Public Risks and the Challenges to Climate-Change Adaptation: A Proposed Framework for Planning in the Age of Uncertainty

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Abstract

Previous research and practice suggest that the lack of a public constituency concerned about public risks and the traditional planning paradigm that is chronically deficient in addressing public risks are major challenges to adaptation to climate change. The core features of public risks associated with climate change are uncertainty about the effects of carbon dioxide emissions, broad distribution, and planning horizons that are decades away. In this article, we present new models that are emerging in research and planning practice that link collaborative governance with anticipatory governance. Coupling the models offers a new approach to planning that simultaneously formulates strategic guidance for current decisions to achieve future resiliency goals, and it builds supportive networks of stakeholders. We offer recommendations on how to make the transition to plans that are premised on uncertainty, flexible polices, monitoring, innovation, and feedback. We then recommend future research needed to examine the effectiveness of the planning framework we propose.

Introduction

For certain risks, it is difficult to create and sustain broad public responses. The inconspicuousness of such risks is common in the absence of a major sudden and harmful event (Birkland, 1997). Recent damaging hurricanes and wildfires and the detection of sea-level rise for which the impacts can be reduced have prompted limited reaction among affected populations and public policymakers. For other risks, however, awareness is sufficient stimulus for pervasive public response. Many consumers decided to not purchase a particular brand of automobile because of a widespread alarm about brake failure, for example.

This article focuses on emerging new models of local government planning to deal with risks for which public indifference is the norm, even when awareness of the risks is common. May (1991: 264) distinguished between the phenomena of public risks and private risks. He observed that public indifference seems to be most common in situations of public risk. He drew on Huber's (1986: 90) conception of *public risk*, "defined as a risk that is mass-produced, broadly distributed, temporally remote, and largely outside the individual risk bearer's direct understanding and control." Examples include sea-level rise, floods, ozone depletion, and earthquake risks. By contrast, May (1991: 264) defined *private risks* as "risks [that] are more immediate, focused upon by the individual, and generally understandable." Examples are automobile brake failures, steep stairs in a house, and tainted food.

For public risks, individuals often have incentives to avert losses, but multiple perceptual factors alter the objective decisionmaking that constrains responses.[1] Alternatively, private risks have sufficient incentives for individuals to act (for example, to fix failing brakes or steep stairs). The lack of incentives for public risks creates major challenges for policymakers and planners who must work to shift public perceptions so that the risks are more apparent, less remote, and more within the realm of acceptance of shared responsibility to take action (May, 1991). The situation is particularly troublesome, because many risks are increasingly perceived as public because of growing concentrations of population exposed to hazards and widespread diffusion of blame (Kahan et al., 2011).

The specific focus of this article is climate-change risk and how a new model of planning that draws on emerging concepts from literatures in collaborative governance and anticipatory governance can encourage the public and private sectors to reduce the risks. As documented in this article, the public is well aware of risks from climate change. Climate change-induced risks have produced limited public action, however. The evidence indicates that local efforts aimed at motivating risk-reducing actions are weak and inconsequential. Differences in levels of planning effort are not a function solely of objective risk; fundamental limitations constrain local adaptation to risks from climate change.

We focus on what local governments can do to reduce public risks based on planning that formulates multiple futures and flexible strategies to prepare for change and that builds a supportive public constituency for decisionmaking amid great uncertainty. Where appropriate, we draw on the instructive experiences of four decades of research and practice aimed at mitigating public risks posed by natural hazards (for example, floods, earthquakes, and hurricanes). These experiences inform the understanding of the effects of the planning function of local governments on a community's ability to take self-organized action to reduce public risks.

The Role of Planning

We focus on climate change-adaptation planning because of a growing chorus of calls for this activity to serve as an essential means to build community resiliency in the face of the increasing risks posed by climate change (Godschalk and Anderson, 2012; Quay, 2010, Wilson and Piper,

[1] See Lorenzoni and Pidgeon (2006) for a recent review of the literature.

2010). Resiliency is the ability of a community or society, along with the biophysical systems on which they depend, to resist or absorb the impacts (deaths, damage, losses, and so on) of hazards, rapidly recover from those impacts and reduce future vulnerabilities through adaptive strategies (Chapin III et al., 2009; Peacock et al., 2008).

A local plan can play a pivotal role in making a community more resilient by guiding how a community anticipates and responds to climate-change risks to people and property (Shuford, Rynne, and Mueller, 2010). By steering urban growth away from flood hazard areas, either current or forecast because of increased sea levels and more intense precipitation events, planning programs significantly reduce the possibility of major loss. For existing development in increasingly hazardous areas, planning programs help property owners relocate structures to safer sites, or elevate and strengthen those structures. Planning controls and land acquisition programs can play key roles in protecting ecosystems that build community resiliency to climate change.

The process of creating a plan directly addresses the core characteristics of public risks that inhibit proactive, near-term, individual action. In a study of 60 planmaking processes associated with natural hazard risk reduction, Burby (2003) found that planners motivate broader involvement by directly engaging more groups and by providing public forums for increasing awareness and understanding that public risks are mass-produced and shared problems. Such collaborative efforts expand the choices and opportunities to codevelop risk-reduction strategies.

Generating the information base as part of the planning process makes future risks seem more tangible. For example, in the process of modifying a floodplain map to account for sea-level rise forecasts, participants can see how climate impacts are relevant to their community, neighborhood, or home and how those impacts are similar to and different from the risks they face today.

A planning process that integrates information generation with public engagement also expands prospects for seeking new opportunities to produce *co-benefits* that have a positive effect on multiple interests rather than having narrowly defined benefits that suit individual interests. Protection of greenway corridors along waterways subject to rain-induced flooding exacerbated by climate change offers co-benefits by preserving flood-prone areas that might otherwise experience urban development (Younger et al., 2008). It can also provide alternatives for biking and walking that reduce automobile use and greenhouse gas (GHG) emissions and improve opportunities for physical activities that yield public health benefits. Previous research on the production of co-benefits revealed that information sharing raises knowledge about the sometimes unrecognized benefits (and costs) of household, business, and public-sector activities, which incentivizes an expansion in the number of participants who might not otherwise be involved and increases their acceptance of the need to act differently (Ostrom, 2010).

Recent studies indicated that, where strong plans have been adopted, they have fostered more robust local government actions aimed at reducing the public risks posed by climate change-induced natural hazards, including hurricane surge and inland flooding (Berke et al., 2006; Burby, 2006). Plans will likely be weakened and sparingly implemented, however, because of a set of climate-change challenges. What follows is a review of these challenges and observations about the application of strategies derived from the collaborative and anticipatory governance planning theories for inducing local action.

