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

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Abstract

Local planning and policy making are chronically weak and inconsequential in adapting to risks from climate change. A major obstacle to effective adaptation is the lack of public constituency. In response to this deficiency, new models are emerging in scholarly literature and planning practice that link collaborative governance and anticipatory governance. This coupling could help communities to confront the complex and fast-moving challenges linked to climate change by simultaneously engaging multiple stakeholders and communities of practice with scientific and technical expertise. We offer recommendations on how to make the transition to plans that are premised on multiple future scenarios, more flexible polices, and implementation and feedback closely tied to monitoring. We then recommend future research needed to examine the effectiveness of the proposed planning framework presented here.

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The climate we live in, the water we drink, and the ground we walk on each pose unforeseen threats of which we are frequently reminded by media coverage of yet another alarm or devastating event. In some cases, awareness of the threats is sufficient motivation for pervasive public response. Many decided to not purchase a particular brand of automobile due to a widespread alarm about brake failure. Yet, in other cases the public is unresponsive. Recent damaging hurricanes and wildfires, detection of sea level rise, and a massive oil spill has prompted a limited reaction among affected populations and governmental jurisdictions.

For certain risks creating and sustaining broad public responses is difficult. The inconspicuousness of such risks in the absence of a major focusing event, and the dominance of technical experts in defining the potential impacts of such risks, raise difficult questions about the role of experts in a deliberative democracy. Further, there are questions about the design of strategies for motivating risk reduction actions.

This paper is broadly concerned with local government planning in the context of risks for which public indifference is the norm, even when awareness of risks is common. The phenomenon of public indifference to certain risks seems to be most common in situations where there exists a “public risk,” defined as a risk that is mass-produced, widely spatially distributed, temporally remote, and largely beyond direct control of individuals who sustain the risk. Examples include sea level rise, floods, ozone depletion, and earthquake risks. In contrast, “private risks” are defined as “risks [that] are more immediate, focused upon by the individual, and generally understandable” (May 1991, p. 264). Examples are automobile brake failures, steep stairs in a house, and tainted food.

Public risks present classic collective action problems. In the absence of major focusing events (e.g., flood, wildfire) there is a relatively limited public response to such risks. Individuals often have incentives to avert losses, but the calculus for decision making is such that a host of perceptual factors alter economic rationality (see Lorenzoni and Pidgeon, 2006 for a recent review of the literature). In contrast, private risks entail sufficient incentives for individuals to avert losses on their own (e.g., fixing failing brakes or steep stairs). The point of this distinction is the differing levels of incentives for individuals to respond to public and private risks. The lack of incentives for responsiveness associated with public risks creates challenges for designing effective local planning strategies aimed at stimulating short- and long-range action to prevent or limit such risks.

In an era when many risks to society are increasingly perceived as "public" by virtue of large numbers of people being affected and blame being diffused, it is important that planners and decision-makers work to change public perception. Strategies are needed to shift public perceptions so that the risks are more apparent, less remote, and more within the realm of acceptance of shared responsibility.

The specific focus of this paper is climate change risks and adaptive planning to encourage public and private sectors to avert losses from climate change. As documented in this paper, risks from climate change are widely acknowledged by the public in at-risk locations. However, climate change induced risks have produced very limited public response. The evidence indicates that local efforts aimed at motivating risk reducing actions are weak and inconsequential. Differences in levels of planning effort are not solely a function of objective risk. There are fundamental limitations that constrain local adaptation to risks from climate change.

We focus on what local governments can do to reduce risks and build resiliency through the planning functions of local governments. Where appropriate we draw on the instructive experiences of four decades of research and practice aimed at mitigation of public risks posed by natural hazards (e.g., floods, earthquakes, hurricanes). The broader significance of the paper is in the conceptualization of the effects of local attributes of planning on community ability to take self-organized action to reduce public risks.

The Role of Planning

We focus on planning because of the increasing societal weight placed on this activity as means to build community resiliency in face of ever increasing risks posed by climate change. Resiliency is the ability of a community or society, along with the bio-physical systems upon which they depend, to resist or absorb the impacts (deaths, damage, losses, etc.) of hazards, to rapidly recover from those impacts and to reduce future vulnerabilities through *adaptive* strategies (Chapin III 2009, Peacock et al. 2008). While climate adaptation lags behind climate mitigation planning, a recent study found that 10 states (e.g., CA, FL, MD, VA, WA) had prepared plans for climate adaptation and a growing number of communities are experimenting on their own with climate adaption plans (Cruce 2009). Further, the international movement toward more attention to climate adaptation has gained momentum as evidenced by countries such as The Netherlands and United Kingdom (Wilson and Piper 2010, ch, 3), and New Zealand (NZ Ministry for the Environment 2011) that have adopted national legislation mandating or incentivizing local plans and implementation actions aimed at climate adaptation.

A local plan can play a pivotal role in guiding how a community accounts for climate change risks to people and property (Shuford et al. 2010). The plan is a statement of intent in dealing with the future of communities. The plan states aspirations, principles of action, and often specific courses of action to reduce potential losses by affecting the location and design of urban development, and by helping create and strengthen networks of stakeholders and the public who support risk reduction actions.

