



Adaptation Working Group Report

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Adapting to Climate Change:
Why Adaptation Policy is More Difficult than We Think
(and what to do about it)

Adaptation Working Group, Wisconsin Initiative on Climate Change Impacts

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1 Introduction

The Wisconsin Initiative on Climate Change Impacts (WICCI) exists to help policy-makers, resource managers, and others lead Wisconsin’s adaptation to climate change. Chapters in the main report examine the impacts of climate change on wildlife, infrastructure, and other parts of the human and natural worlds. Those chapters also suggest adaptation strategies specific to each chapter’s topic.

This paper, on the other hand, explores the nature of climate change adaptation itself. The goal of this paper is to make readers aware of three fundamental problems with climate change adaptation. Those problems limit what society will be able to achieve through adaptation, but they also suggest important ways to focus adaptation efforts.

This paper is an overview and synthesis of the adaptation literature. Our goal is to identify important issues in adaptation, both to alert policy-makers to their importance and to encourage researchers to explore them.

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1.1 Adaptation

Adaptation to climate change is important to human society. At the very least, we aspire to be well-suited to the climates in which we live. If the most extreme climate projections come to pass, adaptation may become a matter of survival for vulnerable populations and regions [Intergovernmental Panel on Climate Change, 2008].

Although adaptation appears at first to be a straightforward idea, when one digs into the topic—or tries to apply it in practice—it becomes clear that adaptation is complicated. In our view, adaptation to climate change will be more successful if society recognizes, understands, and grapples with the complexities of adaptation.

The complex nature of adaptation is apparent from the relatively few concrete adaptation strategies identified by other WICCI working groups. Although the goal of WICCI is to provide adaptation guidance for Wisconsin, we have not been able to do so in depth in this report. Each working group has discovered on its own that developing adaptation recommendations is the more challenging part of their task. The goal of this paper is to identify why adaptation policy is difficult and to suggest directions for subsequent WICCI reports.

1.2 Themes

This paper is a general review of the literature on climate adaptation. The adaptation literature is in its infancy, with only a few thousand scientific publications on the topic, most of which have been written since the late 1990s.¹

Because of this, the literature is still a jumble of definitions, questions, problems, and proposals, without settled organizing themes [Smith et al., 2000]. In this paper, we propose three organizing themes to guide the future work of WICCI: uncertainty, indirect benefits, and planning horizons. These themes have emerged in discussions in the WICCI Science Council, particularly during its review of working group reports.

We will discuss these themes in greater detail below. Briefly, the problem of uncertainty has two parts. First, the complex natures of climate, economics, and culture mean that we are unable to predict the future with confidence. The scientific community can predict with relatively high confidence that human greenhouse gas emissions will continue to rise for several decades and that, as a result, global mean temperatures will continue to rise. But beyond those two simple predictions, we can predict very little about how mean temperatures will affect weather at the local scale on which human decisions are made. We refer to this as *predictive uncertainty*.

Second, there is also great uncertainty about people’s values as they relate to climate adaptation. As is clear from the public debate, there is no values consensus on the seriousness of climate change itself, let alone on the effects of climate change on local issues, such as winter tourism. Though it may be hard for scientists to accept, people’s values are changing, conflicting, and impossible to aggregate into a simple average value. Climate change adaptation policy will have to grapple with this problem, which we refer to as *values uncertainty*.

¹A February, 2010 search of the Annual ISI Web of Knowledge Publications returned 2,078 articles matching the search “climate change adaptation” (searched as independent words, not as a phrase). Eighty-nine percent of these articles were published after 2000. For comparison, a search for the term “climate change” (as independent words) but *excluding* the word “adaptation” returned 46,993 citations dating back to 1969.

We propose a second theme from the literature, the problem of *indirect benefits*. Climate change adaptation is meant to improve people’s lives. However, the people who will benefit from present-day adaptation efforts are not necessarily the same people who will be making those efforts. In the extreme, the beneficiaries are not yet born. But even relatively short-term benefits—over ten to twenty years—are too far in the future for most individuals and organizations to consider. (For many adaptation strategies, the required implementation steps themselves are too far in the future to consider; benefits are usually even further out.) When combined with the problem of uncertainty, the lack of direct benefit to present-day actors means that there are few incentives for pre-planned climate change adaptation. Even worse, uncertainty means that we cannot be sure what the best adaptation actions are at this point in time.

The third theme concerns the time frame over which adaptive strategies must be implemented. Few strategies can be completed in the relatively short planning horizons of individuals and organizations. Instead, most strategies will require sustained or repeated actions over many decades. Planning and sustaining that sort of long-term effort is challenging for individuals and organizations. More to the point, *beginning* that effort is difficult, because of the legitimate doubt about its sustainability. Effective planning for adaptation to climate change will rely on the few long-term institutions available, notably regional planning commissions and similar development planning agencies. Otherwise, adaptation will depend on finding short-term strategies with immediate benefits.

It is our belief that understanding these themes will significantly improve WICCI’s ability to recommend effective adaptation strategies and to understand and avoid barriers to adaptation. Doing so will help Wisconsin avoid wasteful, misguided, and otherwise ineffective strategies.

2 Defining Adaptation to Climate Change

We begin by offering a common definition of climate change adaptation:

“Adaptation to climate change is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.”² [Intergovernmental Panel on Climate Change, 2008, glossary].

This definition is a useful starting point for two reasons. First, it introduces the essential elements of climate change adaptation. Adaptation involves adjustments of some kind; it involves people as well as the environment as a whole; and it involves both harms and opportunities.

The second reason to start with this definition is that, by digging into it, we uncover the complexities with adaptation itself.