Challenges to Climate-Change Adaptation

The major challenges to effective adaptation to climate change include a lack of public constituency concerned about the public risks associated with climate change and plans that are chronically deficient in addressing public risks, primarily because a disinterested public creates minimal incentives for community action. Research initiated in the 1970s on local natural hazard mitigation efforts has accumulated a well-developed knowledge base, which is instructive in understanding the more recent emergence of concerns about the challenges to community adaptation to climate change. Much can be gained given the similarities between hazard mitigation and climate-change adaptation. Both hazard mitigation and climate-change adaptation deal with weather events that are likely to be exacerbated by climate change, both rapid-onset (for example, rain-induced flooding and hurricanes) and slow-onset (for example, drought) events (Min et al., 2011).[2] Both are oriented toward the future in dealing with public risks that generate widespread threats. Both focus on anticipating uncertainties and a range of possible futures, rather than responding to yesterday's events. Thus, the relatively well-developed literature on the human dimensions of natural hazards can be useful in understanding community behavior toward climate change, which is critical to formulating policy solutions that address the underlying symptoms of local reluctance to act.

Weak Public Constituency

May (1991) conceived the lack of a public constituency as a major challenge to action on public risks. In the case of climate-change adaptation, a lack of awareness cannot explain this deficiency. Our review of the risk-perception literature indicates that a low level of priority for action consistently accompanies a moderate-to-high level of awareness. Exhibit 1 illustrates the gap between awareness and priority to act based on survey data from several developed countries (Australia, Great Britain, Japan, and the United States). The gap is relevant for studies on climate change and natural hazards, and it is also relevant to the general public and those actors (for example, planners, real estate agents, elected officials, and so forth) who have a major stake in the potential loss to their communities.

The use of survey results raises cautions in terms of interpreting the responses, including the meaning of responses across cultures, perceptions that are not static over time, and that the aggregation of individual responses could potentially hide variations across different population groups. The results are consistent, however, with findings from risk-perception literature on climate change (Bord, Fisher, and O'Connor, 1998; Lorenzoni and Pidgeon, 2006) and natural hazards (Berke, 1998; May, 1991), in that the public is aware of the risks but assigns low priorities to taking action. In accordance with May's (1991: 266) observation, the perceptions "are consistent with the temporal and geographic remoteness, broad distribution of risk, and limited individual understanding associated with public risks."

[2] Scientific studies (for example, IPCC, 2012; Min et al., 2011) indicate growing confidence that climate change exacerbates some weather events (rain-induced flooding, hurricanes, and drought), but the connection is not as straightforward for other weather events (for example, tornadoes). Some climate scientists and scientific organizations, however, increasingly argue that it is irresponsible to avoid a discussion about the potential links to tornadoes (see Romm, 2011, for a discussion of the claims and emerging but tentative evidence).

Exhibit 1

Awareness of and Priority to Natural Hazards and Climate Change

Investigators	Survey Respondents	Awareness	Priority
Natural hazards			
Beatley and Brower (1986)	113 North Carolina residents facing hurricane risks	69% think damaging hurricanes probable in next 20 years	28% concerned about residential property damage
Becker et al. (2007)	479 Australia residents in four flood-prone communities	49% think major flood will affect their community within 5 years; 87% within 20 years	76% do not plan to seek additional information; 84% do not plan to become involved with local groups to discuss how to reduce risk
May (1995)	Managers from five of six public works and from eight of nine water resource departments that implement flood mitigation policy in New South Wales, Australia	Mean of 3.1 for flood threat to communities; 1 = no threat, 5 = very severe threat	Mean of 0.9 based on rating of the number of demands for action by communities from a list of 10 possible actions
Kunreuther (1978)	2,055 U.S. residents in flood-prone areas	50% report medium (> 0.01) or high (> 0.1) annual probability of damaging flood	27% perceive flood as serious problem
Tadahiro (2003)	3,036 Japan residents in Tokai flood disaster area	64% see need for resident-based flood risk management system	31% will participate in such a system if given the opportunity
Climate change			
Borberg et al. (2009)	295 Oregon coastal officials	82% consider climate change will affect Oregon coast this century	45% prepared to devote time or resources to respond; 31% ready to be a leader
Leiserowitz (2005)	551 U.S. residents	97% believe that climate change have adverse affective images (that is, stable negative images) associated with climate change	12% concerned about impacts on their family; 1% concerned about impacts on local community; 68% concerned for people all over the world and nonhuman nature
Moser and Tribbia (2006)	135 California local coastal government managers	54% strongly agree global warming real or already happening	30% acted on climate change issue
Reser et al. (2011)	3,095 Australia residents 1,822 Great Britain residents	74% of Australians think world's climate is changing 78% of British think world's climate is changing	42% of Australians feel sense of urgency to act 36% of British feel sense of urgency to change behavior
Whitmarsh (2008)	589 Great Britain residents in southern England	62% who experienced recent flooding think something should be done about climate change; 78% who experienced recent air pollution think something should be done	35% who experienced flooding have taken action on climate change; 40% who experienced air pollution have taken action

Sources: Adapted from May (1991); Berke (1998)

Several studies illustrate the challenges to stimulating action on issues that lack a public constituency. Moser and Tribbia (2006) found that 54 percent of 135 California coastal managers strongly agree that global warming is real and already happening in their communities but that only 30 percent acted on a climate-change issue. Leiserowitz's (2005) survey of 551 U.S. residents found that 97 percent believe that climate change has adverse affective images (that is, stable negative images) associated with climate change and 68 percent are concerned for people all over the world, but only 12 percent of those surveyed are concerned about impacts on their family and 1 percent are concerned about the impacts on their community. The findings for the local managers are of particular interest, because local managers tend to specialize in risk management more than residents and elected officials do, and they would be expected to place a higher priority on reducing risk. A possible explanation for managers' low level of time and attention given to climate-change adaptation is the lack of a political constituency (Deyle, Bailey, and Matheny, 2007).

A host of studies have revealed that the lack of a public constituency pushing for efforts to reduce losses is also predominant in the natural hazards policy arena. For example, May (1995) found that the floodplain managers charged with implementing flood mitigation policy in New South Wales, Australia, perceive that communities consider floods to be a moderate threat (mean of 3.1; 1 = no threat, 5 = very severe threat), but they report little community demand for action (mean of 0.9, based on the number of demands for action by communities from a list of 10 demands). Similarly, Beatley and Brower (1986) found that 69 percent of North Carolina coastal residents are aware of the potential damages caused by hurricanes, but only 28 percent are concerned about residential property damage.

Deficiencies of Local Plans

The lack of a public constituency, coupled with local officials' own limited concern about risks from climate change (and natural hazards), has created minimal incentives for local governments to address such public risks. Left to their own devices, relatively few at-risk communities would be expected to initiate risk-reduction actions. Recent reviews of contemporary practice concluded that, although the number of local climate change-mitigation initiatives is increasing rapidly (Wheeler, 2008; Zimmerman and Faris, 2011), only a few adaptation initiatives have emerged in the United States (for example, in Chicago, New York City, and Seattle). Zimmerman and Faris (2011) further concluded that, although more than 1,200 communities in the United States have enacted climate change-action plans,[3] only a few plans address the adaptation issues specifically and the vast majority focus on reducing GHG emissions.

