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Lawrence Susskind

Policy & Practice

Responding to the risks posed by climate change

Cities have no choice but to adapt

Cities, particularly those in coastal areas around the world, need to pay close attention to the risks posed by global warming and climate change. These risks are substantial, and the costs of not taking them into account are likely to be enormous. Planners should take the lead in preparing climate mitigation and adaptation plans, although these need to be approached somewhat differently from other planning assignments. Adaptation planning, in particular, should be viewed as a collective risk management task. As such, new tools for collaboration such as scenario planning, joint fact-finding and the use of role-play simulations to build public support in the face of high levels of uncertainty and complexity might be helpful.

According to the Intergovernmental Panel on Climate Change, greenhouse gas emissions pose a serious threat to the well-being of communities all over the world (IPCC, 2007). Natural 'environmental services' such as water purification and soil revitalisation, as well as basic infrastructure for power production, waste disposal and transportation, are threatened by the likely effects of global warming. Sea level rise, saltwater intrusion into freshwater areas, storm surges and changing patterns of precipitation pose serious risks. As the population of Louisiana learned after Hurricane Katrina, most cities are ill-prepared to deal with unexpected changes in weather patterns or natural disasters, and climate change is very likely to alter and intensify weather events of all kinds.

Even the most ambitious reductions in greenhouse gas emissions, such as those discussed at the 2009 global treaty-making conference in Copenhagen (including a substantial shift to 20 per cent renewable energy, a 20 per cent improvement in energy efficiency and a 30 per cent cut in greenhouse gases by 2020) will not be enough to head off temperature increases that threaten to drown small island nations, chase vast numbers of people from their homes in the river deltas of Africa, Asia and Latin America and cause public health problems far more dire than the 2010 earthquake in Haiti. It is quite likely that almost all the countries that signed the Kyoto Protocol in 2008 will not meet their current greenhouse gas reduction targets – an average reduction of 5.2 per cent from their 1990 emission levels by 2012 – let alone the 20 per cent reductions that would be required over the next few decades to head off severe climate disruption. So, the most likely scenario is that global temperatures will rise and cities around the world will have to cope with the impacts. If average global temperatures

Lawrence Susskind is Ford Professor of Urban and Environmental Planning at the Massachusetts Institute of Technology, Cambridge, MA, USA 02139; email: susskind@mit.edu

Table 1 Impacts of global warming associated with increasing global average temperatures

Temperature increase	Impact
1–2°C above pre-industrial	Major impacts on ecosystems and species
	Increase of heatwaves, droughts, floods and spread of infectious diseases
2–3°C	Major loss of coral reef ecosystems and other species
	Large impacts on agriculture, water resources and health
	Significant increase in droughts and extreme rainfalls
	Up to 74 cm sea level rise in next 100 years
	Terrestrial carbon sink becomes a source, accelerating global warming
1–3°C (?)	Greenland ice cap starts to melt (7 m)
1–4°C (?)	North Atlantic circulation collapses
3–4°C (?)	Major species extinctions
2–4.5°C	1–3 billion people suffer from water scarcity
	Food yields fall everywhere, global production plummets
	Fifth of world population affected by flooding
	Significant increase in human deaths due to malnutrition, disease, heatwave, flood and drought
5–6°C or higher	Don't go there

From: Maslin (2009, p. 76).

rise more than 4°C before the end of the century, the impacts of climate change will be catastrophic (Table 1). Even a rise of 2°C would cross a significant tipping point. Unless greenhouse gas emissions are held at 450 ppm (some say 350 ppm) by 2050, we are sure to experience a greater than 2°C increase in mean global temperature. This seems destined to cause a wide range of deadly impacts. Current levels of CO_2 emissions are 379 ppm and rising annually at a faster rate than ever before, in spite of the voluntary emission reduction efforts adopted in a number of countries. Even if we achieve the very ambitious goal of holding greenhouse gas emissions at 450 ppm, there is still a 40 per cent chance that temperature increases will exceed the 2°C level (Maslin, 2009).

Some communities will not experience any of these effects, at least not right away. The impacts of global warming will be uneven. In some places, global warming might even seem to be a plus, as some cooling or increased rainfall might have advantageous impacts. It is almost impossible to predict with any accuracy, especially in the short term, what the effects of climate change will be in a particular city or metropolitan area. The complexity of the socio-ecological systems involved and the relatively

primitive state of our forecasting models make it hard to forecast what is going to happen. This, in turn, makes planning for climate change extremely difficult. If we do not know what is going to happen, how can we plan? The fact is, the complexities and uncertainties associated with climate change pose by far the greatest challenges that planners have ever been asked to handle.

Threats to nature's services and possible destruction of basic infrastructure are not the only impacts that cities need to worry about. Temperature changes are likely to create heat islands that will adversely affect the poorest residents who do not have adequate shade or air conditioning (and do not have the funds to relocate temporarily). Temperatures only slightly above expected levels in some locations will cause serious difficulties for elderly and infirm residents, even if those same temperatures in other parts of the world (where they are expected and people are prepared) are unlikely to have ill effects. Endangered species will be forced to migrate and habitats will be destroyed. Infectious disease transmission will spike in response to increased temperatures and the added moisture caused by global warming.

