Deconstructing the Four Pillars of the Climate Change Debate: A Critical Review of the Scientific, Economic, Political, and Ethical Dimensions

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Volume 8, Number 8
FES Outstanding Graduate Student Paper Series
July 2003
ISSN 1702-3548 (online)
ISSN 1702-3521 (print)

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Abstract

Four major discourses within the climate change are identified and explored in this paper. First and foremost, there is the scientific discourse of climate change. The prevailing themes in this discourse are complexity, uncertainty, risk, and ultimately, the authority and legitimacy of science-based policy making. Secondly, there is the economic discourse, where the climate change issue is framed in terms of the relative costs and benefits of mitigation vs. adaptation, and command-and-control approaches are compared to free market approaches. Next, there is the political discourse, characterized by issues of cooperation between States, regime formation, and international law vis-à-vis climate change, where realist conceptions of power, based on military and economic strength, are challenged by post-structuralist theories, which stress the roles of knowledge, and persuasion in international politics. Lastly, there is the ethical discourse of climate change. Here, the issue is usually framed in terms of burden sharing, rights and responsibilities, historical accountability, and ability to pay.

While it is possible to understand each of these discourses in isolation, the analysis undertaken here critically examines each of these discourses in detail and explores the connections between them. Two key findings emerge from the analysis. Firstly, there is the recognition that a purely objective analysis of the climate change issue is neither possible, nor desirable. Secondly, each of the four discourses are intimately connected to one another; thus, the science of climate change cannot be divorced from the political context in which it is deployed, just as economic analyses of the issue cannot be understood without also considering the ethical dimensions of the various assumptions involved in any such analyses.

Foreword

The purpose of this paper within the context of my plan of study is to synthesize some of the different discourses of the climate change debate. Previous course work I completed focused on the individual discourses within the climate change debate and within environmental politics in general. This paper will expand upon the ideas that I explored in various courses and show how each of the four discourses of climate change— the scientific, the economic, the political, and the ethical—are interrelated.

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Introduction

Orwellian doublespeak, it seems, is alive and well in Canada these days. One need only look to groups such as "The Canadian Coalition for Responsible Environmental Solutions", which opposes ratification of the Kyoto Protocol for inspiration. Apparently, the coalition's original name, "An Alliance for Responsible Environmental Alternatives", wasn't convincing enough, although the terms, "environmental" and "responsible" were evidently deemed too important to be left out. Such antics have become commonplace over the years, as the climate change debate has progressed.

It has been approximately fifteen years since the issue of climate change emerged in public debate in North America, and a few years longer in Europe. During the early stages of the debate the main source of controversy was whether or not the theory of human induced climate change was scientifically valid, and whether or not there was any evidence that a warming trend could be discerned. Fifteen years later, the bulk of scientific opinion suggests a warming trend can in fact be discerned. Nonetheless, some controversy regarding the scientific underpinnings of climate change continues in the mass media (see for example, Baliunas et al., 2002).

Recently, however, the debate has shifted focus. It has been five years since the Kyoto Protocol, which seeks to commit industrialized nations to binding emission reductions, was signed. Presently, many governments, most notably in the European Union, are moving to ratify the protocol. Similar preparations are being made in other countries such as Canada. Consequently, the public debate has shifted towards the economic costs of implementing the Kyoto Protocol. Within the Canadian context the costs of implementation are particularly controversial given the current United States administration's indication that it will not seek to ratify the Protocol. Many Canadian industry representatives are understandably concerned that this will place their industries at a competitive disadvantage vis-à-vis American industry. More generally, they are concerned that accurate estimates of the costs of implementation have not been conducted. Put another way, the debate has shifted from the theoretical ecological implications of climate change to the practical economic and political implications of mitigating and adapting to climate change.

In fact, the implications of climate change for Canada—with its diverse geographic regions and economic development—are fairly representative of the global global implications as well. Prince Edward Island, small, vulnerable, and relatively weak politically, is understandably concerned about the rising sea levels predicted by climate change models.

People living in the Artic regions of the country, who are already experiencing first hand the effects of climate change, voice similar concerns about the threats posed by climate change. Consequently, their perspective is similar to those of the small island nations, scattered around the globe. At the other end of the spectrum is Alberta, which like other oil exporting countries is heavily dependent on revenues from oil exports and is therefore more concerned about the short-term economic impacts of any international agreement limiting carbon dioxide emissions; whereas people from low lying islands and northern regions stress the need for aggressive action to reduce emissions and mitigate climate change, people from oil exporting regions tend to emphasize the uncertainty in the science, the economic costs of mitigation, and the lack of global political consensus.

Common to scientific and economic discourses surrounding climate change is the pervasive uncertainty that frames the discussion. Even after more than fifteen years of intensive research, the scientific community is still unable to predict *precisely* the extent and magnitude of future warming. Indeed, it is quite likely that science will never be able to make the precise predictions some skeptics, such as U.S. President George Bush, seem to demand, given that the climate system is an extremely complex system where non-linear interactions abound. Projections regarding the costs of climate change are similarly plagued with uncertainties, owing in part to the fact that the scientific predictions upon which they are based are themselves uncertain. Other factors, however, also play a part including: uncertainties regarding future population levels, uncertainties concerning the technological development of fossil fuel alternatives, and uncertainties regarding the level and nature of international cooperation. In short, there are significant uncertainties regarding both the costs of the impacts of climate change and the costs of mitigating climate change.

Environmentalists and other supporters of the Kyoto Protocol tend to emphasize the potential for catastrophic consequences if emissions are allowed to grow unchecked, while many business and industry advocates tend to emphasize the costs in the short-term of implementing emission reduction measures. Put another way, the conflict can be framed as a struggle between those who are risk averse, and therefore wish to minimize the long-term risks of climate change, against those who are not risk averse to the long-term consequences of climate change and wish to minimize the short-term risks associated with mitigation measures.

These conflicting perspectives on acceptable risks are clarified to some extent when one reflects on the fact that there is an asymmetrical relationship between those who are vulnerable to the long-term impacts of climate change and those who have the ability to mitigate it. It is, for the most part, the western nations of the world that are responsible for the majority of

greenhouse gas emissions thought to be responsible for climate change. While their relative contribution will likely decrease in the future as developing countries continue to grow and industrialize, developing countries consistently argue that the West should take a leading role in reducing emissions because it benefited economically in the past from these emissions, and because those benefits have given it the financial and technological resources to do so.

From this perspective the climate change debate can be framed in terms of intergenerational and intragenerational justice. At one end of the spectrum are the people of Tuvalu, whose very existence is threatened by rising sea levels. Their plight—which has received considerable attention in the mass media and is sometimes characterized as cultural genocide—is often used by environmentalists to rebuke the wait-and-see approach of climate change skeptics. At the other end of the spectrum are the skeptics such as President Bush, who maintains that he will not sign Kyoto because it is bad for America's economy and therefore bad for America (never mind the consequences to others).

In order to provide a more complete understanding of the dynamics of climate change politics, it is therefore useful to explore the scientific, economic, political, and ethical dimensions of the issue, and the relationships that exist between them.

An important limitation of the analysis presented in this paper is that it explicitly avoids questions of scale. Thus, it does not compare the evolution of the climate change debate at the local scale with the evolution of the debate at the national, or global scale. Instead, it seeks to explore those aspects of the issue that are relevant at all scales.