The expectation of low levels of community response to public risks is further supported by studies of local natural hazard mitigation planning in both domestic and international settings. Assessments of hazard mitigation plans recently matured to the point at which it was possible to statistically compare findings from multiple studies based on meta-analytic methods. Berke and

[3] More than 1,000 cities, towns, and counties have signed a climate action agreement (USCM, 2009), and more than 1,200 such localities have agreed to mitigate climate-change impacts by reducing GHG emissions through the adoption of climate action plans and other related initiatives (ICLEI, 2009).

Godschalk (2009) conducted a meta-analysis of these studies based on common definitions of plan quality principles (goals, facts, policies, implementation, and monitoring).[4, 5] Exhibit 2 includes definitions of each of the five core principles and associated detailed indicators that serve as evaluation criteria for hazard mitigation plans. Exhibit 3 specifies findings from eight studies that are based on the proportional scores for each principle, ranging from 0 to 1.[6]

The meta-analytical comparisons reveal a host of serious deficiencies with hazard mitigation plans. Across all studies, all five principles of plan quality scored less than 50 percent of the maximum score. The goals principle scored better than 50 percent for two of the studies, and implementation scored better than 50 percent for one study. Common shortcomings identified by these studies include—

- *Goals* that are too narrowly conceived, accounting for efficiency and public safety but not other values critical to long-range resiliency, such as social equity and the protection of natural systems.
- *Fact bases* are typically only based on maps that delineate hazards, and numerical counts of property and population in exposed to hazards, but almost always lack estimates of potential future levels of exposure and alternative future scenarios of exposure to account for uncertainty and the possibility for a range of future changes.
- *Policies* that are narrowly focused on single structural projects (for example, dig drainage culverts, protect electric generators, elevate specific buildings) instead of comprehensive mitigation strategies that coordinate multiple economic, environmental, and social policies and investments in ways that support mitigation.
- *Implementation* elements that commonly do not assign organizational responsibility or identify timelines and sources of funding for carrying out actions.
- *Monitoring* programs that often fail to specify indicators and sources of data to track progress toward plan goals and designate organizations responsible for data collection.

[4] Meta-analysis offers an alternative to the traditional narrative discussions of research studies, which are subject to several shortcomings: (1) the selective inclusion of studies, often based on the reviewer's own impressionistic view of the quality of a study; (2) the subjective weighting of studies in interpreting findings; and (3) the misleading interpretation of study findings (Wolf, 1986).

[5] The Berke and Godschalk (2009) study examined 16 studies focused on the quality of plans that address a range of issues such as biodiversity, affordable housing, and the rights of indigenous people. For our purposes, we focus only on those studies examined by Berke and Godschalk that account for natural hazard mitigation, as exhibit 3 illustrates. We also include a study by Tang et al. (2008) that was not included in the Berke and Godschalk (2009) meta-analysis.

[6] The Berke and Godschalk (2009) meta-analysis found it impossible to use values directly from each study because individual studies differed in how they measured plan quality characteristics (for example, scales and the number of items for each criterion vary) and computed plan quality scores. As an early and influential article on meta-analysis (Glass, 1977) discussed, a critical element of the meta-analytic procedure involves transforming the statistics of interest (for example, means and standard deviations) into standardized scores that permit the analysis of findings across studies. To create the findings reported in exhibit 3, such a transformation made scores comparable across plan quality characteristics. For studies that reported standardized proportionate scores (for example, Berke et al., 1996; Brody 2003a, 2003b), Berke and Godschalk could use the findings directly. For other studies (for example, Burby and May, 1997; Nelson and French, 2002), Berke and Godschalk transformed scores by plan quality characteristic by first identifying the maximum possible score for characteristics in each study, and then dividing the reported score of each characteristic by the total maximum score to determine a proportionate score.

Exhibit 2

Indicators of the Principles of Plan Quality for Hazard Mitigation Plans

Goals. Reflections of public values that express desired future conditions.
- Enhance community resiliency.
- Protect ecosystem services that support hazard mitigation.
- Protect public safety.
- Reduce property damage.
- Reduce economic impacts.
- Promote equity.

Fact bases. Provide the empirical foundation of current and future conditions to ensure that key hazard problems are identified and prioritized and mitigation policymaking is well informed.
- Maps of current and projected hazards.
  - Delineation of location of hazard.
  - Delineation of magnitude of hazard.
- Exposure (current and projected).
  - Number and characteristics of population exposed (low-income, disabled, minority).
  - Number and total value of different types of public infrastructure exposed.
  - Number and total value of private structures.
  - Number of critical facilities exposed.
  - Loss estimations to public structures.
  - Loss estimations to private structures.

Policies. Specification of general guidance to decisions about land use and development and assure that plan goals are achieved.
- Development regulations (zoning, subdivision, setbacks).
- Taxation and fiscal policies.
- Critical public infrastructure investment policies.
- Structural protection (drainage culverts, seawalls, levees).
- Property acquisition and relocation programs.
- Information dissemination program.
- Protection of natural mitigation features.

Implementation. Involves assignment of organizational responsibilities and identification of proposed timelines and projected costs of implementing proposed policies and actions.
- For each proposed policy and actions, identify—
  - Organization with lead responsibility for implementing proposed policy or action.
  - Proposed timeline for completion or milestones toward completion.
  - Projected cost (for example, funds required, staff time).

Monitoring. Involves tracking performance of the plan and its proposed policies and actions.
- Identifies parties responsible for monitoring progress.
- Includes indicators for measuring performance.
- Identifies obstacles to implementation.
- Includes provisions for public involvement in ongoing monitoring.

Source: Adapted from Berke and Godschalk (2009)

Findings from the individual studies in exhibit 3 further illustrate these shortcomings. For example, Burby and May (1997) reported that 90 local governments in three states (California, Florida, and the North Carolina coastal zone) with mandates that require various hazard provisions in comprehensive plans had significantly higher scores for goals, facts, and policies than 90 local governments in three states (North Carolina noncoastal zone, Texas, and Washington) without mandates. Burby and May concluded, however, that most plans under the mandates considered hazard risks in only

Exhibit 3

Findings on the Quality of Local Natural Hazard Mitigation Plans

Investigators	Sample	Goals	Fact Bases	Policies	Implemen-tation	Monitor-ing
Burby and May (1997)	90 mandated local plans;	0.13	0.34	0.36		
	90 nonmandated local plans	0.03	0.09	0.06		
Berke, Dixon, and Ericksen (1997)	16 New Zealand regional plans;	0.68	0.14	0.11		
	7 Florida regional plans	0.53	0.45	0.23		
Berke et al. (1999)	34 New Zealand local plans;		0.06			0.39
	16 New Zealand regional plans		0.12			0.21
Nelson and French (2002)	19 California local plans	0.18	0.21			
Brody (2003a)	59 Florida and Washington local plans; t_1 = 1991; t_2 = 1999	0.10	0.09	0.05		
		0.13	0.12	0.12		
Brody et al. (2004)	35 Florida local plans	0.36	0.24	0.42	0.30	
Tang et al. (2008)	43 local plans in three Pacific coastal U.S. states	0.40	0.32	0.15	0.10	
Lyles, Berke, and Smith (2012)	115 local coastal plans in six states	0.52	0.39	0.29	0.60	0.35

Note: Scores are standardized ranging from 0 to 1.

