Changing Perceptions of Changing Risks: Climate Change and the California Public

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EXECUTIVE SUMMARY

Climate change poses risks to California and to the rest of the world. California's policy makers have recognized these risks, and have become courageous first-movers in addressing this global issue. But to reach the ambitious goals for emissions reductions set by the state government, further policy action and public support for that action is needed. Understanding public perceptions of climate change risks is a critical component for motivating public support for future policy action, in California and elsewhere.

Despite significant levels of public awareness and expressed concern about climate change, and high levels of risk perception expressed by climate experts, climate change is often superseded by other issues perceived as more pressing, including other environmental issues. This disparity can be attributed to a combination of the nature of climate risks and the social context in which those risks are perceived. Public perception of climate risks is attenuated by the characterization of climate impacts as remote (risks affect distant people and places or future generations, but are not local or immediate), as deniable (uncertainty regarding risks is so great, they can be ignored), and as manageable (society will be able to adapt to climate changes and avoid risks). In other words, climate risks are "discountable" in time and space (remote), in terms of personal consequence (deniable), and in terms of adaptive capacity (manageable). A number of social and cultural factors, such as the general treatment of climate change in the mass media, help perpetuate the lack of urgency the public perceives regarding climate risks. Although there is growing concern over the risks of climate change among scientists, the public perception of these risks are changing much more slowly. While public perception lags, climate change is not only creating new risks and hazards (such as sea level rise threatening islands and coastal areas), it is also changing the risks from existing hazards (such as more intense and/or frequent heat waves, hurricanes, and other extreme events). These changing risks are only slowly and incompletely translating into enhanced risk perception of climate change.

Three different "framings" of climate risks are often used to motivate climate policy action, in part by increasing the perceived risk from climate change. We label these as ethics-based, personal welfare-based, and economics-based approaches. Ethics-based approaches emphasize four issues: intergenerational equity, the imbalance between industrialized and developing countries in terms of per capita emissions and vulnerability to climate impacts, the imbalance in adaptive capacity between richer and poorer socioeconomic groups within nations, and our moral responsibility to act as stewards of the Earth and preserve its future well-being. They confront those risks perceived as remote, deniable, and manageable by focusing on the equity and moral values that transcend considerations of personal risk. Ethics-based approaches are more likely to engender support for immediate mitigation activities, as it is difficult to justify delaying emissions reductions on ethical grounds, as damages mount to other species, in other parts of the world, and for vulnerable local populations and future generations.

Personal welfare-based approaches seek to motivate action by promoting the perception of direct risks from climate change on a personal level, either to an individual, family, or community. The personal welfare approach also focuses on emphasizing the impact on individuals' children and grandchildren, highlighting that reducing emissions is an investment in our children's future. They emphasize the physical impacts of climate change that will affect quality of life, and seek to reframe the climate change risks that the public often perceives as remote, deniable, and manageable by characterizing climate impacts as personal, immediate, and significant. In California and more broadly in the US, we are increasingly successful in insulating ourselves from daily weather changes. Personal welfare-based approaches may reinforce support for this trend, providing incentive not to prevent climate change but to adapt, continuing this trend of insulation. That is, until impacts become too intense to ignore—there are certainly limits to adaptation, and mitigation is necessary to prevent impacts beyond those limits.

Economics-based approaches focus on the financial risks and opportunities created by climate change impacts and solutions. They emphasize the ancillary benefits greenhouse gas reductions can create, through "no regrets" actions and through opportunities for "first movers" who invest in new technologies or make voluntary anticipatory cuts. They emphasize the economic implications of climate change impacts, such as the potential for more damaging extreme weather events, which can also be framed in terms of impacts on personal welfare. Like ethics-based approaches, they can transcend perceptions of climate risks as remote, deniable, and manageable by focusing on financial risks and opportunities that exist regardless of the level of perceived risk. Economics-based approaches motivate both adaptation and mitigation. The financial risks from more frequent and/or intense extreme events can motivate anticipatory adaptation, which to a certain extent can reduce damages, but can also motivate early mitigation to prevent these risks from growing. They can also motivate mitigation through arguments for "no regrets" actions, anticipatory reductions prior to mandatory reductions, and "first mover" investment advantages.

This analysis suggests that a blend of these approaches is needed to broadly reframe the climate policy debate so as to generate increased public perception of the

risks of climate change and the need for action now, not just at some indefinite time in the future, and to get the public to endorse—in fact, to demand—concrete actions from their decision makers to lower the risks. These approaches respond to public misperceptions of climate risks as deniable, remote, and manageable, and can lead to a realization that risks can be immediate, unfair, irreversible, unmanageable and local, and that solutions need not be expensive or inequitable. A better understanding of the relative effectiveness of the approaches we describe for communicating climate risks to diverse populations within California can strengthen efforts to motivating policy action.

We offer the following recommendations for motivating policy action in California that emerge from this analysis:

- Recognize that personal welfare arguments may be more effective for motivating adaptation than mitigation.
- Prioritize moral and economic arguments for motivating mitigation.
- Enhance demand for mitigation by integrating climate risks and adaptive measures into everyday life.
- Highlight the limits to coping with climate risks today and adapting to climate risks in the future.
- Consider all the meanings of "dangerous" climate change and their relevance to different populations.

1. INTRODUCTION

Climate change poses risks to California and to the rest of the world. A growing body of scientific research has identified potential climate impacts across many important sectors and regions within the state.[1,2] Although there may be some beneficial impacts from climate change, such as warmer winter temperatures and longer growing seasons, the adverse impacts are very likely to outweigh such benefits, particularly for warming of more than a few degrees above current temperatures. Winter snowpack is projected to decrease significantly, impairing the storage and supply of California's water resources and the winter recreation industry. The frequency and intensity of heat waves and wildfires are projected to rise, increasing the risks of heat-related deaths and the physical damage, air pollution, and suppression costs of large wildfires. Tropical diseases are projected to spread as conditions become more favorable for their expansion. California's agricultural industry could face significant challenges with more frequent summer water shortages and reduced quality and production of valuable goods such as wine grapes and dairy products. These and other climate impacts have the potential to substantially affect key economic sectors and the quality of life for vulnerable populations in the state.

California's policy makers have recognized the risks posed by climate change, and have become courageous first-movers in addressing this global issue, succeeding in generating broad, bipartisan support for the actions already taken. California has sent a strong message to the world that it is committed to reducing its own greenhouse gas emissions and to becoming a world leader in addressing climate change. These actions include the 2002 Pavley California Vehicle Climate Change Law, setting the first ever limits on greenhouse gas emissions from passenger vehicles, the 2005 Schwarzenegger Executive Order #S-3-05, establishing significant emissions reductions targets for the next 50 years, and a variety of agency-level policies.