The paper is organized as follows. The first chapter examines some of the scientific dimensions of the issue and will problematize the notion that science can fully understand and predict the impacts of climate change. It also explores some of the competing epistemological visions of science and offers an alternative methodology, which is better suited for dealing with situations where complexity and uncertainty predominate.

The second chapter explores some of the economic aspects of climate change. It begins by examining some of the rhetoric that has been used over the years to reinforce different ideological positions. Included is a critique of the belief that objective economic analyses of climate change are possible. This is be done by drawing attention to some of the assumptions, e.g. discount rate, choice of baseline, that inevitably influence the outcome such analyses. The chapter concludes by comparing and contrasting free market and command-and-control regulatory approaches.

The third chapter examines the political dimensions of the climate change issue. It begins by examining climate change politics using epistemic community theory and Litfin's

discursive practices. It then explores some of the issues arising from the mass media's coverage of climate change. It concludes by examining climate change politics using realist approaches, including historical materialism and game theory.

The final chapter of the paper examines the ethical dimensions of climate change. It begins by comparing and contrasting utilitarian, Kantian, and Rawlsian ethical theories, and shows how each of these theories support different policy options vis-à-vis climate change. It concludes by examining some of the international legal principles that are relevant to climate change equity.

"Climate is an angry beast, and we are poking it with sticks"

-Wally Broecker

Chapter 1 – Scientific Dimensions of Climate Change

Introduction

Occam's Razor, also known as the law of parsimony, states that for a given phenomenon the simplest explanation—the one with the fewest variables—is most often the correct one. How could this principle of science be applied to the current debate over climate change? There are four findings central to the debate, which are not in dispute. Firstly, carbon dioxide is a known greenhouse gas (GHG), which means it prevents long-wave radiation from escaping out into space. This natural effect is essential to life on earth, since without it the planet would be approximately 30°C cooler than today. The second finding is that atmospheric concentrations of carbon dioxide and other GHG's such as methane are increasing to levels not seen in hundreds of thousands of years, and are expected to continue increasing for at least the next fifty years. Third, these increases in GHG concentrations are directly linked to human activities, particularly the burning of fossil fuels and deforestation. Finally, the International Panel on Climate change (IPCC) has observed that the average global temperature has increased by approximately 0.6°C over the last century.

Simple logic—in line with Occam's Razor—suggests human activity is responsible for this temperature increase, and not some combination of changes in solar intensity and orbital patterns—which happen to coincide with increases in atmospheric GHG concentrations. Yet it wasn't until the third report of Working Group I (WG I) of the IPCC, released in September of 2001, that these competing explanations were convincingly laid to rest.

This is not meant to suggest the science behind climate change is in any way complete, or that it is a simple problem. Indeed, the earth-atmosphere system is enormously complex and science may never be able to fully predict how our actions will affect it in the future. These questions will be dealt with later in this section. What's important to recognize here is that the fundamental mechanisms governing the climate system are well understood, and most of the scientific controversy surrounding climate change to date has revolved around the *rate* and *magnitude* of warming, not on whether warming will occur.

Historical Background

While many people commonly believe the concept of global warming is relatively new, in fact the idea is more than one hundred and fifty years old, putting it in the company of other scientific theories such as Darwin's theory of evolution, and electromagnetism. In 1827, Baron

Jean Baptiste Fourier suggested the Earth's atmosphere acted as a "hothouse" (Fourier, 1827:659). As noted earlier, without this natural greenhouse effect the planet would be too cold to support life. It wasn't until approximately seventy years later, however, that someone suggested human activity, through the burning of fossil fuels, could in fact enhance this natural feature of atmosphere.

In 1896, Svante Arrhenius submitted a paper to the Philosophical Magazine entitled, "On the influence of Carbonic Acid in the Air on the Temperature of the Ground" in which he explored the relationship between atmospheric concentrations of carbon dioxide and surface temperature. He calculated that a doubling of carbon dioxide in the atmosphere would increase global surface temperature by an average of between five and six degrees Celsius (Arrhenius, 1896). He viewed this potential warming in a positive light: "we may hope to enjoy ages with more equable and better climates, especially as regards to the colder regions of the earth; ages when the earth will bring forth much more abundant crops" (Arrhenius, 1896:263). While this may be a predictable response from a Northern European, it is unlikely that people in drought prone areas, such as the Sahel, would view a warmer climate in a similarly optimistic light.

This positive sentiment continued well into the middle of the twentieth century with some arguing additional warming would "be protection against the return of the deadly glaciers" (cited in Lyman, 1990:11). It wasn't until the late 1950's that some scholars began questioning the desirability of an enhanced greenhouse effect. In 1957, Revelle and Suess suggested the world was conducting a large geophysical experiment and contrary to accepted scientific understanding at the time, much of the carbon dioxide (CO_2) being emitted into the atmosphere was not being absorbed by the oceans (Revelle and Suess, 1957). The articulation of this alternative point of view coincided with the rise of the environmental movement in the late 1960's and represented a discursive shift where "the technocratic image of climate as something to be controlled by humans fades towards an image where humans are more dependent on climate for their welfare, and are *unable to manipulate it for their own ends*" (Hart and Victor, 1993:666-9 emphasis added).

The international community responded to these concerns in 1979 by establishing the World Climate Programme (WCP), created to further scientific understanding of the climate system, and in many ways the predecessor for the IPCC. It also helped organize the Villach Conference, where it was stated, "the most advanced experiments…. show increases of the global mean surface temperature for a doubling of the atmospheric CO_2 concentration or equivalent, of between 1.5 and 4.5°C." (WMO, 1986:2). It is interesting to note these predictions are remarkably consistent with the predictions made a hundred years earlier by

Arrhenius, as well as the most recent statements by WG I of the IPCC; which suggests scientific understanding of climate change has not changed in any fundamental way over the last one hundred years.

Two years after the Villach Conference, the IPCC was established under the auspices of the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO). Like the WCP, it was mandated to assess the likelihood and impacts of an enhanced greenhouse effect. Specifically, Working Group I is charged with improving the understanding of the climate system, and providing projections of its future evolution, whereas Working Group II is concerned with the impacts, adaptation, and vulnerability from climate change. Lastly, there is Working Group III, which deals with mitigation issues and is considered to be the most politicized of the three groups. Beginning in 1990, the three groups have each been providing assessment reports approximately every five years, with the third assessment reports having been submitted in 2001. While the fundamental understanding of the mechanics that lead to the greenhouse effect remain unchanged since the time of Fourier and Arrenhius, there has been significant improvement in the more detailed interactions that govern the Earth's climate. Furthermore, the ability of science to uncover details of past climatic conditions and to forecast future climatic conditions has also improved, particularly in the last twenty years. Some of the relevant facts and projections from the third assessment report of WG I include

- The global average surface temperature has increased over the 20th century by about 0.6°C, and is projected to increase by 1.4 to 5.8°C over the period 1990 to 2100.
- Tide gauge data show that the global average sea level rose between 0.1 and 0.2 meters in the 20th century.
- The rate and duration of warming of the 20th-century has been much greater than in any of the previous nine centuries. Similarly, it is likely that the 1990s have been the warmest decade and 1998 the warmest year of the millennium.
- Warm episodes of the El Nino-Southern Oscillation (ENSO) phenomenon (which consistently affects regional variations of precipitation and temperature over much of the tropics and sub-tropics) have been more frequent, persistent and intense since the mid 1970's compared with the previous 100 years.
- The atmosphere concentration of carbon dioxide has increased by 31 percent since 1750. The present carbon dioxide concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years.