The first such complexity is timing. The effects of climate change occur over a span of time. For some aspects of climate change, those effects are already visible. This appears to be the case with the duration of lake ice in winter in Wisconsin [Magnuson, 2002]. On the other hand, some effects have not appeared and are still only projections. At least for conscious adaptations, we have a choice whether to take action *before* effects appear or after.

²Variations on this definition appear in other publications, including CNRA [2009], CCSP [2008], and Smith et al. [2000].

The literature distinguishes “anticipatory” adaptation from “reactive” adaptation. The former occurs before climate change effects appear.³ The latter occurs in response to effects that have already appeared. (Some commentators divide the anticipatory—reactive spectrum more finely.⁴)

A second complexity with adaptation was raised in the example above. We can distinguish conscious adaptation actions from those that occur automatically in some sense. Example of conscious adaptation are easy to identify and understand. For instance, a land manager may choose to research the effects of climate change on tree progression and make plans for incorporating that research into forest management decisions.

Automatic adaptation is more difficult. The IPCC tries to capture the concept with the term “autonomous” adaptation.

“Autonomous adaptation does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems” [Intergovernmental Panel on Climate Change, 2008, glossary].

Autonomous adaptation is distinguished from planned adaptation:

“Planned adaptation is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state”⁵ [Intergovernmental Panel on Climate Change, 2008, glossary].

However, these definitions overlook an important element of autonomous change: Autonomy is a matter of perspective. Adaptation may *appear* autonomous to an observer, *A*, who takes no actions but sees the results of actions that others, *B*, have taken. From *B*s perspective the actions are not autonomous. For example, people may migrate from hazardous coastal areas. From government’s point of view, that is autonomous (no government action), though the migrants took deliberate action in their movements.

For human adaptation, the issue is not really whether the one taking adaptive action was choosing to do so, but whether the observer and the actor are the same individual. For adaptation of species or ecosystems, it makes more sense to think of adaptation as non-conscious results. However, for species or ecosystem adaptation, it makes less sense to speak of these as adaptations *to* climate change. They are merely adaptations, indistinguishable from the normal course of evolution, except perhaps for the rate of change. A species cannot distinguish adaptation to anthropogenic climate change from adaptation to habitat destruction or the competitive pressures of other species.

One might assume that only planned adaptation can be anticipatory, but this is not the case. Autonomous adaptation can also be anticipatory. If the members of an industry, such as the winter tourism industry, make a business decision to diversify or leave the industry *in anticipation* of milder winters, the collective effect of those choices will appear

³“Anticipatory adaptation takes place before impacts of climate change are observed” [Intergovernmental Panel on Climate Change, 2008, glossary].

⁴CCSP [2008, p. 2-19] represents the anticipatory—reactive spectrum with four parts: (a) no adaptation; (b) reactive adaptation (no planning; adapt after impacts observed); (c) anticipatory adaptation (acknowledge impacts; but plan adaptation after impacts observed); and (d) proactive adaptation (acknowledge impacts and plan adaptation in advance).

⁵We suggest that the term “policy” in this definition be read broadly to include actions by individuals, businesses, government, and other institutions.

autonomous to the state’s business sector as a whole, even though each individual business took deliberate action.

Another common distinction in the adaptation literature is between public and private adaptation. The former is undertaken by governments; the latter by non-governmental actors, including businesses, nonprofit organizations, and individuals. The distinction is obviously extremely important in the development of adaptation policy. Adaptation by government will involve different actors, policy tools, and conflicting pressures than will private adaptation. On the other hand, public policy is powerless without the participation of private actors in society.

Even a quick analysis of the IPCC’s simple definition reveals several avenues for deep discussion about climate change adaptation. Adaptation may occur over many different time scales; it may occur in anticipation of or in reaction to climate change; it may involve a range of actors throughout society including public and private actors.

As a brief illustration of the importance of these issues, consider the notion of adaptation strategy. Some fields—such as urban stormwater engineering—are better equipped to address climate change than others. Stormwater engineers realize that their models and designs represent historic rainfall, and recognize the direct threat of climate-related rainfall change to urban infrastructure. Engineers commonly employ models of adaptation. In these models, climate adaptation is an extension of good engineering practice.

Adapting to climate change in this example requires: (a) improved models, (b) conscious policy analysis including cost-benefit analysis, and (c) public engagement in the form of infrastructure planning. This implicitly suggests that climate change adaptation should be planned, deliberate, anticipatory, non-autonomous, and public. In the case of urban stormwater management, the field is predisposed to see climate change adaptation in terms that fit its view of the world. We suggest however that a conscious exploration of the breadth of adaptation will yield strategies that will benefit from more expansive and creative thinking.

3 Fundamental Problems with Climate Change Adaptation

Climate change adaptation is a broad topic, with many nuances, alternative definitions, and competing approaches. The literature on the topic, though relatively new, is already grappling with these issues. In this section, we explore three, which we think have fundamental policy implications for WICCI.

3.1 Uncertainty

The first issue is the problem of uncertainty [Salmon, 2010]. Put bluntly, we cannot know the best course of actions from our current vantage point. Any actions we take will be hunches, hopes, calculations, and educated guesses. This problem has two root causes, or two types of uncertainty: Predictive uncertainty and values uncertainty.

Although some climate change effects have already been observed, adaptation to climate change is a problem of the future. We are warned about significant—perhaps catastrophic—changes in precipitation and temperature with effects on habitat, human health, infrastructure, and other areas. However, as with any discussions of the future, we can not know

what will happen. Our predictions will always have errors in them.⁶ In the case of climate change, the errors are worrisome.