By guiding urban growth to locations outside of current and forecasted hazard areas, planning programs significantly reduce the possibility of major loss. Where hazardous areas have advantages for development that cannot be foregone (e.g., commercial and industrial land uses that are water-dependent), planning programs reduce potential losses by steering development to the least hazardous areas of building sites and by modifying building construction and site design practices so that risk is reduced. For existing development in increasingly hazardous areas (e.g., areas subject to sea level rise), planning programs assist property owners to relocate homes and commercial buildings to safer sites, or to structurally elevate and strengthen them to reduce risk. To further limit risk, planning controls and acquisition programs can play a key role in protecting ecosystems that build community resiliency to climate change. For example, protection of wetland ecosystems reduces the effects of hurricane surge which is likely to increase in severity due to climate change.

In concept, the planning process directly addresses the core characteristics of public risks that inhibit proactive, near-term, individual action. Planning provides forums for increasing awareness and understanding that public risks are mass produced and shared problems. When government agencies, non-profits, businesses and the public raise, study and debate the values and concerns of all participants they are more likely to achieve joint understanding of their interdependent interests and the need for ongoing collaboration to address emerging problems. While climate impacts are beyond the direct control of individuals, such collaborative efforts expand the choices and opportunities to co-develop risk reduction strategies. Further, the process of generating information (or fact) base for a plan -- evaluating past and current conditions and their implications for future conditions -- 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 and different from the risks they face today.

Recent studies indicate that where strong plans have been adopted, they have a positive effect in fostering more robust local government actions aimed at reducing public risks posed by natural hazards (e.g., floods and hurricanes) that are induced by climate change (e.g., Berke et al. 2006, Burby 2006, Dalton and Burby 1994). As will be discussed, such plans have almost always been poorly crafted and implemented due to a lack of a supportive public constituency.

Climate Adaptation Challenges

Two challenges pose major obstacles to the transition to effective adaptation to climate change. First, the lack of public constituency concerned about public risks associated with climate change. Second, planning and policy making is chronically deficient for addressing public risks, which is largely due to a disinterested public that creates minimal incentives for community action.

As noted, a well-developed knowledge base has been accumulated from research initiated in the 1970s on local hazard mitigation efforts, 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 the hazard mitigation and climate adaptation. Both hazard mitigation and climate adaptation deal with climatic events that are rapid-onset (tornadoes, hurricanes) and slow-onset (sea level rise, drought). Both are oriented toward the future in dealing with public risks that generate widespread threats. Both are focused 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 to climate change which is critical to formulating policy solutions that address the underlying symptoms of local reluctance to act.

Lack of a Public Constituency

Despite the growing risks posed by climate change, there is not much pubic constituency pushing efforts to avert losses. This deficiency cannot be explained by a lack of awareness of the risks posed by climate change. The awareness, however, is accompanied by varying degrees of indifference to the risks. Table 1 documents this disjunctive relationship, summarizing results of surveys of awareness of the threats and the degree indifference in priorities to act to reduce losses in developed countries (Australia, Great Britain, Japan, U.S.). The pattern applies to studies on climate change and natural hazards, and to the general public and those "key actors" – planners, real estate agents, elected officials, and so forth – who might be expected to be concerned about potential loss to their communities.

(Table 1)

There are a host of caveats to such survey results concerning the meaning of the responses across cultures, perceptions are not static over time, and the potential masking of pockets of support for increased loss reduction activities (Kahan et al. 2011). Nonetheless, the survey results bear out the more general point of risk perception studies showing that risks from climate change (Board et al. 1998, Lorenzoni and Pidgeon 2006) and natural hazards (Berke 1998, May 1991) tend to fall at the less dreaded and more-accepted ends of the spectra of people's risk perceptions. These perceptions are consistent with the temporal and geographic remoteness, broad distribution of risk, and limited individual understanding associated with public risks (Dessai et al. 2004).

Several studies illustrate the challenges to stimulating action on issues that lack a public constituency. Moser and Tribbia (2007) found that 54% of 135 California coastal managers strongly agree that global warming is real and already happening in their communities, but that only 30% acted on a climate change issue. Leiserowitz (2005) survey of 551 U.S. residents found that 97% believe that climate change have adverse affective images associated with climate change, but only12% are concerned about impacts on their family and 1% on their community, but 68% are concerned for people all over the world. The findings for the local managers are of particular interest, since they tend to specialize more in risk management than residents and elected officials do, and would be expected to place a higher priority on reducing risk. Whitemarsh's (2008) survey of 589 residents in southern England found 62% who experienced flood losses and 78% who experienced health effects from air pollution think something should be done about climate change but only 35% of flood loss victims and 40% of air pollution victims have taken any action (including action to reduce personal risk or to reduce greenhouse gas emissions) out of concern for climate change.

A host of studies also reveal that the lack of a public constituency pushing for efforts to reduce losses is predominant in the natural hazards policy arena. For example, May (1995) found the floodplain managers charged with implementing flood mitigation policy in New South Wales, Australia perceived that communities consider floods to be a moderate threat (mean of

3.1; 1-no threat, 5-very severe threat), but they report that community demand for action is low (mean of .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% of North Carolina coastal residents are aware of the potential damages caused by hurricanes, but only 28% are concerned about residential property damage.