But much more work remains to meet the ambitious goals set by the state government. Without widespread public understanding of the scope of the problem and acceptance of the magnitude and urgency of needed changes, new policy action is likely to be met with considerable public resistance. Human-induced climate change is a reality, and its influence on the world can already be seen. Its impacts and associated risks will only intensify the longer we continue to add to the greenhouse gas concentrations in the atmosphere. A challenge in motivating climate action, given America's highly politicized environment, has been the communication of a convincing message that mainstream climate science is credible and the risks of climate change all too real. Scientific uncertainty, while an expected component of the study of any complex system, is exaggerated by the general portrayal in the media of climate change as an issue fraught with comparably credible, competing claims and lingering questions regarding human and natural driving forces. This portrayal, and the broader social context within which climate change is perceived by the American public, breeds confusion and pushes climate change down the list of priorities for action. As a result, public perception of risk from climate change and the future benefits of emissions reductions are often outweighed by an array of near-term issues perceived to be more pressing.

Understanding public perceptions of climate change risks is a critical component for motivating public support for future policy action, in California and elsewhere. We outline a variety of social and psychological factors that can amplify or attenuate public perceptions of risk from climate change. We argue that the characteristics of climate change currently allow it to be misperceived as a "remote" risk, as a "deniable" risk, and as a "manageable" risk. These factors contribute to reducing the perception of climate risks relative to expert assessment of those risks. We argue that these widespread misperceptions must be addressed in order to motivate widespread support for policy action. We discuss three approaches to counter these attenuating factors and communicate the risks of climate change: ethics-based, personal welfare-based, and economics-based approaches, each of which either individually or in combination may motivate different subsets of the population. Finally, we also discuss the different policy responses (adaptation and mitigation) for which these approaches are likely to motivate support, and the implications of our findings for motivating climate policy action in California.

2. WHAT IS RISK?

2.1 Technical Risk

Risk is classically defined as so-called "technical" risk:

[the consequences of a hazard] X [the likelihood of that hazard]

What can happen, and what are the odds? An example of this definition of risk is the damages caused by a 7.0 earthquake to property and lives multiplied by the likelihood of a 7.0 earthquake occurring in California. This definition can further include scope and intensity to characterize consequences,[3] in this case the persistence and magnitude of earthquake damages.

2.2 Expert Assessment of Climate Risks

Article 2 of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) states its ultimate objective as: "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." Although there may be some thresholds beyond which there would be "dangerous" abrupt climate impacts (e.g., ice sheet collapse and rapid sea level rise), there are other categories for which different points along a rising continuum of impact intensity will be seen as "dangerous" by different people (e.g., gradual sea level rise threatening islands and coastal regions).

Scientific assessments of climate risks have often been framed in terms of defining levels of global or regional temperature change associated with climate impact thresholds likely to be widely perceived as "dangerous." Examples include disintegration of the West Antarctic Ice Sheet or the Greenland Ice Sheet (either of which could lead to several feet of sea level rise) and rapid shutdown of the Atlantic Gulf Stream (which currently creates a much milder climate in Europe than would otherwise exist). The Intergovernmental Panel on Climate Change, for the upcoming Fourth Assessment Report, approaches this problem by assessing "key vulnerabilities" in the climate system such as the processes above. Scientists estimate rough global average temperature thresholds associated with triggering these impacts to range from 1-3.5ºC (1.8-6.3ºF) above current temperatures, well within the range of temperature increase typically projected within the next 50 to 100 years. Climate impacts that are already underway have been identified in some studies as key vulnerabilities. Among these are loss of mountain glaciers, adverse impacts on biodiversity, increases in severity of extreme weather events, and loss of cultural amenities.

A recent survey of experts regarding "dangerous" climate change[4] specifies two key factors as determinants of the level of "danger" associated with climate impacts. First, experts identify the rate of climate change. A more rapid rate of change further deviates from "known" changes observed in the Earth's past and increases the likelihood of abrupt climate changes. Second, experts identify the geographical and societal context

of change. For example, the ability to adapt can decrease the risks from climate change. Most respondents argued that "danger" means reaching a state that is irreversible and is associated with impacts for which an adaptive response is impossible.[4]

2.3 Perceived Risk is Different

Comparisons of expert and lay assessments of technical risk often show great discrepancies.[5] For example, the public continues to build homes in floodplains and earthquake zones, even when warned of the high-probability, high-consequence risks of living in such areas.[6,7] In addition, members of the public are often extremely concerned about low-probability risks, such as radiation from nuclear power plants, while ignoring higher-probability risks like radon exposure in the home.[5]

While the technical definition of risk may suggest some "objective," scientific value of risk from any hazard, different individuals in practice will have very different perceptions of the risks from a given hazard. Researchers have identified a number of social and psychological dimensions of risk that are often more salient for the lay public than technical risk.[5,8] Researchers using psychometric techniques identify two dominant factors in public perceptions of risk across many different hazards: "dread" risk (including the dimensions of perceived lack of control, dread, catastrophic potential, fatal consequences, and the inequitable distribution of risks and benefits) and "unknown" risk (including the dimensions of hazards judged to be unobservable, unknown, new, and delayed in their manifestation of harm).[5,8] Others have suggested "unnatural" or "immoral" risk as an important additional dimension.[9] Research has also examined the broader cultural and political context of risk perception. Differences in risk perception are central to divergent opinions between men and women[10] and people from different cultures.[11] Risk perception is also influenced by cultural factors such as trust, social values and worldviews.[12,13] Research has also demonstrated the crucial role of affect (the specific quality of "goodness" or "badness" associated with a concept or process) and emotion in risk perception and behavior.[5,14] Humans naturally employ an "experiential" mode of thinking[15] to make decisions in the face of danger that is intuitive, automatic, and fast, and represents risk as a "gut feeling."[16] It relies on images and associations, linked by experience to emotions and affect.[16] It indicates whether it is safe to walk alone down a dark alley, or whether a bowl of soup is too hot to eat. This "risk as feeling"[16] tends to assign too much significance to frightening consequences,[17] and can occur at both an individual and societal level.

This "perceived" risk depends on an individual's personal context, their life experiences, values, and culture, and the interaction of those factors with the character of the hazard.[18] Perceived risk, therefore, can be defined as:

["technical" risk] + [nature of the hazard] + [the social context of the perceiver]

In our earthquake example, an individual who was traveling on the Bay Bridge during the 1989 Loma Prieta earthquake and witnessed a section collapsing, or who helped with rescue efforts when the Nimitz freeway collapsed almost certainly would perceive a

higher level of earthquake risk than someone who felt only brief jolts in their undamaged home.