For one thing, our very understanding of the climate system is incomplete. We are evaluating forces and relationships that we cannot test and can only partially observe. We continue to discover new elements of the climate system that change our understanding of it; new circulation patterns, new atmospheric chemical factors, or new human factors.⁷ For instance, it is not clear how smooth climate change has been in the past or will be in the future. It is possible that we will be confronted by abrupt, rapid change [Hallegatte, 2009].

Even if we did fully understand the climate system, it is computationally complex, and modeling it at fine scales does not resolve large scale uncertainty. Weather is the relevant factor for most design horizons. But we know little about how a changing climate will effect weather, including if future climate change will attenuate or exaggerate past deviations from normal weather patterns [Hallegatte, 2009].

Finally, climate change occurs over a nearly impossibly long time frame, from a human vantage point [Salmon, 2010]. Even predicting the next year in climate, ecology, economics, culture, or politics is impossibly difficult and all five of those factors will combine to affect climate change. One has only to look back in time 25, 50, or 100 years to see how much change has occurred over the same time scale being modeled in climate policy.

In addition to predictive uncertainty, climate adaptation is burdened by values uncertainty. Certain knowledge of our values regarding climate change adaptation and social issues related to climate—such as public health or environmental protection—can be difficult to determine.⁸

Values uncertainty arises from three factors. The first is simply predictive uncertainty in the social realm. Climate change adaptation involves changes that will affect people living in the future; perhaps many decades in the future. Even for those future individuals who are alive now, we cannot be sure what they will value in the future. (Consider how much our values change over the course of our lifetimes. Did you value the environment the same way in your teens as you do now?) More importantly, many future individuals are not yet born, and will have values we cannot possibly predict.

Second, individuals cannot accurately identify their own individual preferences at the present moment. It is well-established in the psychology literature that we may not know what we want, even for simple and immediate choices. More abstract and complex choices, like a choice to increase taxes for climate-related health programs, are still more difficult [Gilovich, 1993].

Third and finally, even if current and future individual preferences could be known with certainty, there is no unambiguous way to *aggregate* those preferences into a unique social policy. This may be the most unfamiliar claim of the three, but we have all observed it

⁶As Taleb [2007] points out, it is not only the presence of errors that cause concern, it is also the type of errors. Some phenomena have normally-distributed errors, which cluster around a central tendency. This significantly limits the importance of extreme events. Others have error distributions where extreme values are important, or even dominant. Financial crises involve such distributions. Climate may as well.

⁷Climate models are heavily influenced by forcings, assumptions about the quantity of greenhouse gases emitted over the model period. However, GHG emissions are dependent on global economic activity. A review of past predictions of economic activity should inspire caution about future predictions.

⁸The role of values and value uncertainty in economics, social change, and public policy may be unfamiliar to readers. There are a wide range of books and articles addressing the topic including Arrow [1963]; Gilovich [1993]; Zelizer [1994]; Roch and Samuelson [1997]; Swedberg [1997]; Zelizer [1997]; Hammond [2000]; Hsee and Rottenstreich [2004]; de Kwaadsteniet et al. [2006]; and Hastie and Dawes [2009]. The topic arises in many social science fields, including economic sociology, social judgement theory, welfare economics, and environmental economics.

in the form of three-party elections, in which the outcome depends on how the voting is structured [Arrow, 1963].

In a winner-take-all election, a popular third party C can divert votes from its ideological neighbor, B , leaving A with the majority and a victory in the election. This can occur even if a majority would have voted for B in a head-to-head election with A . In other words, a three-party election can yield a candidate that the majority does not want.

More generally, the method by which votes are taken will affect the outcome. In other words, it is impossible to say which candidate is the unique socially-preferred candidate. The answer will always depend on how individual opinions are collected. This problem applies to any form of social preference aggregation. The method by which individual opinions are aggregated will affect the outcome. (See, e.g., Hunt [2006, ch. 6].)

This point is worth dwelling on. Adaptation choices are guided by a sense of value: People will argue that a given outcome, A , is better than outcome B and should therefore be chosen. However, there can never be a single, universally agreed-upon meaning of “better.” Different people and groups will have different standards or metrics for value. An adaptation strategy that scores high in one group’s metric may score low in another group’s metric.

This leads to the unavoidable problem of deciding which metric should be used. But, as Arrow and others demonstrated, there is no objective, external way of choosing among competing values. Values will always be a battlefield, figuratively or literally. As Adger and Barnett [2009, p. 2803] put it:

“[T]here will be difficulty in adapting cultures and lifestyles when some impacts of climate change involve irreversible losses of things individuals care about. Most of these impacts are invisible because governments and planners inevitably focus on material well being and issues that they can handle through planning systems. But adaptation must seek to include and sustain important values, including places and identity, which means that adaptation will not necessarily be straightforward.”

Incidentally, this is why economic tools like cost-benefit analysis will be useless in evaluating larger scale adaptation issues. The metric of cost-benefit analysis—dollars—itself reflects the current values of the culture. Certain things are expensive because the culture values them that way. A different, equally valid culture, would value them differently. For instance, real estate is inexpensive in Native American cultures in part because of the cultural attitude toward land. We cannot assume that inexpensive Native American land is inexpensive because it is less valuable in any social sense. One could argue that Native Americans value land more highly than Europeans do [Adger and Barnett, 2009].

Values uncertainty is not a trivial problem. Climate adaptation will involve enormous value conflicts in energy use, the built environment, environmental protection, governance, and other areas. We cannot predict what future generations will value, we cannot say what we value, and we cannot unambiguously aggregate individual values. Whether we should, for instance, invest in expensive land conservation efforts or instead foster (or accept) land use changes is a values problem. The phenomena of predictive uncertainty and values uncertainty combine to limit our ability to resolve those problems in advance [Hallegatte, 2009, pp. 245–246].

