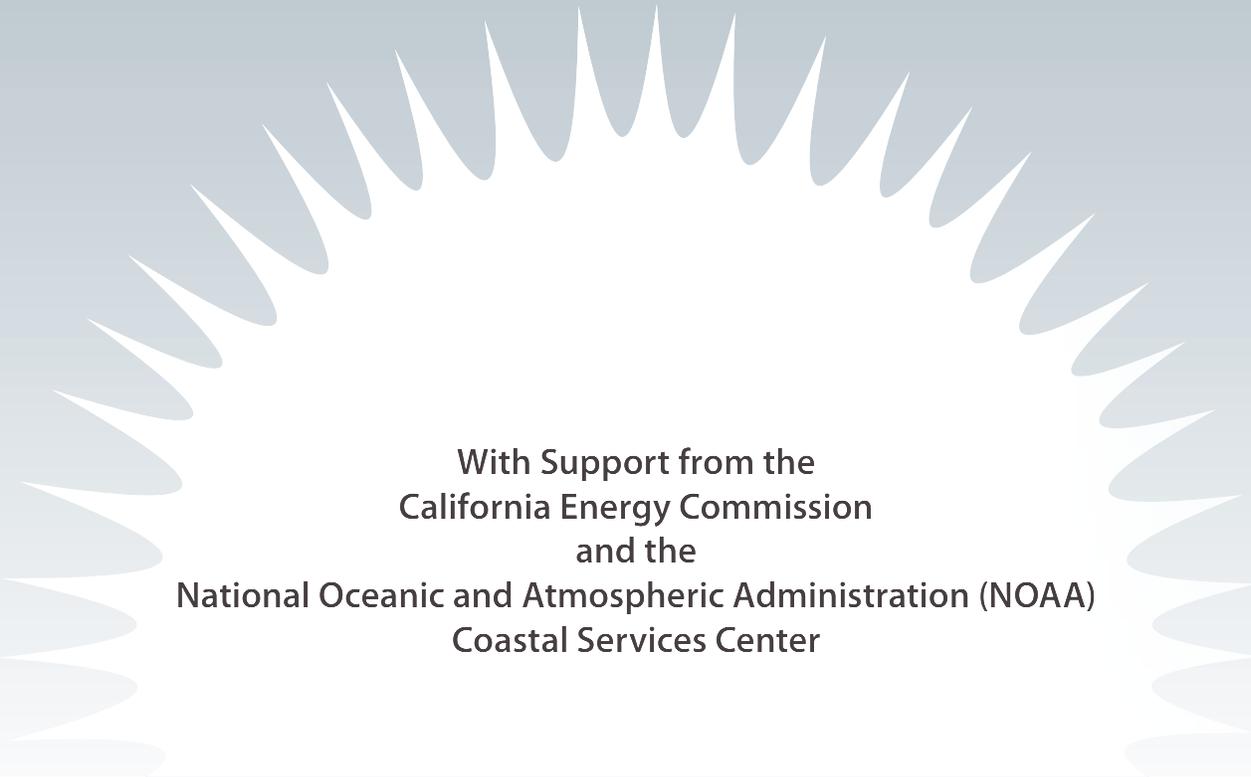


GOOD MORNING, AMERICA!

THE EXPLOSIVE U.S. AWAKENING TO THE NEED FOR ADAPTATION



With Support from the
California Energy Commission
and the
National Oceanic and Atmospheric Administration (NOAA)
Coastal Services Center

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Executive Summary

Focus of this report

Since the early years of the 21st century, and in particular since 2007, the U.S. has been awakening rapidly to the fact that climate change is underway and that even if stringent efforts are undertaken to mitigate greenhouse gas emissions, adaptation to the unavoidable impacts from the existing commitment to climate change is still needed and needs to be begun now.

This report provides an historical overview of the public, political, and scientific concern with adaptation in the United States. It begins by briefly distinguishing ongoing, historical adaptation to environmental circumstances from deliberate adaptation to human-induced climate change. It then describes the shift from the early concerns with climate change and adaptation to the more recent awakening to the need for a comprehensive approach to managing the risks from climate change. Ranging from the treatment of the topic in the news media to the drafting of bills in Congress, to state and local government activities with considerable engagement of NGOs, scientists and consultants, it is apparent that adaptation has finally, and explosively, emerged on the political agenda as a legitimate and needed subject for debate. At the same time, the current policy rush is not underlain by widespread public engagement and mobilization nor does it rest on a solid research foundation. Funding for vulnerability and adaptation research, establishing adequate decision support institutions, as well as the building of the necessary capacity in science, the consulting world, and in government agencies, lags far behind the need.

Adaptation planning and barriers

The inevitability of climate change impacts now conveyed through the media and other scientific communication, and conspicuous events such as Hurricane Katrina and Al Gore's *An Inconvenient Truth* have helped to "legitimize" adaptation as a necessary complement to mitigation. Nevertheless, realization of the magnitude of the challenge is still very limited. Not surprisingly, the adaptation initiatives evident to date consist of relatively conservative, win-win, and low-risk strategies.

In addition to tracing this history, this report identifies a number of barriers to basic adaptation planning and more ambitious policy developments. At the federal level, such barriers include: lack of federal leadership until recently (by Congress, the president, and agencies); lack of funding for research and planning; political opposition; ignorance; lack of intra- and interagency coordination, communication, and collaboration; competing priorities; lack of adaptation mandates; and legal constraints. These barriers do not only affect what does or can happen at the federal level but influence lower levels of government as well. For example, federal failure to take on adaptation leaves states without federal guidance and financial support, adding to the budget constraints that states face already. In addition, states face their own hurdles, including lack of state-level leadership, lack of state- and regionally specific scientific information, lack of expertise within state agencies, reliance on historical conditions, as well as lack of public awareness, engagement, and pressure to make adaptation a policy priority. At the local level, adaptation efforts by cities and counties can be hampered additionally by lack of a functional organizational structure, lack of collaboration with local universities and experts, isolation, and either real or perceived competition between mitigation and adaptation. Cross-scale barriers arise from regulatory and cross-jurisdictional conflicts and missed policy opportunities. In particular, the mismatch between the lack of, and the need for, scientific capacity, technical expertise and widespread, scale-relevant climate change and vulnerability information, America is now entering into an era of climate change consequences for which the country is ill-equipped.

These findings fly in the face of long-standing, and all too simplistic, assumptions that developed nations like the U.S. face relatively low vulnerability and possess high adaptive capacity to address climate change. Rather, concerted effort will be needed to assess vulnerabilities, ascertain adaptation options, and determine relevant governance barriers at and across scales, and build the necessary capacity, skill, resource base, institutional mechanisms, and political will to help reduce and overcome them.

Recommendations

A delicate balance must be struck at this time between initiating (and endorsing the establishment of) ongoing adaptation planning processes and making only common-sense and relatively small if meaningful policy and programmatic commitments rather than over-promise or commit large resources to ill-advised actions. Governments and stakeholders should assume that changing scientific understanding and non-stationary environmental and societal conditions will require considerable policy flexibility, debate over difficult challenges and painful trade-offs. Meanwhile, a serious commitment at the highest levels is required to

- rapidly and substantially expand vulnerability and adaptation research,
- build technical capacity within the sciences and among decision-makers,
- expand the nation's decision support capabilities,
- identify ways to provide financial and technical resources to governing institutions, and
- seriously engage the American public in the development and debate of a comprehensive climate risk management strategy.

Without such a commitment, there is considerable danger that America will engage in countless expensive and damaging maladaptations, and/or that sectors and communities will prepare insufficiently for climate change, creating liabilities far more costly than the investment called for now.

Good Morning, America! The Explosive U.S. Awakening to the Need for Adaptation

Susanne C. Moser, Ph.D.¹

*“Owing to past neglect, in the face of the plainest warnings,
we have now entered upon a time of great danger....
The era of procrastination, of half-measures, of soothing and
baffling expedients, of delays, is coming to a close.
In its place we are entering a period of consequences...
We cannot avoid this period, we are in it now...”*

Winston S. Churchill
November 12, 1936

Introduction

On December 19, 2008, an article in *The San Francisco Chronicle* called for “ideas on living in a warming world” and reported on a competition asking designers to ‘climate-proof’ the Bay Area (King 2008). Twenty years earlier, almost to the day, a news article in *The Boston Globe* reported on an international conference which urged coastal populations to prepare for the impacts of climate change (Dumanoski 1988). Between these two geographic and temporal bookends of concern lies a country that has been largely untroubled by the question of adaptation to the impacts of anthropogenic climate change for most of the intervening 20 years.

Until recently. Since the early years of the 21st century, and in particular since 2007, the U.S. has been awakening rapidly to the fact that climate change is underway and that even if stringent efforts are undertaken to mitigate greenhouse gas emissions, adaptation to the unavoidable impacts from the existing commitment to climate change is still needed and needs to be begun now. This sudden awakening has led to a flurry of activities at the state and local government levels, in the non-governmental community, and to some extent at the federal level. This can be expected to increase in coming years as the Obama administration has expressed willingness to address climate change, thus also fostering policy-making in the U.S. Congress. Capturing all these policy-related activities springing up across the country and in all sectors is a difficult undertaking, as it is not occurring in a centrally organized or guided manner. Equally challenging is to obtain a systematic overview of vulnerability and adaptation-focused scientific research.

This report attempts to provide an historical overview of the public, political, and scientific concern with adaptation in the U.S. It begins by briefly distinguishing ongoing, historical adaptation to environmental circumstances from deliberate adaptation to human-induced climate change. It then describes the shift from the early concerns with climate change and adaptation to the more

¹ A shorter version of this report will appear as a chapter in Ford, J., and L.B. Ford, *Climate Change Adaptation in Developed Nations*, Springer Verlag. Please contact the author for further information.

recent explosive awakening to the need for a comprehensive approach to managing the risks from climate change. This trajectory of change is reflected quite well in media attention paid to adaptation over the past 20 years, which sets the stage for the review of current adaptation efforts across the country. If the media are understood as both mirror of ongoing activities around matters of global, national, and local concern, and as an important force in setting the public and political agendas, then tracking news coverage gives an important first indicator of what is happening where, and how related public debates have been changing over time. The report will place these trends in the context of changes in political leadership and the larger public debate over climate change that have taken place in the U.S. over this period.

This political context has also shaped a national science policy that has tended to relegate vulnerability and adaptation-related research to the “back burner” of federal research budget and agency support. The report will offer some telling insights and discuss the implications for a nation now urgently in need of scientific insights relevant to adaptation planning.

Turning to the more recent history then, the report will capture in an exemplary and summative fashion some of the adaptation efforts initiated in the last three to five years at the federal, state, and local levels, by government and non-governmental entities, and in different climate-sensitive sectors such as public health, coastal areas, water management, winter tourism, natural resource management and habitat protection, urban and transportation infrastructure, and so on. This cursory survey is necessarily incomplete, in part because efforts are not easily tracked, and in part because the landscape of activities is rapidly changing. But the picture unfolding reflects a significant variation in concern, commitment, and sophistication in adaptation planning ranging from virtually absent to significant. It shows where and how efforts have been initiated and what impedes them. This review also reveals an emerging actor network, involving elected officials, career bureaucrats, advocacy and other civic groups, scientists, consultants, philanthropic foundations, and professional associations.

The report will conclude with a discussion of some plausible implications for the state of U.S. preparedness to deal with climate change impacts, opportunities, and barriers to adaptation. It will suggest important future research directions, decision support needs, ways to overcome some of the barriers state and local governments are facing, and discuss the need to engage the American public in a broader dialogue on comprehensive climate risk management and resilience in the face of rapid change.

Defining the Terms: “Normal” Adaptation vs. Deliberate Adaptation to Climate Change

Scientists from a number of disciplines – foremost maybe geography and anthropology – and long before them philosophers, theologians, and the great storytellers of ancient human history, have concerned themselves with the relationship between humans and the environment. This mutual relationship has been viewed through the lens of human transformations *of* the environment (e.g., Marsh 1864; Thomas Jr. 1956; Turner et al. 1990) and through that of human adaptation *to* the environment (e.g., Burton, Kates, and White 1978; Kates, Ausubel, and Berberian 1985). Over the millennia, humans have learned with increasing sophistication to protect themselves from the elements and to conduct virtually every kind of business (from transportation and trade to agriculture, construction, energy production, and tourism) in the face of a variable weather and climate including extreme events (i.e., climatic conditions that deviate – sometimes significantly – from the local mean).

In the U.S., for example, states have built reservoirs to protect themselves against winter floods and store water for dry summer periods. In agriculture, technology has improved irrigation efficiency. Building codes have been established for floodplains and coastal areas to make infrastructure and buildings stronger and able to weather storms, floods, and other hazards. Emergency warning and response systems along with insurance mechanisms have been established to better respond to and recover from weather-related extremes such as wildfires, floods, and frost. Wildlife reserves, protected areas, sustainable yield rules, and other measures have been established with the intent to protect wildlife, biodiversity, natural resources and scenic landscapes, and to sustain ecosystems and resources in a condition that allows them to provide essential goods and services. Typically, each sector's ability to cope through available structural, technological, monetary, institutional, land management and protection, and other mechanisms is confined to a certain range of climatic conditions. This range is referred to as a society's, a community's, or a sector's "coping range" (e.g., Jones and Boer 2005; Smit and Pilifosova 2003).

For the purposes of this report, the efforts a society (or a sub-unit thereof) makes to live with the relatively stable, average climate of the recent past as well as with the naturally variable climatic conditions that affect its operations are considered "normal" background adaptation. Distinct from these historical adaptive efforts are those additional efforts that are now being contemplated, examined, planned, or implemented in response to already discernible or expected changes in climate due to anthropogenic forcing. Such societal adaptation has been formally defined as any "process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity" (Smit and Wandel 2006, p.282). The Intergovernmental Panel on Climate Change (IPCC) more specifically defines adaptation to climate change as any "adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects in order to minimize harm or take advantage of beneficial opportunities" (IPCC 2001, p.982).

While important, in fact, essential lessons and insights can be gained from ongoing background adaptation, the focus of this report is on the additional, deliberate adaptation efforts geared toward dealing with the impacts of human-induced climate change. It may be difficult at times to distinguish one from the other, especially at this early stage: many technological, behavioral, and even policy measures may be mere extensions of past practices; moreover, many may be taken not just in response to climate change, but also to address other stressors or opportunities. What may be different, however, is the intent and public debate surrounding any action being taken. This shift is being witnessed in the U.S. at this time.