With such serious threats looming, one might imagine that most municipal and metropolitan planning agencies would, by now, have turned their attention to these challenges. Unfortunately, many have not. Only a few cities have prepared a serious climate action plan (Wheeler, 2008), and most of these plans focus exclusively on how to reduce greenhouse gas emissions (a process known as *mitigation*), rather than on how to reduce the destructiveness of the impacts likely to occur (a process called *adaptation*). While mitigation is important – indeed, most national commitments to reducing greenhouse gas emissions will not amount to anything if cities do not reduce their carbon footprints – even under the best of circumstances, most cities will not be able to avoid the severe effects of climate change (i.e. stronger storm events, continuous sea level rise, changing patterns of rainfall and erosion, spread of airborne disease, and unusual temperature variations). Regardless of the extent to which they reduce their carbon footprints or engage in mitigation, only cities that engage in adaptation will be able to plan effectively.

It is important for cities to assess the climate change impacts they face and sort through their adaptation options. They need to determine how they can reduce their vulnerability and they need to consider ways of enhancing their resilience in case the worst impacts do occur. In the same way that cities in earthquake zones have had no choice but to prepare for disasters by stockpiling supplies, practising early warning and evacuation procedures, codifying civil defence rules, and adopting building codes and regulations aimed at minimising earthquake damage, all cities should ponder how they can hedge against the risks associated with climate change. They also need to work out how to fit 'adaptation planning' into their normal capital improvement and planning cycles. It makes no sense to plan as usual to maximise economic returns only to have to reverse those decisions when adaptation priorities become clear. Also, there

may be 'no regrets' investments that allow cities to simultaneously reduce vulnerability, enhance resilience, save money in the near term and create new revenue streams over time (through the trading of carbon permits).

In this article, I will describe the key features of adaptation planning, review the new tools and techniques adaptation planning requires and explain why adaptation planning ought to be thought of in terms of risk management rather than in more traditional planning terms.

Overview of adaptation planning

Adaptation planning is different from most other municipal and metropolitan planning activities in at least four ways. First, it is decidedly more complex. The interlocking atmospheric, land-based and ocean systems involved are extremely difficult to model. The risk management moves that can make a difference will require inter-sectoral and multi-level cooperation over extended periods of time. Second, some of the most effective moves are likely to prove quite expensive in the short term even though the savings they will generate in the long term will more than justify their cost. Third, some of the most obvious moves would reassign land uses from more vulnerable to less vulnerable areas. This would mean interfering with the exercise of private property rights. This is particularly controversial when proposals to confiscate or regulate private property are based on highly uncertain forecasts. Fourth, winning support for a suite of risk management actions will be a 'hard sell' because 'climate sceptics' have gained credibility in the public mind through lopsided and ill-considered media coverage. The sceptics provide political cover for anyone who wants to put off taking action for whatever selfish reasons they may have. The sceptics say things such as: 'different models give different results, so how can we trust any of them?', or, 'Climate models fail to reconstruct or predict natural variability.' These questions sow doubt in the public mind, even though the scientific community is very much in agreement regarding the likely risks of climate change.

Ultimately, adaptation planning will need to be:

- *action-oriented* (i.e. risks need to be assessed, vulnerabilities need to be addressed and investments need to be made that will enhance resilience);
- *adaptive* (i.e. intelligence-gathering and recalibration of both risks and risk management options need to be on-going);
- *strategic* (i.e. cities should start with least-cost, no-regrets measures that are widely supported because they can accomplish a variety of important objectives at the same time); and
- *broadly supported* (i.e. risk management choices need to be collective choices that reflect the input and support of all relevant stakeholders).

A number of countries have begun to consider adaptation options (for brief summaries of 16 national plans, see Meister Consultants Group, 2009). Some encourage and support sub-national adaptation efforts, but most are silent about the kinds of adaptation planning that cities or metropolitan areas should be doing. This is troubling. The municipal and metropolitan levels are where the worst effects of climate change will be most visible. City officials will be the first to be held accountable by angry residents. Responsibility for undoing whatever damage occurs will fall squarely on city administrators, as was clear in New Orleans in the aftermath of Hurricane Katrina. This argues for city governments all over the world to take the lead in formulating adaptation plans.

Most of what we know about how and when to formulate urban master plans will have to be set aside as cities wrestle with ways of reducing their vulnerability and enhancing their resilience in response to climate change risks. Adaption plans will be much more incremental. Given the enormous uncertainties involved, city and metropolitan planners will not be able to work backwards from definitive long-range forecasts or a set of carefully defined planning goals and policies. Rather, they will need to embrace the uncertainties involved and plan in a forward-moving, adaptive fashion – looking for public investments and resource allocation choices that make sense for other reasons and reduce vulnerability and enhance resilience. (This is what we mean by 'no regrets' moves.) Planners will not be able to rely on their technical expertise, as they usually do, to justify a specific course of action. There is too much uncertainty involved. Planners will have to build support for an array of possible actions by using the probabilistic language of risk management. Adaptation planning will require municipalities and planners to think in contingent terms, use new tools and work collaboratively to involve and educate all the relevant stakeholders.