3.2 Indirect Benefits

Uncertainty is the first principle we recommend to WICCI. The second has to do with how the benefits of climate change adaptation are arrayed.

Because climate change is a problem of the future—and adaptation strategies are aimed at benefiting people in the future—there is a gap between those who make climate adaptation efforts and those who benefit from them. Climate change adaptation strategies may not directly benefit those who make the effort.

This problem is a general one in human planning, but it is worse in the climate area because of the very long time scales involved. Many climate adaptation strategies will not pay off for several generations. (See NOAA [2010, p. 6], citing Smith and Lenhart [1996].)

Outside of climate change, people make investments in the future when they expect to reap the benefits themselves, or when the benefits will accrue to people they care about, such as their descendants or a community to which they belong.

This kind of investment will occur in the climate realm as well, but it is hampered by predictive and values uncertainty. Unlike saving for retirement or paying for a child's education—which have fairly clear and predictable value for the future—climate adaptation efforts do not have clear value. We have only a vague idea which strategies will be effective and an even more vague idea which strategies will be appreciated by succeeding generations. Perhaps no one will miss winter sports at all, for instance. (See Adger and Barnett [2009] using the example of stormwater management.)

The point here is not that adaptation is not valuable to individuals or society. Rather, the benefits of adaptation have the character of public goods. Climate adaptation benefits are produced by the efforts of group *A*, but accrue to the benefit of a different group, *B*. Because of human nature, benefits that accrue to other people are under-provided by people acting on their own. Public goods, such as police protection or a clean environment, are best provided by some sort of collective organizational structure that transcends individual interests, including but not limited to government [Randall, 1987, Bromley, 1995].

3.3 Planning Horizon

Climate change projections include time scales well beyond society's normal planning horizon. Confounding this are projections showing that climate impacts are both likely to be more severe further in the future, and that uncertainty increases as a function of time. For successful adaptation strategies to be implemented, we must acknowledge and address these factors:

Planning horizon. Society's time frame for making decisions about the future is normally short. For example, municipal and state budgets are annual or biannual, and the four year federal election cycle sets the time frame for national planning. In the most extreme cases, some types of infrastructure such as dams, or urban water and waste water systems have planning horizons of 30–50 years (and these have been designed using assumptions about future conditions).

Long-term planning capacity. Society lacks the capacity to plan and implement adaptation strategies over long time scales, because strategies that address impacts in the future may require sustained or repeated action over the entire planning horizon (i.e., beyond the lifetime of the planner). An example of capacity lost due to poor planning

capacity is the nuclear power industry, which is now inadequately resourced to meet demands for carbon-free energy production [Grimes and Nuttall, 2010].

Indirect benefits. People who are asked to make economic sacrifices today—that may benefit future generations but will not benefit them directly—may lack the incentives to implement long-term adaptation strategies. This is not simply a question of altruism. The uncertainty surrounding long term climate projections can obscure the nature, cost and benefit of the adaptation strategy needed. For example, imagine being asked to pay a substantial sum today for an energy efficient vehicle, to be delivered to one’s unborn grandchild at age sixteen, and being assured that it (in about forty years) will be designed and built to meet the future’s mileage and safety requirements. Even the most doting grandparent will hesitate to spend that money now.

We have suggested that the planning horizon problem will lead to implementation of relatively short-term, no-regrets type strategies. We recommend searching for such strategies wherever possible. Another implication of the planning horizon problem is that existing planning institutions should be mobilized to address adaptation to climate change.

Since the 1950s, state and local governments in Wisconsin have developed planning systems such as municipal planning and zoning; comprehensive planning; farmland preservation planning; and regional planning commissions. The mission of these institutions is to address long-term issues such as demographic changes, transportation, energy, urban development, and environmental protection. (See Wisconsin Department of Administration [2010]. On planning generally, see Berke and Godschalk [2006].)

Climate change is a new issue for these institutions. It may also be significantly more difficult to address in a planning context. In any event, we suggest that planning organizations incorporate adaptation to climate change into their missions. To the extent that adaptation requires long-term effort, some sort of planning system will be required to do the work [Snover et al., 2007, Groves et al., 2008]. (See, e.g., City of New York [2010], City of Chicago [2010].)

4 Evaluating Adaptation Strategies

4.1 Approaches to the Uncertainty Problem

We have identified three significant problems with climate change adaptation. The first is the overwhelming degree of uncertainty involved in climate change. This uncertainty limits both our ability to predict the future and our ability to determine social values vis à vis climate change. There are several general approaches to the problem of uncertainty in climate change adaptation. These are not adaptation strategies themselves. Rather, they should be thought of as criteria by which to generate and evaluate strategies. They are summarized in Table 1.⁹

⁹Most of these criteria are based on Hallegatte [2009]. Hallegatte also proposes the use of “soft strategies” such as rules and procedures as a separate criteria for strategies that address uncertainty. Often the most powerful adaptive strategies involve intangible rules and procedures rather than tangible construction or migration. There is a wide range of possible strategies in this category. They include, adoption of long-term planning horizons for government infrastructure planning; regulatory changes to support long-term climate insurance markets; changes in land-use planning law; or development of early-warning and evacuation procedures for storm hazards. We do not list this as a separate criterion because soft strategies are available under each of the other headings. There is no guarantee that a particular soft strategy will help deal with uncertainty. Those that do will have some of the other attributes listed, such as fostering use of cheap safety margins or fostering changeability.