"In the Face of the Plainest Warnings": Adaptation in the Media

The review of current adaptation efforts across the U.S. begins here by exploring how concern and public debate have been changing over time through the lens of relevant media coverage. As a mirror of scientific findings and policy activities related to adaptation that are deemed newsworthy, it is therefore important to not only focus on the national prestige press, but also on local and regional papers. Most climate change impacts will be felt locally. Moreover, adaptation – while likely to require support from higher levels of governance – will be planned and implemented at the state and local levels. Thus, news coverage in local, regional, and national media markets can provide an interesting indicator of how the U.S. is shifting from "business as usual" in terms of living and coping with a variable climate to a more explicit concern with adaptation to climate change. Space here does not allow for an in-depth analysis of media coverage on adaptation, which is reserved for another paper, but even just a cursory review is revealing (Figure 1).

The chart in Figure 1 provides a graphic illustration of what is described here as an “explosive” awakening to the need for adaptation (67% of all articles appeared between 2006 and 2008; a nearly four-fold increase in the number of articles occurred from 2006 to 2007 alone).²

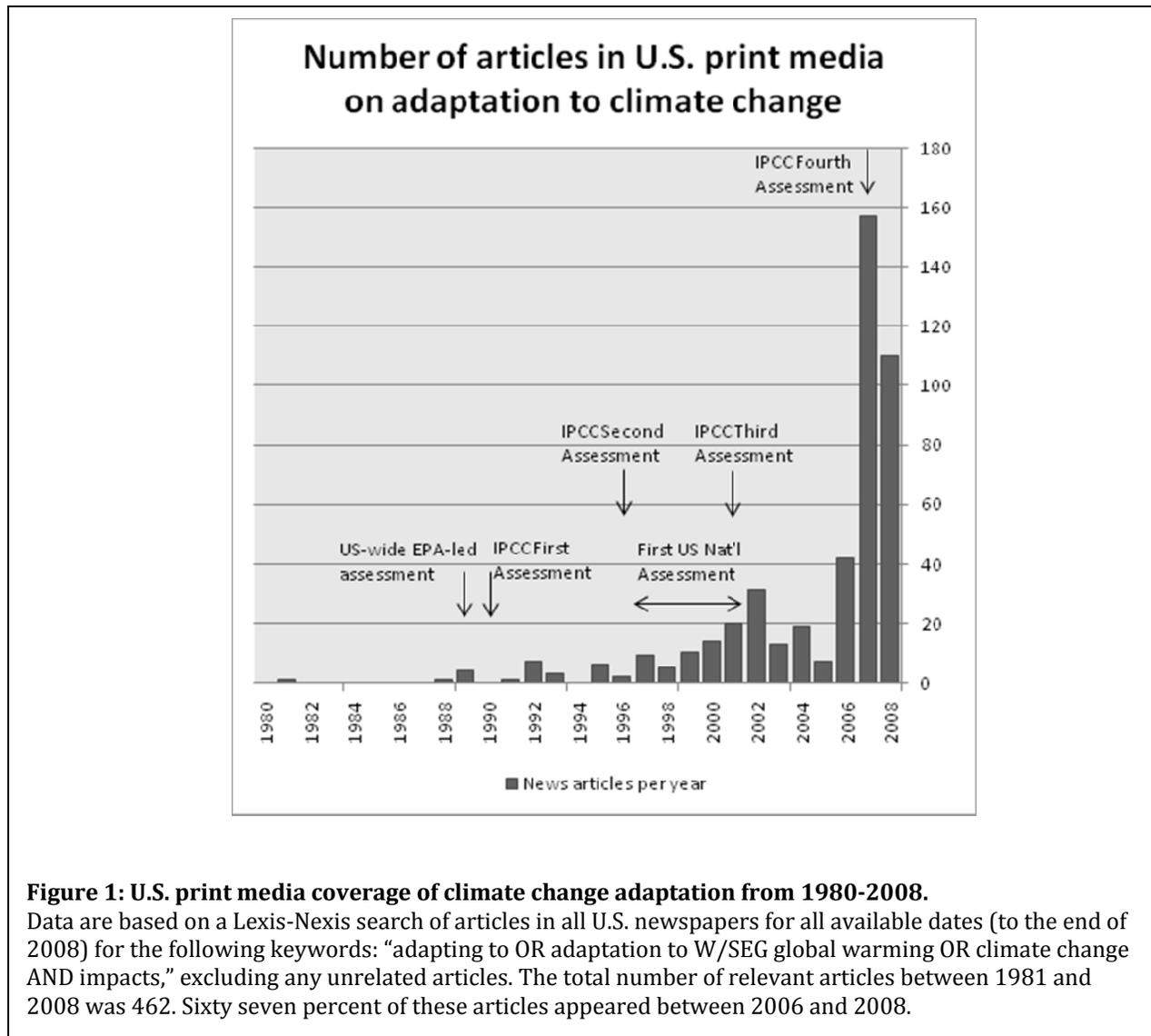


Figure 1: U.S. print media coverage of climate change adaptation from 1980-2008.

Data are based on a Lexis-Nexis search of articles in all U.S. newspapers for all available dates (to the end of 2008) for the following keywords: “adapting to OR adaptation to W/SEG global warming OR climate change AND impacts,” excluding any unrelated articles. The total number of relevant articles between 1981 and 2008 was 462. Sixty seven percent of these articles appeared between 2006 and 2008.

Yet, this simple compilation may underestimate the true news coverage on adaptation over time. A wider range of search terms (such as coping, climate-proofing, adjusting to impacts, and so on) and more comprehensive analysis of media coverage (including television coverage, newswires, magazines, and other news sources) are likely to reveal an even more extensive coverage. For example, newswires allow the same article to be reprinted in newspapers around the state or country. With the consolidation of the U.S. newspaper industry over the last decade and more, such services are of increasing importance, even if local specificity and relevance may be diminished.

² Additional confirmation for this adaptation-specific trend comes from the finding that news coverage on climate change in general has increased substantially in recent years. For dynamically updated data on climate change news coverage, see: <http://www.eci.ox.ac.uk/research/climate/mediacoverage.php> [last accessed January 8, 2009].

A similar rise in relative importance has occurred for web-based information. There is no apparent reason to assume, however, that these additional news sources should follow a completely different pattern of frequency than the one shown in Figure 1. Rather, the technological opportunities that have been opening up rapidly in recent years via the internet, including the interrelated changes in reporting (with combined multi-media print and online reporting, as well as interactive visual and video technology), and market trends in the media industry (e.g., increasing consolidation of newspaper industry, drop in specialized “beat” reporters, and thus greater reliance on online news services, as well as spread of cable network news,) suggest that they may magnify the “explosive” pattern even more (Pew Research Center for the People and the Press, 2008; Croteau, and Hoynes. 2006; Alexander et al., 2004; Compaine and Gomery, 2000; see also the Annual State of the News Media reports at <http://www.journalism.org/>).

What is maybe more interesting than the absolute quantity and true level of increase in recent times, is the dearth of adaptation coverage for much of the time for which data exist. Particularly interesting are key periods over the past 20 years: The first U.S.-wide climate change impacts assessment that discussed and thus could have raised public concern over adaptation needs was a 1989 EPA-led assessment (Smith and Tirpak 1989), yet news coverage was virtually absent. The following year (1990) presented the first scientific assessment by the IPCC – of course, with impacts and vulnerability/adaptation aspects at that time largely underdeveloped. That year was a year without one mention of adaptation to climate change in U.S. newspapers. The second assessment of the IPCC fared little better. The following years (1997-2001) showed a modest increase in the coverage of adaptation. This reflects the regional and sectoral assessment activities and explicit interest in adaptation options in the *First U.S. National Assessment of the Potential Consequences of Climate Variability and Change* conducted during the last years of the Clinton Administration. In 2001, the IPCC also released its third assessment report, thus contributing to the steady increase in coverage in those years. Growing evidence of local, regional and more distant climate change impacts as well as a growing recognition of the need for a comprehensive approach to dealing with climate change risks has kept adaptation coverage in the early years of the 21st century at higher than historical levels. The devastating hurricanes of 2004 and 2005 may also have contributed to these elevated numbers as these extreme events, and the ability to cope with them, were frequently linked with climate change in the media. The release of the fourth IPCC assessment produced the spike in 2007.

The extensive adaptation coverage in 2007 and beyond reflects several important developments. First, scientific insights on vulnerabilities, impacts, and adaptation have matured over the past decade as the thick IPCC volume indicates (Parry et al. 2007). This allows reporters to put a local spin or human face on an otherwise abstract global problem. Second, with the “unequivocal” evidence that climate change is occurring and that the warming observed over the last half of the 20th century is with >90% confidence human-induced (Solomon et al. 2007), the political debate in the U.S. has palpably shifted. This is partly reflected in the shifts that reporters themselves have made in recent years: they changed their reporting style from one described (and widely criticized) as reflecting a misleading, non-scientific balance (Boykoff and Boykoff 2004; Boykoff 2007b) to one reflecting more accurately the weight of scientific evidence (Boykoff 2007a). They also sought a fresh angle on climate change reporting – as this author frequently experienced in requests for interviews – through a greater focus on locally relevant aspects, impacts, and responses. Moreover, non-governmental and media groups made deliberate efforts before and after the release of the IPCC report from Working Group II in April 2007 to educate reporters about impacts and adaptation issues and to connect them with scientists involved in the IPCC. Finally, as discussions below will show, there also has been an increase in policy activities related to adaptation, which are reflected in the news.

In summary, putting the finger on the pulse of the news media, even just of a limited subset, suggests that public attention in the U.S. is being redirected increasingly from questions of whether or not climate change is occurring and human-caused to ones about what this global problem means locally and how to deal with the impacts. This shift, while maybe not surprising, is nonetheless remarkable in light of the changing political context in which adaptation has been debated over the past two decades.

The “Era of Baffling Expedients”: Adaptation in Public Debate

In 2007, at the height of news coverage on adaptation, Roger Pielke Jr. and colleagues (Pielke Jr. et al. 2007) published a commentary in the journal *Nature*, which suggested that there had been a “taboo” on talking about adaptation to climate change until that time. Clearly directed to an international policy audience, the provocation may as well be put before U.S. audiences. Immediately following the publication of the Pielke et al. article, the conservative newspaper *The Washington Times* published a commentary by Henry I. Miller, a fellow at Stanford University's Hoover Institution, who argued,

“Mr. Pielke and his colleagues criticize the political obsession with the idea that climate risks can be reduced by cutting emissions, because it distracts attention from other, more cost-effective approaches. However, for many activists, emissions reduction has become an article of faith: Al Gore dismissed adaptation as a kind of laziness, an arrogant faith in our ability to react in time to save our skins” (Miller 2007).

Former Vice President Al Gore did in fact once reject adaptation as a distraction from the need to reduce the causes of climate change. In a 1989 interview, Gore stated,

“The advice to adapt rather than prevent these [climate] changes is unwise counsel. The changes are occurring so rapidly that adaptation will not be possible without major disruptions in our civilization. The advice to adapt is an obstacle to the correct political response, which is prevention” (quoted in McMasters 1989).

This brief caricature reflects a long-standing framing of climate change solutions, one which has marked U.S. political debate for at least two decades. In this framing mitigation and adaptation are pitched against each other (along with doing more science, before any action is taken at all). In the absence of a solid scientific foundation on vulnerability and adaptation and faced with substantial political resistance to mitigating greenhouse gas emissions (across Democratic and Republican administrations), environmental non-governmental organizations (NGOs) and other emission reduction advocates have avoided talking about adaptation, fearing that it would distract from the need for mitigation or be perceived as defeatist (e.g., Burton 1994). (Moser and Luers 2008), explain this reluctance among many of the key players in the U.S. climate policy debate with the inappropriate or uncritical promotion of adaptation as the cheaper and easier alternative to mitigation by those who opposed changes in energy policy. “Climate contrarians either deny the reality of climate change or promote a view that suggests Americans have the capacity to adapt should climate change materialize, and that therefore there is no need to take action now to prepare or to mitigate” (Moser and Luers, 2008, p.S310; see also Kates 1997). In fact, the recent paper by economist Robert Repetto (Yale University), perceived by many as a political provocation and challenge to common assumptions about America’s ability and actual efforts to adapt, argues

that America's *capacity* to adapt is by no means a guarantee that the country actually *will* adapt (or will do so *efficiently and effectively*). It may be viewed as a corrective response to this misleading, divisive discourse (Repetto 2008).

These entrenched positions on either side of the policy spectrum have begun to be loosened up in the early years of the 21st century. This change is occurring in part because of the findings summarized in the IPCC's Fourth Assessment report, the shift in perception of the inevitability of some climate change impacts, but also in part because of concurrent events, such as Al Gore's movie *An Inconvenient Truth*, the hurricanes of 2004 and 2005, and several other extreme "natural" disasters (such as the Midwestern and Northeast floods of 2008, extended droughts in various parts of the country), and international efforts that legitimized and emphasized the need for adaptation (J. Foster, pers. communication to author, 2009). Opinions continue to differ, however, on how "legitimate" or "politically expedient" it is to tackle adaptation. In a 2007 cover article in the city and state-focused magazine *Governing*, reporting on the emerging local adaptation efforts, Global Warming Task Force coordinator of Homer, Alaska, Anne Marie Holen, was quoted as saying, "It's kind of depressing... It's hard not to see the need for adaptation as a sign of failure. If we'd begun serious mitigation measures when scientists first began warning government leaders about global warming and climate change, we wouldn't be in such a pickle" (Swope 2007). By contrast, the need for a discussion about adaptation is increasingly recognized by others, as this commentary in the same year exemplifies: "Debating how to halt climate change is necessary. Figuring out how to live with it, unfortunately, is urgent" (Washington Post Writers Group 2007). In fact, there is an acceptance of the necessity for adaptation and rational economic arguments are advanced in favor of adapting now rather than delaying until disaster strikes. There is also growing concern whether communities and sectors really do have the capacity to adapt without significant suffering or economic losses or – even if the capacity is there – whether communities will be able to overcome a range of critical barriers that may impinge on, prevent, or at least delay an efficient adaptive response (e.g., Adger et al. 2009; Moser 2009; Moser et al. 2008; Rayner, Lach and Ingram 2005; Repetto 2008; Tribbia and Moser 2008). Commentators again admonish the lack in federal leadership on adaptation similar to that on mitigation. As one biting editorial in the *Sacramento Bee* (adapted in other papers across the nation) in June 2002 put it,

"Break out the sun block. Crank up the air conditioner. The globe is going to warm, and the president [G.W. Bush] has a three-pronged plan: Adapt. Deal with it. Get used to it. That is, as long as any effort to adapt is economically painless. Assuming, of course, that there remains an economy to impact in places such as California, where we rely on a Sierra with snow and a downstream Delta with drinkable water instead of a saline soup from a rising sea." (Sacramento Bee 2002)

The most constructive of the emerging new frames replace the dualistic, mutually exclusive ones that saw mitigation and adaptation as either/or alternatives and instead emphasize complementarity, synergy, and careful attention to trade-offs and mutual support, without one taking away from the necessity or urgency of the other.³

³ These discursive developments in the U.S. parallel trends in Europe where adaptation has been equally marginalized until recently (e.g., O'Brien et al. 2006), but is now rising on the political agenda (see, e.g., Germany's work toward an adaptation strategy (Schuchardt et al. 2008), and strategic thinking at the European level (European Commission 2007)). A global, not just U.S.-focused, survey of the research literature on "adaptation" and "climate change" (by keyword search in the ISI Web of Knowledge) confirms the long dearth of such work in the 1980s and early 1990s, and a steady increase since, with a peak in recent years (Preston et al. 2009). A histogram of the number of scientific adaptation studies globally between 1980 and 2008 (Preston et al.'s Figure 1) shows almost the same shape as Figure 1 in this report.