Source: Adapted from Berke and Godschalk (2009)

the most rudimentary manner. Berke, Dixon, and Ericksen (1997) compared 16 mandated regional plans in New Zealand with 7 in Florida and found core differences across the principles because of differences in mandate design (for example, clarity of goals, local capacity features, and stringency of sanctions for noncompliance). They also found major gaps in both groups of plans, however, including only general verbal descriptions of the natural hazard problem that sometimes lacked numerical facts and vague policies that were not closely linked to local hazard conditions. Tang et al. (2008) studied tsunami mitigation provisions in 43 local coastal plans in three Pacific states and found that the typical plan contained only a general description of the tsunami problem, that vague policies are not closely linked to local hazard conditions, and that less than one-fourth of plans included implementation and monitoring programs.

Given the considerable public indifference and local official reluctance to act on public risks associated with natural hazards and climate change, the limited support for planning and the resulting weak plans in the case of natural hazard mitigation are not surprising. National and state policy interventions designed to mandate, incentivize, and build local government commitment and capacity to take action have had some positive effects in the case of natural hazard mitigation, and in some cases they have led to innovative hazard mitigation plans (Schwab, 2010). Forward movement on action, however, has been slow and limited in the natural hazard mitigation field. Reviews in the 1990s of federal (May, 1991) and state (Berke, 1998) natural hazard mitigation programs drew similar conclusions about the positive but limited external influence of higher level of government programs. Our review suggests that a similar situation might occur in the case of climate change-adaptation planning.

The Local Government Paradox

Burby (2006) summed up the situation of public indifference and limited influence of external interventions as a *local government paradox*. The paradox arises when local governments fail to anticipate the risks or enact strong plans and effective practices although they are at risk to high levels of losses (Burby, 2006). This situation poses a major obstacle to creating high-quality plans that support community resiliency. For natural hazards, Mileti (1999: 66) found that federal disaster relief covered only a small proportion of total U.S. disaster losses between 1977 and 1997 and that most of the losses are not insured, because they are "borne by victims." The implications of failing to enact strong climate change-adaptation plans are daunting. In California alone, for example, $2.5 trillion in real estate assets are at risk from extreme, climate change-induced weather events, sea-level rise, and wildfires, with a projected annual price tag of up to $3.9 billion during this century (Roland-Holst and Kahrl, 2008).

We would expect that hazard mitigation would be a high priority for local officials. As the data on local planning for natural hazards reveal, the paradox is that at-risk local governments are reluctant to take risk-reducing actions, because such hazards are low on their list of priorities. As noted previously, early signs of the comparatively slow response to climate change-adaptation planning unsurprisingly reveal a similar pattern of limited local action.

Although much remains to learn about natural hazards and their effect on natural and built environments, the local government paradox is not one of insufficient scientific and technical knowledge. The past four decades have seen numerous advances in our understanding of risk-reduction practices for natural hazards (Mileti, 1999; NRC, 2006). Despite the growth of a technical knowledge base, the implementation of existing knowledge in natural hazard risk-reduction practices has been limited, as reflected in the quality of local hazard mitigation plans. Scientific groups reviewing the hazard mitigation programs (NRC, 2006) and numerous organizations representing the professions active on issues of the built environment and risk reduction (Thomas et al., 2011) have raised concerns about this situation. Attention has been shifting from technical concerns linked to structural engineering, flood hydrology, and hurricane forecasts to governance approaches aimed at motivating the adoption of risk-reduction actions.

Local action on climate-change adaptation is further constrained relative to action on natural hazards mitigation, because greater scientific uncertainty exists about how natural climate systems will respond over time and how successfully social systems will reduce GHG emissions (Blanco et al., 2009). In a 2009 report, *Global Climate Change Impacts in the United States,* a group of leading scientists agreed that "climate will be continually changing, moving at a relatively rapid rate, outside the range to which society has adapted in the past, [but] the precise amounts and timing of these changes will not be known with certainty" (USGCRP, 2009: 11). The high level of uncertainty could pose an even greater obstacle to climate-change adaptation compared with natural hazard mitigation (Camacho, 2009; Hallegatte, 2009; Patt, Klein, and de la Vega-Leinert, 2005; Popper, Lempert, and Bankes, 2005).

The traditional planning approach of *predict and plan* further constrains action, because local governments are not well equipped to deal with the complex, uncertain, and accelerating changes linked to climate change (Barben et al., 2007; Quay 2010). *Predict and plan* is Quay's (2010) phrase to describe the current practice of physical urban and regional planning, in which most planning forecasts future trends or a future desired state and then identifies the infrastructure and land use requirements needed to accommodate or create this future. This approach has long been rooted in planning practice, wherein forecasts of population and employment drive physical planmaking (for example, Chapin, 1965), and it is clearly evident in hazard mitigation plans (see exhibit 3). Quay (2010: 498) further observed that "the [traditional] approach worked when social and environmental systems were stable and predictable over short periods of time; however, when uncertainty and complexity are high this is not the case, making forecasting difficult."

Drawing on Rittel and Weber's (1973) analogy of wicked public planning problems, which are difficult or nearly impossible to solve, Quay (2010) observed that the characteristics of widely shared climate-change risks (uncertainty about the causes and effects, lack of an immediate or ultimate test of a solution, and planners' liability for the consequences of their actions) pose major obstacles to local climate change-adaptation planning. As evidenced by the serious deficiencies in contemporary local hazard mitigation planning, the situation points to the difficulties of engaging reluctant communities and individuals to be involved in climate change-adaptation planning and to improve their understanding of the need for a greater shared responsibility for addressing public risks.

Expanding the Scope of Planning

In response to these deficiencies, new models are emerging in scholarly literature and practice that extend well-established traditions of consensus building in collaborative governance and link this new thinking to the emerging model of anticipatory governance.

New Conceptions of Collaborative Governance

The traditional approach to collaborative governance is to bring diverse private and public stakeholders together in a consensus-oriented forum for decisionmaking (Innes and Booher, 2010). This literature emerged in the late 1980s in response to failures of top-down decisionmaking processes prioritizing elite or technical knowledge, and it focuses instead on a process of shared learning and understanding through authentic dialogue (Innes, 2004). Planning processes are truly collaborative when "all the affected interests jointly engage in face to face dialogue, bringing their various perspectives to the table to deliberate on the problems they face together" (Innes and Booher, 2010: 6).

During the past 30 years, collaboration has encompassed activities such as joint ventures, regulatory negotiation, public-private partnerships, community gatherings and public meetings, and other settings in which stakeholders with a shared interest assemble to diagnose a problem and develop an understanding of how to address it. This process emphasizes transferring technical knowledge from experts to participants and tapping the ordinary knowledge of participants to produce new knowledge through their interaction (Deyle and Slotterback, 2009). The ultimate aim of collaborative processes is to reduce adversarial relationships, redress power and resource disparities among stakeholders, and achieve consensus (Innes and Booher, 2010).