Table 1: Criteria for evaluating climate change adaptation strategies in light of uncertainty concerns.

Criteria	Description	Example
No-regrets	Strategies with a net benefit, independent of climate change	Building insulation
Cheap safety margins	Modifications yielding low-cost “extra” margin of safety	Additional stormwater capacity
Changeability	Strategies that are easy for people to change in future	Easy-retrofit coastal defenses
Short planning horizon	Short-lived policies allowing for repeated adjustments	Use only cheap housing in potential flood areas
Reduce complexity & scope	Favor the narrow and simple over the complex	Foster adaptation efforts at the local level
Plan to variances	Incorporate variances in planning, not just averages	Extreme high water mark

No Regrets

The first approach, “no regrets,” avoids the problem of uncertainty entirely by identifying strategies that provide a net-benefit regardless of climate change effects [Hallegatte, 2009]. An example is increasing insulation and climate-proofing new buildings. In general, such investments yield a net energy savings in a relatively short time and are therefore worth doing even without taking climate change into account. Another example is increasing protection for coastal areas against ocean storms, such as building homes with hurricane-proof construction techniques.

In some cases, no regret strategies will provide a net benefit to society as a whole, but not to the individuals who implement them. In other words, even no regret strategies may be hampered by the problem of indirect benefits. As Hallegatte [2009, p. 244] notes, many no regret strategies are not being implemented presently due to financial constraints, lack of information, transaction costs, or legal constraints. Removing such barriers may be a highly effective approach to climate change adaptation by freeing up individuals and businesses to adopt no regret strategies on their own.

Cheap Safety Margins

In some cases, a strategy that is already being pursued can be made more resilient for relatively low cost. For example, stormwater planning standards can be changed to include an additional safety margin, beyond that supported by short-term cost benefit analysis. For this approach to be worth while, it must be the case that the “extra” margin of safety—though more expensive than the minimum safety level—is cheaper than alternative climate adaptation strategies. A city that is planning stormwater improvements to address expected city growth could incorporate climate safety margins into the existing design process and save money over the long term [Hallegatte, 2009].

Changeability

A third approach is to choose strategies that are specifically changeable in the future. Repeating the point from the previous section, because of uncertainty, we cannot know

the best course of action from our vantage point in the present. This will always be true, even as our understanding of the climate improves. No matter how well we understand the climate system, it is still a complex and unpredictable system, inextricably linked to other complex systems such as the economy. Furthermore, our ability to predict, identify, and aggregate values will always be limited, regardless of scientific advances.

Our ultimate goal in climate adaptation is to develop strategies that will be effective *from the vantage point of the future*. But since, from our vantage point, we cannot know what those strategies are, the best we can offer the future is to pursue strategies that people in the future can change. In other words, our highest priority should be changeability.¹⁰

We need to spend a moment exploring what kinds of strategies are changeable. A strategy is changeable, from the point of view of the future, if it costs little for future people to modify or abandon that strategy. From the point of view of the future, sunk costs are irrelevant. In other words, even if we in the present spend a lot to build a particular adaptation strategy, people in the future may be able to abandon that strategy at low cost to themselves. To use a household example, if your parent gives you a computer built in 1980, you can abandon that machine with essentially no cost to you, even though it cost tens of thousands of dollars to purchase in 1980.¹¹

Some investments that are expensive for us in the present will also be difficult for future people to abandon. Cities are a prime example. We can see this from our vantage point now. It is costly for us to abandon our current cities, not because people spent money to build them in the past, but because *replacing* them is expensive (relative to the value they provide) in the present.

For a strategy to be changeable in a way that increases adaptation in the future, it needs to be one that people in the future can abandon or replace at relatively low cost to themselves. The guiding question for our choices about climate adaptation should therefore be: “If we pursue this strategy, *A*, how costly will it be for people in the future to switch to a different strategy?” We must also consider the cost to us of a given strategy, but our cost is not relevant to the future changeability of a strategy.

This approach has immediate implications for which climate change effects we should focus attention on, namely those that require a commitment of resources. Any climate change effect or strategy that can be easily adjusted in a short time span can be neglected in favor of issues for which changeability will be difficult. In other words, public and private climate adaptation policy should work first on areas where choices may be “locked in” and difficult to change.

Changeability is a strong theme for managing uncertainty. However, even when individuals, businesses, or organizations take actions that are changeable from their point of view, the aggregate effect can be a system that is unchangeable from society’s point of view. A prime example is cities. A single family can move to or migrate away from a city with relative ease, but the city itself is almost impossible to move. This is the problem that faced many middle eastern cities during the regional climate change of several thousand years ago [Fagan, 2004].

¹⁰Hallegatte [2009] uses the term “reversible.”

¹¹Large costs remain important from the point of view of the present, particularly if those making the expenditures fear that they will get no return or that their money could be better spent. This is the specific asset problem that is central to transaction cost economics. Where an asset is expensive, yet will provide its owner a return only in very specific circumstances, the owner will hesitate to buy the asset in the first place. This is related to the indirect benefits problem, discussed elsewhere.

Short Planning Horizon

A related approach is simply to reduce the planning horizon for public and private actions. In other words, to plan and build things that do not last, but that have to be reevaluated and replaced regularly. This approach should not be misinterpreted as short-sightedness, nor as deliberately ignoring future concerns. Rather, it is intended to explicitly acknowledge that we do not know what will be the best strategies in the future, and making sure that we do not make irreversible decisions.

It should go without saying that a short planning horizon should be coupled with regular and systematic planning updates. There is no value in a five-year planning window if that window never moves forward.

