduce en-

5. A similar initiative in Los Angeles, called Million Trees LA, involves giving homeowners trees to plant in their yards. For more information, go to http://www.milliontreesla.org.

Actions Likely Requiring New Space = 27						
On-Site Stormwater Treatment	Significant New Urban Greening/ Forests	Zoning Changes to Limit Development in Vulnerable Areas	Restoration/ Expansion of Natural Floodplains and Other Waterways	Habitat Corridors to Preserve Migration Routes	Distributed/ Renewable Energy	Increased Urban Agriculture and Food Security
1	1	1	1	1		
1	1		1			
1	1					
1	1		1		1	
		1				
1	1	1	1	1	1	1
1	1	1		1		1
6	6	4	4	3	2	2

> ergy demand to cool buildings (mitigation). Rain gardens and permeable pavement capture stormwater on-site (adaptation), reducing the amount of stormwater that must be pumped and the energy required to pump it (mitigation). (Chicago Climate Action and the City of Chicago Climate Task Force 2008, 43)

The Toronto plan has an explicit preference for actions that address both mitigation and adaptation, such as:

- water-conservation programs (save electricity in pumping/treating and save water for other uses during drought);
- installation of green roofs;
- expansion of the tree canopy; and
- local food procurement (Toronto Environment Office 2008, 4).

Proposed Analytic Framework for Adaptation Policies

The findings of this study suggest that there may be less conflict between adaptation and mitigation than has been reported in earlier studies. One explanation of this is that earlier empirical studies (e.g., Hamin and Gurran 2008) focused primarily on rapidly expanding communities. The current research examined well-established urban areas and one small town. In large urban areas, the lack of space for adaptive actions means that most policy recommendations of necessity must come from the nonspatial categories. These communities concentrate on retrofitting, and the first steps in that process are roof greening, designing small but intensive on-site stormwater systems, and adding to the tree canopy along streets and in existing lawns and yards. It seems logical that policy makers would focus on those actions that are easiest to achieve, which in urban areas tend to involve using existing land.

That being said, the potential for conflict remains significant, and cities seem not to have found appropriate ways to address that conflict other than generally suggesting that adaptive actions should not interfere with mitigative ones. One fairly easy, intuitive approach would be for cities to conduct an analysis of all proposed actions (or potential actions) to assess each action's requirement for new space. Planners could then prioritize the space-neutral practices as the "low-hanging fruit" and address the space-absorbing practices in ways that recognize the spatial challenges. Areas of new growth might incorporate the space-absorbing actions more readily. While the specifics for each particular location will need to be determined based on the policy prescriptions proposed, a suggestive categorization is as follows.

Space-Neutral Practices These make little change in opportunities for densification and are likely to be easier to implement in existing urban environments:

- Albedo lightening.
- Green roofs and green walls.
- Less site-intensive on-site stormwater treatment.
- Larger storm pipes.
- Trees in current lawn spaces.
- Rain barrels.

Space-Absorbing Practices These may reduce opportunities for densification, but may still be necessary and helpful:

- More urban forests.
- More site-intensive on-site stormwater treatment.
- Corridors or patches added to green infrastructure.
- Greening of vacant lots rather than building on them.
- Planned retreat in the municipality designates the area in which a coastline or floodplain will be allowed to erode without interference, and any affected structures are either demolished or moved inland.[6]
- Urban agriculture.

---

6. For more on planned or managed retreat, see the NOAA Web site: http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_retreat.html.

Future research quantifying the levels of urban greening needed along different regional patterns, as well as along the urban-suburban-rural gradient, would be very helpful in assisting communities to make effective choices among these policies.

All of the actions described in this section tend to encourage more climatically comfortable urban conditions by preventing the extremes of urban heat island effects and minimizing the negative effects of severe weather events. As a result, they also tend to encourage people's desire to live in urban areas, which is a key element of achieving the densities required for mitigation to have an effect.

Summary

Four questions guided this research. Following are the findings related to these questions.

- In their statements of intent, do cities seem to prefer mitigation over adaptation or vice versa?
  - Mitigation remains the first priority.
- What sorts of threats are leading municipal adaptation plans addressing?
  - Stormwater and floodwater management is the first priority by a large margin, followed by actions to address both storm/floodwater and urban heat island effects.
- At the policy level, do the recommended adaptive actions conflict with mitigation in any significant ways?
  - For the most part, they do not, as these cities are largely choosing actions that retrofit the existing urban form, such as adding green roofs and other nonspatial treatments.
- Is there a general approach that can be used to identify and prioritize adaptive actions that will not conflict with mitigation?
  - Categorizing actions according to the amount of space they will require appears to be helpful in making policy choices in all the cities, although different opportunities will present themselves in each locality.