Societal risk can best be understood as the product of the probability of a hazard occurring, multiplied by the impact the hazard will cause if and when it does occurs (Schwing and Albers 1980). Risk management involves efforts to reduce the probability of particular hazards occurring (mitigation), as well as efforts to minimise or at least reduce their impact (adaptation). In the case of climate change, the relevant hazards include rising sea levels, increasing storm surges, more destructive storms, erosion, drought, more rapid spread of disease and the like. When such hazards do occur their impact can be reduced through emergency preparedness, urban redesign including the construction of sea walls or building houses higher off the ground, insurance policies, relocation of important at-risk public facilities, revised rules regarding the assignment of vulnerable land uses, the imposition of tougher building codes and other similar forms of government intervention. Managing the risks of climate change is not something that individual landowners can do on their own. While mitigation may require changes in individual attitudes and behaviour, adaptation will have to involve collective action.

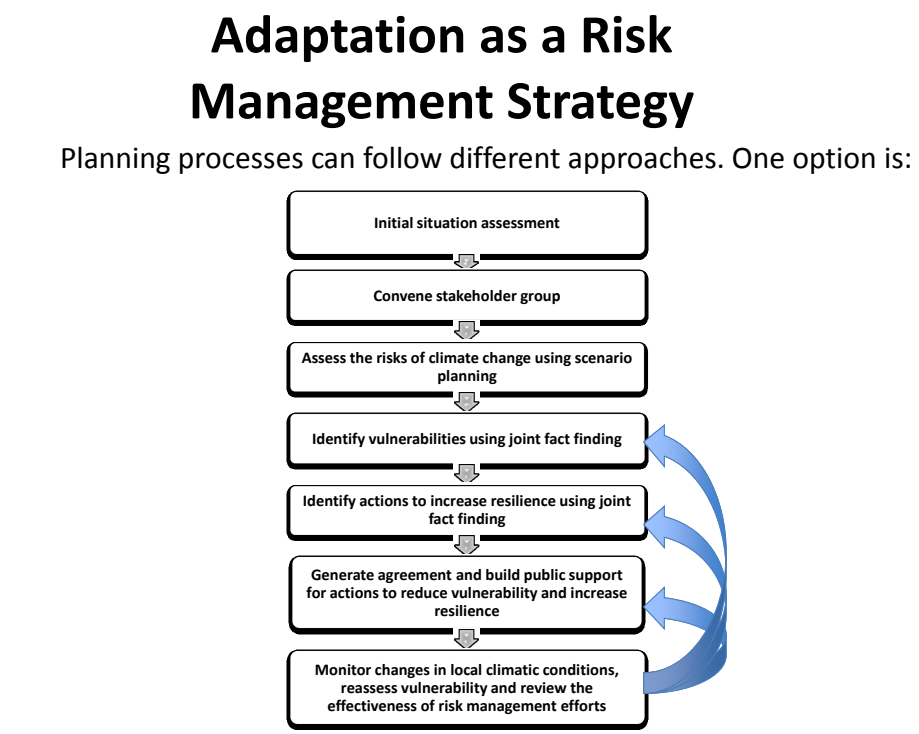

Figure 1 Steps in the adaptation planning process

Mitigation (i.e. risk reduction) and adaptation (i.e. risk management) are not at odds, even though some people think they are. The most aggressive environmental advocates fear that adaptation planning will signal defeat, an acceptance that the growth of CO_2 emissions is inevitable. They want to devote 100 per cent of whatever money and political capital they can muster to risk reduction, reducing CO_2 emissions. That is the only way, in their view, to address the climate change problem in the long term. However, it would be irresponsible for elected and appointed officials to ignore the moves they can take now to soften the climate change impacts that are unavoidable. Moreover, some adaptation measures might even help to promote mitigation. When residents realise what the costs are of fighting coastal erosion through the constant replenishment of beach sand, or protecting homes along the riverbanks, they may be more inclined to do whatever is necessary to reduce CO_2 emissions in the long term. While they are engaged in the long-term struggle, there are relatively less-expensive risk management strategies they can pursue.

One way of thinking about the steps that cities will need to move through as part of their adaptation planning efforts is summarised in Figure 1.

These seven steps seem fairly straightforward in theory. Practice is another matter. An initial situation assessment is sure to be labelled unduly pessimistic if, as it should, it includes worst-case estimates. In my view, it would be irresponsible to leave them out. The uncertainty implied by offering a full range of estimates, however, often makes it seem as if planning professionals do not know what they are doing. Residents, businesses and public officials want certainty, or at least the appearance of certainty. They are put off by an honest presentation of multiple forecasts that reflect the real uncertainties involved and the implications of making conflicting technical assumptions. In short, almost any situation assessment will reveal the deep uncertainties surrounding attempts to translate long-term national estimates of climate risk into useful municipal-level forecasts. In general, most people are not used to thinking in probabilistic terms. So, the presentation of contingent plans – lists of actions that make the most sense given different possible forecasts – is likely to be challenged as a failure to produce useful or meaningful analyses. Nevertheless, it is what needs to be done.