Not all topics affected by climate change will be amenable to a shorter planning horizon. Hallegatte [2009] lists several areas with inherently long planning horizons, summarized in Table 2.

Table 2: Areas with long planning horizons. Based on Hallegatte [2009, Table 1]

Area	Time Scale (years)
Water infrastructures	30–200
Land-use planning	>100
Coastline and flood defenses	>50
Building and housing	30–150
Transportation infrastructure	30–200
Urbanism	>100
Energy production	20–70

We recommend that policy-makers focus on areas with inherently long planning horizons. Those areas are the ones most in need of immediate attention. Planning in areas with short horizons is more nimble; it will be easier to take action on them in the near future, when more information is available. If we delay acting on long planning horizons, we may miss our opportunity.

Reduced Complexity and Scope

Changeability and short planning horizon suggest a related criteria for adaptation strategies. It may be beneficial to pursue adaptation strategies that are deliberately simple and narrow in scope. Almost by definition, strategies that are easily changed and cover a short time horizon cannot be very complicated. Conversely, complex strategies are those that are difficult to change and require longer planning. This is particularly true for strategies that involve infrastructure or significant social change.

This idea draws on the general adaptation literature and trends in complexity research. In a complex adaptive system, such as the economy or an ecosystem, the system’s ability to adapt increases when it is composed of many individual parts, each of which is relatively simple compared to the whole system. When the system comes to be dominated by relatively few and complicated elements, it becomes “brittle”, i.e., has poor resilience; for example, financial crises or ecosystems that are dependent on a single aspect of the environment or on a single species [Colding and Folke, 2002].

Climate change adaptation strategies should strive to be both simple and narrow in scope, and we should deploy many strategies. Adaptation is a situation where redundancy and experimentation are more important than the “efficiencies” that may seem to arise from complexity and broad scope.

Plan to Variances

Many of society’s regulations are aimed at averages. Take the example of lake levels. Lakes fluctuate within seasons and across seasons. A particularly wet year may see a lake’s high water mark several feet above its level in a dry year. For regulatory purposes, it is important to identify the boundary of a lake. In Wisconsin and other eastern states, the lake bed itself is the property of the state, while the shore can be the property of a private citizen. Lake regulation has evolved the concept of the Ordinary High Water mark. This is in essence an average value for the high water marks reached by a lake in various seasons. In some years, the lake may be above the ordinary high water mark, but the newly flooded ground is still the property of the private landowner. In other years, the lake level may fall below the mark, but the exposed lake bed is still the property of the state [DNR, 2008].

Regulating to averages, like the ordinary high water mark, makes sense when the variation is more-or-less normally-distributed. But in a world of changing climate, we are no longer confident that variation follows a normal distribution. Regulations that rely on normally distributed variation will break down if the nature of variability changes. The implication for strategy is that some policies and procedures must be revised to explicitly consider the nature of variation. In some cases, climate change will make no difference. But in others, variation itself will become more important than averages. Strategies that plan to variation instead of to averages will be better able to cope with the uncertainty of the future.

4.2 Approaches to the Indirect Benefits Problem

The second problem facing us is that climate change adaptation strategies will provide few, if any, direct benefits to those who undertake them. This is a profound problem for climate adaptation efforts. The practical, on-the-ground efforts needed for climate change adaptation on a large scale will require the efforts of individuals, businesses, community groups, nonprofits, environmental managers, researchers, and many others. Yet, since most of their efforts will yield benefits only in the distant future, they may be hesitant to act.

It is worth exploring this problem in more detail before discussing possible responses to it. At base, the indirect benefits problem should be viewed from the perspective of an individual actor, a person or organization contemplating spending resources on an adaptive strategy. The indirect benefits problem arises when the costs of that action *to the actor* (in cash, person-hours, opportunity cost, or other resources) is greater than the benefits the action will provide *to the actor*.

The focus on the actor’s perspective is critical here. Except for the relatively narrow cases of filial and in-group altruism, individuals do not take actions where their costs outweigh their benefits. Put another way, it is unwise for society to stake its climate-related future on the hope that people will suddenly become universal altruists. They have not done so through wars, famines, natural disasters, and social upheavals. Hoping they will do so for climate change—an even less immediate problem—is highly questionable [Margolis, 1984, Piliavin and Charng, 1990].

We can examine each half of the actor’s equation separately. First, the benefits to the actor can be low for two general reasons. Because climate change is a problem of the future

and climate adaptation is a benefit in the future, most present-day actors will not exist to see the benefits of their adaptation actions. As noted elsewhere, even familial and in-group altruism are unhelpful here because the time-scales of adaptation are so long and because the specific benefits of adaptation actions are so uncertain. We are willing to invest for our child's education, but not for our great-grandchild's heart surgery needs. Will there even be heart surgery by then?

Apart from time, there is a property rights problem in adaptation benefits. As with other environmental actions, the benefits of adaptation actions will be hard to keep to one's self. Other environmental issues may provide more familiar examples. Although everyone appreciates clean air, no one has the power (by themselves) to prevent others from polluting. The air is a so-called nonexclusive resource. Individuals know that any efforts they take will benefit everyone and therefore be wasted from their point of view [Randall, 1987, Bromley, 1995].

There are countless ways of organizing society to solve this problem, ranging from informal norms among small groups to complex government programs. Consider the example of basic scientific research, which is also a nonexclusive good. Because basic research often provides no immediate benefit to the researcher, we as a society have created organizations which directly reward researchers through employment and accolades. This research is paid for in part by allowing universities to own the results of individual research. An individual research project may or may not pay off, but a university's portfolio includes enough valuable elements to support the entire enterprise. Also, universities are able to package a by-product of research—knowledge—and sell it to students [Ostrom, 1990, Ostrom et al., 1994].