Conclusions

Urban adaptation to climate change is now widely accepted as a necessary goal, even while most agree that it should not conflict with, nor does it take the place of, mitigative actions. In terms of urban design, the need for density in mitigation and the need for space in adaptation create potentially serious conflicts. Now that adaptive practices are becoming more widespread and the specifics of how communities are undertaking adaptation are more apparent, it is possible to evaluate empirically where conflict is occurring and whether communities are choosing adaptation over mitigation. The findings in the current study suggest that, at least so far in urban areas, most adaptive moves are largely space-neutral and appear to create little conflict. The current research suggests that an explicit consideration and categorization of policy proposals based on their spatial impact could assist policy makers in analyzing what impact an adaptive action may have on mitigation. This should help cities in their stated goals of not undertaking conflicting policies.

Policy analysts who have thought carefully about the relative needs for mitigation and adaptation generally believe that mitigation is long-term adaptation, because if we do not reduce emissions and thus reduce climate change, the level of adaptation required to keep our current lifestyles intact is going to be very difficult to achieve. But denser environments also must be designed to be appealing. Generally, greener, more pleasant urban environments are more adaptive ones, and cooler, greener cities will be more attractive to new residents. Thus, it is also clear that adaptation is long-term mitigation, as well as the other way around.

REFERENCES

Bicknell, J., D. Dodman, and D. Satterthwaite. 2009. *Adapting cities to climate change: Understanding and addressing the development challenges*. Sterling, VA: Earthscan.

Brody, S. D., S. Zahran, H. Grover, and A. Vedlitz. 2008. A spatial analysis of local climate change policy in the United States: Risk, stress, and opportunity. *Landscape and Urban Planning* 87(1):33–41.

Burton, I. 1997. Vulnerability and adaptive response in the context of climate and climate change. *Climate Change* 36:185–196.

Campoli, J., and A. S. MacLean. 2007. *Visualizing density*. Cambridge, MA: Lincoln Institute of Land Policy.

Center for Science in the Earth System (The Climate Impacts Group), Joint Institute for the Study of the Atmosphere and Ocean, University of Washington, and King County, Washington. 2007. *Preparing for climate change: A guidebook for local, regional, and state governments*. In association with ICLEI: Local Governments for Sustainability. King County, WA: The Climate Impacts Group, King County, Washington, and ICLEI: Local Governments for Sustainability. Available from http://www.ccap.org.

Chicago Climate Action and the City of Chicago Climate Task Force. 2008. *Chicago climate action plan*. Chicago: City of Chicago.

City of Keene, New Hampshire, and ICLEI: Local Governments for Sustainability. 2007. Adapting to climate change: Planning a climate resilient community. In *ICLEI: Local governments for sustainability*.

City of London. 2010. The draft climate change adaptation strategy for London, public consultation draft. London: Mayor of London.

City of Melbourne. 2009. City of Melbourne climate change adaptation strategy. Melbourne, Australia.

Condon, P. M., D. Cavens, and N. Miller. 2009. Urban planning tools for climate change mitigation. Policy Focus Report. Cambridge, MA: Lincoln Institute of Land Policy.

Ewing, R., K. Bartholomew, S. Winkelman, J. Walters, and D. Chen. 2008. *Growing cooler: The evidence on urban development and climate change*. Washington, DC: Urban Land Institute.

Ewing, R., and F. Rong. 2008. The impact of urban form on U.S. residential energy use. *Housing Policy Debate* 19(1):1–30.

Girardet, H. 2008. *Cities people planet: Urban development and climate change*, 2nd ed. Chichester, U.K.: John Wiley and Sons.

Grimmond, S. 2007. Urbanization and global environmental change: Local effects of urban warming. *Geographical Journal* 173(1):83–88.

Halifax Regional Municipality. 2007. *Climatesmart: Climate change risk management strategy for Halifax Regional Municipality.* Available from http://www.halifax.ca/climate/solution1.html.

Hamin, E., and N. Gurran. 2008. Urban form and climate change: Balancing adaptation and mitigation in the U.S. and Australia. *Habitat International* 33:238–245.

Howard, J. 2009. Climate change mitigation and adaptation in developed nations: A critical perspective on the adaptation turn in urban climate planning. In *Planning for climate change: Strategies for mitigation and adaptation*, ed. S. Davoudi, J. Crawford, and A. Mehmood. London: Earthscan.

ICLEI. 2007. *Preparing for climate change: A guidebook for local, regional and state governments*. King County, WA: Center for Science in the Earth System.

———. 2008. Local government climate change adaptation toolkit. In *Cities for climate protection Australia*. Melbourne: Australian Government Department of Climate Change.

IPCC (Intergovernmental Panel on Climate Change). 1997. *The regional impacts of climate change: An assessment of vulnerability*, ed. R. T. Watson, M. C. Zinyowera, and R. H. Moss. Cambridge, U.K.: Cambridge University Press.

———. 2007a. *Climate change 2007: Impacts, adaptation and vulnerability*, ed. M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, and C. E. Hanson. Cambridge, U.K.: Cambridge University Press.

———. 2007b. *Climate change 2007: Synthesis report*, ed. R. K. Pachauri and A. Reisinger. Geneva, Switzerland: Intergovernmental Panel on Climate Change.

King County, Washington. 2008. *2007 King County climate plan*. Available from http://www.metrokc.gov/exec/news/2007/pdf/ClimatePlan.pdf.