“Owing to Past Neglect”: The State of Adaptation Research

As U.S. states and local communities begin taking on the issue of adaptation as a serious and legitimate policy concern, the need for relevant science on climate change impacts, vulnerabilities, and adaptation options and constraints is growing rapidly. The supply of locally relevant, both spatially and temporally highly-resolved climate change projections, however, is still constrained by the capabilities of currently available climate models (Bader et al. 2008, GAO 2009). In addition, there is an inevitable time lag between the supply of climate projections and the production of impacts studies. The studies that do exist have produced important information on the climatic hazards that some regions of the U.S. may face, yet probabilistic information that quantitatively assesses specific risks is not yet available at these smaller scales.

An even greater lack of scientific information needed to adequately inform regional and local adaptation planning efforts lies in the ecological and human dimensions of global change. In most regions, little is known specifically about the on-the-ground degree of vulnerability of habitats, sectors, communities and subsections of the population to climatic hazards; and only spotty and preliminary research exists, if at all, that assesses the economic costs and benefits, feasibility, and collateral consequences of different adaptation options. This lack of attention paid to vulnerability and adaptation research is rooted deeply in federal science policy and a long-standing imbalance in research funding for global change science. In one recent review of the available knowledge, Easterling, Hurd, and Smith (2004, p.32) concluded,

“U.S. society can on the whole adapt with either net gains or some costs if warming occurs at the lower end of the projected range of magnitude, assuming no change in climate variability and generally making optimistic assumptions about adaptation.

However, with a much larger magnitude of warming, even making relatively optimistic assumptions about adaptation, many sectors would experience net losses and higher costs. The thresholds in terms of magnitudes or rates of change (including possible non-linear responses) in climate that will pose difficulty for adaptation are uncertain. In addition, it is uncertain how much of an increase in frequency, intensity, or persistence of extreme weather events the United States can tolerate.”

In light of this sobering conclusion, and other research findings suggesting that increases in extremes are likely (e.g., Karl et al. 2008), it is legitimate to ask how much federal funding has been put toward eliminating some of these critical unknowns about thresholds, tolerance, costs, or any hurdles that communities, industries, or entire sectors may face, as the report suggests (Easterling, Hurd, and Smith 2004, pp.32-33).

Annual budget allocations to the Climate Change Science Program (CCSP), the smallest of all federal science and technology interagency programs, have varied over the past 15 years, and have been in decline in absolute terms since 2003.⁴ The largest portion of the CCSP budget every year has gone to NASA for development, operation, and support of satellite systems generating Earth

⁴ It is important to recognize that funding for climate change-related research is by and large not *additional* to GCRP/CCSP agencies' budgets, but a matter of accounting (by individual agencies) what portion of the Congressionally appropriated funds for climate change research would be counted as an activity under the umbrella of GCRP/CCSP versus under another agency program. This implies, first, that the notion of a tightly coordinated and integrated climate change science program is largely a “myth” and, second, that keeping track of all funding for climate change-related research is far more difficult than just following CCSP budget allocations (see also Footnote 6).

system information and related research. Less than half of the total budget is spread among the twelve remaining CCSP agencies. While most conduct some climate impacts research, only NSF, NOAA, EPA, and to a lesser extent USDA and NIH have research programs explicitly focused on social, economic, or behavioral science relevant to climate change. Only a small subset of their respective budgets is focused on vulnerability and adaptation (American Association for the Advancement of Science 2008).⁵

According to Tom Wilbanks (pers. comm. to author, December 2008), Chair of the National Research Council's (NRC) Committee on the Human Dimensions of Global Change, probably no more than a fraction of 1% of annual federal climate-related research funds is dedicated to increasing the scientific understanding of vulnerability and adaptation.⁶

Not surprisingly, the NRC's Committee on Strategic Advice to the CCSP concluded in its 2007 evaluation of the Program's progress toward its strategic goals that,

“Progress in human dimensions research has lagged progress in natural climate science, and the two fields have not yet been integrated in a way that would allow the potential societal impacts of climate change and management responses to be addressed” (NRC 2007, p.5).

This NRC assessment is only one in a long string of NRC reports over the past two decades that have bemoaned the lack of federal support for human dimensions research, and specifically for vulnerability and adaptation science. These financial constraints have been exacerbated for decades by inadequate collection, management, integration and accessibility of relevant data; organizational barriers in the federal government hindering the integration of social science information and research capacity; as well as institutional, cultural and human resource/capacity hurdles undermining the effective collaboration of physical and social scientists on climate change problems (Stern and Wilbanks 2008).

The significant neglect of federal funding for adaptation research notwithstanding, small research and decision support programs – such as NOAA's Regional Integrated Sciences and Assessment (RISA) program and Sectoral Applications and Research Program (SARP), as well as some regional or sector-specific research sponsored by EPA, DOI, DOE, and NASA, while often initiated by interest in climate variability, is slowly advancing into climate change and adaptation planning support. As Tom Karl (National Climate Data Center Director and NOAA Climate Services lead) recently suggested, these efforts – while valuable and expanding – are funded at far too small a level to meet the rapidly growing demand (Karl 2009).

However one may judge past choices around research priorities and capacity building, the situation that has arisen because of them is that U.S. states, communities, and industries are attempting to develop adaptation strategies at this time, yet lack the scientific foundation – particular regarding on-the-ground vulnerabilities, the costs, constraints, and feasibility of various adaptation options – on which rational, scientifically informed policy could be made.

⁵ Outside the CCSP, additional federal research funds exist, of course, which may produce knowledge relevant and valuable to issues of vulnerability and adaptation; these are not included here, not coordinated with CCSP strategic plans, and equally difficult to identify or track.

⁶ Exact figures are difficult to generate as agency budgets are not organized around these themes; a project by project review has not been undertaken to date (Tom Wilbanks, pers. comm. to author, December 2008).

The Close of the “Era of Half-Measures”: Emerging Adaptation Efforts across the U.S.

In 2004, the Pew Center for Global Climate Change released a report on the role of adaptation in the United States (Easterling, Hurd, and Smith 2004). In it the authors asked whether the U.S. is already adapting to climate change. They pointed to changes in industry where business managers were investing in weather insurance and interest among farmers in seeds more resistant to damages from heat or moisture extremes. They also documented some proactive measures taken in long-term transportation and water infrastructure planning. Notably absent were any mentions of state-level adaptation planning efforts or changes at the federal level. Since then significant policy developments have occurred and examples of these are provided in the sections below.

Federal Policy Developments and Planning for Climate Impacts

The development of federal climate change policy has become an active area of Congressional activity since the Democratic Party gained control of the House of Representatives after the 2006 elections. Democratic leadership in key committees has opened the door to hearings and discussion of a wide range of climate-related bills. The 110th Congress (January 3, 2007 – January 3, 2009) also produced a variety of bills in both the House and the Senate that address adaptation, sometimes generally, and sometimes sector-specific. Appendix 1 lists a number of climate change bills that have a significant adaptation component. In March 2009, the House Committee on Energy and Commerce (Subcommittee on Energy and Environment under the leadership of Rep. Ed Markey, D-MA) held its first hearing on adaptation, reflecting the Democratic leadership’s willingness to become informed on the issue and formulate comprehensive federal adaptation policy, but also revealing significant ignorance and skepticism among committee members about the challenges and the need to help America plan and prepare for, and successfully adapt to, the impacts of climate change (hearing and testimony online at <http://energycommerce.house.gov/>).

One of the climate change bills already enacted into law at this time is that which authorized the *America’s Climate Choices* study, initiated in late 2008 by the NRC. It represents a Congressional request for scientific input into the development of mitigation and adaptation strategies, and a fresh look at research priorities, including how to rapidly build the country’s climate-related decision support capability. This NRC effort builds on other recent studies and advisory activities and is expected to be highly influential over the coming year and beyond in helping to shape federal climate policy, including on adaptation (NRC 2003, 2004, 2007, 2009a, 2009b).

Outside the legislative branch of federal government, federal agencies have sponsored limited adaptation-specific research and assessments or made policy changes for their own operations. In 2007, the Government Accountability Office (GAO) highlighted the lack of guidance on managing the effects of climate change in an influential and widely reported report, and noted the growing vulnerability of federal and private insurers to the impacts of weather-related disasters (GAO, 2007a, 2007b). In response, federal agencies have significantly increased their internal review and strategic planning efforts since (GAO 2009), though actual planning, management or rule changes affecting operations on the ground are still very limited.

Agency-specific adaptation-relevant research in support of their own land, resource and habitat management efforts has been spotty, though more focused attention is beginning to be paid in recent years. For example, in a visioning exercise undertaken by NOAA (together with the Coastal States Organization), climate change related coastal hazards now are a principal strategic focus (see: http://coastalmanagement.noaa.gov/czm/czma_vision.html). The agency is also making

progress toward including climate change in its stewardship responsibilities for living marine resources, and coastal ecosystems (Griffis et al. 2008). The EPA – through its Climate Ready Estuaries Program - has prepared a summary of adaptation options for the management of the nation’s estuaries (US EPA 2009). Without formal federal policy or mandate, however, it is unlikely that these programs will receive the necessary budgetary support or be viewed as binding guidance by federal resource managers.

Under the auspices of the CCSP – in accordance with the 2003 interagency Strategic Plan – several “Synthesis and Assessment Products” (SAPs) were produced that address questions concerning vulnerability, adaptive capacity, adaptation options and constraints (e.g., Anderson et al. 2009; Fagre et al. 2008; Julius et al. 2008; Wilbanks et al. 2007; Gamble et al. 2008; Savonis, Burkett, and Potter 2008). Several others address issues that affect the U.S.’s ability to adapt, such as extreme and abrupt climate and environmental changes, and the ability to use climate change-related information in decision making (e.g., Karl et al. 2008; Clark et al. 2008; Backlund et al. 2008; CCSP 2008; Morgan et al. 2009; Beller-Simms et al. 2008). These SAPs involved both agency experts and volunteer scientists from across the U.S., and were financially supported largely by sponsoring lead agencies.

For years, researchers in a number of federal agencies (e.g., EPA, NOAA, USGS, U.S. Forest Service, and others) have conducted investigations – even in the absence of an official Congressional mandate or presidential directive, on how best to adapt to climate change impacts, such as sea-level rise. Those charged with the implementation of laws, policies, and programs – after years of remaining rather disconnected from the findings of their colleagues in the research branches of their agencies – are beginning to assess possible response options (Anderson et al. 2009).⁷ Some federal agencies with responsibility for land, coastal, marine, species and natural resource management have explored options and some have quietly adopted policies that require consideration of climate change in long-term decisions. For example, the Department of Interior through a 2001 Secretarial Order has begun to require climate change impacts be considered in planning and decision making (Scarlett, 2007 cited in Anderson et al. 2009; see also DOI’s Climate Change Task Force website at: http://www.usgs.gov/global_change/doi_taskforce.asp). The National Park Service has been collaborating with the U.S. Geological Survey to assess the physical exposure in many of its coastal parks to sea-level rise (Pendleton, Williams, and Thieler 2004). The Fish and Wildlife Service is also incorporating climate change impacts in its Comprehensive Conservation Plans but the agency does not have a comprehensive strategy for addressing climate change impacts at this time. While both the Park Service and Fish and Wildlife Service are concerned about sea-level rise, and generally prefer to let “nature take its course,” neither has an explicit policy on how to deal with it, has made any land purchase decisions or put in place easements to enable parks and refuges to migrate inland (Anderson et al. 2009). The USDA’s Forest Service in January 2009 issued guidance to its staff for including climate change considerations in planning and project implementation (building on the Forest Service’s own researchers, see Joyce et al., forthcoming), although – according to Forest Service leadership – climate change risks and uncertainties have yet to rise in prominence in management decisions (GAO 2009, p.4).

In other agencies, the threat of climate change impacts has been recognized, even included in official guidance documents, but has not led to an appreciative change in actual decision-making (e.g., the U.S. Army Corps of Engineer’s consideration of sea-level rise in coastal protection projects) (Knuuti 2002; Anderson et al. 2009). Some federal agencies also face statutory hurdles to integrating climate change, even if they understand how climate change increases certain risks. For example, the Federal Emergency Management Agency at present cannot require the use of data

⁷ International adaptation-related activities carried out by federal agencies (e.g., USAID, State Department) are not discussed in this chapter.

reflecting future conditions (e.g., based on planned land-use changes, proposed development, or sea-level rise) for purposes such as floodplain management or insurance ratings unless statutory and regulatory changes are made to the National Flood Insurance Program (NFIP) (Anderson et al. 2009; Association of State Floodplain Managers 2007). In response to the GAO's 2007 report of growing federal and private insurance vulnerability to weather-related catastrophes, the NFIP (flood insurance) and Federal Crop Insurance Program (FCIP) (drought insurance) are in the process of assessing how increasing frequency and severity of weather extremes are impacting the programs and expected to report back to Congress in late 2009 or 2010 (GAO 2009, pp.8-9).

Table 1: Some Observed and Documented Barriers to Federal Attention to Adaptation

- 1. *Lack of Federal Leadership* – Until recently, neither Congressional, presidential nor agency leadership has focused on adaptation, which has resulted in lack of mandates, lack of funding for research, lack of policy guidance, and lack of accountability.**
- 2. *Lack of Funding* – Agency funding for adaptation research has been minimal compared to funding for other climate change research. This is only slowly and recently changing.**
- 3. *Political Opposition* – Attention to adaptation has been stymied by the long-standing federal-level resistance to climate change policy generally. This has begun to shift with the 2006 shift in majority in Congress and the 2008 presidential election.**
- 4. *Ignorance* – The lack of federal funding for adaptation research, failure to prepare periodic, integrated nationwide climate impacts assessments, and general lack of attention to adaptation to date has one costly political price: namely, the widespread lack of appreciation and understanding of the needs, opportunities, and challenges involved in adaptation. This fundamental lack of knowledge has undermined Congressional leadership on the issue.**
- 5. *Lack of Intra- and Inter-Agency Coordination* – Despite the interagency Climate Change Science Program, federal agencies – with few exceptions – have not undertaken joint adaptation-focused or –relevant research. They have also not formally exchanged insights and coordinated planning for climate change impacts. The spotty internal research frequently has not informed land, resource, water, marine, or species management within their own agencies.**
- 6. *Competing Priorities* – Agencies are charged to manage multiple resources and public interests (health, safety, environmental protection, commerce, national security, etc.). Climate change has not yet been made a top priority in most agencies. Until agency policy and guidance places it higher on the agenda, adaptation actions by agencies and the legislature will be further delayed.**
- 7. *Lack of Adaptation Mandates* – While agencies have the general authority to manage resources under changing conditions, most do not currently have specific or redefined Congressional mandates to plan and prepare for climate change. Agencies may find it difficult to obtain sustained funding, or redirect/focus scarce financial and staff resources to climate change adaptation research and implementation without such specific mandates.**
- 8. *Legal Obstacles* – A number of federal policies, rules and regulations are – by law – based on historical conditions. Only legislative action would allow them to be changed, e.g., to be forward looking, take non-stationarity into account, or be based on future projections rather than historical averages.**

Source: Adapted from GAO (2009), Stern and Wilbanks (2008), and author observations.