Convening a representative group of stakeholders willing to work for several months (or years) to educate themselves about the risks and dynamics of climate change is difficult. Advocacy groups will want to be involved, but they often have narrow, self-interested reasons for demanding a place at the table. They are focused on pursuing and defending their short-term agendas. Many scientifically adept individuals, on the other hand, will be uncomfortable getting involved because they do not like the glare of the political spotlight. A 'blue ribbon' or expert committee might understand the issues, but it will not have credibility with all the political constituencies whose support will be needed to enable collective action. A purely open or voluntary task force will not be politically credible either, because it will not, by definition, be representative. There needs to be a careful effort to construct a group of stakeholders that overcomes each of these shortcomings.

Even if a municipality agrees that it faces serious risks, and even if a credible, representative task force can be assembled, it may still be hard to take the next step and generate agreement on a set of actions that a city ought to take. Some task force members are sure to be more concerned about short-term issues, while others will prefer an agenda focused on long-term considerations. Some members will value potential environmental losses just as highly as economic losses, while others will trivialise them. The idea of generating contingent risk management strategies, in an if–then format that presumes we cannot know the future, will be extremely troubling to those who have difficulty living with uncertainty. So, a process is needed by which public support can be generated for a set of actions that factor in uncertainty.

The next step in the adaptation planning process involves enumerating vulnerabilities as well as strategies for enhancing resilience (McFadden *et al.*, 2007). This requires blending expert and local environmental knowledge. General technical

understanding has to be meshed with site-specific insights that only 'locals' possess. Such a merger is not something that many people know how to construct. Most people over-value expertise and under-value the deep understanding that non-experts have of the history and dynamics of local situations (Innes and Booher, 2010). Only a process that balances these two can succeed.

Finally, committing to ongoing monitoring and improvement of whatever risk management or adaptation plans may seem to many to be an admission that the problem they were asked to solve has not been 'solved' at all. The call for collaborative adaptive management as a way of dealing with complexity is not yet accepted by most people. The planning profession needs to integrate the tools and techniques of collaborative adaptive management into its efforts at adaptation planning (Innes and Booher, 2010). So, preparing an adaptation plan will be more difficult than preparing traditional master plans, community development plans or conservation plans.

Balancing science and politics

Both science and politics need to be taken into account in adaptation planning. There is no point in building an informed city-wide consensus on the need for land-use changes or the desirability of relocating vulnerable pieces of infrastructure if those decisions will not work to lessen the risks of climate change because they are based on inaccurate assumptions. Likewise, investing in technical analyses and acquiring expert advice only to discover that key citizen groups and elected leaders are in no mood to take such information seriously, or refuse to take action given their other priorities, is a waste of time. Scientific data are needed to inform policy-making, while policy-making and planning need to take account of the political realities that circumscribe collective action. Finding the right balance between science and politics is the key to adaptation planning. The only way to do this is to involve self-identified representatives of all relevant stakeholder groups in a process of joint inquiry that moves them beyond what they think they already know (Susskind and Cruikshank, 2006).

Stakeholder engagement and collective decision-making

The National Research Council in the United States, among others, suggests that stakeholder engagement in science-intensive public decision-making is crucial (NRC, 2008; 2009). Exactly how this ought to play out, however, is unclear. Historically, planners have relied on standard methods of public engagement including information dissemination (i.e. hearings and public notice), information collection (e.g. surveys and focus groups) and the appointment of hand-picked advisory groups to ensure appropriate public input. In science-intensive policy disputes, however, especially when collective risk management decisions have to be made, these techniques will not

work. They are good for giving residents the feeling that they are being heard, but they do nothing to build informed public understanding of the scientific issues involved. They do not require groups with conflicting views to engage in constructive discourse. They rarely yield consensus; in fact, they usually encourage people to take extreme positions that make agreement unlikely. More active involvement in collaborative or consensus-building processes by larger numbers of stakeholder group representatives is needed to justify multi-year investments in adaptation planning. This requires more than an exchange of fixed political views; it requires a commitment to collaboration and joint problem-solving.

Collaborative risk management

The first step in collaborative risk management is to organise a credible group of stakeholder representatives. This is best done using a technique called Conflict Assessment (CA) (Susskind *et al.*, 1999). While most public advisory groups expect to make recommendations to elected officials, the extent to which their recommendations are taken seriously depends on the community's perception that the group making the recommendations has done its homework and stayed in touch with all the relevant constituencies. That perception, in turn, hinges on the transparency of the participant selection process, the extent to which stakeholder groups have the final say over who represents them, and the mechanisms used to ensure that ad-hoc representatives stay in touch with and can speak for the groups they presumably represent.