The 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 concludes that although climate mitigation initiatives are increasing at a rapid pace at the local level (Zimmerman and Faris 2011, Wheeler 2008), only a few adaptation initiatives have emerged in the U.S. (e.g., Chicago, New York City, and Seattle). Zimmerman and Faris (2011, p. 185) further concluded that although over 1,200 communities in the U.S. have enacted climate change action plans,[1] only a few plans address the adaption issues specifically and that the vast majority are focused on reducing greenhouse gas emissions.

The expectation of low level 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 have matured to the point where it was recently possible to statistically compare findings from multiple studies based on meta-analytic methods. Berke and Godschalk (2009) conducted a meta-analysis of these studies based on common definitions of principles of plan quality (goals, facts, policies, implementation and monitoring).[2, 3] Table 2 includes definitions of each of five core principles and associated detailed indicators that serve as evaluation criteria. Table 3 specifies findings from eight studies that are based on the proportional scores for each principle ranging from a low of 0 to a high of 1.[4]

(Table 2 here)
(Table 3 here)

The meta-analytical comparisons reveal a host of serious deficiencies with hazard mitigation plans. All five principles of plan quality scored less than 50% of the maximum score for all studies, with only goals for two of the studies and implementation for one study that included these principles scoring above this threshold. Common shortcomings identified by these studies include:

- *Goals* that are too narrowly conceived by accounting for efficiency and public safety, but not other values critical to long-range resiliency, including social equity and 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 (e.g., dig drainage culverts, protect electric generators, elevate specific building), but not 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, and identify timelines for action and sources of funding for carrying out actions; and

- *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.

Findings from individual studies shown on table 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 non-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 without mandates (North Carolina coastal zone, Texas and Washington). However, this study concluded that most plans under the mandates considered hazard risks in only the most rudimentary manner. Berke et al. (1997) compared mandated 16 regional plans in New Zealand with 7 in Florida and found core differences across the principles due to differences in mandate design features (e.g., clarity of goals, local capacity features, stringency of sanctions for non-compliance), but also found major gaps in both groups of plans, including only general verbal description of the natural hazard problem that sometimes lacked numerical facts, and vague policies that were not closely linked to local hazard conditions.

Other studies report several additional weaknesses. Tang et al. (2008) study of tsunami mitigation provisions in 43 local coastal plans in three Pacific states found that the typical plan contained only a general description of the tsunami problem, vague policies that are not closely linked to local hazard conditions, and less one-quarter of plans including implementation and monitoring programs. Berke and Lyles and Smith's (2012) examined 175 local mitigation plans in six coastal states prepared under the U.S. Disaster Mitigation Act that mandates all local governments to prepare stand-alone hazard mitigation plans. The core conclusion was that mitigation policies in plans were more likely to be simply a series of disconnected "projects" intended to address past "mistakes," and not premised on an integrated and flexible forward-looking approach.

The Local Government Paradox

The situation might be summed up as a local planning paradox that poses a major obstacle to creating high quality plans that advance more resilient communities. The paradox arises when local governments fail to anticipate the risks, and enact plans and practices even though they are at-risk to high levels of losses (Burby 2006). For natural hazards, Mileti (1999, p. 66) found that only a small proportion of total disaster losses of over $800 billion (2010 dollars) between 1977 and 1997 in the U.S. are covered by federal disaster relief, and that most of the losses are not insured as they are "borne by victims." The implications for failure to enact strong adaptation plans for climate change are daunting. In California alone, for example, $2.5 trillion in real estate assets are at risk from extreme climate induced weather events, sea level rise, and wildfires with a projected annual price tag of up to $3.9 billion over this century (Roland-Holst and Kahrl 2008).

We would expect that hazard mitigation would be a high priority for local officials. As revealed by the data on local planning for natural hazards, the paradox is that local governments that are at-risk are reluctant to take risk reducing actions because such hazards are low on their list of priorities. It is not surprising that early signs of the comparatively slow response to climate adaptation planning reveal a similar pattern of limited local action.

In the case of natural hazards, while there is much to learn about natural hazards and their impact on natural and built environments, the paradox discussed here is not one of insufficient scientific and technical knowledge. The past four decades has seen numerous advances in our understanding of natural hazards and for risk reduction practices. Despite the growth of a technical knowledge base, there has been limited implementation of existing knowledge in natural hazard risk reduction practices as reflected in the quality of local hazard mitigation plans. Concerns about this have been voiced by scientific groups reviewing the hazard mitigation programs (NRC 2006) and by numerous organizations representing the professions that deal with the built environment who are seeking to review efforts to increase risk reduction efforts

(NHMA 2011). Such pleas have increasingly turned attention from the technical details of engineering, floodplain hydrology, and hurricane prediction to federal, state and local approaches aimed at encouraging adoption of risk reduction actions.

Local action on climate change is further constrained relative natural hazards mitigation as there is greater scientific uncertainty about how natural climate systems will respond over time and how successful social systems will be at reducing GHG emissions (Blanco et al., 2009). In its 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" (U.S. Global Climate Research Program 2009, p. 11). The high level of uncertainty could pose an even greater obstacle to climate adaptation compared to natural hazard mitigation (Camacho, 2009; Hallegatte, 2009; Patt, Klein, & de la Vega-Leinert, 2005; Popper et al., 2005).