In summary, important movement toward adaptation planning is now observable at the federal level, both in the legislative and executive branches (and the research arm thereof). While federal

efforts are still in the early stages, there is considerable more activity at this time than suggested in Repetto's (2008) assessment. Long-term observation, as well as the statements and findings in published documents cited here, suggest that a number of factors have delayed concerted attention to adaptation until recently. These barriers (Table 1) are only beginning to be overcome.

In the future, changes at the federal level have to be carefully reviewed and coordinated with state-level efforts (and vice versa) to ensure that federal adaptation approaches and compliance obligations will not counteract, hinder, or delay state adaptation planning attempts.

State Planning for Climate Change Impacts

Ironically, some of the earliest evidence of U.S. states beginning to address and plan for the impacts of anthropogenic climate change comes from states which received federal financial and/or technical assistance to assess impacts and vulnerabilities (see, e.g., Moser 2005). In other instances states' interest in adaptation has its roots in the federally sponsored First U.S. National Assessment of the Potential Consequences of Climate Variability and Change (conducted between 1997 and 2001 with a deliberate focus on sectors and regions) (National Assessment Synthesis Team 2000). In yet other instances, state and regional efforts evolved locally out of existing concerns with climate variability (as, e.g., in the Pacific Northwest, see Mote et al. 2003; Snover, Miles, and Hamlet 2003) or in response to experiencing severe climate-related disasters, in the larger context of the changing public discourse described above. Several states initiated their adaptation efforts while, or subsequent to, writing their climate action plans, typically with state agency staff, non-governmental advocacy groups, or scientists taking the lead in advocating for attention to adaptation. In all cases, however, the state and regional adaptation planning now evident and underway is not a federally guided or coordinated effort, and while states make every effort to creatively finance adaptation planning, including where possible with federal money through existing programs and allocations⁸, the bulk of the necessary resources, leadership, and staffing comes from the state level.

There is considerable regional variation in the level of effort and recognition of the need for adaptation as a complementary strategy to mitigation. As was the case with the development of climate action plans involving voluntary and mandatory emission reduction policies, adaptation planning over the last few years has tended to appear first on the political agendas in some of the Northeastern and western coastal states. By contrast, most Midwestern, central, and Gulf states (with few exceptions) have not yet officially announced efforts to begin adaptation planning. According to the Pew Center for Global Climate Change, seven states – Arizona, Colorado, Utah, Arkansas, North Carolina, South Carolina, and Vermont – currently recommend creating plans for adaptation in their climate action plans. Since the Pew Center's review, Connecticut, Minnesota, and Illinois have joined this group of states or have begun more extensive adaptation planning (Dinse, Read and Scavia 2009; Don Wuebbles, pers. comm. to author April 2009; and <http://www.ctclimatechange.com>).

Eight states have launched more comprehensive assessment and planning efforts parallel to their mitigation activities – Alaska, California, Maryland, Oregon, Florida, Washington, Massachusetts and New Hampshire (Pew Center on Global Climate Change 2008; see Appendix 2).

⁸ For example, President Obama's first budget proposal increased funding for adaptation for federal and state land management. The budget allocation for the Department of the Interior, for example, recognizes the need for a better scientific understanding of climate change impacts on fish and wildlife, monitoring, and safeguarding land and habitat to allow species to migrate. The funds to be allocated are to be shared with the states to support wildlife adaptation (information provided by Peter LaFontaine, NWF, pers. comm. to author, April 2009).

More than a dozen states are currently revising their state climate action plans or are charged under various executive orders to develop such plans and can be expected to follow the lead of one or the other group of states (e.g., Virginia, Kansas, Michigan, and Wisconsin). Appendix 2 summarizes the efforts of those with the most concerted efforts to date.

In addition to state-by-state efforts, supra-state organizations are also recognizing, supporting, and fostering attention on adaptation, though concrete action to date is very limited. For example, the Western Climate Initiative – a state-coalition including Arizona, New Mexico, Oregon, California, Utah, Washington, and Montana (as well as four Canadian provinces), with six more Western U.S. states, one Canadian province, and six Mexican states observing, not only focuses on regional greenhouse gas emissions reductions, but has also agreed to work jointly to identify measures to adapt to climate change impacts. Likewise, the U.S. National Governors' Association (NGA) recently adopted a policy position (primarily focused on coastal and ocean management) that called on the NGA and individual states to advocate for the creation of a national strategy for climate change adaptation (NGA 2009).

States with comprehensive efforts underway initiated those no more than two or three years ago, adding further weight to the central argument of this report that the U.S. is in a period of rather sudden awakening to the need for adaptation. This argument notwithstanding, it would be a mistake to overlook the many earlier, often sector-specific policies which preceded the more comprehensive efforts or which exist outside official state climate action plans. Regionally, for example, one early published recognition of the need for adaptation appeared in the New England states, when the New England Governors' and their counterparts across the Canadian border released their regional climate action plan in 2001. Action Item 7 in that plan called for the reduction and/or adaptation of negative social, economic and environmental impacts of climate change (New England Governors/Eastern Canadian Premiers 2001). As a non-binding document, this call to action led to a workshop on the topic in 2004 and may have inspired some of the adaptation planning efforts now underway in that region, but – given the unevenness across New England – did not have a consistent policy-initiatory impact on state actions.

Dispersed state efforts can be found across the U.S., though a systematic compilation does not currently exist.⁹ Some highlights thus must suffice. Maine, for example, does not currently have a statewide adaptation plan or policy (though has recognized the need), but the state was the first in the U.S. to revise its coastal law to include anthropogenically driven sea-level rise. Its Sand Dune Rules were first changed in 1988 and revised in the years since, mostly not out of concern for climate change impacts, however, but as a way to limit coastal development in hazardous areas (Moser 2006, 2005). In 1995, with federal funding, Maine completed one of the earliest state-specific assessments of the potential impacts of sea-level rise, which have not led to additional policy changes, but helped defend the Sand Dune Rules when challenged. Several other coastal

⁹ Several independent efforts have been made or are underway to remedy this situation: The U.S. Department of Energy's Integrated Assessment Research Program is supporting the development of a web-based, searchable data base on climate change adaptation processes and practices to be compiled at Oak Ridge National Laboratory (Adaptation Network 2008). A second searchable data base of US state and local adaptation initiatives has been created by the University of Washington Climate Impacts Group (<http://cses.washington.edu/cig/cases/home>); most entries to date are impact assessments, but reveal additional activity not captured by the Pew Center's compilation (Pew Center on Global Climate Change 2008), nor in the survey compiled by the Heinz Center (Perkins, Ojima, and Corell 2007), and goes beyond the partners of ICLEI's or the Center for Clean Air Policy's programs (see section on local initiatives). A new clearinghouse focused on state and federal adaptation activities is currently being established at Georgetown University (The *State-Federal Climate Resource Center* at the University's Law Center) under the leadership of former Pew Center Director of Policy Analysis, Vicki Arroyo (for more information see: <http://www.law.georgetown.edu/gcc/index.htm>). It is highly probable that far more efforts have been initiated, even if they are relatively minor (still).

states have begun incorporating climate change impacts and sea-level rise into their coastal management plans or have established Task Forces to develop policies and rules, even in the absence of a comprehensive state adaptation policy. North Carolina, for example, received a \$5 million grant from FEMA in early 2009 for a statewide risk assessment and demonstration of strategies to mitigate the impacts of climate change-induced sea-level rise; the results of the study are to be shared with other coastal states and will be used by the federal agency to assess the fiscal implications of sea-level rise on emergency response and on the National Flood Insurance Program (FEMA 2009). Other state coastal planning efforts explicitly focused on accelerating sea-level rise include New York, Rhode Island, Delaware, and several coastal authorities in California (Pew Center on Global Climate Change 2008; Coastal States Organization 2007, 2008; Rubinoff, Vinhateiro, and Piecuch 2008). For example, the California Coastal Conservancy incorporated 13 objectives in its 2007 Strategic Plan which require the state agency to consider the best available science on climate change in the design, siting and management of infrastructure, and natural resource projects (California Climate Action Team 2009, pp.3.1-3.2). Most of these early efforts, however, have not fundamentally changed coastal hazards management approaches.¹⁰

A similar picture emerges for the water sector. Many states faced with drought in recent years have established drought plans. New Mexico's Drought Plan, revised in 2006, acknowledges climate change as an issue, but does not – like all other such plans – explicitly account for climate change in its drought planning, monitoring, or preparedness efforts (New Mexico Drought Task Force 2006). The state's Drought Management Task Force is involved in assessing the state's vulnerability to drought and its ability to manage supply shortages but climate change rarely enters the discussions (G. Garfin, pers. comm. to author, March 2009). In Arizona, water managers from local, state, tribal and federal institutions came together in 2008 to discuss adaptation strategies and, specifically, ways to improve manager's access to useful decision support (Garfin et al. 2008). California's Department of Water Resources (DWR) has been concerned with climate change for several years, included it already in its 2005 State Water Plan Update, and in 2006, released a report reflecting the agency's progress in incorporating climate change into ongoing planning and management efforts (California DWR 2006, 2005). The Agency's 2008 White Paper on adaptation proposes bold general strategies, illustrating DWR's commitment, but the suggested changes are still in the planning stages and implementation has yet to pass challenging state budget hurdles and stakeholder concerns (California DWR 2008a). Moreover, DWR – like many other state agencies elsewhere in the U.S. – seems to perpetuate the view that “standard” water management strategies, maybe augmented by technological innovations or improvements (e.g., efficiency, desalination), will be sufficient for adaptation if only they were applied more broadly than at present (e.g., California DWR 2008b, see esp. pp.54-56).

Numerous other examples from other sectors could be cited, including North Carolina's efforts in developing decision support tools for agriculture to help farmers with crop management in the face of a changing and variable climate; Maine's efforts to understand the potential impacts of climate change on forests and explore the adaptation options to minimize the risk of forest fires; the California Department of Fish and Game's 2005 Wildlife Action Plan, which identified climate change as one of four primary stressors affecting wildlife and which made recommendations on how to incorporate climate change in the state's restoration efforts (California Department of Fish and Game 2005). Already in 2003, the California Department of Forestry and Fire Protection considered the effects of climate change in its Fire and Resource Assessment Report and will do so

¹⁰ See NOAA Coastal Services Center (2009) for several additional state examples. Many of those, however, while billed as local strategies for addressing climate change, are predominantly examples of using existing or novel programs to deal with ongoing climate variability and related hazards. While undoubtedly valuable for adapting to anthropogenic climate change, this report focuses mainly on deliberate and explicit efforts to plan for and manage impacts from anthropogenic climate change.

again in its 2009 update (California Climate Action Team 2009, p.3.1). Massachusetts is also engaged in species preservation and habitat conservation planning that aims to take climate change into account (Galbraith 2008). In fact, most wildlife and ecosystem adaptation efforts to date are essentially habitat restoration efforts (Peter LaFontaine, Mike Dettinger, and Gregg Garfin, pers. comm. to author, March 2009).

In some instances, states are collaborating on sector-specific issues that concern them regionally. For example, in the American West, water managers are collaborating and sharing information regionally (e.g., in the 2008 workshop on adaptation in the water sector, co-sponsored by the Governors' Association, Western States Water Council and the California Department of Water Resources). Similarly, in the Great Lakes region, Midwestern states and Canadian provinces have expressed concern over the impact of climate change on their joint water basin (though concrete adaptive management actions have not yet been specified) (Dinse, Read, and Scavia 2009). In the Northeast, coastal managers have come together under the auspices of the Northeast Regional Ocean Council to exchange information, learn from each other, and form coalitions to bolster and implement regional coastal management initiatives (NROC 2008).

Many of these early state efforts share an initial focus on assessing – quantitatively where the science allows, but sometimes only qualitatively – the potential or most critical impacts of climate change on key resources and assets of each state. They typically also recognize that their territories, sectors, and communities will be affected differentially by climate change and that the ability to respond to climate change varies within and across entities. Only a small number of state efforts to date involve vulnerability assessments informed by social science (e.g., Maryland), clearly reflecting the common lack of scientific information on local or system-wide vulnerabilities as well as the lack of expertise among staff and many consultants to assess them. Most state strategies recognize that adaptation involves costs and that these costs, while not trivial by any stretch of the imagination, are likely to be lower than “doing nothing” and confronting the impacts unprepared. Recognizing that the past is no longer an adequate guide to the future, existing state plans call for more monitoring, research to improve scientific understanding, new planning guidelines, and more flexible procedures. They also recommend improving the preparedness for already apparent climate risks while limiting future liabilities by preventing more people and assets being put at risk. In light of considerable uncertainties and lack of knowledge, most initial state adaptation strategies thus consist of best practices, efforts to avoid future harm, win-win strategies that appear robust in the face of a range of climate futures, ways to improve preparedness, build adaptive capacity, and remove barriers to implementing adaptation strategies. There is also a growing recognition for the need to educate and engage the public on adaptation, a challenging task as hardly any opinion and communication studies exists to date regarding how the public thinks and feels about adaptation (exceptions are Oregon and Maine, where the opinions of selected coastal stakeholders were explored; see Cone et al. 2008; Center for Research and Evaluation 2008).

Even in states and agencies where adaptation strategies are being developed, it is important to recognize that institutions consist of many individuals and agency staff's willingness to consider climate change in strategic or operational decisions varies considerably. Political leadership, likewise, makes a decisive difference as to what agency staff perceive as “politically feasible”, even if they themselves are very interested and committed (Moser 2009). These internal dynamics should not be underestimated in their impact on the policy process and proposals ultimately put forward. It is not surprising therefore, at this early stage, that most state adaptation strategies to date do not fundamentally stray from previous policies and recommendations. Rather, adaptation plans most commonly use climate change as justification to do (or pursue) no-regrets (or at most low-regrets) policies that officials believe should be implemented independent of whether or not the climate is changing.

States face many of the same barriers encountered at the federal levels, and face some *because* of the lack of federal action (see Table 1 above). For example, lack of federal leadership and lack of funding has led to states lacking federal guidance, and the monetary assistance to begin adaptation planning. Table 2 lists some additional observed and documented barriers to state adaptation planning.