Recent literature has extended the collaborative governance model to embrace the concept of communities of practice. Rather than resolving conflicts and achieving agreement to solve specific problems, the purpose of communities of practice is expanding collaborative partnerships and cultivating expertise. Goldstein and Butler (2010: 240) maintained that "… a community of practice is assembled not around a problem, but around a core domain [of issues] that its members know and care about. Activities around this common domain may include critiquing existing practice, developing innovative approaches, or imparting traditional practices to new members." Rather than bridging ideological or expertise boundaries to achieve agreement on a course of action, communities of practice strengthen connections among participants who "aim for good collective practice" (Goldstein and Butler, 2010: 240).

Within communities of practice, participants gain status and authority based on respect and trust rather than on formal authority, because involvement is voluntary. Participants "cultivate a sense of belonging by sharing stories from experience and demonstrating the skills and techniques associated with their practice" (Goldstein and Butler 2010: 240). Goldstein and Butler's (2010) study of the U.S. fire management learning network concluded that, rather than paying attention to building consensus, the network fostered the expertise of managers in ecological protection and cultivated an expanding network of collaboratives by linking localized planning efforts with regional communities of practice. They maintained that the new approach might amplify the potential for fundamental change in the culture and practice of public risk management. In addition, as evidenced by the growth of the learning network, individuals who benefit from participation in a community of practice can become motivated to nurture and distribute expertise in other locales and, in turn, expand and sustain broader regional and national networks. Finally, Goldstein and Butler (2010) argued that linking multistakeholder collaborations and communities of practice can provide autonomy for individual collaboratives while also fostering cohesion across collaboratives.

Anticipatory Governance

Anticipatory governance is "a new model for planning and decision making under high uncertainty based on concepts of foresight, flexibility, and a wide range of futures to anticipate adaptation strategies, and then monitoring change and uses of these strategies to guide decision making" (Quay, 2010: 497). Instead of attempting to avoid or deny uncertainty, anticipatory governance aims to explore uncertainty and its implications for guiding current and future decisionmaking. This model of planning recognizes the limitations of managing built, natural, and social environments based on previous experience, and it offers opportunities to build local networks and problemsolving capacity amid great uncertainty about the future. Fuerth (2012: 1) contended that anticipatory governance "provide[s] a way to use foresight, networks, and feedback to reduce risk, improve planning…by mobilizing the full capacities of government, and increase capacity to respond to events at earlier stages, just barely visible at the event horizons."

Most of this literature is new, not yet well defined in theory, and only beginning to be applied to planning practice. For example, Godschalk and Anderson (2012) recently called for the integration of anticipatory governance concepts into the next generation of comprehensive plans.

Because anticipatory governance recognizes that some aspects of the future are uncertain and that forecasts should represent a range of plausible futures, scenario planning has emerged as a core means to apply new concepts (Fuerth 2009, 2012; Quay, 2010). In the case of climate change, plans that include a range of future climatic conditions and impacts provide foresight and enhance local ability to adapt to uncertainty. Planners would rely on foresight and modeling methods as a means to help identify and mobilize responses to new challenges when they are still nascent (Hopkins and Zapata, 2007). They would avoid reliance on historical data, because they should not expect past trends to be valid in the development of future trends. The aim of scenarios is to bound the future but in a flexible way that permits learning and adjustment as the future unfolds.

Coupling the Collaborative and Anticipatory Models

Our conception of climate change-adaptation planning entails integrating the collaborative approach now dominant in planning with the anticipatory governance model. Emerging new models of collaborative governance would embrace the traditional practice of authentic dialogue, wherein stakeholders and experts fashion plans and policies together, but they would also emphasize building and expanding a core network of members focused on the public risks associated with climate-change adaptation. Anticipatory governance would address the twin climate-change phenomena of acceleration and complexity and would help identify otherwise unforeseeable events sooner. We suggest that this coupling could help communities confront a new class of complex and rapidly changing challenges linked to climate change and simultaneously build a public constituency by engaging multiple stakeholders.

The integrated approach would explicitly recognize that local governance capacity to plan needs to be improved to foster interactive dialogue between experts and stakeholders. Such a dialogue would construct plausible futures that are well understood and technically informed, and it would create flexible strategies that are publicly relevant, tangible, and adaptable across a range of future impacts. It would also focus on the expansion of networks of actors among typically compartmentalized public agencies, private-sector groups, and nonprofit groups.

Our reading of scholarship and practice suggests that planning that provides effective adaptation strategies and builds a public constituency amid conditions of great uncertainty should consist of specific actions across multiple stages of decisionmaking. Specifically, we use Quay's (2010) broad stages of anticipatory governance but extend his formulation to embrace the concepts of collaborative planning. These stages are to (1) develop a knowledge base through collaborative scenario formation that anticipates multiple futures and associated impacts, (2) formulate flexible adaptation policies, and (3) create a program of action for implementation of polices and monitoring outcomes. For each stage, we describe the core concepts and examples from climate change-adaptation planning practice in which local governments are applying concepts of collaborative and anticipatory governance.

Develop a Knowledge Base That Anticipates Multiple Futures

Amid great uncertainty, the knowledge base for local planmaking and implementation should consider a range of possible future scenarios rather than a forecast premised on a single future scenario based on previous experience and the historic range of previous variability (Fuerth, 2009; Quay, 2010). Scenario development can employ a range of methods and approaches (aggregated averages, sensitivity analysis of factors or decisions driving the scenarios, identification of unacceptable scenarios or worst cases, and assessment of common and different impacts among the scenarios).

Local planmaking that accounts for a range of possible future climate conditions and associated impacts on human, built, and natural systems will provide local governments the foresight to reduce risks and to increase their ability to anticipate and adapt to events at early rather than later stages of their development.

Scenarios are generally thought of as cogent stories intended to aid decisionmakers. They are intended to foster imagination and facilitate critical thinking about how a future might unfold. The practice of scenario planning should not be solely be expert driven but also facilitate public participation with focus groups, roundtable discussions, or Delphi methods. Thus, involving the lay public, a diverse range of stakeholder groups, and experts in the process of developing and evaluating scenarios enables the integration of expert knowledge with lay knowledge of existing conditions and future concerns (Innes and Booher, 2010).

The Denver and London climate change-adaptation planning efforts offer two distinct approaches to using scenario-planning concepts, but both entail weaving expertise into multistakeholder collaboration and fostering the expansion of a network of collaborators. The initial work of Denver Water, a public utility separate from the government of the city of Denver, focused on constructing simple, normative scenarios that served as imaginative stories. The scenarios use metaphors such as "traditional future," "hot water," "green revolution," and "economic woes," with each scenario having alternative impacts on future water supply and demand (Denver Water, 2008). The scenarios were initially established by planning staff at Denver Water, then reviewed by water resource experts and the Denver Board of Water Commissioners. A second initiative of Denver Water's scenario development involved a more expansive probabilistic futures analysis, which aimed at fostering a broader involvement among water managers and interest groups and at embracing a stronger technical and scientific basis for scenario construction (Quay, 2010). It includes a multistakeholder collaborative from state agencies, local agencies, and interest groups (conservation groups, real estate development interests, and stormwater utilities) who are working with practitioners from organizations with considerable technical expertise (for example, Western Water Assessment and the National Center for Atmospheric Research).