Businesses—which are essential to adaptation efforts—have no such structure. They have to focus their attentions on activities that provide short-term benefit to their owners and employees. For instance, though an agricultural producer may have a personal concern about climate change, his or her year-to-year business decisions have to be driven by current climatic conditions and current markets. This is also true for industries with longer planning horizons than agriculture. The uncertain potential threat of climate change is not strong enough to influence current business decisions.¹²

Turning to the cost side of the individual actor's equation, there are two more aspects to consider. Time again plays a role. The individual actor's costs have to be paid in the present by the actor him or herself. This suggests a general policy approach, find ways to help adaptation actors defer the costs of their actions to the future.

Secondly, the costs of taking adaptation actions in the present may be high due to a more general economic problem: transaction costs. The term "transaction costs" brings to mind direct costs of doing business, such as transportation, attorneys fees, permits, and so on. In economics, the term has a broader meaning that includes information problems associated with transactions, including the following:

- Search costs.
- Bargaining costs.
- Policing and enforcement costs.

¹²We are tempted to decry this present-orientation of business as selfish, short-sighted, or ignorant. But the problems of predictive uncertainty and values uncertainty should give us pause. How certain are we that a particular adaptation strategy would prove valuable to future people? Even the most altruistic business is not sure what the best course of action is, from the vantage point of the present.

These costs can be enormous. Just discovering that a product or service is available can be prohibitively time-consuming and difficult. Transaction costs are generally most problematic for transactions that are infrequent and specific (unique or unusual). The problem of transaction costs stems from our nature as people: we face an uncertain world, we have limited brain power, and we often try to take advantage of one another [Furubotn and Richter, 1997, ch. 2] [Williamson, 1989].

We can expect transaction costs to be a significant problem in climate change adaptation. The problem is uncertain, our abilities to understand it are limited, the transactions involved are infrequent, and they are specific. As is the case with public goods, there are many approaches to dealing with transaction cost problems, which can be applied to climate change adaptation. These include changing the transactions themselves to be more frequent, an approach that echoes some of the ideas for reducing uncertainty [Williamson, 1989, North, 1990].

5 Approaches to Developing Adaptation Policy

We have identified three central problems in climate change adaptation—uncertainty, indirect benefits, and planning horizon—and discussed ideas for evaluating adaptation strategies in light of those problems. This section takes a more detailed approach to adaptation by identifying and discussing questions that policy-makers should address in developing adaptation strategies. Many of the questions discussed in this section follow from the ideas discussed above, but others are general policy design issues.

The questions are grouped into six areas, as follows:

1. Scope, scale, and time frame (related to predictive uncertainty and planning horizon).
2. Benefits and harms (related to values uncertainty).
3. Actors and actions (related to lack of direct benefits and planning horizon).
4. Strategy focus (general policy question).
5. Criteria for evaluation (general).
6. Suggested common strategies (general).

We suggest that those working on climate change adaptation strategies apply these questions to specific climate change effects relevant to their area of concern, be that health, fisheries, agriculture, storms, or any other topic. Some of the questions apply to the the climate change effect itself. Others apply to specific strategies devised in response to the effect.

Scope, scale, and time frame questions are aimed at establishing the rough magnitude of the climate effect under consideration.

- What is the geographic area involved? Is it contiguous or fragmented?
- What is the social breadth involved? Are there many or few groups or cultures? How similar are they?

- What parts of the scale of social or ecological organization¹³ will feel the greatest effect from the impacts? To what parts are the strategies aimed?
- How soon are impacts likely to arise (or have they already arisen)? For how long are impacts likely to endure?
- How much lead time is required for strategies to be effective? How quickly can strategies be altered?

The second set of questions—*benefits and harms*—are meant to help policy-makers understand the differential nature of climate change effects. Some places or groups will be harmed, others will be benefited by a particular effect. These questions also relate to the problem of values aggregation; the adding-up of different benefits or harms among individuals.

- Are the impacts harmful or beneficial (or is it too early or difficult to tell)?
- How will benefits and harms vary among affected groups or places?
- Are there significant impacts indirectly related to climate change (e.g., impacts from human migration)?
- When there are multiple benefits and harms, do they aggregate into an overall benefit or harm or are the combined effects indeterminate?
- Is determining benefits and harms objective or subjective?
- Will the strategies affect some groups differently than others?
- Will the strategies have negative (or positive) spillover effects (unintended consequences, externalities)?

Third, we suggest that policy-makers ask questions about *actors and actions*. In other words, *who* will take action and *what* specific actions will they take. This relates to the problem of indirect benefits. It is helpful to identify who will take action, so we can consider what benefits they will receive and look for ways to increase those benefits.

- To whom are the adaptation strategies addressed?
- Is the audience expected to take action to implement the strategies or will others take actions?
- Who or what is most affected by the impacts under consideration?
- Is the focus on human or ecological systems? Or are they connected?
- What benefits are expected for the actor from their actions?

The remaining three questions sets are more general policy design questions intended to identify policy alternatives and to increase clarity. First, we suggest asking the following questions to bring focus to climate change adaptation strategies under consideration:

¹³Social scale is a range of organizational sizes: individuals—small organizations (businesses, nonprofits, etc.)—large organizations—societies. Similarly, the ecological scale ranges from individual organisms through large ecosystems. Impacts, strategies, and adaptation success will vary across scales.