The current rate of increase is unprecedented during at least the past thousand years.

- Global mean surface temperature increases and rising sea level from thermal expansion of the ocean are projected to continue for *hundreds of years* after stabilization of greenhouse gas concentrations (even at present levels)

The last point is particularly important in terms of how the issue of climate change is framed. Too often it seems that the debate is framed in terms of the changes in climate that are to be expected over the next 50 to 100 years, when in fact the impacts are likely to be felt for thousands, if not tens of thousands of years. Consequently, policy makers and the public in general are likely to underestimate the long-term consequences of climate change, while overemphasizing the short-term economic costs of mitigation. This tension between the short-term economic interests of nation-states and individuals and the long-term physical impacts of climate change permeates all facets of the debate and will be examined in greater detail in subsequent chapters.

Complexity and Uncertainty

Complexity and uncertainty are two of the most important and enduring features of the climate change debate. They permeate the scientific, economic, and political aspects of the issue. However, in the same way that it is important to distinguish between accuracy (i.e. how close the arrow is to the target) and precision (i.e. how close the arrows are to one another), it is also important to distinguish between different kinds of uncertainty in the context of climate change. Here, Wynne's taxonomy of uncertainty is useful for describing the differences between risk, uncertainty, ignorance, and indeterminacy.

> RISK: system behaviour is known, and outcomes can be assigned probabilistic values.
> UNCERTAINTY: important system parameters are known, but not the probability distributions.
> IGNORANCE: what is not known is not known.
> INDETERMINACY: causal chains, networks or processes are open, and thus defy prediction.
>
> (Source: Wynne, 1993, quoted in Healy, 1999:659)

According to Wynne's definition, our knowledge of climate change is primarily characterized by uncertainty since many system parameters are known, whereas the probability distributions are not. For example, changes in incoming solar radiation, radiative forcing potentials of various atmospheric gases, and oceanic absorption rates of carbon dioxide are all well understood components of the climate system, but it is not possible to assign absolute probabilistic values in relation to their effect on the Earth's climate. This raises two important questions about the

role of science in society when dealing with complex problems, and specifically about climate change. First, can uncertainty be sufficiently reduced so that the risk presented by climate change can be quantified? Second, what role should science play in situations where ignorance and indeterminacy dominate?

To answer the first question it is necessary to determine the level of uncertainty in our knowledge of the climate system, which is a function of its complexity. It is reasonable to assume our understanding of the climate system will continue to improve. Nevertheless, is there a limit to how much can be known? With what accuracy and precision? The principle of fuzzy logic—where the solution to a problem becomes fuzzier the closer one looks—is appropriate in this respect and suggests uncertainty will always be present, "trading precision for accuracy effectively precludes diminishing uncertainties beyond a certain point" (Martin, 1997:273). In quantum physics the limit is enshrined in Heisenberg's uncertainty principle: one can determine the velocity of a particle or its location, but never both, because the energy used to observe the particle disturbs its motion and velocity (Hawking, 1996).

Some might argue this epistemological constraint is only relevant at the subatomic scale and is not appropriate at the meso-scale of the earth-atmosphere system. One of the most confounding aspects of the earth-atmosphere system is the level of complexity it exhibits at every scale—from the microscopic scale where raindrops form, to the meso-scale where hurricanes and global ocean currents operate. Therefore, I would argue, the application of the principle still holds. In other words, there will always be a certain amount of uncertainty in predictions relating to climate change scenarios, regardless of future scientific and technological advances. Meteorologists, like particle physicists, are accustomed to dealing with uncertainty. They routinely assign probabilities to outcomes, such as precipitation events over the course of a few days and sometimes over one-week periods, always with the understanding that the probabilities are of a provisional nature. The chaotic, complex nature of weather makes longer-term predictions unfeasible, just as the chaotic, complex nature of the stock market makes long-term predictions of its state unreliable.

It is important to distinguish between short-term phenomena associated with weather and longer-term phenomena associated with climate change. One might be tempted to think, as the public sometimes does, that the science of climate change is unreliable. After all, if the weatherman cannot provide an accurate forecast one week from now, how can a climatologist (or some other 'climate change expert') make predictions of events taking place 50 years from now? This line of reasoning is faulty because it fails to differentiate long versus short-term: climate prediction deals with *yearly average* temperatures and precipitation patterns, for

example, whereas weather forecasts are limited to *daily* or *weekly* predictions. The longer time frame and more generalized parameters are thus insensitive to the daily fluctuations associated with weather. This doesn't mean there are fewer uncertainties in climate related predictions than weather related predictions, but rather that they are of a different type. Specifically, there is uncertainty regarding the *timing* and *magnitude* of temperature and precipitation increases, rather than probabilities of their occurrence.

Most scenarios, including those done by the IPCC, use a doubling of carbon dioxide forcing equivalent as the benchmark for determining the risks associated with climate change. As noted earlier these scenarios suggest the planet will warm on average from 1.5 to 5.8°C by the year 2100. The confidence, or certainty, attached to these predictions is relatively high.

Feedback Loops

There is much less confidence, however, in assigning probabilities to potentially catastrophic positive feedback loops. Recalling Wynne's taxonomy, current scientific understanding of these feedback loops is more aptly characterized by ignorance and indeterminacy since it is not well understood what thresholds would have to be crossed in order to trigger them, or what their long-term impact on the climate system would be. Indeed, many scientists, environmentalists, and policy makers feel the work of groups such as the IPCC understate the dangers associated with climate change. The following examples help illustrate why.

Methane trapped in the permafrost in upper latitudes of the Northern Hemisphere represents one such potentially catastrophic positive feedback loop. Rising temperatures will cause the permafrost to melt, releasing the trapped methane into the atmosphere, thus leading to a further intensification of the greenhouse effect, increasing temperatures even more, and so further melting of the permafrost.

A second example involves the oceanic conveyor belt, which is responsible for the warmer than average temperatures in Northern Europe and for pumping large amounts of carbon dioxide into the deep ocean. Falling salinity levels, (caused by the augmented flow of fresh water from melting glaciers) in the North Atlantic Ocean could disrupt this process, thereby reducing the carbon absorption capacity of the North Atlantic. More carbon dioxide in the atmosphere leads to a rise in temperature, which in turn accelerates the melting of the glaciers, etc. This process is compounded by the fact that as glaciers in polar latitudes begin to melt, darker, dirtier ice will be exposed. This ice will have a lower albedo, meaning it will reflect less short wave radiation back into space, causing the planet to warm even faster.