3. Understanding Public Perception of Climate Risks

Climate experts generally express high levels of risk perception of climate change, citing the uncertainty in scientific knowledge of the climate system and the future trajectory of climate change not as reasons to delay action, but as reasons to invoke the precautionary principle. In the words of Roger Revelle,[5] one of the first scientists to recognize the potential risks of climate change, "Human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be reproduced in the future." In the words of one of us,[19] this is "a planetary gamble we can't afford to lose." Climate experts also accentuate the urgency of emissions reductions, given the inertia of the climate system and the potential for "dangerous" impacts. For example, James E. Hansen, director of the Goddard Institute for Space Studies, states that action "is needed urgently, because we are on the precipice of climate system tipping points beyond which there is no redemption."[20] The public, however, generally expresses lower levels of perception of climate risks and less urgency regarding the need for significant action.

Research on public opinions of climate change in the US and Europe indicates widespread and increasing public awareness and concern about climate change but uncertainty regarding the need for an immediate policy response. A 2002-2003 national survey found that 92% of Americans had heard of climate change, and 70% of Americans were very (25%) or somewhat concerned about it.[5] A new ABC News/Time/Stanford national poll found that 82% of respondents felt that climate change was at least somewhat important to them personally, with 50% of respondents calling it very or extremely important.[21] Also, there is widespread recognition that climate change is already having an impact on the world. In a 2003 CBS News poll, a majority of Americans (59%) viewed climate change as an environmental problem causing a serious impact now.[22] In California, the results are very similar. A 2005 Public Policy Institute of California (PPIC) survey found that 75% of Californians see climate change as a very serious or somewhat serious threat to the economy and quality of life for California's future.[23] 57% of Californians believe the effects of climate change have already begun.[23]

But, despite significant levels of awareness and expressed concern, climate change is often superseded by other issues perceived as more pressing. A 2003 British study found that although 67% of respondents felt global warming was important or very important to them, their main priorities lay with health, family, safety, and finances.[4,24] Two 2004 surveys in the UK found that while most respondents rated global warming as the most important environmental issue for the world today, respondents saw terrorism and domestic issues as having a higher priority.[4,25] Among environmental issues, climate change is generally ranked higher as a global issue than as a national or local issue. In the 2006 ABC News/Time/Stanford poll, climate change was cited most frequently as the single biggest environmental problem facing the world today.[21] But in a 2000 Gallup Poll, climate change was not only ranked lower than national issues such as the economy,

education and health care, it was also ranked 12th out of 13 environmental issues facing the nation, below more regionally experienced issues such as clean air, clean water and urban sprawl.[26] When asked to identify the single most important environmental issue facing California today, climate change was not among the top five issues identified by Californians in the 2005 PPIC survey, and was mentioned by less than 5% of respondents.[23]

The disparity between public risk perception and expert risk assessment can be attributed to a combination of the nature of climate risks and the social context in which the risks are perceived. These factors contribute to making climate change a "hidden hazard."[27] In this section, we discuss the characteristics of climate risks and key social processes that influence perceived risk from climate change.

3.1 The Nature of Climate Risks

Table 1 lists a set of hazard characteristics that affect how individuals perceive risks.[18,28] This set is not intended to be comprehensive, but is intended to focus on factors identified in the literature that are specifically relevant to risk perception of climate change. Moving from left to right in each category, these factors amplify the perception of risk.

Table 1. Hazard characteristics that Affect Perceived Risk

Factors Attenuating Risk Perception:	Factors Amplifying Risk Perception:
Low-probability	High-probability
Low impact	Catastrophic
Familiar	Unknown
Affecting others	Affecting an individual personally
Not dreaded	Dreaded
Natural	Human-made
Evenly distributed	Unevenly distributed
Voluntary	Imposed
Under an individual's control	Controlled by others or uncontrollable

Climate change poses four distinct types of risks:

- Gradual changes in climate conditions that, for example, are leading to loss of mountain glaciers and polar ice and changes in species behavior and distribution. These changes are projected, for example, to necessitate modifications to agricultural systems and to lead to loss of coastal lands from rising seas.
- Global-scale abrupt changes such as the disintegration of the West Antarctic Ice Sheet, or the shutdown of the Gulf Stream. These low-probability, high-impact "imaginable surprises" have the potential to fundamentally change elements of the Earth system, and the complexity of the system may conceal other "unknown" mechanisms of abrupt change.

- Increasing risks from existing hazards due to climate change, such as increased intensity and frequency of extreme events like hurricanes and heat waves. These hazards are already perceived as posing risks, but climate change can already be shown to be changing the technical risk associated with these hazards. For example, research regarding the 2003 heat wave in Europe indicates that climate is increasing the likelihood of such events.[29,30]
- Indirect or secondary risks created by these direct risks, such as increasing drought or coastal flooding in other parts of the world displacing populations and leading to increased emigration and political instability that impact regions not directly affected by the climate impacts.

Climate change is not only creating new risks and hazards, it is also changing the nature of existing risks. For example, using the terminology of Table 1, human-induced climate change is making intense heat waves more probable, more catastrophic, more unknown, and more human-made. These processes should lead to heightened risk perception, enhancing important elements such as those associated with "dread" risk (catastrophic potential, fatal consequences, etc.) and "unknown" risk (new, delayed manifestation of harm, etc.).[8] However, these increasing risks are only slowly and incompletely translating into enhanced risk perception of climate change.

3.2 Attenuating Characteristics of Climate Risks

There are a number of characteristics of these climate risks that can attenuate risk perception.,[4,9] In table 2, we highlight three categories of these characteristics. A common theme among these categories is that the risks from climate change are currently "discountable" for many people. They are discountable in time and space (remote), in terms of personal consequence (deniable), and in terms of adaptive capacity (manageable). Socioeconomic factors may strongly influence the degree to which this discounting occurs.

Table 2. Attenuating Characteristics of Climate Risks

Attenuating Factors	Illustrative Example
Remote Risk to distant people and places or future generations, but not locally or immediately	*Melting polar ice caps* Melting polar ice and permafrost is threatening the way of life of the Inuits, but those impacts have no direct effect outside of that area and take a long time to fully materialize.
Deniable Uncertainty regarding risks is so great, they can be ignored	*Hurricanes* Hurricanes in the Atlantic Ocean seem to be getting stronger, but the linkage between climate change and hurricane intensity is so uncertain that the linkage can be ignored.
Manageable Society will be able to adapt to changes to avoid risks	*Heat waves* More frequent and intense heat waves would be unpleasant, but we can rely on increased air conditioning to offset the increased temperatures.

3.2.1 A "Remote" Risk

Although the signs of climate change are already apparent in California and throughout the US, climate change is most often perceived as only affecting distant communities or future generations, and thus it is not considered an imminent or high-priority risk. In a 2002-2003 survey of the American public, 68% of respondents were most concerned about the impacts of climate change on people around the world and non-human nature.[5] Only 13% were most concerned about impacts on their family and local community.[5] In the 2006 ABC News/Time/Stanford poll, 60% of respondents felt climate change threatens the future generations "a great deal," compared to 56% for "plant and animal species," 32% for "other Americans," and only 25% on a personal level.[21] National issues such as the economy and health care, and environmental issues such as air and water pollution are more easily linked to local impacts, while many of the most dramatic existing impacts of climate change are "remote" for most Americans. When asked to provide the first thought or image that came to mind with the words "climate change," the most common response by participants in the 2002-2003 US poll was associated with melting glaciers and polar ice.[26] The perception of climate risks as remote is likely to be stronger for individuals from less affluent socioeconomic groups, who are more likely to have concerns over essential needs that outweigh climate risks, even though these groups may be more vulnerable to climate risks (see below).