The traditional planning approach of "predict and plan" further constrains action as local governments are not well equipped to deal with the complex, uncertain, and accelerating changes linked climate change (Barben et al., 2007, Quay 2010). "Predict and plan" is environmental planning scholar Ray Quay's (2010) phrase to describe the current practice of physical urban and regional planning (including, for example, hazard mitigation, land use and transportation 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 where forecasts of population and employment drive physical plan making (e.g., Chapin 1965), and is clearly evident in hazard mitigation plans (see Table 3). Quay further observes 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" (2010, p. 498).

In sum, drawing on Rittle and Weber's (1973) analogy of *wicked* public planning problems that are difficult or nearly impossible to solve, Quay (2010) observes the characteristics of widely shared risks associated with climate change (uncertainty about their causes and effects, no immediate and no ultimate test of a solution, and planners has no right to be wrong as they are liable for the consequences of their actions) pose major obstacles to local climate adaptation planning. As evidenced by the serious deficiencies in contemporary local hazard mitigation planning, the situation points to the difficulties in engaging reluctant communities and individuals to accept a greater shared responsibility for addressing public risks.

Expanding the Scope of Planning: Coupling Collaborative Governance and Anticipatory Governance

In response to these deficiencies, new models are emerging in scholarly literature and practice that link collaborative governance and anticipatory governance.

Collaborative Governance

Collaborative governance brings a diversity of private and public stakeholders together in a consensus-oriented forum for decision-making (Innes and Booher 2010). This literature has emerged in the late 1980s in response to failures of top-down decision-making processes prioritizing elite or technical knowledge and 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, p. 6). Collaboration over the past 30 years has encompassed activities like joint ventures, regulatory negotiation, public-private partnerships, community gatherings and public meetings, and other settings in which stakeholders with a shared interest assembled to diagnose a problem and develop understanding of how to address it. There is an emphasis on transferring technical knowledge to participants by experts and on tapping the ordinary knowledge of participants and producing new knowledge through their interaction (Deyle and Slotter 2009). The ultimate aim of collaborative processes is to reduce adversarial relationships and redress power and resource disparities among stakeholders.

The collaborative governance model has recently been extended to cultivate *communities of practice* that include scientific and technical expertise. The purpose is to expand expertise rather than to solely focus on resolving conflict and reaching consensus (Goldstein and Butler 2010). The goal is to facilitate collaborations to be better organized and informed to respond to the quickening pace of change, recognizing that knowledge would be critical to facility resilience by improving societal ability to adaptively respond. Goldstein and Butler (2010) study of fire management in the U.S. concluded that expansion of the scope of collaborative governance through inclusion of communities of practice has created and sustained a network of collaboratives that amplify their ability to adaptively manage forest ecosystems.

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, p. 497). Such governance recognizes that some aspects of the future are not knowable and that any prediction or forecast represents only one of many possible futures (Fuerth 2009, Quay 2010). Most of this literature is new and not yet well defined in theory and only beginning to be applied to planning practice (Godschalk and Anderson 2012, ch. 6). Fuerth (2012) describes anticipatory governance as "a system of institutions, rules, and norms that provide a way to use foresight, networks, and feedback to reduce risk, improve planning and operations by mobilizing the full capacities of government, and increase capacity to respond to events at earlier stages, just barely visible at the event horizons" (p. 1).

Scenario planning has emerged as a core means to apply anticipatory governance concepts (Fuerth 2009, 2012, Quay, 2009). In the case of climate change, plans that include range of future climatic conditions and impacts provide foresight, and enhance local ability to adapt to uncertainty. Scenarios should not be taken too literally as though they were static and out a fixed future. In actuality, their aim 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 adaptation planning entails integration that combines the collaborative approach now dominant in planning with the anticipatory governance. Collaborative governance would embrace practices of authentic dialogue wherein stakeholders and experts fashion plans and policies together. Anticipatory governance would address the twin phenomena of acceleration and complexity and help identify otherwise unforeseeable events earlier in time. We suggest that this coupling could help communities to confront a new class of complex and fast-moving challenges linked to climate change that simultaneously engage multiple stakeholders and communities of practice. In addition, it would explicitly recognize that local governance capacity to plan needs to be improved in ways that foster interactive dialogue between technical experts and stakeholders in order to construct plausible and fair futures, and to create alternative strategies tailored to the needs and capabilities of local communities to deal with such futures.

Our reading of scholarship and practice suggests that planning that promotes authentic dialogue under conditions of high uncertainty should consist multiple stages of decision making. Specifically, we use Quay's (2010) formulation of three broad stages of anticipatory governance but extend his formulation to embrace the concepts of collaborative planning. These stages include: develop a knowledge base through collaborative scenario formation that anticipates multiple futures; formulate flexible adaption policies; create a program of action for implementation of polices; and monitoring outcomes. For each stage, we describe the core concepts and examples from climate adaption planning practice in which local governments are applying concepts of collaborative and anticipatory governance.