Finally, it is possible that changes in ocean currents and temperature could cause irreparable damage to marine organisms and ecosystems that enhance the ocean's ability to absorb carbon, such as phytoplankton and coral reefs. An extreme die-off of marine organisms would lead to a dramatic reduction in the ocean's carbon uptake ability, leading to increasing concentrations of atmospheric carbon dioxide, leading to higher temperatures, and so on (the scenario described here serves as the basis for Rock Brynner's 1998 novel, *The Doomsday Report).* This scenario is potentially the most catastrophic of the ones described thus far; unfortunately, the processes and mechanisms that could trigger it are also the least understood—in short, ignorance and indeterminacy abound.

A number of scientists, politicians, activists, and environmentalists are understandably concerned these positive feedback loops could lead to a 'runaway' greenhouse effect, where temperatures rise by 10°C or more, in a relatively short period of time. The IPCC notes the probability of a 'runaway' greenhouse effect is low, but admits thresholds are still not known because the mechanisms governing such feedback loops are complex and difficult to model, as the previous examples have shown. More importantly, it is quite possible that scientists may never be able to create reliable models that incorporate such feedback loops because of the complexity involved. It seems reasonable to conclude uncertainty, ignorance, and indeterminacy will therefore be enduring features of our understanding of our influence on the Earth's climate. Wally Broecker, arguably the world's most respected oceanographer, is clearly pessimistic about science's ability to accurately predict humanity's influence on the Earth's climate,

> My lifetime of study of Earth's climate has humbled me. I'm convinced that we have greatly underestimated the complexity of this system. The importance of obscure phenomena, ranging from those that control the size of raindrops to those that control the amount of water pouring into the deep sea from the shelves of the Antarctic continent, makes *reliable* modeling very difficult, *if not impossible.*
> (Quoted in Homer-Dixon, 2000:146, emphasis added)

In summary, climate change is an environmental problem with two important characteristics—the stakes are very high, and there is a great deal of unrelenting uncertainty. The question then becomes how does one act in the face of persistent uncertainty? Does one simply throw more resources, i.e. research staff, at the problem in the hopes that the uncertainty will be reduced to a manageable level? Put another way: is it enough to simply rely on the judgments of experts, when their understanding of the problem is admittedly incomplete? In these types of situations many people (see Funtowicz and Ravetz, 1996, for example) argue that the methodologies of traditional science and risk assessment should be complemented by

the approaches of post-normal science, which purports to respond to uncertainty in a more effective, and more socially acceptable way.

Two Epistemological Views on Science

Before examining in detail the differences between normal and post-normal science, it is useful to compare two epistemological perspectives on science, drawing from the works of Litfin (1994) and Frechette (1996). At one end of the spectrum is the modernist, positivist perspective. Its central tenet holds that reality can be objectively observed, and then understood through the use of reason – the foundation for the scientific method. Schrader-Frechette argues some procedural components of the scientific method allow it to claim at least partial objectivity: predictive power, explanatory power, and the ability to survive criticism. She supports the goal of the positivists, noting the principle of complete neutrality "represents a noble aim and an important effort to keep both science and policy evenhanded and empirically relevant" (Schrader-Frechette, 1996:40).

At the other end of the spectrum are cultural relativists, who deny the claim that we can objectively observe reality and contend the scientific method is subjective and value-laden. Schrader-Frechette believes the cultural relativists are at least partially correct. She distinguishes between two types of biases, or values, which inevitably makes science at least partially subjective. The first set of values is contextual; a researcher may lack funds to produce original data, or may tailor her research to meet the needs of their funding source — choosing for example, to focus on agricultural benefits associated with increased carbon dioxide levels rather than on damages, in spite of any epistemological considerations. The second set of values is constitutive—and more difficult to avoid. These values influence which methodological rule is chosen over another, what sample size is used, what confidence level is used to determine statistical significance, and so on (Schrader-Frechette, 1996:41).

She argues, however, there are problems at both extremes of the epistemological spectrum, particular with regard to risk assessments,

> Cultural relativists overemphasize values and reduce all risk evaluations to mere sociological constructs, devoid of objective science. Naïve positivists underemphasize values and attempt to reduce all risk evaluations to algorithms of allegedly pure science…to accept the ideal of complete neutrality in hazard evaluation is to ignore the reality that risk evaluations affect public policy, and that public policy is made in a political environment.
>
> (Shrader-Frechette, 1996:45-7)

Litfin also opts for a middle position, noting there are intransitive facts such as the law of thermodynamics or gravity, and transitive facts, such as the atomic weight of oxygen, or the "length" of one meter (Litfin, 1994:26). Like Shrader-Frechette, Litfin rejects the modernist

assumption that science and reason automatically produce consensus. While science may give us "facts", it tells us nothing about what to do with them—that is the realm of politics. Beck echoes a similar sentiment, noting, "there are no expert solutions in risk discourse because experts can only supply factual information and are never able to assess which solutions are culturally acceptable" (Beck, 1999:42).

Modernists fail to recognize two other important points. Science operates dialectically—information begets more information, new knowledge renders old knowledge invalid. What was once considered harmless—spraying DDT on children, using X-Ray machines in shoe stores, and using lead-based paints to name a few—are now deemed unsafe. As Beck points out, "it is the successes of science which sow the doubts as to its risk predictions"(Beck, 1999:58). Modernists also fail to recognize that facts are almost always open to interpretation,

> If confidence in science is a hallmark of the modern era, then scientific knowledge can be expected to facilitate cooperation. But if the production and *interpretation* of scientific knowledge is an unavoidably political process, then knowledge may feed into new or existing arenas of contestation
> (Litfin, 1994:19, emphasis added)

Litfin is alluding to the delegitimation of science through its politicization. If information begets counter-information then who is to say which information is superior? How does one respond to Beck's "battleground of pluralistic rationality claims"? In this context, post-normal science can assist traditional decision-making vis-à-vis the issue of climate change.

Post-Normal Science and Climate Change

> To use the traditional scientific method to deal with issues where facts are uncertain, stakes are high, values in dispute and decisions urgent is to be like the drunkard who lost his keys. Although he had misplaced them elsewhere, he looked for them under the streetlight because it was the only place where he was able to see. The problem is that the key is not there, we don't even know if there is a key, and the light of the lamppost is getting weaker.
> (Silvio Funtowicz, quoted in Tognetti, 1999:690)

In the case of climate change, how does one proceed when even the basic facts of the debate are uncertain and contested, while the decision-making is urgent, and includes a vast spectrum of interests ranging from those of the small island states to those of the oil producing countries". According to Funtowicz and Ravetz (1996) the methodologies of post-normal science should be applied whenever the stakes and uncertainties surrounding a problem are high (biotechnology, nuclear power generation, etc.

Proponents of post-normal science generally level three criticisms against normal science in these types of situations. First, traditional reductionist methods of science are inappropriate when evaluating risks associated with a complex system, such as the earth-

atmosphere system, because the properties of a complex system "cannot be fully described only by understanding its subcomponents" (Saloranta, 2001: 395). This is because complex systems exhibit emergent properties—where simple interactions lead to a complex behaviour. So, for example, knowing the life-cycle of a variety of species of trees says little about the dynamics of an unmanaged forest composed of those trees (Martin, 1997:274). In other words, it is not enough to understand the properties of clouds, deep ocean currents, and the biosphere. In order to understand the complexity of the climate system it is necessary to understand how all of these different systems affect one another—and as the earlier section on feedback loops demonstrated, this is no easy task.