3.2.2 A "Deniable" Risk

Future projections of climate change and climate impacts are inherently uncertain, due both to uncertainty in the trajectory of future greenhouse gas emissions and to uncertainty in the response of the climate system to those emissions. The current IPCC projections for temperature increase by the year 2100 range from 1.4-5.8ºC (2.5-10.4ºF).

Uncertainty compounds when attempting to project regional and local climate impacts, making it quite easy to "deny" risks on an individual or local level. For example, recent projections show that under a relatively low global greenhouse gas emissions future, California could lose 30-70% of the Sierra snowpack.[1] While on the one hand this projection may be startling, the range is also so wide that some respond by concluding that the science that led to this conclusion is still too uncertain. Although there is widespread consensus among scientists about the basic science of global warming,[31] a number of groups work to accentuate these uncertainties, reinforcing the deniable character of climate change. Indeed, recent US polls do not find high levels of belief that there is a strong consensus among scientists regarding the existence of climate change. A 2004 report found only 43% of respondents believed that there is a strong consensus,[22] and the 2006 ABC News/Time/Stanford poll found only 35% of respondents believed that most scientists agree that climate change is happening.[21] The perception of climate risks as deniable is likely to be stronger for individuals from less educated socioeconomic groups, who are less likely to be knowledgeable about the complexity of climate change and the reality of climate risks.

3.2.3 A "Manageable" Risk

Finally, there is an expectation that, even if local impacts occur due to climate change, we will be able to adapt to those impacts. For example, some individuals are not threatened by projected rising temperatures and associated loss of snowpack, claiming that California can adapt to the changes by building new dams or relying on desalinization plants for water supply. This confidence in the capacity to "manage" climate impacts at an individual and societal level further reduces the perception of climate risks. However, there are costs and limitations to managing continued climate changes that are often not well understood by the general public. Furthermore, different socioeconomic groups will have differing capacity to truly "manage" these impacts. In many cases less affluent socioeconomic groups are more likely to be vulnerable to the climate risks outlined above, because they are less likely to have the capacity to adapt to a changing climate. It is also important to note that the effects of policy responses to climate change, such as higher energy rates to fund the transition to renewable energy, may impact less affluent groups more significantly and further decrease manageability.

3.3 Social Context of Climate Risk Perception

Risk perceptions are determined only partially by the nature of the hazard and the expected harm. Social, institutional and cultural factors create signals that are also important in influencing risk perception of hazards.[32] A "risk signal" can be any message about a hazard event that influences perceptions about the severity of that hazard.[32] For example, risk perception of the 2001 anthrax attacks was amplified by the emotional state of the nation following September 11 and the considerable media coverage of the attacks. These factors contributed to a widespread sense of "dread" that something horrible could happen to "me," despite the fact that the anthrax attacks only led to a handful of deaths. Risk perception can also be amplified by other signals, such as the stigmatization of places or products.[32] For example, the few but well-publicized poisoning cases in the

early 1980s due to Tylenol tampering generated a widespread perception that Tylenol was unsafe and great financial losses for the manufacturer, Johnson & Johnson, even though the company acted quickly to remedy the situation.

Some signals have enormous "ripple effects,"[32] and a terrorist attack is a prime example. Terrorism has been called "a new species of trouble,"[16] a term originally coined to describe hazards related to chemicals and radiation.[33] These hazards do not have a fixed duration like floods or earthquakes; instead, they persist, causing considerable dread. Despite the real harm of September 11, the actual loss of life from those events is duplicated in the US about every three months from gunshot wounds, about every three weeks from automobile accidents, and about every three days from cigarette smoking. Clearly, the perceived risk versus technical risk for this hazard is orders of magnitude higher.

Climate change is creating or enhancing a variety of persisting hazards, and thus has the potential to fall into this "new species of trouble." However, the complexity and "creeping" character[34] of climate change make the impacts difficult to detect, and allow the attenuating characteristics described above to dominate. Without distinct experience of risk signals from climate impacts, the public is left to respond primarily to scientific assessments of current risks and projections of future risks, which are then amplified or attenuated by social and political processes. Table 3 summarizes the amplifying and attenuating processes we discuss here associated with climate change.

Table 3. Social Context of Risk Perception[35]

Risks are attenuated when:	***Risks are amplified when:***
Media reporting on the hazard is limited and not sustained; discussion within immediate social network is limited.	Media reporting on the hazard is widespread and frequent; discussion within immediate social network occurs often.
Trusted managers provide information on risks and demonstrate control of hazards.	Managers try to conceal risks and lose public trust when concealment is revealed; managers are not perceived to be in control of hazards.
Benefits of the hazard are necessary.	Benefits of the hazard are not critical or are replaceable.

Signals that can amplify perception of climate risks include media-worthy events that are perceived as related to climate change. Examples include the 1988 heat waves in the US, which motivated the first widespread national concern over climate change, the European heat wave of 2003, and the hurricane seasons of 2004 and 2005. But, forces of denial work to emphasize in organized and well-financed media campaigns the uncertainties in the underlying science, attempting to distance the public from any tipping point toward action catalyzed by a media-worthy event.[36] This is exacerbated by the typical media doctrine of "balance": give equal time or space to all views, regardless of the fact that in science decades of assessment differentiate the relative credibility of various "sides." This differential credibility is rarely reported and the public simply is

confused by the impression given by the media of "dueling scientists" (e.g., see results regarding perception of scientific consensus cited in 3.2.2).[37]

In addition, the limited imagery and direct signals of climate risks have likely contributed to the decline in media coverage since reporting on climate change began. A 2001 study found that television coverage of climate change had declined by 50% and newspaper coverage had declined by 25% from 1990 levels.[5,38] Furthermore, nearly 70% of respondents reported that climate change is rarely discussed among their families and friends.[5] Research indicates that concern over risk can be driven more by interpersonal communication than by communication through the mass media.[39] These factors contribute to a view of climate change as an issue that can be set aside to address issues with more immediate impacts on everyday life.

Public confusion is further enhanced through sensationalization or downplaying of climate risks. The 2004 blockbuster *The Day After Tomorrow* enhanced moviegoers' concern over the threats of climate change[40] through an exaggerated representation of the risks, tapping into personal dread and utilizing catastrophic imagery. A few months later, Michael Crichton's book, *State of Fear*, characterized global warming as a hoax created and reinforced by scientists. The book's journalistic style and copious footnotes mislead the reader into thinking that the novel is fact rather than fiction. The novel contributes to attenuating climate risk perceptions by conveying a message that climate scientists lack credibility.