Once public officials agree that a collaborative risk management process is required, a professional mediator can undertake a CA. This will probably take about three to four months to complete (Schenk, 2008). Using CA, city officials can create an Adaptation Planning Advisory Group including anywhere from 25 to 50 self-identified stakeholder-group representatives along with designees from all the relevant city (and regional) agencies.

The CA process begins with preliminary interviews that are confidential and not for attribution. Initially, a professional mediator (or mediation team), with the approval of the city government, interviews a list of obvious stakeholder representatives. This first list is usually identified by the local government based on a scan of the media. These interviews are best done in person, pursuant to letters of introduction sent from the mayor or city council to prospective interviewees, explaining that an effort to identify the risks associated with climate change is about to get underway. The goal of the interviews, which typically take about an hour to complete, is to determine each interviewee's preliminary ranking of the climate-change risks facing the city. In addition, these interviews should help identify the kinds of information that will be needed to plan for adaptation. Interviewers solicit the names of other groups and individuals who ought to be involved. Thus, the first round of interviews typically

leads to an even larger second round. Once all the interviews are done, everyone in both groups is sent a composite summary of the results for their review. No names are mentioned, although reference is made to the categories of stakeholders interviewed. The city government announces that the CA is under way and encourages interested groups that have not yet been contacted to be in touch with the mediator; this often leads to a small third round of interviews. These steps guarantee the transparency and credibility of the stakeholder identification process.

With feedback from interviews in hand, the mediator can then generate a proposed list of stakeholder categories (such as environmentalists, real-estate interests, fishing industry leaders, commercial tourism interests, etc.) which ought to be invited by the city to be involved, along with a description of these groups' interests. The mediator must then ask each category of stakeholders to choose its own representative, assisting those who need help organising an informal caucus to make their selection. Some groups, particularly those that are not well organised, may need help finding an ad-hoc representative or proxy to represent them. Thus, if the city wants to proceed in a credible fashion, it must allow the relevant stakeholder groups to select their own representatives.

Based on the interviews, the mediator also prepares a proposed agenda, timetable, work plan, and ground rules to guide the group's deliberations, along with a detailed budget and staffing plan. These materials are all sent in draft form to everyone who was interviewed to see if they will agree to participate. Once the mediator has heard back from everyone involved, and made appropriate adjustments, the city government must then decide whether or not to move ahead.

New tools and methods

New tools, including scenario planning, joint fact finding and public learning using tailored role play simulations, can help cities respond to the unique requirements of adaptation planning. Joint fact finding (JFF) is an emerging approach to building shared understandings about complex socio-ecological systems through face-to-face facilitated dialogue (Susskind *et al.*, 2005). Scenario planning (SP), originally developed in the 1970s by Royal Dutch Shell and used recently in the Millennium Ecosystem Assessment, is an alternative to traditional modelling and forecasting that is better able to take account of multiple contingent assumptions (Van Der Heijden, 2005). Role-play simulation (RPS) is a public education strategy for engaging the broader community in planning for uncertain futures (Susskind and Paul, 2010).

JFF provides a structured way to explore underlying assumptions and select credible methods of analysis in science-intensive policy disputes when uncertainty is high and trust levels are low. By focusing on key drivers, complex interactions, and irreducible uncertainties, SP provides a systematic framework for exploring

alternative futures, assessing strategies for reducing the vulnerability of critical urban services and increasing their resilience. RPS enables planners to convey a great deal of scientific or technical information to non-expert publics in a story-like form and introduce them to the dynamics of collaborative adaptive management by involving them in mock decision-making that mimics the political realities they will actually face. Properly conducted, a combination of SP, JFF, and RPS is more likely than conventional planning to yield a technical assessment of climate-change risks that is credible to stakeholders, produces an array of measures to avoid and mitigate risks, and generates the political momentum needed to adopt and implement whatever measures are recommended.

Scenario planning

SP is a specific method for exploring plausible alternative futures; it was originally developed to assist business managers facing uncertainty and a volatile future (Ringland, 2002). Instead of focusing on a single prediction extrapolated from past trends, scenarios focus on uncertain drivers and expand the assumptions of predictive models to illuminate otherwise unforeseen interactions. Thus, a carefully constructed set of scenarios can highlight future risks and opportunities, providing managers with the information needed to assess the effectiveness of alternative strategies. Each scenario represents an account of a plausible future. Together, multiple scenarios help focus attention on a handful of plausible alternative directions that build on the most relevant uncertainty dimensions. Perhaps what scenarios do best is help expand an organisation's understanding of future risk by systematically exploring plausible futures whose risks the organisation has not yet considered, let alone thought about strategically. There has been some new work in the sustainable development field using scenario planning (Chapin *et al.*, 2009).

Scenarios presume that in highly uncertain and dynamic situations there is no single 'best strategy', but rather a series of strategies that allows an organisation to be prepared for different situations. Just as a financial advisor may recommend building a portfolio of investments that is resilient in a changing economy, scenarios help decision-makers create a robust portfolio of strategies that will 'work' as conditions change in uncertain ways.