The second criticism concerns the closed, elitist nature of the scientific peer community, which does not allow for "outside" stakeholders to participate in the scientific problem solving process. Saloranta contends this lack of participation frequently leads to a distrust of scientists, and other experts, thereby hampering effective problem solving (Saloranta, 2001:398).

The final, and most important criticism of normal science with respect to complex problems concerns the management of uncertainties and is related to the exclusionary practices within the scientific community. Normal science typically uses "experts" to "calculate" the amount of risk a particular policy or situation presents while excluding outsiders, such as affected residents, journalists, or concerned citizens. This assumes that uncertainties, and the risks associated with them, can be objectively, and reliably, quantified. This assumption is highly problematic with respect to the complex systems that influence climate change for reasons that have already been discussed in detail. Moreover, as Tognetti (1999) notes, policy driven research based on positivist science

> Will always operate in a double bind because new sources of uncertainty typically fall outside the paradigm and are either not seen or are considered intractable and therefore not suitable for scientific consideration.
>
> (Tognetti, 1999:700)

The practical implication of this is that risk assessments that are based solely on the methodologies of positivist science will often understate the risks of the issue in question.

What then is post-normal science and how does it differ from traditional scientific approaches? According to Funtowicz and Ravetz post-normal science (PNS) can be described as a "strategy for dealing with environmental issues in which there are high stakes and uncertainty, plural and conflicting value systems, and in which decisions are urgent" (Funtowicz and Ravetz, 1991, quoted in Tognetti, 1999:691). PNS attempts to address the weaknesses mentioned above in two important ways; namely, through its approach to complexity and subsequent management of uncertainties, and the use of extended peer communities.

From an epistemological perspective the approach of PNS closely mirrors the cultural relativist position, recognizing that there may be multiple valid perspectives on a given issue rather than a single objective narrative. It rejects deterministic versions of uncertainty framed in terms of imprecision to be solved by more research. Instead, PNS accepts that ignorance and indeterminacy may be permanent features of environmental problems. The focus of PNS is not to eliminate uncertainty, but on how to proceed in spite of it. PNS is therefore better able to deal with complexity. As Luks notes,

> Complexity is respected through its recognition of a multiplicity of legitimate perspectives on any issue: and reflexivity is realiased through the extension of legitimate accepted 'facts' beyond the supposedly objective productions of traditional research.
>
> (Luks, 1999:691)

However, one should not infer from this that scientists and policy makers ought to simply throw their hands in the air, accept uncertainty, and abandon traditional scientific inquiry altogether. Instead, PNS is best viewed as an ally rather than as a competitor of normal science, particularly when complex problems requiring urgent decision-making present themselves. In the case of climate change, such 'facts' might include the observations of farmers, fishermen, aboriginal peoples, and others who have an intimate knowledge of local climatic conditions and wildlife. One might include, for example, the observations of Paul Okalik, the Premier of Nunavut, who noticed, "melting glaciers had turned [what used to be a small stream] into a raging torrent" (*Globe And Mail,* August 5, 2002*)*.

Extended Peer Communities

In the above example these people represent the "extended peer community", arguably the most important feature of PNS. Understood to include a variety of individuals ranging from journalists, politicians, to concerned citizens, an extended peer community provides an important source of additional factual information.

The purpose of extended communities is twofold. Its first function is to provide a broader, more diverse base of opinion so that the choices made reflect the best available knowledge, while its second function is to restore the public's faith in the scientists and other experts, thereby increasing the legitimacy of the process. While this information is often anecdotal, it is nevertheless considered valid within the context of PNS. In situations where the window of opportunity is small this information can play a crucial role in determining the appropriate policy direction. In the developing world, observations of the extended peer community are particularly important since the majority of traditional scientific research studying the impacts of climate change has focused on impacts affecting developed countries. Indeed,

one of the lamentable aspects of the work that has been produced by the IPCC is the scarcity of studies that deal with the impacts of climate change in developing countries. While understandable—for the most part, governments in those countries simply do not have the financial, or technical resources to carry out such studies—the relative lack of studies is nevertheless regrettable, given that developing countries are the most vulnerable to climate change. This unfortunate circumstance underscores the importance of extended peer communities in these countries.

However, the most important aspect of the extended peer community is its' role in the decision making process. Recall Shrader-Frechette, Litfin, and Beck's observation: science may provide an abundance of facts, but it cannot determine the appropriate course of action, in light of those facts, since *appropriate* is culturally determined and is informed by values rather than facts. Moreover, the importance of values over facts increases as the uncertainty surrounding the facts increases. So, for example, two communities may respond to the same set of facts dealing with climate change mitigation in completely different ways depending on how risk averse they are, and how committed they are to principles of intragenerational and intergenerational justice. It is in this context that extended peer communities can play an important role in determining what is culturally acceptable.

Proponents of PNS would likely argue many of the environmental controversies of the last twenty years are a direct result of policies being *imposed* on populations without adequate public consultation, regardless of the substantive details of the policies themselves. It's possible the European public's opposition to genetically modified foods, for example, stems in large part from the fact that there was little public consultation and involvement in the research and policy discussions, although the public relations campaigns by GreenPeace and other NGO's were also important.

In addition, extended peer communities can restore the functional link between scientific rationality and social rationality. As Beck astutely observes, "scientific rationality without social rationality remains *empty,* but social rationality without scientific rationality remains blind" (Beck, 1999:30). Most importantly, however, extended peer communities represent an attempt to restore the public's *faith* in science and rational administration, which has greatly diminished over the past eighty years.

> Rationality holds a severely diminished influence with a public long exposed to expert discord over everything from whether or not, for example, British beef is safe to eat, Sydney's water is safe to drink or whether the global climate is changing.
>
> (Luks, 1999:660)

Hans Morgenthau echoes a similar sentiment, writing after a time when the world had just witnessed the horrors of two world wars, which saw the introduction of rational genocide and the detonation of two nuclear bombs over civilian populations,

> Two moods determine the attitude of our civilization to the social world; confidence in the power of reason, represented by modern science, to solve the social problems of our age, and despair at the ever-renewed failure of scientific reason to solve them.
>
> (Quoted in Litfin, 1994:30)

In this context, the purpose of extended peer communities is twofold—to avoid the excesses the singular application of rationality engenders, and to increase the legitimacy of science in the policy making process. Working Group I of the IPCC seemed especially cognizant of the importance of legitimacy, to the extent that it felt compelled to release a separate information note along with its Third Assessment Report, which stressed that the report represented "the work of 123 lead authors…[who] drew on more than 516 contributing authors…. went through extensive review by experts *and* governments…and was unanimously approved" (IPCC, 2000). Clearly, the point of the information note was to stress the legitimacy of the report based on the consensus achieved during its formulation and the large number of people involved in forming that consensus.

Legitimacy becomes even more important when the questions move out of the realm of scientific inquiry and technical evaluations of risks and into the realm of economics where mitigation and adaptation strategies are weighed in terms of costs and benefits—and the public is told, for example, that they will have to pay for protection, or that millions of jobs are at stake. In the context of climate change, it is in the realm of economics that the paradigm of PNS becomes even more important, where hard facts are hard to come by and conflicting 'objective' studies abound, as the next chapter will demonstrate.