Like Denver's second initiative, London's approach emphasizes the construction of predictive scenarios based on statistical probabilities of occurrence that involve modeling (see exhibits 4 and 5). In developing the first local climate change-adaptation plan in the United Kingdom in 2007 (City of London, 2007) and updating it in 2010 (City of London, 2010), planners were keenly interested in including a wide range of stakeholders from within city government. They facilitated a series of small working meetings to identify and appraise climate change-adaptation action within collaborative groups of stakeholders and representatives from different departments (planning, economic development, children's and adults' services, and others). Representatives would host workshops pertinent to their area of administration. The intent was for the groups to exchange information, receive technical advice from invited experts, and aid in the creation of cooperative solutions. London planners also organized citywide meetings in which department leaders could exchange ideas, compare individual department plans, and seek better ways to innovate and make progress. The citywide effort facilitated sharing ideas and resources across departments, making work at individual departments more consistent. The goal was not only to create a climate change-adaptation plan but also to gain initial acceptance and build inhouse capacity among city staff.

Exhibit 4

London Climate Action Plan

Predictive modeling

London initially explored four major climate risk factors: temperature, precipitation, sea-level rise and extreme events. To define these factors, climate specialists examined temperature and precipitation results from multiple climate-change models for two emission scenarios defined by the IPCC Working Group III report (Nakićenović et al., 2000) in each of two future 30-year periods. The United Kingdom Environment Agency projections were used to estimate the rise of the River Thames in the range 0.2 to 0.9 meters by 2100, with a worst case scenario of 2.7 meters.

The committee estimated the most likely range for each factor in each future period, including the 33- to 66-percent likely events range, and the 10- to 90-percent extreme events range. The probabilistic projections were used to illustrate ranges of future changes in climate variables over a selected location. The information on low-probability (extreme) events will be particularly relevant for contingency planning.

To illustrate how the average change and probabilistic ranges for factors are presented in the London climate change-adaptation plan, exhibit 5 shows the average projected future increase and possible ranges in the wettest winter day for London in a high greenhouse gas emissions scenario. In this scenario, the likely range of change in average summer rainfall is +1 to +9 percent by the 2020s and +7 to +19 percent by the 2050s.

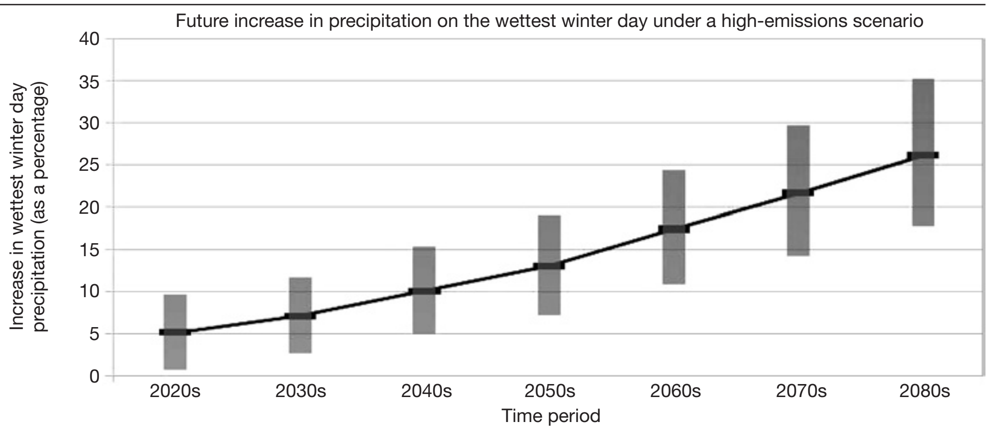
Engagement

Staff from across city, metropolitan, and national government agencies were then asked to identify which social, economic, and infrastructure systems would be vulnerable to impact from the climate risk factors using these probabilities. Next, planners facilitated four smaller working meetings among these experts to identify and appraise adaptation action to assess the climate risks, with representatives from different departments (including planning, economic development, children's and adults' services, and others) hosting various workshops pertinent to their area of administration. During these meetings, agency staff were also asked to assess how an impact caused by a change in the risk factor would affect the scope of responsibilities of their agencies and to determine and prioritize subsequent actions.

Source: City of London (2010)

Exhibit 5

Rise in Winter Precipitation in City of London Because of Climate Change



Notes: The black line shows the central estimate (50th percentile) of the increase in precipitation on the wettest winter day for the high-emissions scenario. The wide gray bars show the likely range of change (33rd to 66th percentiles). The error bars show the 10th and 90th percentile events (future increase in precipitation on the wettest winter day is very unlikely to be outside this range).

Source: City of London (2010: 11)

In 2010, the climate change-adaptation plan was updated (City of London, 2010) and integrated into the city's Local Development Framework, adopted in 2011 (City of London, 2011). The framework is a comprehensive spatial plan that includes strategies focused on climate change and other ongoing city development goals and programs (for example, environment, economic development, and health). The goal of the next cycle of climate change-adaptation planning is to engage broader stakeholder involvement that includes partners from across the metropolitan region (City of London, 2010).

Formulate Flexible Adaptation Policies

After scenarios are complete, the next step is to craft flexible policies (to be linked to appropriate monitoring systems, as we will discuss). Analysis of the risk-reduction effects of potential policies across a range of scenarios can be used to develop integrated adaptation plan polices. Policies and strategies (an integrated set of policies) represents the heart of a plan, because they guide public and private decisions to achieve a desired state of resiliency, but climate-change policies must be designed to be adaptive.

The anticipatory governance literature suggests that adaptation policies can be arranged into two broad classes of action (Chakraborty et al., 2011; Hallegatte, 2009; Quay, 2010). *Contingent* policies are tailored to a specific future. If a particular policy is preferred under one set of changes but not under other sets of changes, then the policy is contingent. If a future outlined by a particular scenario does not materialize, then the policy aligned with that scenario will remain unused, but without such a policy a community risks being unprepared. The *worst case* option is an instance of a contingent policy. *Robust* policies are those that have a positive effect across many possible futures and can preserve future options. These policies offer a robust decision that yields preferable results under multiple scenarios, and include two options. The *no-regrets* option is justified by current climate conditions, and further justified when climate change is considered across many possible scenarios. The *low-regrets* option is low cost in the short term and can be adapted over time to address several possible scenarios. This latter option allows for the distribution of costs over time as opposed to one-time lump sum investments to carry out a particular policy that might be abandoned.