SP begins by identifying focal problems or decisions. The next step is to identify a large range of 'driving forces'. This helps to highlight important and long-term, rather than urgent and immediate, dynamics of the system. Driving forces that are predetermined (e.g. the ageing of a population) are separated out to reveal the most significant uncertainties, which are then ranked by locally knowledgeable participants to determine which forces are most significant and difficult to assess. Based on these results, a preliminary matrix can be constructed, leading to a set of distinct scenarios.

Each scenario must then be expanded. Plans or decisions which have already been proposed or are subsequently developed are then evaluated against each scenario. The decisions and plans that are most robust are those that play out acceptably across all scenarios. Those that play out well against only a few scenarios are noted. Thus, scenario planning involves eight steps: (1) identify focal issues or decisions, (2) identify driving forces, (3) rank their importance and uncertainty, (4) select scenario logics, (5) flesh out a suite of scenarios, (6) select indicators to monitor change over time, (7) assess impacts under different scenarios, and (8) evaluate alternative strategies.

Joint fact finding

JFF is a procedure that only makes sense in the context of collaborative decision-making (Susskind *et al.*, 2005; Susskind *et al.*, 2010). When collaborative decision-making processes involve non-experts (as they almost always do), it is necessary for the participants to agree on providers and methods of technical assistance all the participants can trust. Participants in JFF jointly select the technical advisors they want. This allows them to feel confident that the right questions are being asked, the methods used to collect and analyse data are reliable, and the analysis is sound. JFF builds confidence among group members in their expert advisors – even if they disagree among themselves – while ensuring that both technical and political credibility are achieved.

JFF begins when the participants in a collaborative planning or policy analysis effort, with the help of a mediator, specify the questions or concerns they have with regard to the issues or problems they have been asked by public officials to address (Susskind and Cruikshank, 2006). Next, aided by a range of technical specialists, identified by a mediator with the concurrence of all the participants, the group agrees on one or more approaches to data-gathering and analysis to help them answer the questions on their agenda. Technical advisors, often representing a carefully selected range of disciplinary skills or methodological orientations, then produce the information requested by the group.

When the advisors have completed their work, they meet with the participants to explain what they did and how and why they did it. Aided by a professional mediator, the group explores the non-objective judgements the technical advisors were obliged to make in order to make their task manageable. The group also prepares a sensitivity analysis indicating the extent to which their findings hinge on the key assumptions made. With these results in hand, the group can then generate policy proposals of various kinds and ultimately formulate prescriptive agreements. On occasion, they may draw their technical advisors back into the conversation to be sure that the recommendations or policy proposals they develop take proper account of the technical information that was provided as well as the disagreements among the

technical experts that were presented to the group. Although the technical advisors are not asked to make policy recommendations, they may on occasion be asked to help the group think through problems that might come up if the group's recommendations are enacted by public officials.

JFF aims to provide an opportunity for stakeholders to learn more about technical issues without taking sides. By allowing stakeholders to participate in the generation of information that will be used in decision-making, JFF reduces suspicion that data have been collected or interpreted to support a particular view. When diverse groups participate in the generation of information, it is less likely that the best-available information will be ignored in favour of the loudest voice or most extreme political agenda. By defining the role and facilitating the participation of experts within a collaborative process, JFF makes it easier for non-experts to participate.

Role-play simulation

The third tool for adaptive planning is tailored role-play simulation (RPS). This can be used to engage and educate the public by sharing what has been learned through JFF and SP and illuminating the collective choices involved in managing risks. RPS is an effective tool for conveying a great deal of scientific or technical information to a non-expert public and helping them to understand the policy choices they face. Incorporating the preliminary results of the JFF and SP into an RPS allows planners to introduce thousands of residents in each city (through social, political, neighbourhood and religious organisations, as well as public schools) to measures that might be taken to decrease vulnerability and increase resilience. The results of many plays of a role-play game in a community can help ground the final decisions made by the adaptive planning group in preparing its recommendations to a city government. Thus, role-play games can be used to help build political support for the actions that the city government must ultimately take.

RPS involves putting a group of 8–10 people around a table for an hour or two. Ten to 20 tables can play the 'game' in the same venue at the same time. They are given written information they need to play the roles they have been assigned. This information is based on actual interviews conducted with dozens of people in key roles. The participants in the game are asked to stay 'in role' and consider the climate change adaptation problems faced by a hypothetical community which should look and sound a lot like the city in which they actually live. They are given both general and confidential instructions ahead of time, sometimes on-line, as well as in written form in person to ensure that they are prepared to play the roles they are assigned. The game is designed to make it difficult for the group to reach agreement on a specific set of measures – each with its own projected costs and likely level of effectiveness – appropriate to the risk management problems facing the hypothetical community.