Chapter 2 — Economic Dimensions of Climate Change

Introduction

Of all the social sciences few strive to emulate the methodologies of the natural sciences more than economics. Indeed, the perceived objectivity of economics is at the core of its legitimacy and this perception is largely responsible for its enormous influence in policy-making discussions. The desire to appear scientific and objective can easily been seen in the language and metaphors economists use. Luks (1999), for example, deconstructs an influential article by Nordhaus (1991), who attempts to 'calculate' the economic impacts of global warming. Like most economists, Nordhaus presents his work as a scientific undertaking—exact calculations are displayed that give the initial appearance of objectivity. However, as Luks observes,

> By the time that the author has admitted the manifold oversimplifications and uncertainties in his analysis, and has shown how strong are the ad hoc adjustments and hunches which are needed to bring his numbers back into the realm of plausibility, we have to ask whether these statistical exercises are totally redundant except for rhetorical purposes.
>
> (Luks, 1999:706)

As the last chapter attempted to demonstrate, even the natural sciences can claim only partial objectivity in the knowledge they produce, since a variety of factors often influence what is researched and how it is researched. If anything, these factors are even more influential in the construction of knowledge based on economics. Those claiming that economics is objective and value-free make the mistake of equating economic modeling and analysis with the theory of the free market. Specifically, they assume that since the marketplace is objective (a tenuous claim in itself), it follows that economic models and forecasts can be similarly objective. On the first claim they are partially correct—the free market is objective, if only in the sense that it is *amoral* and is merely concerned with profit. It does not follow, however, that economic studies and forecasts are similarly free of biases. One of the aims of this chapter is to show that a number of methodological and technical obstacles exist when trying to provide economic assessments of climate change. When one takes these obstacles into account it becomes difficult to deny Luks' charge that such studies are created more for their rhetorical usefulness than for their epistemological value.

The Rhetoric of Climate Change Heats Up

In the early stages of the climate change debate most of the controversy revolved around the scientific aspects of the issue. At one end of the spectrum were skeptics such as the Global Climate Coalition (GCC) and U.S. Republican Senator Chuck Hagel who argued the

science was “inconclusive”. His colleague, Senator Tom DeLay, went further, claiming the “hysteria” incited by President Clinton was based on “bogus” science (*Washington Times*, April 20, 2000). At the other end of the spectrum were most scientists, environmentalists, and the general public, who felt the scientific evidence was compelling enough, given the risks involved, to warrant precautionary action. Since the release of the third assessment report by WG I of the IPCC most contrarians have accepted that climate change does indeed pose a credible threat in the near future.

The result has been a shift in tactics; namely, to stress the economic implications of mitigation efforts such as the Kyoto Protocol. One of the most vocal critics of the Kyoto, Hagel, has warned the Protocol would cause “millions of Americans” to lose their jobs, and the consequences for the United States would be severe economic harm. Fellow Senator, Tom DeLay, speculates mitigation measures would be enforced through “extraordinary” price increases, “dramatic” reductions in consumption by all Americans, and therefore concludes that Congress should *delay* any action until the science was more conclusive and a *fairer* deal for Americans was negotiated. The position of U.S. Congressman John Doolittle is no less skeptical of climate change, and of science in general. Adopting a stance of scientific ignorance altogether, he prefers not “to get involved in peer-reviewed mumbo jumbo” as he told a reporter in an interview with the Washington Post (January 29, 1996). On his website he contends climate change is a theory concocted by “greenies” and “eco-Marxist global warming fanatics”. The irony of the positions on climate change taken by these two politicians in light of their last names should not be lost on the reader.

Environmentalists, meanwhile, have responded by stressing the economic impacts that will occur if Kyoto *is not* implemented and emissions are not reduced. The main difference between the two positions seems to be attitudes towards different kinds of risks. For the GCC and other business interests the emphasis is on short-term *economic* risks associated with any mitigation measures, while for many scientists and environmentalists the emphasis is on the long-term economic and *ecological* risks posed by climate change. These differences are effectively contrasted in the comments of Josph Steed, DuPont environmental manager, and former EPA administrator, Lee Thomas, in relation to the ozone depletion issue. Steed argued, “There just wasn’t scientific or economic justification to proceed. How do you trade a possible [environmental] risk for a [business] risk that is real?” while Thomas noted, “Where there was uncertainty, they thought we needed more research and I thought we needed to be cautious. We just looked at the same science and came to two different conclusions” (quoted in Litfin, 1994:52, 78 respectively). These differences in opinion are not limited to ozone depletion.

Indeed, they find expression in a variety of environmental issues including nuclear technology, gene technology, and climate change.

It should be noted, however, this is a highly simplified representation of the debate and a wide variety of opinions exist on the issue—particularly within the business community. The European business community, for example, has been largely supportive of the Kyoto Protocol. Support is especially evident in the insurance sector there, led by Munich Re. The support of the insurance industry lends more legitimacy to the concerns of environmentalists, since insurance specializes in profiting from the management risk.

The Insurance Industry and Climate Change

Dlugolecki (2000) contends attitudes within the insurance industry regarding climate change are mixed, and the attitudes of individual companies tend to mirror those of the political elite of their home country. Thus, insurance companies in the United States tend to be skeptical of threats associated with climate change, while in Europe insurance companies such as Munich Re and Swiss Re are far more concerned about the potential consequences. Other factors accounting for the ambivalence of the insurance sector as a whole are a lack of specific information about the impacts, lack of political direction, and the short-term bias of the market (Dlogolecki, 2000:600).

The most obvious impact of climate change on the insurance industry will be the increase in insured property losses from extreme weather events—expected to increase in both frequency and intensity (Dlugolecki, 2000). It is also important to note the nonlinear relationship between storm severity and damages—increasing the speed of a 200 kpm storm by 10 percent, for example, can magnify the damage by 150 percent (UNEP, 1997, quoted in Dlugolecki, 2000:584). The social costs associated with extreme weather events are likely to increase in the future as well, owing to increased 'coastalization' and larger populations.

This scenario does not bode well for insurers who depend on a market where the risks are evenly spread, of low probability, and potentially devastating; in this kind of situation many people are likely to buy insurance, but very few are likely to make claims (White and Etkin, 1997). White and Etkin (1997) are also concerned the insurance industry will be lulled into a state of overconfidence by relying on historical data to assess the risks associated with future extreme weather events. Moreover, they argue current government and industry proposals are inadequate:

> Even with government support and industry-wide cooperation these proposals can be considered as an adequate response only if these extreme events are viewed as an anomaly, and not as a long-term trend associated with an enhanced greenhouse effect…Right now, neither the insurance industry nor

> governments are prepared for climate change. Nor are they prepared for related societal trends that are increasing the pressure on the insurance industry.
> (White and Etkin, 1997:155)

In light of this, does it make economic sense for insurers to provide coverage to coastal areas fifty years from now—when sea levels are expected to be significantly higher and hurricanes more frequent and severe? And would they be able to provide adequate coverage even if they wanted to? White and Etkin are certainly doubtful and lament the implications, noting that in the past economic progress was made by reducing societal risks through such things as improved medical services, education, clean water supply, and so on. Yet the future risks may be greatly increased "by changing the composition of the atmosphere, merely for the convenience of enjoying cheap fossil fuels in the short-term" (White and Etkin, 1997:248).