The public response to multiple risk signals is importantly influenced by the level of trust they have in the information source and those responsible for managing the risk.[32] When managers are believed to be concealing risks, they often lose public trust and the perception of "concealed" risks and uncontrolled hazards may be amplified. When the British health minister announced evidence of a causal linkage between BSE and CJD in 1996, beef consumption drastically and immediately dropped.[41] This response is believed to have been triggered by a lack of trust in those responsible for regulating the risks associated with BSE, and the perception that risks were concealed to promote vested interests.[41] The important role of trust in risk perception suggests that signals of climate risks may be amplified by the increasing exposure of the Bush administration's censorship of climate science. For example, the recent "gag order" on NASA's top climatologist, James E. Hansen, following his call for swift action to reduce US greenhouse gas emissions mentioned above, has drawn much media attention across the country and may be decreasing the public's trust of the federal government as managers of climate risks.

Finally, risk perception can be attenuated by the tangible benefits associated with the behaviors that create a given risk.[42] A risk signal could be a government official warning that cutting greenhouse gas emissions would have devastating effects on the US economy. Such a message implies that the activities that contribute to climate change are necessary, and that no economically feasible alternatives exist. This perception is amplified by popular American culture, which encourages fossil fuel-intensive lifestyle choices, such as driving SUVs.

4. FROM PERCEPTION TO ACTION

The section above describes amplifying and attenuating social and psychological factors influencing individuals' perceived risk of climate change. In this section, we identify three approaches of communicating climate risks to motivate climate policy action, which we label ethics-based, personal welfare-based, and economics-based approaches. Each of these approaches makes the underlying assumption that individuals make decisions about supporting policy responses to climate change by assessing the "costs" and "benefits" associated with different options. Each approach targets different values and metrics on which such a decision can be based. This decision-making process involves a weighing of the perceived risks and benefits both from climate change and from climate policy actions, and the factors outlined in the previous section are critical to this process. An important barrier that must be overcome is that the implications of responding to climate change are generally perceived as far less remote, deniable, or manageable than the risks associated with climate change. Although alternative behaviors, products, and policies (e.g. hybrids, renewable energy) can still provide the benefits associated with activities currently contributing to climate change while reducing or phasing out that contribution, the necessary transition is neither remote nor deniable. Also, the response to climate change is not manageable on an individual level, as meaningful response can only occur through collective action.

The three approaches presented here each employ a different "framing" of climate risks in order to shift the risk-benefit assessment individuals make regarding climate change towards support for climate policy action. "Framing" is defined in psychological literature as "the process by which a communication source constructs and defines a social or political issue for its audience."[43] How an issue is framed can elicit significantly different response behavior, particularly with respect to risk perception.[44] Each approach emphasizes different risks and motivates different response strategies. We provide illustrative examples of organizations or specific initiatives that have employed these approaches to motivate climate policy action nationally and in California. There are also, of course, a number of organizations that attempt to attenuate risk perception of climate change based on different framings of climate risks and that reinforce perceptions of climate change as remote, deniable, and manageable.[*]

4.1 Ethics-Based Approaches

In 1998, a coalition of academics and religious and political leaders signed the "Moral Call on Global Warming and Future Generations," and presented it to members of the US Senate. This letter was one of the first few major attempts in the US to address the moral responsibility of today's decision makers to reduce greenhouse gases for the sake of future generations. Since then, the movement to motivate action to slow global warming on moral or ethical grounds has grown, particularly within faith-based organizations. A number of faith-based groups have emerged that focus exclusively on

[*] We do not discuss these "skeptics organizations" in detail here, though there are many, for example, that downplay the personal and economic impacts of climate change and emphasize scientific uncertainty and the economic costs of climate policy.

motivating climate action, such as Interfaith Power and Light, the Interfaith Climate Change Network, and the Evangelical Environmental Network, which have produced campaigns such as, "What Would Jesus Drive?" In February 2006, 86 evangelical leaders, led by Rev. Jim Ball, launched the Evangelical Climate Initiative, calling emissions reductions the "basic task for all of the world's inhabitants" and spreading its message through ads, meetings with key legislators, and educational events at churches and Christian colleges around the US. Of course, not all faith-based organizations support action on climate change. The National Association of Evangelicals was preparing to endorse the Evangelical Climate Initiative before a small group of influential leaders convinced the nation's largest evangelical group to abstain.

Equity arguments raised by ethics-based approaches emphasize four issues: intergenerational equity, the imbalance between industrialized and developing countries in terms of per capita emissions and vulnerability to climate impacts, and the imbalance in adaptive capacity between richer and poorer socioeconomic groups within nations. While industrialized countries are responsible for and have enjoyed the majority of benefits from greenhouse gas emissions to date, they are expected to bear less of the detrimental impacts of climate change, and generally are seen to possess greater adaptive capacity to insulate themselves from future changes. The recognition that greenhouse gas emissions in one nation increase the risk from climate change for future generations, for other nations, and for vulnerable populations within that nation leads to a perception of moral responsibility toward affected persons,[45] and can be a powerful motivation to promote action to reduce emissions.

Ethics-based approaches also focus on the moral implications of "tampering with nature."[9] As scientists identify thresholds of abrupt and irreversible climate impacts, ethics-based approaches may become increasingly important for motivating policy action, because these rising threats, while remote, are likely unmanageable and increasingly undeniable. A number of faith-based and environmental groups emphasize our responsibility to act as stewards of the Earth and preserve its future well-being, and draw on moral arguments to engage constituents in concern over the increasing threats to critical species or cultures. An example is the Natural Resources Defense Council (NRDC) "Polar Bear on Thin Ice" campaign, which seeks to list polar bears as endangered species. In the international climate negotiations (the Conferences of the Parties—COPs), the Alliance of Small Island States is often labeled the "conscience of the COPs," and advocates significant emissions reductions based on the danger to their nations and traditional cultures from climate change-induced sea level rise. These approaches tap into the "unnatural" or "immoral" characteristics of risk that can amplify risk perception.[9]

The effectiveness of ethics-based approaches to motivating climate action is that they can confront those risks perceived as remote, deniable and manageable by focusing on the equity and moral values that transcend considerations of personal risk and invoke beliefs more widespread across the political spectrum. Unfortunately, however, not all of the population is motivated by moral values alone, particularly equity and stewardship.

An increasing number of groups seeking to motivate climate action are thus turning toward documenting the threats to personal welfare from climate change.