- Are strategies meant to reduce impacts as such or to reduce exposure or harm from impacts?
- Do strategies respond directly or indirectly to a climate impact?
- Are strategies focused on deliberate, planned, and centralized actions?
- If strategies use autonomous adaptation, are policy actions needed to support it?
- Are the strategies aimed at changing processes (e.g., changing the governing rules or professional practices by which decisions are made) or achieving outcomes (e.g., building a new storm drain)?

Policy-makers will consider a large number of possible strategies, and it will be helpful to develop criteria for comparing and ranking them. That effort may be helped by the following questions:

- Which impacts and strategies are of greatest importance?
- What criteria are most pertinent to evaluating importance?
 - Risk or urgency (i.e., a matter of survival or mere accommodation)?
 - Feasibility and cost?
 - Positive or negative spillover effects, including co-benefits?
 - Predictive uncertainty?
- What strategies would be worth doing even without their climate adaptation benefits?

Finally, in identifying potential strategies, it may be helpful to consider the following *categories of common strategies*:

- **Information:** Generating and sharing information about climate change and adaptation. Including monitoring and early warning capacity.
- **Research:** Researching impacts of climate change. Supporting public and private innovation through theoretical and applied research.
- **Mainstreaming:** Incorporating climate adaptation issues in other government policies and procedures.
- **Infrastructure:** Strategies to build or modify infrastructure.
- **Resilience and adaptive capacity:** Increasing resilience and adaptive capacity of ecological or social systems, including removing barriers to adaptation.
- **Inequality:** Addressing social inequality in distribution of climate impacts.
- **Market mechanisms:** Using regulated markets (taxes, trading systems) or private businesses to foster adaptation.
- **Externality control:** Regulating negative externalities from other adaptation strategies, including autonomous adaptations.

6 Conclusion

We have proposed three concepts around which the Wisconsin Initiative on Climate Change Impacts could organize its future work: uncertainty, indirect benefits, and planning horizons. These concepts have three things to recommend them. First, they are general enough to cover a range of climate change adaptation topics. Second, they are definite enough to yield specific policy recommendations. Finally, they are, in our view, the three most important problems facing climate change adaptation efforts.

The problem of uncertainty—both predictive and values uncertainty—hangs like a cloud over every aspect of climate change adaptation. Put most simply, society does not and cannot know what adaptation strategies will be most effective over the time span of climate change. We are left with one response: whatever adaptation strategies we choose, let us make sure they can be changed in the future when information about climate and people's values become clearer.

We find it interesting that the idea of changeability appears in so many variations in the climate change adaptation debate. In its discussions, the Adaptation Working Group has generated at least five variations on the concept:

- Sustainability, or, in one group member's terms, "living lightly on the land."
- System resilience.
- Social capacity to implement change.
- Preserving options and opportunities for future generations.
- Maintaining ecosystem services.

All of these variations are driven by the concerns we have identified above, namely, our difficulty in predicting the future, our difficulty in determining and aggregating social preferences, and our difficulty in organizing and sustaining adaptation strategies over long time periods. The five variations above may be too vague to apply to some aspects of climate change, but they should be incorporated into adaptation efforts where possible. See, e.g., City of New York [2010], City of Chicago [2010].

In addition to the problem of uncertainty, an understanding of climate change adaptation requires considering the indirect benefits problem. Even if uncertainty were reduced dramatically, society still has to *take action* to adapt to climate change. Even if we know *what* to do, we still have to decide *who* should do it.

This problem tends to be overlooked, especially by advocates who accept the importance of the problem and may even see it in moral terms. However, for a problem like climate change adaptation, any solution will require the efforts of people who are not advocates. For these people, calls to take adaptive action will be viewed as just another option in an ever changing mixture of options. For such a person to take adaptive action, the action must be worth it to them. Finding creative policy solutions to bring home the value of adaptation actions will be essential. Merely asserting that climate adaptation is important will not be sufficient to move most individuals and businesses to action.

Finally, the long time spans involved in implementing many climate change adaptation strategies will tax the managerial and strategic capacity of individuals and organizations. We feel that successful adaptation will address this problem directly and focus on strategies that avoid the need for sustained or repeated actions by the same groups or individuals. In

other words, we suggest avoiding strategies that *depend* on continued effort and focusing on strategies that can be reassessed and renewed by successors.

We close with a caution. Climate change is an exceptionally complicated problem that deserves the best efforts we can give it. We urge climate change adaptation researchers, advocates, and policy-makers to continually remind themselves of this fact.

Allow us to illustrate with two examples from Adger and Barnett [2009]. These are examples of the complicated social feedback loops that can arise when policy meets reality.

First, Adger and Barnett [2009] note that many adaptation strategies are vulnerable to moral hazard problems. For instance, public policy often tries to insulate people from impacts of climate change, rather than foster adaptation. They give the example of Australian payments to farms and businesses that suffer from drought. This policy reduces the incentive for recipients to adapt. If Australian drought has become the norm rather than the exception, a policy that pays people to not adapt is not maintainable, will actively hinder adaptation, and will be a colossal waste of money.

Second, climate change and adaptation policy will spur political opportunism. Certain groups will use the uncertainty and possibilities of major climate change to drive otherwise impossible political changes. A disturbing possibility is forced migrations, done for racial, political, or economic reasons under the guise of climate adaptation policy.

In other words, climate change adaptation is not an academic exercise. It is a problem with wide ranging, complex, and unpredictable effects. All of this is made more challenging by the interconnectedness of our world. Adaptation policy in one region will have spillover effects on another region, affecting ecosystems, cultures, markets, and more [Adger and Barnett, 2009].

It is our hope that the Wisconsin Initiative on Climate Change Impacts can continue to contribute valuable analysis and recommendations to foster climate change adaptation in Wisconsin.

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