Kirshen, P., M. Ruth, and W. Anderson. 2008. Interdependencies of urban climate change impacts and adaptation strategies: A case study of metropolitan Boston. *Climatic Change* 86(1–2).

Klinenberg, E. 2002. *Heat wave: A social autopsy of disaster in Chicago*. Chicago: University of Chicago Press.

Kovats, R. S., H. Johnson, and C. Griffiths. 2006. Mortality in southern England during the 2003 heat wave by place of death. *Health Statistics Quarterly* 29(Spring):6–8.

Laukkonen, J., P. K. Blanco, J. Lenhart, M. Keiner, B. Cavric, and C. Kinuthia-Njenga. 2009. Combining climate change adaptation and mitigation measures at the local level. *Habitat International* 33(3):287–292.

Ligeti, E., and Clean Air Partnership. 2007. *Cities preparing for climate change: A study of six urban regions*. Toronto, ON: Clean Air Partnership.

Lowe, A., J. Foster, and S. Winkelman. 2009. *Ask the climate question: Adapting to climate change impacts in urban regions*. Center for Clean Air Policy (CCAP), Urban Leaders Adaptation Initiative.

National Research Council. 2009. *Driving and the built environment: The effects of compact development on motorized travel, energy use, and CO_2 emissions*. Washington, DC: Transportation Research Board.
Norman, J., H. L. McLean, and C. A. Kennedy. 2006. Comparing high and low residential density: Life-cycle analysis of energy use and greenhouse gas emissions. *Journal of Urban Planning and Development* 132(1):10–21.
Olson, M. 1971. *The logic of collective action: Public goods and the theory of groups*. Cambridge, MA: Harvard University Press.
Ostrom, E. 1991. *Governing the commons: The evolution of institutions for collective action*. Cambridge, U.K.: Cambridge University Press.
———. 2009. *A polycentric approach for coping with climate change*. New York: World Bank.
Ostrom, E., J. Burger, C. B. Field, R. B. Norgaard, and D. Policansky. 1999. Revisiting the commons: Local lessons, global challenges. *Science* 284(5412):278–282.
Perkins, B., D. Ojima, and R. Corell. 2007. *A survey of climate change adaptation planning*. Washington, DC: The H. John Heinz III Center for Science, Economics and the Environment.
Pew Center on Global Climate Change. 2008. *Adaptation planning—What U.S. states and localities are doing*. Arlington, VA: Pew Center on Global Climate Change.
———. 2009. *Climate change 101: Adaptation*. Arlington, VA: Pew Center on Global Climate Change.
Pizzaro, R. 2009. Urban form and climate change: Towards appropriate development patterns to mitigate and adapt to global warming. In *Planning for climate change: Strategies for mitigation and adaptation*, ed. S. Davoudi, J. Crawford, and A. Mehmood, 33–45. London: Earthscan.
Rosenzweig, C., D. C. Major, K. Demong, C. Stanton, R. Horton, and M. Stults. 2007. Managing climate change risks in New York City's water system: Assessment and adaptation planning. *Mitigation and Adaptation Strategies for Global Change* 12(8):1391.
Saavedra, C., and W. W. Budd. 2009. Climate change and environmental planning: Working to build community resilience and adaptive capacity in Washington state, USA. *Habitat International* 33(3):246–252.
Shaw, R., M. Colley, and R. Connell. 2007. *Climate change adaptation by design: A guide for sustainable communities*. London: TCPA.
Smit, B., I. Burton, R. J. T. Klein, and J. Wandel. 2000. An anatomy of adaptation to climate change and variability. *Climate Change* 45:223–251.
Stern, N. 2007. *The economics of climate change: The Stern review*. Cambridge, U.K.: Cambridge University Press.
Stone, B. 2005. Urban heat and air pollution: An emerging role for planners in the climate change debate. *Journal of the American Planning Association* 71(1):13–25.
Stone, B., A. C. Mednick, T. Holloway, and S. N. Spak. 2007. Is compact growth good for air quality? *Journal of the American Planning Association* 73(4):404–418.
Toronto Environment Office, in collaboration with the City of Toronto Climate Adaptation Steering Group and the Clean Air Partnership. 2008. *Ahead of the storm . . . Preparing Toronto for climate change*. Toronto, ON.
United Nations Department of Economic and Social Affairs and Division for Sustainable Development. 1993, 2009. *Agenda 21—table of contents*. Available from http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm.

Wheeler, S. M., J. Randolph, and J. B. London. 2009. Planning and climate change: An emerging research agenda. In Shaken, shrinking, hot, impoverished and informal: Emerging research agendas in planning, ed. H. Blanco and S. M. Alberti, special issue, *Progress in Planning*, 72(1):210–222.

Wilby, R. L., J. Troni, Y. Biot, L. Tedd, B. C. Hewitson, D. M. Smith, and R. T. Sutton. 2009. A review of climate risk information for adaptation and development planning. *International Journal of Climatology* 29(9):1193–1215.

Wilson, C., and T. McDaniels. 2007. Structured decision-making to link climate change and sustainable development. *Climate Policy* 7(4):353–370.