Table 2: Selected Observed and Documented Barriers to State Adaptation Planning
1. <i>Lack of federal guidance</i> – States have not yet received federal guidance or other broad and varied support (e.g., in the form of policy guidelines, financial support, technical assistance, standard climate change scenarios, climate services, or planning requirements.
2. <i>Lack of state-level leadership</i> – State-level leadership (either from the governor, the state legislature or among agency heads) has varied considerably, and in the majority of states has been missing to date.
3. <i>Lack of state- and regionally specific scientific information</i> – Even those states that have begun state-specific impacts/climate risk assessments and adaptation planning have bemoaned the lack of state-specific climate projections, much less probabilistic information, or socio-economic information. Support is needed for decision-scale relevant climate change projections, vulnerability and adaptation options and feasibility assessments, observations of current conditions, policy tools and action inventories; and continuing monitoring capabilities, in addition to fundamental adaptation research.
4. <i>Budget constraints</i> – States have been severely constrained, especially during the economic crisis of 2008-2009, to fund additional climate change and adaptation-relevant research, much less provide additional funds for state agencies to conduct assessments, develop adaptation strategies or implement actions above and beyond existing state programs.
5. <i>Reliance on historical conditions</i> – States continue to base most of their decisions on historical data, averages, and observations. Uncertainties about future conditions have more often than not led to conservative adherence to known procedures than to a shift toward risk management.
6. <i>Lack of public awareness, engagement, pressure</i> – States that have begun planning for adaptation have done so largely without grassroots pressure. The public, while superficially aware of potential impacts, is not yet concerned about local impacts, and has yet to be engaged more fully on the needs and challenges of adaptation.

Sources: GAO (2009), Moser (2009), Tribbia and Moser (2008), Pew Center on Global Climate Change (2008), and additional author observations (barriers are additional to and interacting with those mentioned in Table 1).

Local Adaptation Efforts

Local adaptation initiatives much resemble those at the state level and for some of the bigger metropolitan areas, such as New York City or Chicago, they are hardly less complex or challenging. These efforts can be grouped into three categories (Appendix 3): (1) those initiated and supported by the Center for Clean Air Policy (CCAP) with funding, since 2008, through the Rockefeller Foundation's Climate Change Resilience Initiative; (2) those initiated and facilitated by ICLEI-Local Governments for Sustainability; and, finally, (3) independent efforts, several of which are closely related (through scientific support, staffing, and the underlying political mobilization process) to

regional assessments previously conducted as part of the National Assessment (e.g., New York City); regionally based, NOAA-sponsored Regional Integrated Sciences and Assessment (RISA) centers (e.g., King County, WA); or other regional assessments (e.g., Chicago). Emerging efforts not tied to any of these mechanisms remain the most difficult to track.

As Appendix 3 suggests, communities of all sizes – from tiny villages at the Arctic shores of Alaska to metropolitan Boston, New York, and Miami – have begun assessing their physical vulnerabilities and develop an initial set of strategies to reduce them. If this list of two dozen localities is indicative of the larger universe of U.S. cities concerned with adaptation at this time, they appear to be among the pioneers because of their perceived or already experienced vulnerability to climate variability and change, their previous engagement (and often leadership) in climate mitigation policy, and the presence of the above-mentioned supportive or facilitative organizations and experts.

Typically done in collaboration with locally-based university researchers and consulting teams, most of these cities' adaptation plans initially focus only on a few high-risk areas. Coastal New York City, not surprisingly, focuses primarily on protecting its critical infrastructure from sea-level rise and storm surges (e.g., sewer and wastewater treatment systems, subways, airports and power plants), but also on establishing an ongoing adaptation process that involves neighborhood and environmental justice groups (Rosenzweig et al. 2007; City of New York 2007). Boston, San Francisco and Seattle share similar infrastructure concerns. Chicago's adaptation plan focuses primarily on reducing vulnerability to extreme heat events, stormwater management, reducing the impacts from extreme events on buildings, infrastructure and equipment, and on protecting urban ecology (Parzen 2008). None of these large metropolitan areas is seriously considering relocation. By contrast, several of the Alaska communities listed are actively in the process of relocating their villages further inland as coastal erosion threatens to completely destroy their homes.

Some cities have only begun to set an adaptation process in motion (e.g., Los Angeles, CA; San Francisco, CA; Guilford, CT), while others have only commissioned comprehensive impacts assessment to date, but have not yet changed local policies (e.g., San Diego, CA, Aspen, CO). A small number of cities astonish, by contrast, by the level of detail and by how long they have been thinking about adaptation issues (e.g., King County, WA; Keene, NH; Miami-Dade County, FL). The South Florida Regional Planning Council – which includes representatives from the climate-progressive Miami-Dade County – offers, for example, an extensive “Climate Change Community Toolbox” with basic factsheets, numerous adaptation-related resources, and coastal “vulnerability” (exposure) maps under different amounts of sea-level rise (see: <http://www.sfrpc.com/climatechange.htm>). Boston, MA, for example, while only recently engaging in a comprehensive adaptation planning effort, built its Deer Island sewage treatment plant back in 1993 already taking climate change-driven sea-level rise into account. San Francisco Bay's coastal management agency – the Bay Conservation and Development Commission – has been assessing sea-level rise risks for two decades, but because of its very limited regulatory power has focused most of its efforts on generating scientific understanding, and raising awareness to the inevitable challenges associated with sea-level rise. Besides recently producing detailed inundation maps, it has been a driver in educating local governments around the Bay about risk and vulnerability assessments, providing discussion for a, and engaging in international partnerships with Dutch research centers to explore creative and effective adaptation strategies (http://www.bcdc.ca.gov/planning/climate_change/climate_change.shtml; see also: <http://risingtidescompetition.com/>). The multi-agency regional management agency CALFED and a Governor-appointed Blue Ribbon Task Force has begun exploring the implication of climate change for the San Francisco Bay–San Joaquin Delta region and in its vision and strategic plan recognizes the need for climate-cognizant adaptive management (Delta Vision Blue Ribbon Task Force 2007, 2008). Dettinger and Culberson (2008) have proposed a number of strategies to integrate climate

change and sea-level rise projections into regional ecosystem and resource management decisions but all these proposals remain – to date – in the planning stages.

In the rebuilding efforts along the Gulf of Mexico after hurricanes Rita and Katrina, extreme weather events, climate variability and climate change have risen in people's awareness. According to Savonis, Burkett and Potter (2008, p. 5-9), the metropolitan transportation plan for the New Orleans region has been refined post-Katrina to provide a framework in which projected climate change impacts can be assessed and addressed. Important bridges and highways damaged in Katrina are being rebuilt at significantly higher elevations (though whether climate change and accelerated sea-level rise or the hurricane was the primary driver behind that decision is unclear). The Houston-Galveston Area Council has begun considering climate change in a regional visioning exercise, at least in public discussions. At the same time, planners, transportation officials, engineers and employees of regional port authorities interviewed for that study varied in their assessment of how important climate change had become in local and regional planning and decision-making (Savonis, Burkett and Potter 2008, pp. 5-10 to 5-13).

In addition to these locally focused and based adaptation initiatives, several organizations representing local interests – parallel to the state level – beginning to become increasingly interested in adaptation. For example, the Conference of Mayors established its "Climate Protection Center" in 2007 (see: <http://usmayors.org/climateprotection/about.htm>) – a resource center primarily to provide support and guidance to mayors across the U.S. on greenhouse gas emissions, but increasingly interested in adaptation as well (J. Foster, pers. comm. to author, March 2009). The National Association of City and County Health Officials (NACCHO) is particularly outspoken on urging governments at all levels to prepare for the public health impacts of climate change (see: <http://www.naccho.org/topics/environmental/climatechange/>).

Based on personal observation and reflections shared by participating scientists and staff in several of these local initiatives, the initial emphasis in local adaptation planning typically is on operations of the local jurisdiction, public lands, or municipality or county-controlled processes, bringing staff and political leaders on board with adaptation while engagement of citizens is at least initially relatively limited. In an ongoing, iterative process, where all involved still have to learn about adaptation, this may be appropriate at the outset, and communities, local (and state) managers are aware of the need for, but not necessarily certain about the ways of, effective citizen involvement. It remains to be seen how governments proceed to fully and meaningfully engage their communities in shaping future adaptation strategies.

Additional reflections on these local initiatives indicate a range of benefits of being part of a learning network that allows lessons, approaches, tools, and expertise to be exchanged. In addition, an external organizational sponsor can help maintain motivation and provide a central focal point that facilitates the sharing of information (Lowe, Foster and Winkelmann 2009). Table 3 lists some of the early lessons learned from community efforts.

Table 3: Early Lessons from the “Urban Leaders Adaptation Initiative”	
1.	<i>The importance of leadership</i> – The presence of an adaptation champion at the top levels of local government has proven essential to stimulate public interest, increase buy-in, support funding commitments, and maintain momentum.
2.	<i>A functional organizational structure</i> – Administrative subdivisions of local government can be useful to focus adaptation efforts, but cross-departmental working groups are needed to address cross-cutting impacts, leverage resources and expertise, and ensure integration.
3.	<i>The need from federal agencies for actionable science</i> – Regional to local scale specific climate change information as well as other kinds of data that can be integrated at the local scale (e.g., in common platforms such as GIS) increases usefulness, accessibility, and relevance.
4.	<i>The need for downscaled climate change information to relevant scales</i> – Some, but not all, local communities have been able to obtain downscaled climate change data. Additional locally relevant information is needed from the social, economic and ecological sciences.
5.	<i>Collaborating with local universities</i> – Access to the relevant and needed knowledge base is best achieved through collaboration with local universities. Independent, credible and relevant information is best developed in partnership of scientists and decision-makers.
6.	<i>The value of networking for exchange of knowledge and experiences</i> – Evidence from the interaction among Urban Leaders suggests that formal and informal sharing of ideas, tools, knowledge, experience, and approaches is useful and a highly valued opportunity.
7.	<i>Financial support for regional and local adaptation</i> – Limited funding is one of the greatest challenges communities face in developing and implementing adaptation strategies. Federal and state sources can and should support local efforts through reliable funding.
8.	<i>Addressing the perceived and real competition between mitigation and adaptation</i> – Even if mitigation and adaptation are complementary and equally necessary, perceptions of competition persist, and staff resources and funding are limited. Emphasis on synergies help.
9.	<i>Higher level governments can enable local adaptation action</i> – Funding and regulatory mechanisms at the federal and state level can and should be used to enable local governments to plan for adaptation and build climate change into ongoing decisions.
10.	<i>A call for urban climate services and extension services</i> – Urban Leaders support the creation of a national initiative on providing climate services, and build networks of decision support providers, connecting the extension model with community development and education.
11.	<i>Avoiding regulatory and cross-jurisdictional conflicts</i> – As much as higher-level governance mechanisms can enable local action, they can also be at cross-purposes, delay or hinder local adaptation efforts. These constraints and barriers must be assessed and removed.
12.	<i>Exploring policy and regulatory opportunities</i> – Opportunities exist and should be used to end perverse subsidies, cease incentives that place people/assets at risk, invest in climate-related business opportunities, (re)train professionals, and mainstream climate into existing laws.

Source: Adapted from Lowe, Foster and Winkelman (2009), GAO (2009), and author observations

Those local efforts undertaken independently may lack some of the benefits of being part of a learning network of communities beginning to adapt.

Non-State Actors and the Emerging Actor Network

The general lack of widespread citizen-involvement in U.S. adaptation planning to date notwithstanding, one of the remarkable characteristics of the rapid awakening in the U.S. to the need for adaptation is the strong role that non-state actors have and continue to play in bringing about this mobilization and in assisting communities and states. The major categories of such actors are non-governmental organizations, scientists, and consultants, with professional organizations (such as coastal, floodplain, water and conservation managers, or insurance commissioners) also playing an important networking and information disseminating role.

The active engagement, if not initiative, from some of the advocacy groups in the last few years is surprising at first given the stance many of them held historically toward adaptation as a form of capitulation (see discussion above). It is less surprising, however, considering that several of these groups have either strong conservation interests – such as the World Wildlife Fund or The Nature Conservancy – and as such are themselves already confronted with managing climate change impacts on their land holdings or, as in the case of the National Wildlife Federation, see opportunity in engaging their membership on climate change by way of their direct exposure to noticeable changes in the environment. TNC, as one of the largest private holders of conservation land in the US, is not only addressing adaptation needs on its own land, but its scientific staff are working closely with local communities in developing strategies for ecosystem management. In New Mexico, for example, the organization has been able to hire a research fellow through dedicated donor funding, produced several reports, convened a stakeholder workshop, and embarked upon a new project to implement specific climate change adaptation measures for ecosystems in the Four Corners region since 2006 (http://nmconservation.org/projects/new_mexico_climate_change/; see also McCarthy et al. 2007, 2008).¹¹

Another conservation group – the National Wildlife Federation (NWF) – has also been very active on climate change impacts at the regional level and – more recently - specifically on adaptation (see the regional impacts reports and related work toward adaptation options at: <http://www.nwf.org/globalwarming/globalwarmingresources.cfm>). In February 2009, together with the National Council for Science and the Environment (NCSE)'s Wildlife Habitat Policy Research Program, NWF organized a conference entitled “Adaptation 2009: Safeguarding Fish, Wildlife and Natural Systems in the Face of Climate Change.” Conservation professionals discussed research findings, programmatic experiences, and science, policy and funding needs for adaptation management of wildlife and natural habitat (see: <http://ncseonline.org/WHPRP/NWF/Adaptation2009/>). In advance, NWF had prepared a review of the literature on adaptation in the conservation area and interviewed dozens of conservation managers on challenges and experiences – a helpful overview and entry for others, and useful guide to federal policy needs (Glick, Staudt and Stein 2009; Theoharides et al 2009; NCSE 2009).

The Union of Concerned Scientists (UCS), while once hesitant to focus on adaptation because of the potential distraction from mitigation, has changed its stance over the years due to its commitment to representing the state of the science (e.g., IPCC views on the dual need for mitigation and adaptation) and through its leadership over more than a decade on several regional impacts assessments across the U.S. which increasingly brought attention to impacts and the need to address them with adaptation. UCS's assessments have played initiatory and facilitative roles in

¹¹ This work has been undertaken in cooperation with CLIMAS – the RISA center of the Southwest, and the Institute for the Study of Planet Earth (both based at the University of Arizona, underlining the notion proposed in this section of emerging networks of diverse actors initiating and engaging in adaptation planning.

several local and state adaptation efforts (e.g., in California, the Great Lakes region (Chicago), the Gulf of Mexico and across the Northeast).