CATEGORY 1: Reducing Vulnerability of the Built Environment

Subcategory 1: Remove from harm's way

1. Ban the building of new primary dwellings and prohibit the expansion of footprints on existing developed lots within the 100-year tidal floodplain.
2. Incorporate elements into the county's comprehensive plan that address and accommodate for sea level rise and an increased storm surge vulnerability zone. This could include provisions such as overlay zones, tiered zoning with increasingly strict regulations within areas of vulnerability, increased buffers in areas of vulnerability, etc.
3. Establish a transferable development rights (TDR) system to encourage swapping of land in coastal areas vulnerable to sea level rise and storm surge for inland parcels.
4. Develop a timeline and strategic plan to move or abandon existing infrastructure in areas subject to more frequent storm surge and damage due to sea level rise inundation.
5. Require mandatory disclosure statements about property's vulnerability to sea-level rise in all real estate transactions.
6. Establish and fund a buy-out program for the purchase of repetitive loss properties within the 100 year floodplain.

Subcategory 2: Protect in place

7. Require a 2-foot freeboard elevation above the FEMA requirements for all new and existing buildings in the 100-year tidal floodplain.
8. Develop an Infrastructure Improvement Plan that establishes timelines for raising roads and bridges, higher volume stormwater management, etc. based on vulnerability to sea level rise.
9. Provide tax rebates on investments in adaptation measures for homeowners and small business owners in at risk areas (e.g. elevating houses, upgrading well water and septic systems).
10. Create a comprehensive local adaptation plan.
11. Enhance federal flood insurance by contributing to a state insurance pool for homeowners and small businesses located in areas vulnerable to sea level rise and storm surge.

CATEGORY 2: Water & Wastewater Infrastructure

Subcategory 1: Increase supply

12. Use water banks/pools, and water markets to facilitate the reallocation of water resources.
13. Develop advanced wastewater treatment capacity for water reuse ('gray water').
14. Build a desalinization plant to provide additional drinking water.

Subcategory 2: Decrease demand

15. Increase billing rates for water from $400/yr avg per household to $800/yr avg per household; use additional revenue to fund water efficiency measures.
16. Provide financial incentives (e.g., tax breaks, rebates) for switching to more efficient water technologies (e.g. manufacturing processes and appliances).
17. Include information on climate change impacts to water supplies and how residents can reduce water use in utility bill inserts, newsletters, web sites, and local newspapers.
18. Update drought management plans and/or water resources elements in the comprehensive plans to recognize changing conditions.
19. Require farmers to install high efficiency water delivery systems for irrigated agriculture.

CATEGORY 3: Protecting Wetlands and Wildlife

Subcategory 1: Protect existing assets

20. Expand critical area buffers to include land with historically tidal-influenced soils (i.e. hydric soils).
21. Create a county-level map showing areas that if protected, would provide suitable habitat over the long term for the maximum number of the county's terrestrial and wetland plant and animal species and natural communities.

22. Increase monitoring of existing wetlands and conservation areas to track changes in water levels, species composition and abundance.

Subcategory 2: Intervene to improve resiliency

23. Purchase ecological buffers, at market rate, to allow for inland preservation and migration of wetlands, salt marshes, and other natural flood control systems.

24. Target land preservation efforts for wetland and coastal systems that create wildlife corridors and artificial wetlands to enable species to move to higher elevation and latitudes.

CATEGORY 4: Farm and Forestland Preservation

Subcategory 1: Protect existing farm and forest assets

25. Modify agricultural practices to reflect increasing variability in historic weather patterns (e.g. change planting season, plant drought resistant crops, etc.).

26. Commission a state-supported study to determine the net present value for ecosystem services (e.g. pollination, water filtration, erosion control, carbon capture, etc) in the county to incorporate this value into future planning.

27. Increase monitoring and assistance for existing conservation easement landowners to ensure effective conservation is taking place on these lands.

Subcategory 2: Intervene to improve farm and forest resiliency

28 Provide tax rebates for farmers who use conservation and adaptation practices on land they own / rent / lease.

29. Cut public crop subsidies to farmers whose crops face repetitive loss damage from flooding.

30. Require forested buffers on agricultural lands to improve resilience of adjacent waterways and wetlands.

31. Assess forested areas at risk of being lost and identify reforestation sites outside the sea level rise risk zone.

32. Develop a county tree canopy plan to increase tree coverage.

CATEGORY 5: Public Education

Subcategory 1: Community Education

33. Publish an annual report highlighting local climate adaptation measures taken by local residents and businesses and measuring progress of locally defined climate adaptation goals.

34. Create a coast smart street or business program to recognize and promote local achievements in implementing adaptation strategies.

35. Create citizen emergency preparedness teams to encourage readiness for the next major storm (e.g. people who will help their neighbors identify evacuation routes, shelters, etc.).

36. Create climate change information sessions for local governments to learn what they can do to promote climate adaptation planning.

37. Organize community workshops and forums to educate the general public about climate risks.

Subcategory 2: Youth Education

38. Create a new school curriculum to introduce and reinforce understanding of climate change risks.

39. Have schools adopt a section of shoreline at risk to climate change to study and work to protect (like an adopt-a-highway program).

Figure 2 'Scorecard' from Building CoastSmart Communities: The Maryland Climate Change Adaptation Game

In the game, the parties have to stay within a realistic budget. In the game, any table that can reach nearly unanimous agreement 'wins'.