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Develop a Knowledge Base that Anticipates Multiple Futures

Under conditions of high uncertainty the knowledge base for local plan making and implementation should consider a range of possible scenarios of the future, rather than a forecast premised on use of a single scenario of the future that is based on previous experience and the historic range of prior 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 plan making 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 decision makers. They are to foster imagination and facilitated 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 in which scenario construction may involve workshops, backcasting, 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 incorporation of both expert-driven technical, scientific knowledge with lay knowledge of existing conditions and future concerns (Innes and Booher 2010).

The 2008 Denver and the 2010 London climate change adaptation planning efforts offer two distinct approaches to using scenario planning concepts. As discussed in detail in figure 1, Denver's initial work is premised on simple normative scenario construction as imaginative stories that use metaphors like "hot water," "green revolution," and "economic woes," which evolved from input by technical consultants and public officials (Denver Board of Water Commissioners). A second initiative of Denver Water's scenario development involved a more expansive probabilistic futures analysis which fosters a broader stakeholder involvement but also embraces a stronger technical and scientific basis for scenario construction (Quay 2010). It includes a multi-stakeholder collaborative from state, local agencies, and stakeholder groups (conservation groups, real estate development interests, and stormwater utilities) who are working with practitioners from organizations with considerable technical expertise (e.g., Western Water Assessment, National Center for Atmospheric Research). Similar to Denver's second initiative, London's approach places more emphasis on construction of predictive scenarios based on statistical probabilities of occurrence that involve modeling (see figures 2 and 3). However, engagement was limited to technical consultants and a core group of government agency officials with representatives from different departments (including planning, economic development, children and adult services, and others), but the stakeholder groups outside of government were not involved.

(Figure 1 here)
(Figure 2 here)
(Figure 3 here)

Formulate Flexible Adaptation Policies

Once the scenarios are completed, the next step is to craft flexible policies (to be linked to appropriate monitoring systems, as discussed below). Analysis of the risk reduction impacts 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 could be arranged under two broad classes of action (Chakraborty et al. 2011, Hallegatte 2009 and Quay 2010). *Contingent* policies are those tailored to a specific future. If a particular policy is preferred under a set of changes but not the other, then the policy is contingent. However, if a future outlined by a particular scenario does not materialize, then the policy aligned with that scenario will remain unused; yet, 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 impact 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 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* policies and *worst-case* (or contingent) policies offer a flexible approach that can be implemented as needed. Work associated with the *City of Punta Gorda Adaptation Plan* (2009) 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 face growing hurricane prone region subject to sea level rise (figures 4 and 5). Similarly, the London plan offers a comprehensive set of low-regrets, no-regrets policies (see figure 6). Whenever possible the London plan attempts to use these policies in ways that generate co-benefits (e.g. wetland protection enables climate adaptation by reducing flood severity from sea level rise, as well as generates benefits for climate mitigation by sequestering carbon, conservation by supporting biodiversity, and economic development and food security by producing sea food production).

(see figure 4)
(see figure 5)
(see figure 6)

In both of these cases, development of policies was based on collaborative process that supported development of flexible policies that require joint actions by participants. Both cases involved policy formation process that involved engagement of government agencies that normally focus on single policy domains (e.g., emergency management, transportation, land use, economic development). Given the large spatial and multi-organizational scales of the City of London, planners initially decided to focus planning at the city-scale, but will initiate a bottom-up climate adaptation policy formulation at the neighborhood scale during the next cycle of planning (City of London 2010). In Punta Gorda, there was an extensive effort to include a broad range of stakeholders and the public affected by policy outcomes that extended beyond government agencies (NOAA 2010, Charlotte Harbor National Estuary Program 2010, pp. 17-20). Planners emphasized co-develop information, engaged climate scientists, and design a bottom-up review process for selection of strategies. In both cases, the intent was to build commitment to act cooperatively. Compared to expert-driven planning, an inclusive process generates a broader number of technically and politically feasible joint policy options since such policies are subject to evaluation from multiple perspectives and assumptions (Deyle and Slotterback 2009, Burby 2003).

Create a Program for Implementation Action and Monitoring

In contrast to a fixed predict and plan approach, an adaptive approach in 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 decision making, 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 where local plans languish or are forgotten (Laurian et al. 2004).

For climate change adaptation, this would mean (science permitting) identifying and monitoring climate factors most closely tied to local impacts to allow sufficient time to respond through action. Since climate change will unfold slowly over the next 100 years, decisions on implementation, monitoring and adaptive actions should be implemented incrementally across a long period of time (Quay 20010, Wilson and Piper 2010, ch. 6). Indicators of change should be monitored on a regular basis and decisions to implement anticipated adaption 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 engagement of experts and stakeholders (Innes and Booher 2010, ch. 1). Given the scientific limitations of climate change, and uncertainties of how different population groups (e.g. defined by race, class and gender), and stakeholder interests (e.g., businesses, environmentalists) are affected by climate change, many kinds of knowledge will be important for ongoing problem-solving. Participants need to work together to improve their shared experiences of the effects of change given such complexity. Moreover, there needs to be ways of jointly analyzing data derived from indicators of changes.