Aside from their traditional roles, some NGOs serve important clearinghouse roles regarding adaptation (e.g., the Pew Center for Global Climate Change or the virtual Adaptation Network [<http://adaptationnetwork.org>]). Others have emerged as active partners in adaptation, such as the Center for Clean Air Policy (CCAP) and ICLEI-Local Governments for Sustainability. As described above in the section on local initiatives, CCAP is working with nine U.S. cities (and one Canadian city, Toronto) in its “Urban Leaders Adaptation Initiative” to help operationalize key steps in the adaptation process and ensure that one or more policies or programs get implemented locally. Its role, however, is broader in that CCAP educates and advocates for the development of national adaptation policy and programs and helps disseminate lessons learned and success stories to other local communities (see the report by Lowe, Foster, and Winkelman [2009], which captures early lessons learned from participating cities). Similarly, ICLEI began assisting local governments on adaptation questions after years of experience with helping cities commit to mitigation. By working with several pilot communities, the organization developed its Climate Resilient Communities™ Program, which now appears to have expanded its efforts. Maybe most notable is ICLEI’s collaboration with King County, WA and the University of Washington’s Climate Impacts Group to develop a procedural guidebook for local, regional, and state governments on how to begin preparing for the impacts of climate change (Snover et al. 2007). NOAA funded the preparation of this freely available handbook and was actively involved in creating and supporting ICLEI’s Climate Resilient Communities project from which this book emerged.

In addition to environmental groups, some business alliances are also emerging as important non-state actors in the adaptation arena. For example, in 2007, the eight largest US water utilities launched the Water Utility Climate Alliance (WUCA) – a coalition advocating for more research on climate change impacts on the water sector and commenting on federal climate and water policy and research proposals (see: <http://www.wucaonline.org/html/>). The Association of Metropolitan Water Agencies (see: <http://www.amwa.net/cs/climatechange>) and the American Water Works Association (see: <http://www.awwa.org/awwa/community/links.cfm>) are also increasingly interested. In March 2009, the National Association of Insurance Commissioners also adopted a mandatory “climate change risk disclosure” requirement, demanding that insurance companies across the United States report on the financial risks they face from climate change and what actions companies are taking to protect themselves against them. Observers of the industry expect this much-debated motion to strongly affect all climate-sensitive construction, development, and economic activity (see: <http://www.ceres.org>; Mills 2009).

Only regionally or locally active NGOs occasionally play prominent roles as well, such as Clean Air – Cool Planet in the Northeast, or the Public Policy Institute of California (see its recent adaptation-focused report on California, (Bedsworth and Hanak 2008) in collaboration with Next10, who also sponsored an economic assessment of climate impacts and adaptation options (Kahrl and Roland-Holst 2008) – all have become active on adaptation only in the last few years. In Texas, the Texas Climate Initiative, a project of the Houston Advanced Research Center (see <http://www.texasclimate.org>), has also begun discussing adaptation as a needed “climate solution,” thus helping to open up and frame the discourse there.

In most cases, the NGOs are either themselves very science-focused or work closely with local scientists in assisting governments in their initial adaptation plans. The acknowledgement section of any existing adaptation plan reflects this large collaborative effort between engaged scientists, career staff, political leaders, NGO representatives, and other technical experts. Some of these collaborative efforts spawn valuable new information sources on adaptation (see, e.g., <http://www.climateandfarming.org/index.php>, meant to assist adaptation in the agricultural sector of the Northeast). A cadre of consultants plays a significant role in providing some of the needed

technical assistance and in facilitating adaptation planning processes. For example The Center for Climate Strategies has informed and facilitated adaptation processes in Maryland, Alaska, and other states (<http://www.climatestrategies.us>); many other consulting firms have quickly recognized adaptation as a “growth industry,” but expertise is quite variable across these companies. Most desperately missing is in-depth knowledge of the (social science) adaptation literature, reflecting again, the general lack of this type of expertise as communities and states begin to manage the unavoidable impacts of climate change.

The emerging actor network described here is rapidly growing and nodes of interaction are multiplying with every new initiative launched. In this time of mushrooming interest in adaptation, it appears that one (and maybe the most) significant “bottleneck” to increasing U.S. preparedness still lies in adaptation-specific expertise. This bottleneck stems from the limited U.S.-specific literature on vulnerability and adaptation, the lack of research funding and data gathering, the general dearth of social science expertise in government agencies, a comparatively small number of university scientists working in this area and/or willing to engage in policy-relevant work, and the limited capacity in this area of specialization in consulting firms. As a consequence, the burgeoning U.S. adaptation efforts are at once a welcome development and at risk of being under-informed, done hastily, or simply done without the benefit of all the appropriate expertise at the table.

Conclusion: Entering into a “Period of Consequences”

This report has taken a cursory survey of adaptation-related activity currently underway in the United States. Ranging from the treatment of the topic in the news media to the drafting of bills in Congress, to state and local government activities with considerable engagement of NGOs, scientists and consultants, it has become apparent that adaptation has finally, and explosively, emerged on the political agenda as a legitimate and needed subject for debate. At the same time, the current policy rush is not underlain by widespread public engagement and mobilization nor does it rest on a solid research foundation. Funding for vulnerability and adaptation research, establishing adequate decision support institutions, as well as the building of the necessary capacity in science, the consulting world, and in government agencies, lags far behind the need.

The inevitability of climate change impacts now conveyed through the media and other scientific communication, and conspicuous events such as Hurricane Katrina and Al Gore’s *An Inconvenient Truth* have helped to “legitimize” adaptation as a necessary complement to mitigation. Nevertheless, realization of the magnitude of the challenge is still very limited. Not surprisingly, the adaptation initiatives evident to date consist of relatively conservative, win-win, and low-risk strategies.

In addition to tracing this history, this report identifies a number of barriers to basic adaptation planning and more ambitious policy developments. At the federal level, such barriers include: lack of federal leadership until recently (by Congress, the president, and agencies); lack of funding for research and planning; political opposition; ignorance; lack of intra- and interagency coordination, communication, and collaboration; competing priorities; lack of adaptation mandates; and legal constraints. These barriers do not only affect what does or can happen at the federal level but influence lower levels of government as well. For example, federal failure to take on adaptation leaves states without federal guidance and financial support, adding to the budget constraints that states face already. In addition, states face their own hurdles, including lack of state-level leadership, lack of state- and regionally specific scientific information, lack of expertise within state agencies, reliance on historical conditions, as well as lack of public awareness, engagement, and pressure to make adaptation a policy priority. At the local level, adaptation efforts by cities and counties can be hampered additionally by lack of a functional organizational structure, lack of

collaboration with local universities and experts, isolation, and either real or perceived competition between mitigation and adaptation. Cross-scale barriers arise from regulatory and cross-jurisdictional conflicts and missed policy opportunities. In particular, the mismatch between the lack of, and the need for, scientific capacity, technical expertise and widespread, scale-relevant climate change and vulnerability information, America is now entering into an era of climate change consequences for which the country is ill-equipped.

These findings fly in the face of long-standing, and all too simplistic, assumptions that developed nations like the U.S. face relatively low vulnerability and possess high adaptive capacity to address climate change. Rather, concerted effort will be needed to assess vulnerabilities, ascertain adaptation options, and determine relevant governance barriers at and across scales, and build the necessary capacity, skill, resource base, institutional mechanisms, and political will to help reduce and overcome them.

A delicate balance must be struck at this time between initiating (and endorsing the establishment of) ongoing adaptation planning processes and making only common-sense and relatively small if meaningful policy and programmatic commitments rather than over-promise or commit large resources to ill-advised actions. Governments and stakeholders should assume that changing scientific understanding and non-stationary environmental and societal conditions will require considerable policy flexibility, debate over difficult challenges and painful trade-offs.

Meanwhile, a serious commitment at the highest levels is required to

- rapidly and substantially expand vulnerability and adaptation research,
- build technical capacity within the sciences and among decision-makers,
- expand the nation's decision support capabilities,
- identify ways to provide financial and technical resources to governing institutions, and
- seriously engage the American public in the development and debate of a comprehensive climate risk management strategy.

Without such a commitment, there is considerable danger that America will engage in countless expensive and damaging maladaptations, and/or that sectors and communities will prepare insufficiently for climate change, creating liabilities far more costly than the investment called for now.

References

- Adaptation Network. 2009. *Building Resilience in a Changing Climate*. Available at: <http://www.adaptationnetwork.org/index.html>.
- Adger, W.N. et al. 2009. Are there social limits to adaptation? *Climatic Change* 93 (3-4): 335-354.
- Alexander, A., J. Owers, R. Carveth, C. A. Hollifield, and A. N. Greco eds. 2004. *Media Economics: Theory and Practice*. Philadelphia, PA: Lawrence Erlbaum Associates.
- American Association for the Advancement of Science. 2009. *Climate Change Research Flat in 2008 Budget*. Available from <http://www.aaas.org/spp/rd/ccsp08p.htm>.
- Anderson, K. E., D. R. Cahoon, S. K. Gill, B. T. Gutierrez, E. R. Thieler, J. G. Titus, and S. J. Williams. 2009. *Coastal Elevations and Sensitivity to Sea Level Rise*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 4.1, Washington, DC: Climate Change Science Program.
- Association of State Floodplain Managers. 2007. *National Flood Programs and Policies in Review 2007*. Madison, WI: ASFPM. Available at: http://www.floods.org/Publications/NFPPR_2007.asp.
- Backlund, P., A. Janetos, D. Schimel, J. Hatfield, K. Boote, P. Fay, L. Hahn, C. Izaurralde, B. A. Kimball, T. Mader, J. Morgan, D. Ort, W. Polley, A. Thomson, D. Wolfe, M. G. Ryan, S. R. Archer, R. Birdsey, C. Dahm, L. Heath, J. Hicke, D. Hollinger, T. Huxman, G. Okin, R. Oren, J. Randerson, W. Schlesinger, D. Lettenmaier, D. Major, L. Poff, S. Running, L. Hansen, D. Inouye, B. P. Kelly, L. Meyerson, B. Peterson, and R. Shaw. 2008. *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. *Synthesis and Assessment Product 4.3*, Washington, DC: Climate Change Science Program.
- Bader, D. C., C. Covey, W. J. G. Jr., I. M. Held, K. E. Kunkel, R. L. Miller, R. T. Tokmakian, and M. H. Zhang. 2008. *Climate Models: An Assessment of Strengths and Limitations*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 3.1, Washington, DC: Department of Energy, Office of Biological and Environmental Research.
- Bedsworth, L., and E. Hanak. 2008. *Preparing California for a Changing Climate*. San Francisco, CA: PPIC.
- Beller-Simms, N., H. Ingram, D. Feldman, N. Mantua, K. L. Jacobs, and A. M. Waple. 2008. *Decision-Support Experiments and Evaluations Using Seasonal-to-Interannual Forecasts and Observational Data: A Focus on Water Resources*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 5.3, Asheville, NC: NOAA National Climatic Data Center.
- Boykoff, M. T. 2007a. Flogging a dead norm? Newspaper coverage of anthropogenic climate change in the United States and United Kingdom from 2003 to 2006. *Area* 39 (4):470-481.
- . 2007b. From convergence to contention: United States mass media representations of anthropogenic climate change science. *Transactions of the Institute of British Geographers* 32 (4):477-489.
- Boykoff, M. T., and J. M. Boykoff. 2004. Balance as bias: global warming and the US prestige press. *Global Environmental Change* 14 (2):125-136.
- Burton, I. 1994. Deconstructing adaptation... and reconstructing. *Delta* 5 (1):14-15.
- Burton, I., R. W. Kates, and G. F. White. 1978. *The Environment as Hazard*. New York: Oxford University Press.
- California Department of Fish and Game. 2005. *California Wildlife: Conservation Challenges*. Sacramento, CA: Department of Fish and Game. Available at: <http://www.dfg.ca.gov/wildlife/wap/report.html>.

- California Department of Water Resources (DWR). 2005. *California Water Plan Update 2005: A Framework for Action*. Sacramento, CA: DWR.
- . 2006. *Progress on Incorporating Climate Change into Management of California's Water Resources*. Technical Memorandum Report. Sacramento, CA: DWR.
- . 2008a. *Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water*. Sacramento, CA: DWR.
- . 2008b. *Water and Border Area Climate Change: An Introduction. Special Report for the XXVI Border Governors Conference*. Sacramento, CA: DWR.
- California Climate Action Team. 2009. *Draft 2009 Climate Action Team Biennial Report to the Governor and Legislature*. Sacramento, CA: California Environmental Protection Agency.
- CCSP. 2008. *Uses and Limitations of Observations, Data, Forecasts, and Other Projections in Decision Support for Selected Sectors and Regions*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 5.1, Washington, DC: NASA.
- Center for Clean Air Policy. 2009. *Urban Leaders Adaptation Initiative: Building Resiliency to Climate Change Impacts through Community Action*. Available at: <http://www.ccap.org/index.php?component=programs&id=6>.
- Center for Research and Evaluation, University of Maine. 2008. *Climate Variability and Coastal Community Resilience: Results of Coastal Property Owner and Public Officials Survey*, 51 pp. Orono, ME: University of Maine.
- Churchill, W. S. 1936. *The Locust Years*. Speech before The House of Commons on November 12, 1936. London, UK: The Churchill Society. Available at: <http://www.churchill-society-london.org.uk/Locusts.html>.
- City of New York. 2007. *PlaNYC: A Greener, Greater New York*. New York: City of New York.
- Clark, P. U., A. J. Weaver, E. Brook, E. R. Cook, T. L. Delworth, and K. Steffen. 2008. *Abrupt Climate Change*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 3.4, Washington, DC: Climate Change Science Program.
- Coastal States Organization. 2007. *The Role of Coastal Zone Management Programs in Adaptation to Climate Change*. Final Report of the CSO Climate Change Work Group. Washington, DC: CSO.
- . 2008. *The Role of Coastal Zone Management Programs in Adaptation to Climate Change*. Second Annual Report of the CSO Climate Change Work Group. Washington, DC: CSO.
- Compaine, B. M., and D. Gomery. 2000. *Who Owns the Media? Competition and Concentration in the Mass Media Industry*. 3rd. ed. Philadelphia, PA: Lawrence Erlbaum Associates.
- Cone, J., L. Jodice, J. Borberg, M. Harte, and P. Corcoran. 2008. *SARP Survey Analysis: Climate Change Survey of Oregon Coast Decision-Makers 2008 (Draft of 12/30/08)*. Corvallis OR: Oregon Sea Grant, Oregon State University.
- Croteau, D., and W. Hoynes. 2006. *The Business of Media: Corporate Media and the Public Interest*. 2nd. ed. Thousand Oaks, CA: Pine Forge Press.
- Delta Vision Blue Ribbon Task Force. 2007. *Delta Vision: Our Vision for the California Delta*. Sacramento, CA: Resources Agency.
- . 2008. *Delta Vision Strategic Plan*. Sacramento, CA: Resources Agency.
- Dinse, K., J. Read, and D. Scavia. 2009. *Preparing for Climate Change in the Great Lakes Region*. Ann Arbor, MI: Michigan Sea Grant.
- Dettinger, M. D., and S. Culbertson. 2008. Internalizing Climate Change-Scientific Resource Management and the Climate Change Challenges. *San Francisco Estuary and Watershed Science* 6 (2): Article 5 [<http://repositories.cdlib.org/jmie/sfews/vol6/iss2/art5>].
- Dumanoski, D. 1988. Coastal regions urged to prepare for rising sea level: Planners decry apathy toward greenhouse effect's threat. *The Boston Globe*, December 13:A1.