A combination of robust and contingent policies offers a flexible approach that can be implemented as needed. Work associated with the *City of Punta Gorda Adaptation Plan* (Beever et al., 2009) and with transportation and land use planning for the Charlotte County-Punta Gorda area (Chapin, Deyle, and Higgins, 2010) in southwest Florida illustrates how a range of robust and contingent policies, linked to land use and emergency preparedness, are packaged and applied in the context of a growing, hurricane-prone region subject to sea-level rise. For example, exhibits 6 and 7 illustrate the transportation and land use planning effort. Similarly, the London plan uses primarily robust policies that offer a comprehensive set of low-regrets and no-regrets options (see exhibit 8). Whenever possible, the London plan attempts to use these policies in ways that generate co-benefits (or win-wins). For example, the installation of green roofs enables climate-change adaptation by reducing stormwater runoff and generates benefits for climate-change mitigation by reducing electricity consumption to heat and cool buildings and GHG emissions.

Exhibit 6

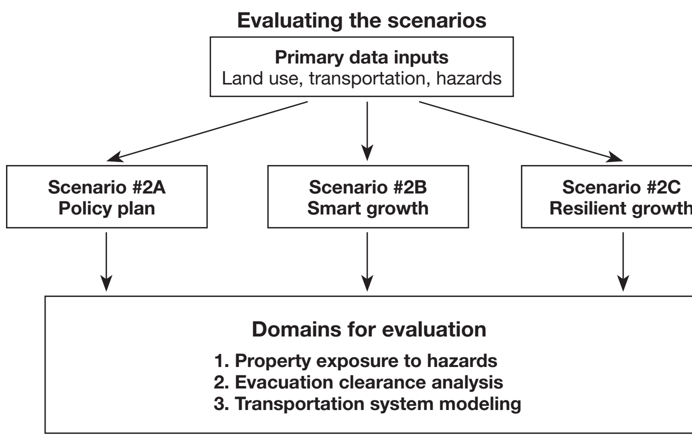
City of Punta Gorda Adaptation Planning Polices

Alternative climate-change and urban-growth futures for the City of Punta Gorda, Florida, adaptation plan (Beever et al., 2009) included robust policies that would work well across all scenarios and, under a transportation planning initiative for Charlotte County-Punta Gorda, included a worst case policy focused on altering urban land use pattern to reduce property loss (Chapin, Deyle, and Higgins, 2010). One example of a robust policy arose from the finding that all scenarios of sea-level rise impacts on hurricane surge penetration, assuming no further urban growth, showed evacuation capacity to be adequate to meet existing demand, even in the worst case hurricane event. In all scenarios of future urban growth patterns (see exhibit 8), however, growth from new development would either trigger the need for an expansion of highway capacity (more lanes) for evacuation or require significant demand reduction through alternative modes of evacuation (for example, more bus service and carpooling). In response, the city has a concurrency requirement to ensure expansion of transportation capacity to accommodate additional growth.

The pilot planning project included a worst case scenario portraying the severity of potential property loss from smart growth development patterns to be greater than that of the other two development scenarios (see exhibit 7). The smart growth land use scenario consists of three conditions: (1) development is constrained to a smaller urban service area, (2) a range of housing types are developed in or near identified urban centers, and (3) commercial development is targeted to identified urban centers. Using this scenario, it would be possible for local planners to modify traditionally accepted model land use regulations and infrastructure investment schemes that often support smart growth development in dangerous locations (Berke, Song, and Stevens, 2009).

Exhibit 7

Evaluating the Impacts of Future Scenarios, Punta Gorda, Florida



Source: Chapin, Deyle, and Higgins (2010)

In the Florida and London cases, the collaborative planning processes supported development of flexible policies that require joint actions by participants. Both planning efforts involved a policy formation that engaged government agencies that normally focus on single policy domains (for example, emergency management, transportation, land use, and economic development).

Although the intent of the Punta Gorda and London efforts was to build commitment to acting cooperatively, the engagement processes were distinct. London worked internally at first, and then externally expanded the network, whereas Punta Gorda attempted to expand the network up

Exhibit 8

Adaptation Actions To Manage Flood Risks in the City of London's Climate Change-Adaptation Plan

Research and monitoring

- *No regrets.* The City of London should work to identify and map flash flood 'hotspots' and assign responsibility for coordination and liaison on flood risk management in order to ensure its practical implementation.
- *Low regrets.* The City of London should improve the monitoring and recording of gully overflows linked to heavy rainfall events and assess the capacity of sewers managed by the City of London to cope with increasing rainfall due to climate change, as well as coordinating with the Thames Tideway Tunnel project.

Policy

- *No regrets.* The draft LDF (Local Development Framework) includes policies on Flood Risk and Sustainable Design and Climate Change, which promote the use of sustainable drainage systems (SuDs), such as green roofs, and street enhancements. Sustainable drainage systems such as green roofs should be encouraged as part of new developments, redevelopments, and major refurbishments the LDF planning agreements should be used to secure long-term commitment to the management and maintenance of SuDs.
- *Low regrets.* The City of London LDF should require that drainage systems in all developments have the capacity to cope with heavier rainfall events expected over their lifetimes, taking account of climate change.

Practical actions

- *Low regrets.* The City of London should encourage businesses to consider relocating flood-sensitive IT equipment and archives to areas with low risk of flooding. The Contingency Planning Department should encourage businesses with assets and equipment that need to be on site, to move them away from locations at higher risk of flooding, such as basements.
- *No regrets.* Developers should be encouraged to install sustainable drainage systems and green roofs in targeted flash flood 'hotspots' for new developments, redevelopments, or major refurbishments.
- *Win-win* and *No regrets.* The City of London Corporation should consider installing sustainable drainage systems, green roofs, or green walls on City of London-owned car parks and buildings, when they are refurbished or replaced.
- *Low regrets.* The City of London should examine a range of incentives to encourage sustainable drainage systems and green roofs.

Source: City of London (2010: 18)

front. As noted previously, London planners focused within city government in the 2007 planning process, but the scope of engagement expanded when the plan was integrated into the 2011 Local Development Framework (City of London, 2011). Developing the framework, a comprehensive spatial plan that coordinates climate-change adaptation with other ongoing city development goals and programs, involved extensive public involvement and review, as discussed in the public participation plan (City of London, 2011). The Punta Gorda initiative involved an extensive effort to include the public and a broad range of stakeholders, beyond government agencies, affected by policy outcomes (Beever et al., 2009; NOAA, 2010). Planners emphasized the codevelopment of information, engaged climate scientists, and designed a bottom-up review process for selection of strategies.

Create a Program for Implementation Action and Monitoring

By contrast to a fixed predict-and-plan approach, an adaptive approach is premised on the idea that communities are dynamic and changing, and plans must be revised in a continuing process. For a plan to be influential in guiding decisionmaking, it should contain a flexible program of actions, including the tracking of action items and the resiliency of outcomes of such actions. Such a program decreases the likelihood of the common occurrence whereby local plans languish or are forgotten (Laurian et al., 2004).

For climate-change adaptation, this approach would mean (science permitting) identifying and monitoring the climate factors most closely tied to local effects, to allow for sufficient time to respond through action. Because climate change will unfold during the next 100 years, decisions on implementation, monitoring, and adaptive actions should take place incrementally over a long period (Quay, 2010; Wilson and Piper, 2010). Indicators of change should be monitored on a regular basis, and decisions to implement anticipated adaptation strategies considered in light of actual trends.