To date, among the limited number of adaptation planning efforts all are only in the early stages of developing structured monitoring programs. A major challenge to moving forward is the current state of climate science. By the time change in temperature, precipitation and sea levels are locally detected it may be too late to adapt. Instead, global level climatic indicators may be the best option to monitor changes. For example, changes detected in El Nino and ocean current oscillations could be applied to consider potential trends at the regional and local scale.

However, how these broader trends can be used by local government planning programs 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 due largely to technical assistance from the national government. Specifically, each local government throughout the country is to gauge progress in the context of *The Local Government Performance Framework*, introduced by the national government in 2008 (Berke forthcoming). The framework includes a set of 188 national indicators that local governments must use to measure the national priorities. Local governments have yet to begin reporting against national indicators which is to occur on an annual basis.

Conclusions and Implications for Policy and Future Research

Our discussion of adaptation planning for public risks illustrates the special challenges to city and regional planning programs for addressing such risks through management of the built and natural environments. Given the lack of a public constituency pushing for efforts to reduce climate risks and, as illustrated by the case of natural hazard mitigation planning, the result has been poor performance by local governments in taking planning seriously as a means to avert losses.

Public risks, as defined earlier, 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 is not well-suited to the traditional approach. The risks are too diffuse, temporally remote, and indirect to assign blame and attach responsibility.

We argue that coupling collaborative governance and anticipatory governance models of policy making offers a new approach in the modification of traditional planning for addressing pubic risks associated with climate change. The main thrust involves increasing acceptance of shared responsibility for addressing public risks. While the concepts of collaborative governance and to a lesser extent anticipatory governance are not new, what is new is how they can be combined into a planning framework that acknowledges uncertainty throughout the planning process from futures analysis through plan policy formation, implementation and monitoring.

A core premise of this new framework is that climate science and climate 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, while anticipatory governance would offer guidance for planning practice under conditions of accelerating change and high uncertainty. Further, given the early stages of climate adaptation planning and uncertainties about future impacts, emphasis would be on cultivating the ability of local planning to engage scientific and technical expertise. Embracing the uncertainties of climate science will likely be difficult for many local planners, decision makers, stakeholders and the public. As noted, most planning efforts in natural hazard mitigation have performed poorly dealing with just one future, let alone multiple ones.

The transition to plans that are 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 early innovators discussed in this paper. For example, London is using simple probabilities to specify climate changes and possible impacts, but Denver uses plausible story lines 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.

Finally, research is needed to examine the effectiveness of the proposed planning framework presented here. The contribution 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 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, in the planning field there are few systematic validated analyses of planning processes. For an exemplary exception, Deyle and Slotterback (2009) examined how attributes of a collaborative planning process affected 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 government in Florida. The field of planning, especially climate 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 use of scenarios lead to better integration of climate science knowledge bases into decisions and plans aimed at adapting to climate change? How can networks that circulate technical knowledge about climate change more effectively be engaged in collaborative climate change planning processes? How do attributes of planning processes influence the formation and sustained implementation of climate action plans? What are the core principles (and indicators) of climate adaptation plans that most effectively foster collective implementation actions?

In sum, the emergence of climate 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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Table 1: Awareness of and Priority to Natural Hazards and Climate Change

Investigators	Survey Respondents	Awareness	Priority
Natural Hazards			
Beatley and Brower (1986)	113 residents in North Carolina facing hurricane risks	69% think damaging hurricanes probable in next 20 years	28% are concerned about residential property damage
Becker et al. (2007)	479 Australian residents in 4 flood prone communities	49% consider a major flood will affect their community within 5 years, 87% within next 20 years	76% do not plan to seek additional information; and 84% do not plan to become involved with a local groups to discuss how to reduce risk
May (1995)	Managers from 5 of 6 Public Works and 8 of 9 Water Resource depts. who implement flood mitigation policy in New S. Wales, Australia	Mean of 3.1 for flood threat to communities; 1-no threat, to 5-very severe threat	Mean of .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 (>.01) or high (>.1) annual probability of a damaging flood	27% perceive flood as a serious problem
Tadahiro (2003)	3,036 Japanese residents in Tokai flood disaster area	64% think there is a need for a 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/resources to respond, 31% ready to be a leader
Leiserowitz (2005)	551 U.S. residents	97% believe that climate change have adverse affective images associated with climate change	12% are concerned about impacts on their family and 1% on local community, but 68% are concerned for people all over the world and non-human nature
Moser and Tribbia (2007)	135 California local coastal government managers	54% strongly agree global warming real/already happening	30% acted on a climate change issue
Reser et al. (2011)	3,095 Australian residents	74% of Australians think the world's climate is changing	42% of Australians feel a sense of urgency to act
	1,822 British residents	78% of British think the world's climate is changing	36% of British feel a sense of urgency to change behavior
Whitmarsh (2008)	589 British 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

Table 2: Indicators of the Principles of Plan Quality for Hazard Mitigation Plans

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Goals: Reflections of public values that express desired future conditions that reflect breadth of public values.