Others characterize such sentiments as naïve. Indeed, for Beck (1999) one of the defining features of modern society is the production of potentially catastrophic risks that are *uninsured*. The most striking example of this is nuclear technology. In the United States the nuclear industry's abdication of responsibility is enshrined in law by the Price-Anderson Act, which limits the industry's liability to *one percent of damages* (Shrader-Frechette, 1991:15). If nuclear fission technology is so safe and the risks are so negligible, then what need is there to limit liability at all, let alone to one percent? Beck argues economic realism prevents private insurers from getting involved, and that in an uninsured society

> Controversial industries and technologies are often those which not only do not have private insurance but are completely cut off from it…what goes without saying for motorists—not to use their car without insurance cover—seems to have been quietly dropped for whole industrial branches and sunrise technologies, where the dangers simply present *too many problems*…with protection paradoxically diminishing as danger grows…[and so] political stability in risk societies is the stability of not thinking about things.
> (Beck, 1999:31 emphasis added)

Keeping this sobering observation in mind, the next section will explore climate change from an environmental economics perspective, while illustrating the numerous difficulties that exist when trying to assess the economic impacts of mitigation, as well as those of a business-as-usual approach.

Environmental Economics and Climate Change

From an environmental economics perspective, climate change is a classic case of Garrett Harding's "tragedy of the commons" where unregulated access to a common resource leads to its eventual demise through overexploitation. The resource in question in this case is the atmosphere itself, or more specifically, the absorptive capacity of the atmosphere. The

problem can be seen as a market failure, where part of the costs of production and consumption are externalized. In the context of climate change, the externalized costs are CO_2 and other GHG emissions (methane, nitrous oxide), and the loss of carbon sinks, such as forests and wetlands. The solution, from this perspective, is to internalize these costs. Generally, there are two types of approaches: free market solutions, which typically rely on clearly defined property rights in the form of tradeable emission permits; and command-and-control approaches, in which a central authority imposes a tax, and/or minimum standards regulations, or some other regulatory mechanism.

In both approaches estimating the costs of climate change can vary widely, depending on a number of methodological assumptions, which makes determining the appropriate price for an emission permit or determining the right amount of tax to impose difficult. It is therefore useful to take a closer look at the methodological difficulties that occur when trying to calculate the costs and benefits of climate change before looking at the strengths and weaknesses of the different regulatory approaches.

Uncertainty, Causality, and Economics

Several problems arise when one tries to determine the economic impact of climate change. From a legal or insurance industry perspective climate change is problematic because it is a *gradual* process rather than a series of discrete events. Establishing causal links between an enhanced greenhouse effect and *specific* weather events, such as hurricanes, droughts, and heat waves, is currently beyond the capabilities of modern science, and will likely remain so for the foreseeable future. Thus, attributing the costs of such events to climate change remains highly problematic, particularly when issues of liability are raised. As Stone (1992) notes,

> Any climate change case will have to surmount daunting problems of proof: the defendant is bound to raise issues of remote and speculative causality, contributory negligence…Will defendants bear the burden of showing that the storm was *x* percent more severe than would have been "naturally"?
>
> (Stone, 1992:460)

The legal and ethical questions that Stone raises will be dealt with in more detail in the final chapter of this paper. At this stage it is sufficient to consider how the scientific uncertainties associated with climate change invariably undermine the accuracy and confidence associated with studies that estimate the economic impacts of the problem.

Choice of Baseline and Endpoint

Another problem for modelers who seek to provide objective assessments of the costs of climate change—not often discussed in the literature- is baseline and endpoint choice in assessing costs and benefits. The standard assumption in most scenarios, including those

done by the IPCC, use 1990 as baseline and a doubling of atmospheric CO_2 equivalent as the endpoint.

At first glance, the choice of 1990 as the baseline year might appear to be random, but in fact significant political pressure was applied by a number of countries, most notably by the Eastern Bloc countries that made up the former Soviet Union, to have 1990 chosen as the baseline year, rather than an earlier date. For Eastern Bloc countries the advantage of using 1990 is clear. Prior 1990, these countries' emissions were significantly higher under the Soviet regime, and only fell after the collapse of the USSR and the subsequent collapse of their economies. Consequently, they would easily meet their targets using 1990 as a baseline since their output of emissions has already declined considerably due to less economic activity. It can be argued that this amounts to a bribe since it gives these countries an enormous economic advantage over countries that had would be required to significantly reduce their emissions under the Protocol. Supporters, meanwhile, argue the concession was necessary to enlist the support of formerly communist countries. Nevertheless, the choice of 1990 as the baseline is based exclusively on political rather than on scientific or economic considerations.

Similarly, it is not clear why the doubling of CO_2 radiative forcing equivalent endpoint is anymore valid than, for example, one using a tripling of equivalent radiative forcing as the baseline. It may have been chosen for simplicity and because the time horizon involved is relatively small, which is important since errors are invariably magnified over time. However, this can create a misleading perception that greenhouse gases will stop accumulating after reaching this threshold, and costs will not continue to escalate. Some authors have explored the implications of long-term warming, most notably Cline (1992), who found costs increase *exponentially* once average surface temperatures increase beyond a few degrees, and in the long-term (100-300 years) a 10°C warming is possible. WG I of the IPCC seems well aware of the dangers in framing the issue strictly in the short-term when it notes

> Ice sheet models project that a local warming of larger than 3°C, if sustained for millennia, would lead to virtually a complete melting of the Greenland ice sheet with a resulting sea level rise of about 7 metres. A local warming of 5.5°C, if sustained for 1000 years, would be likely to result in a contribution from Greenland of about 3 metres to sea level rise.
>
> (PMS-WGI, 2002:17)

Discount Rate

Closely related to baseline and end point choice in modeling scenarios is the choice of discount rate. The 'tyranny of discounting' has been particularly controversial among environmentalists who have argued it is inappropriate to apply standard discount rates to

scenarios occurring over very long timescales, because it amounts to a form of intergenerational discrimination. There are numerous ethical considerations involved in the use of discounting, which will be addressed in the last section of this paper. At this point it is sufficient to say that the choice of discount rate can dramatically affect the prognosis of a cost-benefit analysis, and its importance increases in proportion to the time period used. Consider the following examples: Using a 4 percent annual discount rate for the future values, an amount of $7.106 billion in the year 2050 is worth $1 billion in the year 2000, whereas with a 7 percent annual discount rate an amount of $29.457 billion is required in 2050 to be worth investing or forgoing a benefit of $1 billion in 2000. In this example, a mere 3 percentage points lead to more than a fourfold difference in only 50 years (Rao, 2000:73). The choice of discount rate becomes even more important when one recalls the impacts are likely to be felt for centuries, possibly millennia, rather than decades. In the context of climate change, then, the choice of discount rate is critical in informing the policy decisions vis-à-vis mitigation and adaptation measures; a high discount rate would tend to bias adaptation measures (see Nordhaus, 1990), and a low, or zero discount rate would favor mitigation strategies (see Cline, 1992).

Different Emission Scenarios

Perhaps the greatest difficulty in estimating the costs associated with climate change, both in terms of impacts and mitigation measures, is factoring in different emission scenarios. These scenarios are dependent on different development paths the world's nations take in the future and are influenced by a number of social, technological, and economic factors. The two most influential factors in this respect are population growth and technological development.