Although relatively new in the climate change field, role-play simulation has been employed recently by the MIT-USGS Science Impact Collaborative in Maryland.[1] In April 2009, the Governor's office invited 150 community leaders (including local and county elected and appointed officials, farmers, real-estate developers, state legislators, environmental group heads, religious leaders, chamber of commerce members, fisherman, boating interests, and others) to play an Annapolis, Maryland version of the game (Susskind and Paul, 2010). In the debriefing of the game results, the participants indicated quite clearly their positive reactions to the RPS and the extent to which it helped them understand (1) the choices involved in adaptation planning, and (2) the dynamics of collaborative decision making required for any community to reach an informed agreement on how best to respond to the risks of climate change. Twenty professional mediators supplied by the Maryland Association for Conflict Resolution assisted in the event, which enabled most of the tables to reach a technically and financially feasible agreement in 120 minutes.

It took our team almost eight months to build the Maryland RPS. The first step is to select a 'story' or a premise that recreates a problem-solving situation facing the inhabitants of an actual city. This provides the essence of what are called General Instructions that all game players receive. Based on extensive interviews with experts at the local, county and state level, and drawing on the published literature, the participants also receive confidential instructions telling them which options they favour and why (for both political and technical reasons). The game designers begin with a fact-based analysis and fashion it into simplified score sheets that helps each game player make a case for what they do and do not want (regardless of their own real-life experience with these issues) (see Figure 2).

Through our work with coastal communities in Maryland, we identified a wide range of adaptation moves (above and beyond emergency preparedness) that coastal communities could take to: (1) reduce the vulnerability of the built environment (either by removal from harm's way or protection in place), (2) strengthen water and wastewater infrastructure (either by increasing supply or decreasing demand), (3) protect wetlands and wildlife (either by protecting existing assets or by intervening to enhance resilience), (4) preserve farms and forestland (by intervening to protect existing farm land and forests or by intervening to improve farm and forest resilience), and (5) educate the public about the nature of the risks that they face (either through adult or youth education).

In the game developed for Maryland, the goal of the negotiation is to come to agreement on a set of adaptation policies using the policy scorecard. The group is required to achieve a minimum 'effectiveness score' without exceeding a maximum

1 See: www.maryland.coastsmart.org

cost in order to qualify for state subsidies of various kinds. Each of the characters is restricted in which policies and levels of spending they can support. With the help of the mediator, the players have about two hours to work through all the different categories of action in the scorecard. At least eight out of nine role players at each table must agree for a final package to be acceptable. A full consensus is preferred, but not required.

In the Maryland case, the participants involved in making adaptation decisions for a hypothetical coastal community wrestled with competing policy objectives. They had to decide how to choose among the specific ways offered of meeting each of the policy objectives given the financial constraints, uncertainty about how bad the worst effects were likely to be in the near future and the competing self-interests of the stakeholder groups represented in the conversation. The game teaches that it will not be easy to find agreement on a risk management strategy that is technically plausible, politically palatable and financially realistic. Nevertheless, the results of the Maryland game also suggest that governmental entities can use RPS to build political support for an informed agreement.

Conclusions

- The chances are high that most cities, particularly those along rivers and coasts, will be adversely affected by climate change over the next two to three decades and beyond.
- Vulnerability takes the form of infrastructure likely to be destroyed, housing likely to be uninhabitable, food production that is seriously hampered, habitats and species that are destroyed or forced to move, humans whose lives are in jeopardy as water supplies become limited and temperatures become unbearable, and large populations forced to migrate to less exposed areas. Consider the second-order effects of Hurricane Katrina and the Haitian earthquake – the spread of disease and hunger, inadequate medical supplies and services, and the breakdown of civil order. These, too, must be addressed by an adaptation plan. Climate change could create repeated events of this kind all over the world.
- It may be possible to head off some of these difficulties through effective risk management. While mitigation – reductions in greenhouse gas emissions – will be necessary to reduce the risks of climate change in the long term, risk reduction in the short term should focus on adaptation. Municipal vulnerabilities can be reduced by anticipating and responding to the likely impacts of climate change. Similarly, the resilience of socio-ecological systems can be enhanced through changes in land-use rules and regulation, insurance programmes, emergency preparedness and other kinds of regulatory intervention. Specific choices, however, need to be based on appropriate forms of risk assessment using JFF and SP. They also need

to be made collaboratively, so that they have political credibility, and in ways that honour both expert and local knowledge.

- Decisions about how and whether to make risk reduction moves at the municipal or metropolitan scale must be made collectively, monitored closely and revised periodically. Since uncertainty is so great (at the micro-scale and in the short term), it is best to look for no-regrets moves at the outset that meet otherwise important needs. Public support for such investments and changes in policy can be built through the use of new public learning tools like RPS.
- Planners and planning departments should take the lead in adaptation planning because they already know how to work cross-sectorally, think long-term, worry about balancing science and politics and are committed to public learning and public engagement.

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