- Enhance community resiliency
- Protect ecosystem services that support hazard mitigation
- Protect public safety
- Reduce property damage
- Reduce economic impacts
- Promote equity

Fact base: Provides the empirical foundation of current and future conditions to ensure that key hazard problems are identified and prioritized, and mitigation policy-making 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, minorities)
    - 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 towards completion
    - Projected cost (e.g. 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

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Table 3: Findings for the Quality for Local Natural Hazards Mitigation Plans

Investigators	Sample	Goals	Facts	Policies	Imple-ment	Moni-toring
Burby and May 1997	90 mandated local plans	.13	.34	.36		
	90 non-mandated local plans	.03	.09	.06		
Berke et al. 1997	16 New Zealand regional plans	.68	.13	.11		
	7 Florida regional plans	.53	.45	.23		
Berke et al. 1999	34 New Zealand local plans	.	.06			.39
	16 New Zealand regional plans		.12			.21
Nelson and French 2002	19 California local plans	.18	.21			
Brody 2003	59 Florida and Washington local plans					
	t_1 = 1991	.10	.09	.05		
	t_2 = 1999	.13	.12	.12		
Brody et al. 2004	35 Florida local plans	.36	.25	.44		.30
Tang et al. 2008	43 local plans in 3 Pacific coastal states in U.S.	.40	.32	.15	.10	
Berke, Lyles and Smith 2011	175 local coastal plans in six states	.52	.34	.33	.58	.35

Figure 1: Scenario Development for the Denver Water Resource Plan

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Scenario Development

Denver planning experts derived a comprehensive list of climate change factors (e.g., changes in precipitation and temperature), and social and economic factors (e.g., changes in energy prices and environmental values) that could impact Denver's water supply, using existing studies of trends and potential future conditions for water utilities. The Denver Water staff grouped these factors into five possible future scenarios, which were then reviewed by various experts and the Board of Water Commissioners. These scenarios are not predictions of the future and not assigned probabilities. The intent is to provide imaginative stories intended to capture the public attention of possible futures.

Water future scenarios

- Traditional future: Imagine the future is extrapolated from past trends. Few unanticipated major changes occur.
- Water quality rules: Imagine drinking water quality is a paramount consideration. The public demands the highest practical quality of drinking water. Contaminant removal and other drinking water requirements are extremely stringent.
- Hot water: Imagine a warmer climate accompanied by more frequent and more severe droughts.
- Green revolution: Imagine environmental values and sustainable living become dominant social norms.
- Economic woes: Imagine an ongoing energy crisis accompanied by a prolonged, deep economic downturn.

Source: Denver Water (2008), and adapted from Quay (2010).

Figure 2: 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 and Swart 2000) in each of two future 30-year time periods. The UK Environment Agency projections were used to estimate the rise of the River Thames in the range 0.2 to 0.9m by 2100 with a worst-case scenario of 2.7m.

The committee estimated the most likely range for each factor in each future time period, including the 33% to 66% likely events range, and the 10% to 90% 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 relevance for contingency planning.

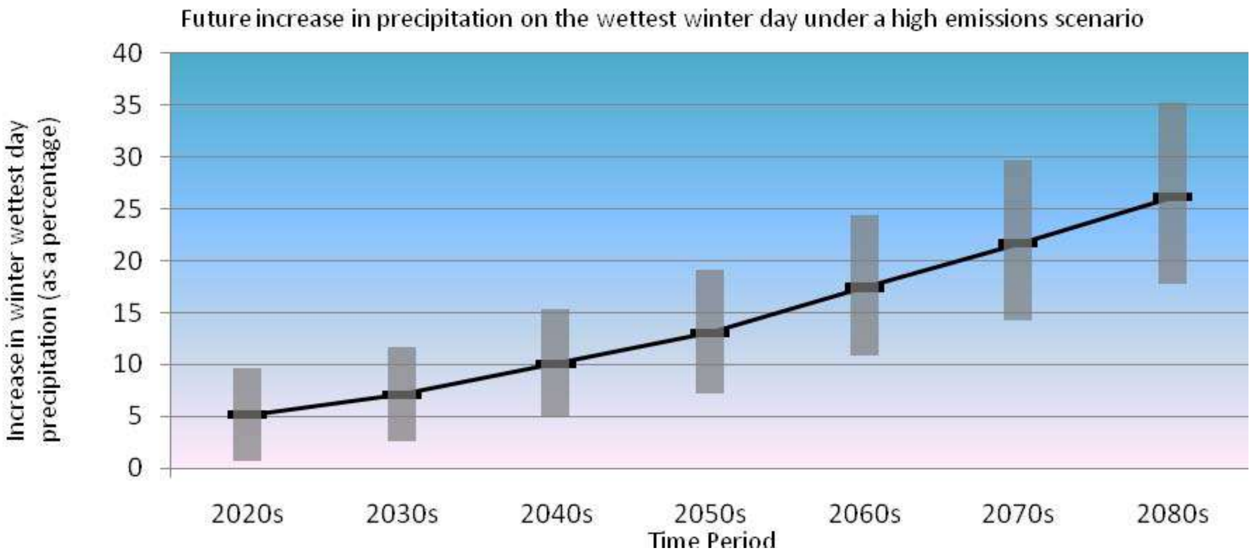
To illustrate how the average change and probabilistic ranges for factors are, Figure 3 shows the average projected future increase and possible ranges in wettest winter day for London under a high greenhouse gas emissions scenario. Under this scenario, the likely range of change in average summer rainfall is +3 to +10% by the 2020s and +11 to +22% by the 2050s.