4.2 Personal Welfare-Based Approaches

Personal welfare-based approaches seek to motivate action by promoting the perception of direct risks from climate change on a personal level, either to an individual, family, or community. They emphasize the physical impacts of climate change that will affect quality of life, such as the spread of infectious diseases and increases in the frequency and intensity of heat waves, droughts, floods, and other extreme events. Whereas ethics-based approaches may highlight global climate impacts such as polar deglaciation or shutdown of the Gulf Stream as intrinsically undesirable changes to the Earth system, whether or not they directly affect those being addressed, personal welfare-based approaches focus on the local impacts of such global changes, such as sea level rise from glacial melting and local coastal flooding.

Organizations such as the Union of Concerned Scientists (UCS), Environmental Defense (ED), and NRDC have emphasized personal welfare considerations through a series of local climate impact reports that seek to characterize what is at stake for our children and grandchildren. For example, UCS produced two reports documenting the expected impacts on quality of life for California. The first assessment, produced in December 1999, "Confronting Climate Change in California," sought to characterize what projected climate changes are expected to mean for quality of life in California for our children and grandchildren. The second UCS impact report (2004) painted a consistent picture of the expected climate impacts in California over the next 100 years, and sought to highlight the costs in health and quality of life for our children if climate action is not taken. In March 2006, ED and the Ad Council launched a TV and radio campaign, "Fight Global Warming," which focuses on the danger to our children from failing to address climate change now. This approach blends personal welfare and moral elements described above, seeking an emotional response to engage the public.

The personal welfare-based approach seeks to reframe the climate change risks that the public often perceives as remote, deniable, and manageable by characterizing climate impacts as personal, immediate, and significant. Shifting perceptions with this approach involves framing impacts and climate hazards so that perceptions move from the characterizations in column A to column B in Table 1. However, these efforts do not effectively account for how individuals discount the future. For example, the projections of large-scale loss of Sierra snowpack may be perceived as a significant risk to California, but the fact that this risk will not manifest for several decades blunts its effectiveness as a message to provoke immediate action. Furthermore, most efforts to motivate action through the personal welfare approach do not directly address the opportunities and constraints surrounding adaptation. Because most environmental groups are concerned that a discussion around adaptation will divert attention away from much-needed mitigation strategies, adaptation is seldom raised as a strategy when generating support for climate policy action. This may be counterproductive, as advocating for adaptation policies that highlight the need for managing the climate

changes already underway could help to reinforce climate change as a problem of today rather than a remote threat of tomorrow.

4.3 Economics-Based Approaches

Many organizations are focusing on making the case that climate policy action is good for business. Groups such as Ceres and the Investor Network on Climate Risk highlight the economic opportunities of emissions reductions and clean energy investments. By focusing on the risks and opportunities created by climate change impacts and by policy responses to climate change, economics-based approaches emphasize the risks of ignoring future greenhouse gas regulations in business planning, and the "first mover" investment opportunities available for those who develop new technologies or who make voluntary cuts in anticipation of mandatory cuts in the future.

Other groups, such as the International Council for Local Environmental Initiatives (ICLEI) and the Climate Group emphasize the ancillary benefits greenhouse gas reductions can create, through energy efficiency cost-savings or other "no regrets" actions.[46] ICLEI works worldwide with small business and local governments to reduce greenhouse gas emissions, while the Climate Group focuses on sharing the stories of how big business and national and state efforts have reduced emissions and saved money.

Prominent members of the insurance industry, especially the re-insurance industry, emphasize the economic implications of climate change impacts, such as the potential for increased damages from more frequent and/or intense natural hazards due to climate change. As climate change is increasingly linked directly to what were once characterized as "natural" hazards, (hurricanes, droughts, heat waves, etc.) insurance groups have become deeply concerned. Preliminary studies indicate that the climate change already underway has made an event such as the 2003 European heat wave twice as likely,[29] and analyses of hurricane destructiveness show that the intensity of storms is increasing.[47] Notable examples such as the 2003 heat wave and Hurricane Katrina provide indications that future climate change may not be "manageable."

Like ethics-based approaches, economics-based approaches can transcend perceptions of climate risks as remote, deniable, and manageable by focusing on financial risks and opportunities that exist regardless of the level of perceived risk. Financial risk, similar to technical risk, must often be quantified and assessed as part of a larger business plan. Companies reliant on fossil fuels are exposed to the risk that greenhouse gas emissions will be regulated, forcing costly changes to business processes. Companies who do not anticipate such regulations risk losing out to other more innovative companies who take advantage of new market opportunities. These risks must be weighed against the financial risk associated with investment in clean technologies should those technologies fail to be viable in the future.

The limitations of the economics-based approach are that the full range of climate action needed cannot be easily justified by simple economics. While individual companies can show net economic benefits for reductions in emissions of 50% or more,

the large-scale institutional and lifestyle changes needed to fully address climate change may be more difficult to motivate from an economic basis alone, even though the projected costs of atmospheric greenhouse gas stabilization are dwarfed by the projected growth in global GDP over the time necessary to make such a transition.[48]

5. Policy Actions: Mitigation, Adaptation, and Dangerous Climate Change

Climate policy has often been presented as a choice between mitigation and adaptation.[49] Mitigation refers to reducing the rate of greenhouse gas accumulation in the atmosphere through emissions reductions, and adaptation refers to adjusting to the impacts of a warming world. This "tradeoff" between mitigation and adaptation evolved, in part, out of a perception of climate change as primarily a problem of the future, with impacts resulting from gradual and uncertain processes. This dichotomy underlies the cost-benefit approach to climate policy that is widely used in the US and broader research and policy communities. However, it is increasingly understood that adaptation and mitigation must be complementary responses to climate change, not tradeoffs.[50] Because of the lag in the climate system, some impacts of continued climate change are unavoidable, due to the emissions already released into the atmosphere. For example, even if global emissions are reduced, snowpack in California is expected to decline by as much as 25% by the 2040s. This would put increasing pressure on the state's water supply, of which melting snowpack is a significant component during the dry spring and summer months.[1] Adaptive actions must be taken to prepare for these changes. Far greater loss of snowpack, which may outstrip the state's ability to cope, is expected if emissions are not reduced, and can only be avoided through mitigation.

The approaches for communicating climate risks outlined above motivate support for different policy actions. In California and more broadly in the US, we are increasingly successful in insulating ourselves from daily weather changes. Personal welfare-based approaches may reinforce support for this trend, providing incentive not to prevent climate change through mitigation but to devote resources to continue this trend of insulation through adaptation. That is, until impacts become too intense to ignore—there are certainly limits to adaptation, and mitigation is necessary to prevent impacts beyond those limits

Ethics-based approaches are more likely to engender support for immediate mitigation activities. It is difficult to justify on ethical grounds delaying emissions reductions, as damages mount to other species, in other parts of the world, and for vulnerable local populations and future generations, while focusing only on adapting to climate changes on a regional or local level. It is also difficult to justify increasing the risk of abrupt large-scale climate changes by delaying reductions. Ethics-based approaches do, however, encourage helping vulnerable nations and populations adapt to the climate change already under way.