As with the knowledge base and policy stages, collaborative approaches are essential in the action and monitoring stage. Adaptive implementation and monitoring are socially constructed processes that require the engagement of experts and stakeholders, especially those with on-the-ground local knowledge (Innes and Booher, 2010). Given the scientific limitations of climate-change research, and the uncertainties of how different population groups (for example, those defined by race, class, and gender), and stakeholder interests (for example, businesses and environmentalists) are affected by climate change, many kinds of knowledge will be important for ongoing problemsolving. Given such complexity, expert and lay participants need to work together to improve their shared experiences of the effects of change. Moreover, ways are needed of jointly analyzing data derived from indicators of change. As noted previously, broad-based communities of practice are useful for providing participants forums for comparing their plans with those of their peers, sharing ideas, and developing innovations (Goldstein and Butler, 2010). This benefit should extend not only to developing plans, but also to participants sharing experiences of the challenges they have faced in implementation and monitoring and sharing insights on the approaches they have taken that have supported effective implementation and monitoring.

To date, of the few adaptation planning efforts, all are in the early stages of developing structured monitoring programs. London indicated that it will monitor implementation of the actions in the plan at 6-month intervals at interdepartmental working group meetings and through annual reports to sustainability officers responsible for coordinating the strategy (City of London, 2010). Punta Gorda's plan described the importance of engaging a network of stakeholders—including the most vulnerable groups—in ongoing monitoring, the need for "carefully developed sets of indicators," and the value of "mainstreaming" adaptation to generate co-benefits for other community goals and objectives (Beever et al., 2009: 316–319). In terms of ongoing monitoring, a table in the plan lists six main adaptation actions and details the relevant measures of the physical environment, a responsible agency for collecting data, and primary target goals.

A major challenge to moving forward is the current state of climate science. By the time change in temperature, precipitation, and sea levels are detected locally, it may be too late to adapt. Quay (2010) observed that global climatic indicators may be the best option to monitor changes. For example, changes detected in El Nino and in ocean current oscillations could be applied to consider potential trends at the regional and local scales. Quay (2010) noted, however, that how local government planning programs can use these broader trends is not clear.

The United Kingdom is one of the most advanced countries where local governments are furthest along in setting indicators of climate change, primarily because of technical assistance from the national government. Specifically, each local government throughout the country is responsible for gauging progress in the context of *The Local Government Performance Framework*, introduced by the national government in 2007 (UK Department for Communities and Local Government, 2007). The framework includes a set of 198 national indicators that local governments must use to measure their progress toward the national priorities. Local governments have yet to begin their annual reporting against national indicators.

Conclusions and Implications for Policy and Future Research

Our discussion of adaptation planning for public risks illustrates the special challenges to local governments and the public in addressing such risks. A chronic lack of a public constituency supportive of action on climate change poses a significant obstacle to local government to take planning seriously as a means to avert future losses.

Public risks, as defined previously, pose the generic difficulty of creating and sustaining public support and action. Devising strategies for dealing with public risks, especially those generated by climate change, requires a rethinking of the traditional predict-and-plan approach used in most of contemporary planning practice. The accelerating rates of change and increasing levels of future uncertainties associated with climate change are not well suited to the traditional approach. The risks are too uncertain, diffuse, temporally remote, and indirect to assign blame and attach responsibility.

We argue that coupling the collaborative and anticipatory governance models of policymaking offers a new approach in the modification of traditional planning for addressing public risks associated with climate change. The main thrust involves increasing acceptance of shared responsibility for addressing public risks. Although the concepts of collaborative governance and, to a lesser extent, anticipatory governance are not new, when coupled they offer a novel governance framework that accounts for public risks throughout the planning process, from futures analysis to policy formation, implementation, and monitoring.

A core premise of this new framework is that climate science and policies should use a set of flexible forecasts rather than depend on a single forecast. Collaborative governance calls for authentic dialogue, wherein stakeholders and experts fashion plans and policies together, whereas anticipatory governance offers guidance for planning practice amid conditions of accelerating change and great uncertainty. Furthermore, given the early stages of climate change-adaptation planning and uncertainties about future impacts, the emphasis would be on cultivating a community of practice, with the aim of building the local planning capacity to engage scientific and technical expertise (Goldstein and Butler, 2010). Embracing the uncertainties of climate science will likely be difficult for many local planners, decisionmakers, stakeholders, and the public. Most planning efforts in natural hazard mitigation have performed poorly in dealing with only one future, let alone multiple ones. Developing scenarios that provide cogent stories that prompt critical thinking and considering combinations of no-regrets, low-regrets, and contingent actions, however, should make adaptation planning more evocative, tangible, and contemporarily relevant for all parties. As a staged approach, the London effort could be instructive, given an initial focus on developing inhouse capability within city government agencies and an ultimate goal of imparting their know-how to others in the metropolitan area.

The transition to plans premised on multiple future scenarios, more flexible polices, and implementation more closely tied to monitoring is in the early stages, as illustrated by the diverse approaches of the early innovators discussed in this article. For example, London is using simple probabilities to specify climate changes and possible impacts, but Denver uses plausible storylines and metaphors of alternative futures. Punta Gorda proposes flexible robust policies that are desirable across a range of futures and contingent policies that are most appropriate if a worst case event were to occur. London's policies produce co-benefits whenever possible. The three innovators are dissimilar in terms of population (small to large city), location (coastal to high plains), and national context (United Kingdom and United States), and key climatic changes of concern (coastal flooding and sea-level rise and water supply). These differences suggest that the approaches we are describing can be applied across multiple contexts.

Finally, research is needed to examine the effectiveness of the planning framework this article proposes. The combination of anticipatory governance and collaborative planning has great potential but is dominated by normative thinking. The bulk of the research is composed of single-case studies that are not comparable given the lack of common variables and measurements. Its subjective and heuristic nature requires critical examination that emphasizes comparative analysis. In general, the planning field includes few systematic, validated analyses of planning processes. An exemplary exception, Deyle and Slotterback (2009) examined how the attributes of a collaborative planning process affect the level of group learning, agreement on strategies, and strength of supportive community networks based on pretest-posttest surveys of participants before and after the planning process in eight local governments in Florida. The field of planning, especially climate change-adaptation planning, would gain in scientific standing and policy relevance if more research, as exemplified by Deyle and Slotterback, were conducted to examine its comparative performance and underlying conceptual premises.

Many questions remain unanswered that merit serious investigation. Will the use of scenarios lead to better integration of climate-science knowledge into decisions and plans aimed at adapting to climate change? How can social networks that circulate technical knowledge about climate change be engaged more effectively in collaborative climate change-planning processes? How do the attributes of planning processes influence the formation and sustained implementation of climate action plans? What are the core indicators needed for assessing local capacity for climate-change adaptation, planning processes, plans, and resiliency outcomes?

In sum, the emergence of climate change-adaptation planning by local governments offers laboratories for testing new ideas on how best to motivate communities to take action to avert loss. Planning researchers should carefully evaluate these experiments as they evolve and educate the public and planning practitioners about how best to advance resilient communities.

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