- Easterling, W. E., B. H. Hurd, and J. B. Smith. 2004. *Coping with Climate Change: The Role of Adaptation in the United States*. Arlington, VA: Pew Centre on Global Climate Change.
- European Commission. 2007. *Adapting to Climate Change in Europe - Options for EU Action*. Green Paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Bruxelles: European Commission.
- Fagre, D. B., C. W. Charles, C. D. Allen, C. Birkeland, F. S. C. III, P. M. Groffman, G. R. Guntenspergen, A. K. Knapp, A. D. McGuire, P. J. Mulholland, D. P. C. Peters, D. D. Roby, and G. Sugihara. 2008. *Thresholds of Climate Change in Ecosystems*. A report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 4.2, Washington, DC: Climate Change Science Program.
- Federal Emergency Management Agency. 2009. FEMA grants \$5 million for sea level rise study in North Carolina. www.fema.gov/news/newsrelease.fema?id=47583, February 24, 2009.
- Galbraith, H. 2008. *Confronting Climate Change - The Challenge of Adaptation: Presentation to the California Climate Adaptation Working Groups on October 23, 2008*. Sacramento, CA. Climate Change Initiative, Manomet Center for Conservation Science.
- Gamble, J. L., K. L. Ebi, F. G. Sussman, and T. J. Wilbanks. 2008. *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 4.6, Washington, DC: Climate Change Science Program.
- Garfin, G., K. Jacobs, and J. Buizer. 2008. Beyond brainstorming: Exploring climate change adaptation strategies. *EOS Transactions of the American Geophysical Union* 89 (25):227.
- Glick, P., A. Staudt, and B. Stein. 2009. *A New Era for Conservation: Review of Climate Change Adaptation Literature*. Washington, DC: National Wildlife Federation.
- Government Accountability Office (GAO). 2007a. *Climate Change: Agencies Should Develop Guidance for Addressing the Effects on Federal Land and Water Resources*. Washington, DC: GAO.
- . 2007b. *Climate Change: Financial Risks to Federal and Private Insurers in Coming Decades Are Potentially Significant*. Washington, DC: GAO.
- . 2009. *Climate Change: Observations on Federal Efforts to Adapt to a Changing Climate*. Testimony before the Subcommittee on Energy and Environment, Committee on Energy and Commerce, House of Representatives on March 25, 2009. Washington, DC: GAO.
- Griffis, R. B., R. L. Feldman, N. K. Beller-Simms, K. E. Osgood, and N. Cyr (eds.). 2008. *Incorporating Climate Change into NOAA's Stewardship Responsibilities for Living Marine Resources and Coastal Ecosystems: A Strategy for Progress*. NOAA Technical Memorandum NMFS-F/SPO-95, Silver Spring, MD: NOAA, National Marine Fisheries Service.
- ICLEI Local Governments for Sustainability. 2009. *Climate Adaptation: Introducing ICLEI's Climate Resilient Communities Program*. Available at: http://www.iclei.org/programs/climate/Climate_Adaptation/adaptation.
- Intergovernmental Panel on Climate Change (IPCC). 2001. Appendix B: Glossary of Terms. In *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, eds. J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken and K. S. White, 981-996. New York, NY: Cambridge University Press.
- Jones, R., and R. Boer. 2005. Assessing current climate risks. In *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*, eds. B. Lim, E. Spanger-Siegfried, I. Burton, E. Malone and S. Huq, 91-117. Cambridge, UK: Cambridge University Press.

- Joyce, L. et al. (forthcoming). Managing for multiple resources under climate change: National forests. *Environmental Management*, revised manuscript submitted.
- Julius, S. H., J.M. West (eds.), J. S. Baron, B. Griffith, L. A. Joyce, P. Kareiva, B. D. Keller, M. A. Palmer, C. H. Peterson, and J.M. Scott (authors). 2008. *Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 4.4, 873 pp. Washington, DC: U.S. Environmental Protection Agency.
- Kahrl, F., and D. Roland-Holst. 2008. California Climate Risk and Response. Berkeley, CA: University of California-Berkeley, Department of Agricultural and Resource Economics.
- Karl, T. R. 2009. Written testimony for the hearing on "Preparing for Climate Change: Adaptation Programs and Policies" before the House Committee on Energy and Commerce, Subcommittee on Energy and Environment, March 25, 2009. Asheville, NC: NOAA, NCDC.
- Karl, T. R., G. A. Meehl, C. D. Miller, S. J. Hassol, A. M. Waple, and W. L. Murray. 2008. *Weather and Climate Extremes in a Changing Climate. Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 3.3, Washington, DC: NOAA, National Climatic Data Center.
- Kates, R. W. 1997. Climate change 1995: Impacts, adaptations, and mitigation. *Environment* 39 (9):29-33.
- Kates, R. W., J. H. Ausubel, and M. Berberian eds. 1985. *Climate Impact Assessment*. New York: Wiley.
- King, J. S. 2008. Call for ideas on living in a warming world: Competition asks designers to 'climate-proof' Bay Area. *The San Francisco Chronicle*, December 19:B1.
- Knuuti, K. 2002. Planning for sea level rise: U.S. Army Corps of Engineers policy. In *Solutions to Coastal Disasters '02*, eds. L. Ewing, L. and L. Wallendorf, 549-560, American Society of Civil Engineers.
- Lowe, A., J. Foster, and S. Winkelman. 2009. *Asking the Climate Question: Lessons Learned in Effective Adaptation from Urban Leaders Partners*. Washington, DC: Center for Clean Air Policy.
- Marsh, G. P. 1864. *Man and Nature: or Physical Geography as Modified by Human Action*. New York: Charles Scribner.
- McCarthy, P., C. Enquist, D. Gori, G. Garfin, T. Sullivan, and D. Bachelet. 2007. *New Mexico Climate Change Ecology and Adaptation Workshop – REPORT*. Albuquerque, NM: The Nature Conservancy.
- McCarthy, P. D., C. A. F. Enquist, and G. Garfin. 2008. Mitigating climate change in the American Southwest. *EOS Transactions of the American Geophysical Union* 89 (1):3.
- McMasters, P. 1989. Topic: The Ozone Shield: Nations must join hands against a global threat. *USA TODAY*, January 4, 1989:11A.
- Miller, H. I. 2007. Global warming resilience required. *The Washington Times*, March 16, 2007:A18.
- Mills, E. 2009. *From Risk to Opportunity 2008: Insurer Responses to Climate Change*. Berkeley: Lawrence Berkeley Laboratory.
- Morgan, G., H. Dowlatabadi, M. Henrion, D. Keith, R. Lempert, S. McBrid, M. Small, and T. Wilbanks. 2009. *Best Practice Approaches for Characterizing, Communicating, and Incorporating Scientific Uncertainty in Decisionmaking*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 5.2, Washington, DC: NOAA.
- Moser, S. C. 2005. Impact assessments and policy responses to sea-level rise in three US states: An exploration of human-dimension uncertainties. *Global Environmental Change Part A* 15 (4):353-369.
- . 2006. Climate Change and Sea-Level Rise in Maine and Hawai'i: The Changing Tides of an Issue Domain. In *Global Environmental Assessments: Information, Institutions, and Influence*,

- eds. R. B. Mitchell, W. C. Clark, D. W. Cash and N. Dickson, 201-239. Cambridge, MA: MIT Press.
- Moser, S.C. 2009. Whether Our Levers Are Long Enough and the Fulcrum Strong? -- Exploring the Soft Underbelly of Adaptation Decisions and Actions. In: *Adapting to Climate Change: Thresholds, Values, Governance*, eds. W. N. Adger, I. Lorenzoni and K. O'Brien, 313-334, Cambridge, UK: Cambridge University Press.
- Moser, S. C., and A. L. Luers. 2008. Managing climate risks in California: The need to engage resource managers for successful adaptation to change. *Climatic Change* 87 (Suppl 1):S309-S322.
- Moser, S. C., and J. Tribbia. 2006/2007. Vulnerability to inundation and climate change impacts in California: Coastal managers' attitudes and perceptions. *Marine Technology Society Journal* 40 (4):35-44.
- Moser, S.C. et al. 2008. Adaptation to climate change in the Northeast United States: Opportunities, processes, constraints. *Mitigation and Adaptation Strategies for Global Change* 13 (5-6): 643-659.
- Mote, P. W., E. A. Parson, A. F. Hamlet, W. S. Keeton, D. Lettenmaier, N. Mantua, E. L. Miles, D. W. Peterson, D. L. Peterson, R. Slaughter, and A. K. Snover. 2003. Preparing for climatic change: The water, salmon, and forests of the Pacific Northwest. *Climatic Change* 61:45-88.
- National Assessment Synthesis Team. 2000. *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change*. Foundation. New York, NY: Cambridge University Press.
- National Council for Science and the Environment (NCSE). 2009. Adaptation 2009: Safeguarding Fish, Wildlife and Natural Systems in the Face of Climate Change: Conference Summary Report Washington, DC: NCSE.
- National Governors' Association. 2009. Policy Position: NR-10. Ocean and Coastal Zone Management, ed. N. R. Committee. Washington, D.C.: NGA.
- National Research Council (NRC). 2003. *Planning Climate and Global Change Research: A Review of the Draft U.S. Climate Change Science Program Strategic Plan*. Washington, DC: National Academy Press.
- . 2004. *Implementing Climate and Global Change Research: A Review of the Final U.S. Climate Change Science Program Strategic Plan*. Washington, DC: National Academy Press.
- . 2007. *Evaluating Progress of the U.S. Climate Change Science Program: Methods and Preliminary Results*. Washington, DC: National Academies Press.
- . 2009a. *Restructuring Federal Climate Change Science*. Washington, DC: National Academies Press.
- . 2009b. *Informing Decisions in a Changing Climate*. Washington, DC: National Academies Press.
- New England Governors/Eastern Canadian Premiers. 2001. *Climate Change Action Plan 2001*. Halifax, NS
Boston, MA: Conference of New England Governors and Eastern Canadian Premiers.
- New Mexico Drought Task Force. 2006. *New Mexico Drought Plan*. Albuquerque, NM: NM Office of the State Engineer.
- NOAA Coastal Services Center. 2009. *Local Strategies for Addressing Climate Change*. Charleston, SC: NOAA CSC.
- Northeast Regional Ocean Council. 2008. *Northeast Region Coastal Hazards Resiliency Workshop Report*. Charleston, SC: NOAA Coastal Services Center.
- O'Brien, K., S. Eriksen, L. Sygna, and L. O. Naess. 2006. Questioning complacency: Climate change impacts, vulnerability, and adaptation in Norway. *Ambio* 35 (2):50.
- Parry, M. L., O. F. Canziani, J. P. Palutikof, P. J. v. d. Linden, and C. E. Hanson eds. 2007. *Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the*

- Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- Parzen, J. ed. 2008. *Chicago Area Climate Change Quick Guide for Municipalities and Other Organizations: Adapting to the Physical Impacts of Climate Change*. Chicago, IL: City of Chicago.
- Pendleton, E. A., S. J. Williams, and E. R. Thieler. 2004. Coastal Vulnerability Assessment of Assateague Island National Seashore (ASIS) to Sea-level Rise. *Open-File Report*. Reston, VA: U.S. Geological Survey.
- Perkins, B., D. Ojima, and R. J. Corell. 2007. *A Survey of Climate Change Adaptation Planning*. Washington, DC: The H. John Heinz III Center for Science, Economics and the Environment.
- Pew Center on Global Climate Change. 2008. *Adaptation Planning - What U.S. States and Localities are Doing (2008 Update)*. Arlington, VA: Pew Center for Global Climate Change.
- Pew Research Center for the People & the Press. 2008. Internet Overtakes Newspapers as News Outlet. Washington, DC: Pew Research Center for the People & the Press; available at: <http://pewresearch.org/pubs/1066/internet-overtakes-newspapers-as-news-outlet>.
- Pielke Jr., R. A., G. Prins, S. Rayner, and D. Sarewitz. 2007. Lifting the taboo on adaptation. *Nature* 445: 597-598.
- Preston, B. L., R. Westaway, S. Dessai, and T. F. Smith. 2009. Are We Adapting to Climate Change? Research and Methods for Evaluating Progress. Paper presented at the *Greenhouse2009* conference, Boston, MA, March 22-26, 2009.
- Rayner, S., D. Lach and H. Ingram. 2005. Weather forecasts are for wimps: Why water resource managers do not use climate forecasts. *Climatic Change* 69: 197-227.
- Repetto, R. 2008. *The Climate Crisis and the Adaptation Myth*. New Haven, CT: Yale School of Forestry & Environmental Studies.
- Rosenzweig, C., D. C. Major, K. Demong, C. Stanton, R. Horton, and M. Stults. 2007. Managing climate change risks in New York City's water system: Assessment and adaptation planning. *Mitigation and Adaptation Strategies for Global Change* 12 (8): 1391-1409.
- Rubinoff, P., N. D. Vinhateiro, and C. Piecuch. 2008. *Summary of Coastal Program Initiatives that address Sea Level Rise as a result of Global Climate Change*. Narragansett, RI Rhode Island Sea Grant/Coastal Resources Center, University of Rhode Island.
- Sacramento Bee. 2002. Chilling fatalism? *Sacramento Bee*, June 5, 2002:B6.
- Savonis, M. J., V. R. Burkett, and J. R. Potter. 2008. *Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, Phase I*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 4.7, Washington, DC: Climate Change Science Program.
- Schuchardt, B. et al. 2008. Adaptation is necessary: Germany in the midst of climate change. Dessau-Roßla Umweltbundesamt, Kompass Kompetenzzentrum für Klimafolgen und Anpassung (Federal Environment Agency Division I 2.1 "Climate Change" Competence Centre on Climate Impacts and Adaptation (KomPass)).
- Smit, B., and O. Pilifosova. 2003. From adaptation to adaptive capacity and vulnerability reduction. In *Climate Change, Adaptive Capacity and Development*, Smith, J.B., Klein, R.J.T., Huq, S. (eds.), 9-28, London: Imperial College Press.
- Smit, B., and J. Wandel. 2006. Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* 16 (3): 282-292.
- Smith, J. B., and D. Tirpak eds. 1989. *The Potential Effects of Global Climate Change on the United States: Report to Congress*. Washington, DC: US EPA, Office of Policy, Planning and Evaluation, Office of Research and Development.