Economics-based approaches motivate both adaptation and mitigation. The financial risks from more frequent and/or intense extreme events can motivate anticipatory adaptation, which to a certain extent can reduce damages, but can also

motivate early mitigation to prevent these risks from growing. Economics-based approaches can also motivate mitigation through arguments for "no regrets" actions, anticipatory reductions prior to mandatory reductions, and "first mover" investment advantages, as discussed above.

The ultimate goal of a response strategy can be seen as the prevention of "dangerous" climate change. At an international level, this is the goal to which the US and over 180 other nations are bound by international law as signatories to the UNFCCC (see section 2.2). At a regional and local level, policy makers are likely to be most concerned about what is dangerous to their constituents, and this may not be the same for all constituents (e.g., see section 3.2.3). In addition to motivating support for different policy actions, the approaches above also lend different meanings to "dangerous" climate change. The personal-welfare approach suggests a definition of "dangerous" as impacts which outstrip the ability of individuals or local communities to cope. The ethics-based approach suggests that "dangerous" climate change is already occurring in some parts of the world (e.g., Arctic regions, US Gulf Coast), and these conditions will spread the longer action is delayed. Finally, the economics-based approach suggests that "dangerous" climate change be defined in terms of direct monetary damages from climate impacts and monetized assessments of non-market impacts (e.g., ecosystem services).

Policy makers concerned with preventing dangerous climate change are faced with a situation where the determination of what constitutes "dangerous" varies across regions and stakeholders, and this diversity must be considered when crafting a policy response. It is clear that a blend of adaptation and mitigation is necessary for a robust prevention strategy, and motivating support for such action will require a combination of the approaches we outline here.

6. Conclusions and Recommendations

Climate risks are widely misperceived as remote (risks affect distant people and places or future generations, but are not local or immediate), as deniable (uncertainty regarding risks is so great, they can be ignored), and as manageable (society will be able to adapt to climate changes and avoid risks). We argue that these misperceptions must be addressed in order to motivate widespread support for policy action. Managing climate change requires both mitigation and adaptation, and effectively motivating both of these complimentarily strategies requires a combination of ethically based, economically based, and personally relevant messages. These messages respond to the misperceptions of climate risks as remote, deniable, and manageable, and can lead to a realization that risks can be immediate, unfair, irreversible, unmanageable and local, and that solutions need not be expensive or inequitable. A blend of these approaches is needed to broadly reframe the debate so as to generate increased public perceptions of the actual risks of climate change and the need for action now, not just at some indefinite time in the future, and to get the public to endorse—in fact, to demand—concrete actions from their decision makers to lower the risks. In conclusion, we offer the following recommendations for motivating policy action in California that emerge from this analysis:

- **Recognize that personal welfare arguments may be more effective for motivating adaptation than mitigation.** Due to the lag in the climate system, the benefits of avoided climate impacts from reducing greenhouse gas emissions will not be realized for several decades. As a result, personal risks from climate change cannot be addressed by mitigation over the near-term.

- **Prioritize moral and economic arguments for motivating mitigation.** Because the impacts over the next few decades are likely to be similar regardless of mitigation choices, ethics and economics-based approaches may be more effective than personal welfare-based approaches for motivating near-term mitigation.

- **Enhance demand for mitigation by integrating climate risks and adaptive measures into everyday life.** Some impacts of continued climate change are unavoidable, due to the emissions already released into the atmosphere. As a result, while adaptation is not the solution, it is an essential component of addressing climate change. Implementing adaptive strategies that highlight the increasing risks of climate change can minimize the impacts in the near term while shifting the mindset of the public that climate change is not merely a threat of tomorrow but a problem today. This shift in public perception is critical for creating demand for mitigation.

- **Highlight the limits to coping with climate risks today and adapting to climate risks in the future.** The American public does not fully understand the urgency of emissions reductions. Presenting the constraints to coping with climate-related risks today (such as wildfires, hurricanes, droughts, and floods) can highlight existing vulnerabilities that are likely to be exacerbated by climate change. Focusing on these increasing vulnerabilities can illustrate the limits to adapting to future climate change and the need for mitigation.

- **Consider all the meanings of "dangerous" climate change and their relevance to different populations.** Ethics-based, personal welfare-based, and economics-based approaches suggest different criteria for assessing danger from climate risks that will vary in importance for different populations. A clearer understanding of the salience of these different definitions for different populations can provide a powerful tool for motivating policy action.

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[1] Hayhoe, K. et al. (2004) "Emissions Pathways, Climate Change, and Impacts on California." *Proceedings of the National Academy of Sciences* **101**:12422-12427.
[2] Cayan, D., Luers, A., Hanemann, M., Franco, G., Croes, B. (2006) "Climate Change Scenarios for California: An Overview." California Energy Commission. PIER Working Paper.
[3] Bostrom, N. (2002) "Existential Risks: Analyzing Human Extinction Scenarios and Related Hazards." *Journal of Evolution and Technology* **9**:1-30.
[4] Lorenzoni, I, Lowe, T., and Pidgeon, N.F. (2005) "A Strategic Assessment of Scientific and Behavioural Perspectives on 'Dangerous' Climate Change." Tyndall Centre Technical Report 28, University of East Anglia, Norwich, U.K.