Engagement

Staff from across city, metro 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 and adult services, and others) hosting various workshops pertinent to their area of administration. During these meetings agency staff were also asked to assess how the scope of responsibilities of their agencies would be effected due to an impact caused by a change in the risk factor, and determine and prioritize subsequent actions.

Source: City of London (2010)

Figure 3: Rise in Winter Precipitation in City of London due to Climate Change*



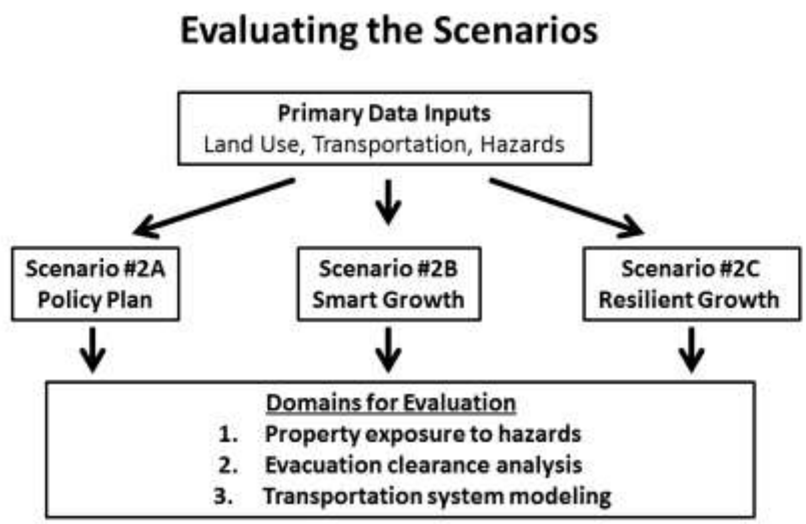
* The black line shows the central estimate (50th percentile) of the increase in precipitation on the wettest winter day for the high emissions scenario. The wide grey bars show the likely range of change (33rd to 66th percentiles). The error bars show the 10th and 90th percentile events (future increase in precipitation on the wettest winter day is very unlikely to be outside this range).
Source: City of London (2010)

Figure 4: City of Punta Gorda Adaption Planning Polices

Alternative climate change and urban growth futures for the City of Punta Gorda, Florida adaptation plan (2009) included *robust* policies that would work well across all scenarios; and 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 under the worst case hurricane event. In all scenarios of future urban growth patterns (see figure 5), however, it was growth from new development that would either trigger the need for expansion of highway capacity (more lanes) for evacuation or require significant demand reduction through alternative modes of evacuation (e.g., more bus service and car-pooling). 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 the other two of development scenarios (see figure 5). "Smart growth" land use scenario consists of three conditions: a) development is constrained to a smaller urban service area; b) a range of housing types are developed in or near identified urban centers; and c) 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, Stevens and Song 2009).

Figure 5: Evaluating the Impacts of Future Scenarios, Punta Gorda, Florida



Source: Chapin, Deyle and Higgins (2010)

Figure 6: Adaptation Actions to Manage Flood Risks in the City of London's Climate Adaptation Plan

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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, such as green roofs, in developments1 and street enhancements. Sustainable drainage systems (SuDs) such as green roofs should be encouraged as part of new developments, redevelopments and major refurbishments through 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, p. 17

End Notes

[1] Over 1,000 cities, towns and counties have signed a Climate Action Agreement (U.S. Conference of Mayors 2009), and over 1,200 such localities have agreed to mitigate climate change impacts by reducing greenhouse gas emissions through adoption of climate action plans and other related initiatives (ICLEI 2009).

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

[3] The Berke and Godschalk (2009) study examined 16 studies focused on plan quality that address a range of issues like biodiversity, affordanble housing, and the rights of indigenous people. For our purposes, we focus only on studies examined by Berke and Godschalk that account for natural hazards mitigation as illustrated on table 3. We also included a study by Tang et al. (2008) that was published after the Berke and Godschalk (2009) meta-analysis.

[4] The Berke and Godschalk (2009) meta-analysis found that is not possible in the meta-analytic findings reported in table 3 to directly use values from each study because of individual study differences in how the plan quality characteristics are measured (e.g., scales and number of items for each criterion vary) and how plan quality scores are computed. As discussed in an early and influential article on meta-analysis by education psychologist Gene V. Glass (1977), a critical element of the meta-analytic procedure involves transformation of the statistics of interest (e.g., means and standard deviations) into standardized scores that permit analysis of findings across studies. To create findings reported on table 3, such a transformation makes scores comparable across plan quality characteristics. In studies that reported standardized proportionate scores we could directly use the findings (e.g., Berke et al. 1996; Brody 2003a, 2003b). In other studies, we transformed scores by plan quality characteristic by first identifying the maximum possible score of characteristics for each study and then dividing the reported score of each characteristic by the total maximum score to determine a proportionate score (e.g., Burby and May 1997; Nelson and French 2002).