- Snover, A. K., L. W. Binder, J. Lopez, E. Willmott, J. Kay, D. Howell, and J. Simmonds. 2007. *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments*. Oakland, CA: ICLEI- Local Governments for Sustainability.
- Snover, A. K., E. L. Miles, and A. F. Hamlet. 2003. Learning from and adapting to climate variability in the Pacific Northwest. Paper presented at "Insights and Tools for Adaptation: Learning from Climate Variability" Workshop, November 18-20, 2003, in Washington, D.C.
- Solomon, S. et al. eds. 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Intergovernmental Panel on Climate Change's Fourth Assessment Report*. Cambridge, UK: Cambridge University Press.
- Stern, P. C., and T. J. Wilbanks. 2008. Fundamental Research Priorities to Improve the Understanding of Human Dimensions of Global Change. A discussion paper prepared for the National Research Council's Committee on Strategic Advice to the U.S. Climate Change Science Program. Washington, DC: National Academy of Sciences.
- Swope, C. 2007. Local warming: It's too late to stop global warming. What we can do is plan for it. *Governing*. Available at: <http://www.governing.com/articles/0712warm.htm>.
- Theoharides, K., G. Barnhart, P. Glick, with contributions from Noah Matson, A. Choudhury, and A. Staudt. 2009. Climate Change Adaptation across the Landscape: A survey of federal and state agencies, conservation organizations and academic institutions in the United States, 61 pp. Washington, DC: The Association of Fish and Wildlife Agencies, Defenders of Wildlife, The Nature Conservancy, and The National Wildlife Federation.
- Thomas Jr., W. L. ed. 1956. *Man's Role in Changing the Face of the Earth*. Chicago: The University of Chicago Press.
- Tribbia, J. and S.C. Moser. 2008. More than information: What coastal managers need to prepare for climate change. *Environmental Science & Policy* 11: 315-328.
- Turner, B. L. I., W. C. Clark, R. W. Kates, J. F. Richards, J. T. Mathews, and W. Meyer eds. 1990. *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere Over the Past 300 Years*. Cambridge, U.K.: Cambridge University Press.
- Washington Post Writers Group. 2007. A really 'inconvenient truth'. *Chattanooga Times Free Press*: B6.
- U.S. Environmental Protection Agency. 2009. *Synthesis of Adaptation Options for Coastal Areas*. Washington, DC: U.S. Environmental Protection Agency, Climate Ready Estuaries Program.
- Wilbanks, T. J., V. Bhatt, D. E. Bilello, S. R. Bull, J. Ekmann, W. C. Horak, Y. J. Huang, M. D. Levine, M. J. Sale, D. K. Schmalzer, and M. J. Scott. 2007. *Effects of Climate Change on Energy Production and Use in the United States*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Synthesis and Assessment Product 4.5, Washington, DC: Climate Change Science Program.

Appendix 1:

Federal Legislative Activity in the 110th Congress Regarding Adaptation

During the 110th Congress, approximately 75 bills were introduced that contained adaptation provisions. Of these, five became law: HR 6 (Omnibus Energy Bill), HR 2764 (2008 Appropriations) and HR 4986 (National Security), SJ RES 17 (Fishery Mgmt), SJ RES 45 (Water Resources). The majority of bills focused on individual sectors (coastal/ocean management – 22; fish and wildlife – 21; water resources – 11; national security – 8; infrastructure/transportation – 5; forestry and land management – 3; etc.). These generally had broader sponsorship and bipartisan support. A smaller number held provisions called for federal, state and local adaptation planning (6), cross-scale coordination (6), vulnerability assessments and other types of adaptation-relevant research (~17), or other topics (T. Cruce, pers. comm. to author, March 2009).

Bills listed below are either mentioned in the report, include some that have become law, or exemplify the types of bills introduced in the Senate and the House of Representatives. A full list of bills can be obtained from <http://thomas.loc.gov/>. Bills introduced in the 111th Congress are not included and legislative action continues.

Law or Bill	Title and Contents	Status
Public Law 101-606 (prior to 110 th Congress)	US Global Change Research Act of 1990 (as amended) – requires national assessments of climate change impacts and response options every four years	Underlies research activities of the CCSP; only one comprehensive national assessment completed; 21 Science and Assessment Products completed and are currently being integrated into a Unified Synthesis Product
Public Law 110-140	Energy Independence and Security Act of 2007 – Section 712 Requires among other things, the development of adaptation and mitigation strategies	Became law in December 2007
Public Law 110-161	Department of Commerce Appropriations Act of 2008 – authorizes the National Academy of Sciences' <i>America's Climate Choices</i> (ACC) study	ACC study initiated in late 2008; one panel exclusively focused on adaptation; one on science needs, one on mitigation, and one on climate change-related decision support needs
S 280 (Lieberman)	Climate Stewardship and Innovation Act of 2007 – would, among other things, authorize research funds for NOAA on abrupt climate change	Hearings held in July 2007 in the Senate Committee on Environment and Public Works
S 2156 (Bingaman)	Science and Engineering to Comprehensively Understand and Responsively Enhance Water Act – would direct DOI to establish a US Bureau of Reclamation climate change adaptation program, with special attention to impacts and adaptation options for water resource management	Several hearings held, amended and placed on senate legislative calendar in September 2008

S 2204 (Sheldon)	Global Warming Wildlife Survival Act – would require DOI and DOC to establish national strategies for maintaining wildlife populations, listed species, and marine ecosystems under climate change	Measure referred to the Senate Committee on Environment and Public Works in October 2007
S 2307 (Kerry)	Global Change Research Improvement Act of 2007 – would amend the Global Change Research Act to establish a National Climate Service within NOAA	Placed on Senate Legislative Calendar in May 2008
S 2355 (Cantwell)	Climate Change Adaptation Act – among other things, would establish a National Climate Service within NOAA, require DOC to conduct regional assessments of coastal and ocean vulnerability to climate change, and allow DOC to provide grants to states to develop adaptation plans	Measured referred to several Committees and placed on Senate Legislative Calendar in June 2008
S2970 (Reid) /HR 6297 (DeGette)	Climate Change Drinking Water Adaptation Research Act – would require EPA, together with DOC, DOI, and DOE, to fund an applied research program focused on adaptation for drinking water utilities	Placed on Senate Legislative Calendar in September 2008
S3515 (Whitehouse)	A bill to establish four regional institutes as centers of excellence for research, planning, and related efforts to assess and prepare for the impacts of climate change on ocean and coastal areas	Referred to the Senate Committee on Commerce, Science, and Transportation in September 2008
HR 135 (Linder)	Establishes the Twenty-First Century Water Commission; requires that Commission to develop adaptation strategies (and conduct related research) for the water sector	Placed on Union Calendar in June 2008
HR 906 (Udall, M.)	Global Change Research and Data Management Act of 2007 – would reauthorize the US Global Change Research Program and focus it more on decision support needs; would also require national vulnerability assessments every 5 years	Discussed in several Committees, hearings held, placed on the Union Calendar in April 2008
HR 2338 (Dicks)	Global Warming Wildlife Survival Act – would require DOI to develop a national strategy for protecting wildlife under climate change, establish a research program within USGS focused on wildlife impacts, and provide additional research support	Measure referred to several House Committees in June 2007
HR 4174 (Allen)	Federal Ocean Acidification Research And Monitoring Act of 2008 – establishes an interagency committee to develop an ocean acidification research plan, including adaptation options.	Placed on Senate Legislative Calendar in July 2008; became law as part of a large omnibus bill in January 2009 (S.22) as the “Federal Ocean Acidification Research And Monitoring Act of 2009”
HR 5453 (Capps)	Coastal State Climate Change Planning Act – would amend the Coastal Zone Management Act of 1972 by establishing a DOC coastal climate change adaptation planning and response program, and to authorize assistance to coastal states to develop coastal climate change adaptation plans pursuant to approved management programs approved under section 306	Hearings held in the House Subcommittee on Fisheries, Wildlife, and Oceans in February 2008

Source: Library of Congress Thomas (<http://thomas.loc.gov/>), Status January 2009.

Appendix 2:**States with Comprehensive Adaptation Planning Efforts (in alphabetical order)**

State	Steps taken	Lead organization	Initial focus
Alaska	<p>Alaska Climate Impacts Assessment (2006-08)</p> <p>Climate Change Strategy developed, with recommendations (2007), IAW report (2008)</p> <p>Facilitated work groups developing adaptation strategies (since 2007)</p>	<p>Alaska Climate Impacts Assessment Commission</p> <p>Sub-Cabinet for Climate Change, Immediate Action Workgroup (IAW)</p> <p>Alaska Climate Change Adaptation Advisory Group</p>	<p>CC impacts on people, resources, economy and assets</p> <p>Coastal erosion, fires, permafrost, flooding</p> <ul style="list-style-type: none"> • Public infrastructure • Health & Culture • Natural systems • Economic activities
California	<p>State-sponsored climate impacts research, biannual synthesis reports and updates on state actions (mitigation and adaptation)</p> <p>Development of a comprehensive Climate Adaptation Strategy (CAS) in 7 working Groups (CAWGs), initiated in 2008 (builds on various existing agency efforts); Executive Order S-13-08 (Nov 2008) demands CAS (among other things) by June 2009</p>	<p>California Energy Commission's PIER Program is lead on science CalEPA and other agencies form the Climate Action Team, prepare biannual summary reports (2006, 2008)</p> <p>Natural Resources Agency (lead), in collaboration with numerous other state agencies</p>	<p>Impacts on all climate-sensitive sectors, climate science</p> <ul style="list-style-type: none"> • Agriculture • Biodiversity & Habitats • Forestry • Infrastructure (transportation, energy) • Oceans & Coastal Resources • Public Health • Water
Florida	<p>Florida's Resilient Coast: State Policy Framework for Adaptation to Climate Change (2007)</p> <p>Executive Order 07-128 requests (among other</p>	<p>Center for Urban and Environmental Solutions</p> <p>Action Team on Energy and Climate Change</p>	<ul style="list-style-type: none"> • Land use planning and building regulation • Water supply & delivery • Transportation and infrastructure • Conservation of natural lands and marine life • Beaches and beach mgmt • Extreme events <p>All climate-sensitive sectors of state and state operations</p>

	things) adaptation plan Facilitated work groups developed Final Energy and Climate Change Action Plan (2008); contains a “baseline adaptation plan”	One technical working group of the Action Team is focused on adaptation	
Maryland	Executive Order 01.01.2007.07 established the MD Climate Change Commission, charged with developing plans for mitigation and adaptation Facilitated working group meetings to develop adaptation plan Action plan released in 2008	Maryland Climate Change Commission Maryland’s Adaptation and Response Working Group is chaired by the Department of Natural Resources, co-chaired by Department of Planning	Reducing vulnerability of coastal, natural, and cultural resources and communities <ul style="list-style-type: none"> • Existing built environment and infrastructure • Future built environment and infrastructure • Resources and resource-based industries • Human health, safety & welfare
Massachusetts	2004 Massachusetts Climate Protection Plan contained minor language on adaptation Global Warming Solutions Act signed in 2008; GHG reduction mandates and call to convene an advisory committee to analyze adaptation strategies (report expected at end of 2009, progress uncertain)	Secretary of Energy and Environmental Affairs	<ul style="list-style-type: none"> • Transportation and built infrastructure • Commercial, industrial and manufacturing activities • Low-income consumers • Energy generation and distribution • Land conservation • Water supply and quality • Recreation • Ecosystem dynamics • Coastal zone and oceans • Rivers and wetlands • Local government
New Hampshire	Executive Order 2007-3 created Climate Change Policy Task Force Climate Change Action Plan with draft Adaptation Action Report submitted to Governor in July 2008	Climate Change Policy Task Force (one working group focused on adaptation) Climate Change Advisory Council	<ul style="list-style-type: none"> • Development and distribution of critical information • Help for most at risk populations • Public health • Natural systems • Resilience to extreme events • State economy
Oregon	Oregon legislature enacted HB 3543 (2007), creating a permanent Global Warming	Global Warming Commission	Dual responsibility for mitigation and adaptation/preparation

	<p>Commission and the Oregon Climate Change Institute</p> <p>Formed the Climate Change Integration Group (2006), produced “A Framework for Addressing Rapid Climate Change” (2008)</p> <p>Completed report “Preparing the Pacific Northwest for Climate Change: A Framework for Integrative Preparation Planning for Natural, Human, Built, and Economic Systems” (2008)</p>	<p>Climate Change Integration Group</p> <p>Climate Leadership Initiative (CLI), University of Oregon</p>	<ul style="list-style-type: none"> • Preparation and adaptation • Mitigation • Education and outreach • Research <p>(integrating ideas from CLI)</p>
<p>Washington</p>	<p>Preparation/Adaptation Working Groups (PAWGs) formed in 2007 to develop recommendations for governor on how to prepare for and adapt to climate change</p> <p>Leading the Way on Climate Change: The Challenge of Our Time” (2008); Section C “Preparing for the Impacts of Climate Change In Washington”</p> <p>Comprehensive Climate Change Impacts Assessment for the state currently underway</p>	<p>Climate Action Team with PAWGs (lead agency WA Department of Ecology)</p> <p>Climate Action Team; Section C by PAWGs</p> <p>University of Washington, Climate Impacts Group</p>	<ul style="list-style-type: none"> • Agriculture • Forestry resources • Human health • Water resources & quality • Coastal infrastructure <p>All climate-sensitive sectors</p>

Source: Pew Center on Global Climate Change (2008), status early January 2009; summarized and updated by the author.

Appendix 3:

Examples of Local Adaptation Initiatives

Local Government Entity	Partners of the CCAP's Urban Leader Adaptation Initiative	Partners of ICLEI's Community Resilient Communities Program	Independent Effort
Chicago, IL	X		X
King County, WA	X	collaboration	X
City of Los Angeles, CA	X		
Miami-Dade County, FL	X	X (pilot and ongoing)	
City of Milwaukee, WI	X		
Nassau County, NY	X		
Phoenix, AZ	X		
San Francisco, CA	X		
New York City, NY	X	*	X
Ft. Collins, CO		X (pilot)	
Homer, AK		X (pilot)	
Keene, NH		X (pilot)	
Santa Cruz, CA		*	
San Francisco, CA (BCDC)		*	X
Newtok, AK		*	X
Shismaref, AK		*	X
Kivalina, AK		*	X
Shaktoolik, AK		*	X
San Diego, CA			X
Berkeley, CA			X
Sonoma County, CA			X
Chino, CA (Inland Emp. Utilities)			X
Aspen, CO			X
Guilford, CT			X
Boston, MA			X
Sandwich, MA			X

Sources: Perkins, Ojima, and Corell (2007); Center for Clean Air Policy (2008); ICLEI Local Governments for Sustainability (2008); Adaptation Network (2008); Moser and Tribbia (2006/2007); updated by author; Status January 2009. The (*) notates cases where communities are listed at the ICLEI website, but their status as partners in the program is unclear.