[5] Leiserowitz, A.A. (2003). "Global Warming in the American Mind: The Roles of Affect, Imagery, and Worldviews in Risk Perception, Policy Preferences and Behavior." Unpublished Dissertation, University of Oregon, Eugene. Available online at: http://www.decisionresearch.org/pdf/540.pdf
[6] Cutter, S. L. (1993) *Living with Risk: The Geography of Technological Hazards*. New York: Edward Arnold.
[7] Palm, R. I., and Carroll, J. (1998) *Illusions of Safety: Culture and Earthquake Response in California and Japan*. Boulder: Westview Press.
[8] Slovic, P. (1987) "Perception of risk." *Science* **236**:280-285.
[9] Sjöberg, L. (2000) "Factors in Risk Perception." *Risk Analysis* **20**:1-11.
[10] Finucane, M.L. et al. (2000) "Gender, Race, Perceived Risk: The 'White Male' Effect." *Health, Risk, & Society* **2**:159-172.
[11] Weber, E.U. and Hsee, C.K. (1998) "Cross-Cultural Differences in Risk Perception but Cross-Cultural Similarities in Attitudes Towards Risk." *Management Science* **44**:1205-1217.
[12] Slovic, P. (1997) "Trust, Emotion, Sex, Politics and Science: Surveying the Risk-Assessment Battlefield." In M. Bazerman et al. (Eds.), *Environment, Ethics and Behavior*. San Francisco: New Lexington Press.
[13] Peters, E. and Slovic, P. (1996) "The Role of Affect and Worldviews as Orienting Dispositions in the Perception and Acceptance of Nuclear Power." *Journal of Applied Social Psychology* **26**:1427-1453.
[14] Slovic, P. et al. (2002) "The Affect Heuristic" In T. Gilovich, D. Griffin, and D. Kahneman (Eds.), *Heuristics and Biases: The Psychology of Intuitive Judgment*. Cambridge: Cambridge University Press.
[15] Epstein, S. (1994) "Integration of the Cognitive and the Psychodynamic Unconscious." *American Psychologist* **49**:709-724.
[16] Slovic, P. (2002) "Terrorism as Hazard: A New Species of Trouble." *Risk Analysis* **22**:425-426.
[17] Rottenstreich, Y. and Hsee, C.K. (2001) "Money, Kisses and Electric Shocks: On the Affective of Probability Weighting." *Psychological Science* **12**:185-190.
[18] Adler, P.S. and Kranowitz, J.L. (2005) "A Primer on Perceptions of Risk, Risk Communication and Building Trust." Keystone: The Keystone Center.
[19] Schneider, S.H. (1997) *Laboratory Earth: The Planetary Gamble We Can't Afford to Lose*. New York: Basic Books.
[20] Hansen, J.E. (2005) "Is There Still Time to Avoid 'Dangerous Anthropogenic Interference' with Global Climate?" Presentation on December 6, 2005 at the American Geophysical Union, San Francisco, California
[21] Langer, G. and Krosnick, J. (2006) "Poll on the Environment." Available online at: http://abcnews.com/pollvault.html
[22] PIPA (2005) "Global Warming: New Poll Results Since Last Revision of Online Analysis." Available online at: http://www.americans-world.org/
[23] Baldassare, M. (2005) "PPIC Statewide Survey: Special Survey on the Environment." Public Policy Institute of California, San Francisco, CA. Available online at: http://www.ppic.org/content/pubs/S_705MBS.pdf
[24] Poortinga, W. and Pidgeon, N.F. (2004) Public Perceptions of Genetically Modified Food and Crops, and the GM Nation? Public Debate on the Commercialization of Agricultural Biotechnology in the UK. Technical Report of a British survey. Centre for Environmental Risk, University of East Anglia, Norwich.
[25] Norton, A. and Leaman, J. (2004) "The Day After Tomorrow: Public Opinion on Climate Change." MORI Social Research Institute, London, U.K.
[26] Leiserowitz, A.A. (2005) "American Risk Perceptions: Is Climate Change Dangerous?" *Risk Analysis* **25**:1433-1442.
[27] Kasperson, R.E. and Kasperson, J.X. (1991) "Hidden Hazards." In D.G. Mayo and R.D. Hollander (Eds.). *Acceptable Evidence: Science and Values in Risk Management.* New York: Oxford University Press.
[28] Fischoff, B., Lichtenstein, S., Slovic, P., and Keeney, D. (1981) *Acceptable Risk*. Cambridge: Cambridge University Press.
[29] Stott, P.A., Stone, D.A., and Allen, M.R. (2004) "Human Contribution to the European Heat Wave of 2003." *Nature* **432**:610-614.

[30] Schar, C. et al. (2004) "The Role of Increasing Temperature Variability in European Summer Heat Waves." *Nature* **427**:332-336.
[31] Oreskes, N. (2004) "The Scientific Consensus on Climate Change." *Science* **306**:1686.
[32] Kasperson, J.X. et al. (2003) "The Social Amplification of Risk: Assessing Fifteen Years of Research and Theory." In N. Pidgeon, R.E. Kasperson, and P. Slovic (Eds.). *The Social Amplification of Risk.* Cambridge: Cambridge University Press.
[33] Erikson, K. (1994) *A New Species of Trouble*. New York: W.W. Norton & Company, Inc.
[34] Glantz, M. ed., (1999) *Creeping Environmental Problems and Sustainable Development in the Aral Sea Basin*. Cambridge: Cambridge University Press.
[35] Based on: Kasperson, R.E., Jhaveri, N., and Kasperson, J.X. (2001) "Stigma and Social Amplification of Risk: Toward a Framework of Analysis." In J. Flynn, P. Slovic, H. Risk, (Eds.) *Media and Stigma: Understanding Public Challenges to Modern Science and Technology*. London, Earthscan; Kasperson, R.E. et al. (1988) "The Social Amplification of Risk: A Conceptual Framework." *Risk Analysis* **8**:177-187.
[36] Gelbspan, R. (1998) *The Heat is On*. New York: Perseus.
[37] Boykoff, M.T. and Boykoff, J.M. (2004) "Balance as Bias: Global Warming and the US Prestige Press." *Global Environmental Change* **14**:125-136.
[38] FrameWorks Institute (2001) *Talking Global Warming*. Washington, DC: FrameWorks Institute.
[39] Trumbo, C.W. (1996) "Examining Psychometrics and Polarization in a Single-Risk Case Study." *Risk Analysis* **16**:429-438.
[40] Leiserowitz, A.A. (2004) "Before and After The Day After Tomorrow: A US Study of Climate Change Risk Perception." *Environment* **46**:22-37.
[41] Frewer, L.J. (2003) "Trust, Transparency, and Social Context." In *The Social Amplification of Risk* Pidgeon, N., Kasperson, R.E., and Slovic, P., eds. Cambridge, Massachusetts: Cambridge University Press.
[42] Lorenzoni, I., Pidgeon, N.F., and O'Connor, R.E. (2005) "Dangerous Climate Change: The Role for Risk Research." *Risk Analysis* **25**:1387-1398.
[43] Nelson, T.E., Clawson, R.A. and Oxley, Z.M. (1997) "Toward a Psychology of Framing Effects." *Political Behavior* **19**:221-246.
[44] Tversky, A. and Kahneman, D. (1981) "The Framing of Decisions and the Psychology of Choice." *Science* **211**:453-458.
[45] Rehmann-Sutter, C. (1998) "Involving Others: Towards an Ethical Concept of Risk." *Risk: Health, Safety & Environment* **9**:119-136.
[46] Kousky, C. and Schneider, S.H. (2003) "Global Climate Policy: Will Cities Lead the Way?" *Climate Policy* **3**:359-372.
[47] Emanuel, K., (2005) "Increasing Destructiveness of Tropical Cyclones Over the Past 30 Years." *Nature* **436**:686-688.
[48] Azar, C. and Schneider, S.H. (2002) "Are the Economic Costs of Stabilizing the Atmosphere Prohibitive?" *Ecological Economics* **42**:73-80.
[49] National Academy of Sciences (NAS) (1992) *Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base.* Washington, DC: The National Academies Press.
[50] Luers, A.L. and Moser, S. 2006. Preparing for the impacts of climate change in California: Opportunities and constraints on Adaptation. California Climate Change Center Report (available online: http://www.energy.ca.gov/2005publications/CEC-500-2005-198/CEC-500-2005-198-SD.PDF)