The IPCC uses four general 'storylines' to describe future possible emission scenarios. The A1 storyline, for example, describes a world where global economic growth is high, population stabilizes by 2050, and the emphasis is on global, centralized solutions. This particular storyline is then subdivided along three technology-dependent paths: fossil intensive, non-fossil energy sources, or a balance across all sources where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies (PMS-WG III: 5). The B2 storyline, by contrast, is one where global population is still increasing slowly by 2050, solutions tend to be locally or regionally based, and technological alternatives develop more slowly.

It is not surprising, then, that there is enormous uncertainty surrounding the costs of climate change. Indeed, with all of the assumptions that are involved in producing these scenarios, and the impact that they have on economic estimates, one is tempted to dismiss

these exercises altogether and concur with Luks' earlier observation that they are done simply for rhetorical purposes, rather than for any useful epistemological contribution.

Commensurability and Non-Market Goods and Services

Finally, a more general criticism can be made concerning economic approaches to climate change, noted in the WG II report, that "the benefits and costs of climate change...only partially account for impacts on goods and services that are not traded in markets" (PMS-WG II, 2002:14). The problem here is one of commensurability, a topic that is central to the emerging field of ecological economics. How, for example, does one place a monetary value on the environmental services provided by ecosystems, such as water purification, oxygen production, flood protection, etc? Mainstream economists typically use willingness-to-pay (WTP) functions as a proxy for such services, so that, for example, the value of clean air is determined by how much people are willing to pay for catalytic converters and other technologies that improve air quality. There are, however, a number of problems with this approach—it assumes, for example, that people have extra income to spend for a cleaner environment, which is highly unlikely in most developing countries. Other problems with this approach will be explored in the final chapter of the paper.

WG II also notes that most economic estimates of the impact of climate change do not adequately account for the influence of different rates of change—which to a certain extent is unavoidable, given the scientific uncertainty that exists about rates of change. Coupled with the fact that non-market goods and services are also excluded leads them to suggest

> These estimates generally exclude the effects of changes in climate gradeability and extremes, do not account for the effects of different rates change, and only partially account for impacts on goods and services that are not traded in markets. These omissions are likely to result in under estimates of economic losses and over estimates of economic gains.
>
> (PMS-WG II, 2002:8)

Under current models, most ecosystems are only valued to the extent of their capacity as carbon sinks, or for the timber that they contain. It is not surprising then that the most studied impacts of climate change concern the agriculture, forestry, and tourism industries in the United States, as they lend themselves to traditional economic analysis, and are of concern to policy makers in that country. It is interesting to note that early on in the climate change debate skeptics argued that a CO_2 enhanced atmosphere would increase crop yields in the developed countries. However, as the comments from the WG II report show, these benefits may be negated by the increase in heat stress on crops. Nevertheless, the perception that climate

change may be beneficial for some countries has certainly played an important role in the evolving politics of climate change.

By far the most studied aspects of climate change are the costs of mitigation. To a certain extent this is understandable given all of the uncertainties in estimating the impacts, as mentioned above. At this stage it is useful to explore the different regulatory approaches that have been proposed to mitigate climate change.

Command and Control Approaches

Historically, the most common strategy for regulating domestic environmental problems has been the command-and-control approach. Sands (1995) lists several mechanisms using this approach grouped into two categories: direct regulation, and economic instruments, such as charges and taxes. The direct regulations he mentions include environmental quality standards, product standards, emission standards, and process standards (Sands, 1995:126-128). Of particular relevance to climate change are emission standards and product standards. In the past, emission standards for sulphur dioxide have been used for large industrial utilities and could certainly be used in the future to regulate CO_2 emissions. Product standards were gradually introduced in the case of ozone depleting substances, and emission standards have already been introduced in the United States under the form of corporate average fuel economy (CAFÉ) standards, which requires automobile makers in the United States to meet certain minimum fuel efficiency standards.

This raises an important point that cannot be overemphasized. Climate change, unlike other air pollution problems, is not just about reducing CO_2 or methane emissions. It is also fundamentally about energy consumption, and is therefore about energy efficiency. While some studies (for example, Nordhaus, 1991) find abatement costs excessively high, others argue as much as a 20percent reduction in GHG emissions is possible simply through energy conservation and increased energy efficiency measures (Cline 1992). These are usually lumped together under the rubric of a 'no regrets' policy. WG III defines no regrets opportunities as "those options whose benefits such as reduced energy costs and reduced emissions of local/regional pollutants equal or exceed their costs to society, excluding the benefits of avoiding climate change" (IPCC, WG III 2001:9).

Economic instruments also have an extensive track record in dealing with environmental problems; still, in today's political climate where existing taxes are being reduced and national governments are competing with one another for investment, it seems unlikely a new tax would be politically acceptable (in North America, at least) even if the economic rationale for it were sound.

The most widely discussed option is a carbon tax, which would be levied on fuels on the basis of their carbon content and/or energy content (for example, Stone 1992, Sands 1995:131). The failed proposal by the Clinton administration to implement a British thermal unit (BTU) tax suggests this approach is unlikely in the future, at least in the United States. Advocates of a carbon tax argue it could be made more politically attractive if it were designed to be revenue neutral, where the imposition of an additional carbon tax would be offset by a decrease in other forms of taxation, such as sales and/or income tax. A recent commentary published by the C.D Howe Institute in Canada has noted that a carbon tax is likely the most efficient option, but concedes that it is likely to face opposition from the federal government (McKitrick and Wigle, 2000:18). Indeed, this message seems to find a more receptive audience in the European Union, for reasons that will be discussed in the next chapter.

Negative taxes (i.e. subsidies) can also play an important role in mitigation efforts. Many of the emerging industries in renewable energy (wind, solar, biomass cogeneration etc.) do not yet have the economies of scale of traditional energy companies, making it difficult to compete on an open market. Incubating these industries through the use of subsidies and preferred access could go a long way towards reducing emissions of GHG's.

Free-Market Approaches

Not all abatement measures need to involve command and control approaches. Indeed, within the climate change debate free-market solutions are the preferred choice. Three mechanisms in particular have been included in the Kyoto Protocol under the heading of 'flexibility mechanisms': emissions trading under Article 17, Joint Implementation under Article 6, and Clean Development Mechanisms (CDM's) under Article 12 (Yamin, 1999: 268). These systems share a common underlying premise— the marketplace can achieve abatement costs more efficiently than direct government regulation, and can determine the appropriate price of emissions. Before exploring each of these in detail, it is useful to first look at the underlying logic of this approach to environmental problems.

Opponents of command-and-control taxation schemes often argue taxes and strict across-the-board emission cuts are inherently inefficient. They base this claim on the equimarginal principle, which states,

> If you have multiple sources to produce a given product or achieve a given goal, and you want to minimize the total cost of producing a given quantity of that output, distribute production in such a way as to equalize the marginal costs between the production sources.
>
> (Field and Olewiler, 1995:59-60)

Taxes and sweeping cuts are inefficient because they are applied equally to all actors, even though individual marginal abatement costs can vary widely (owing to differences in technological inputs, substitution possibilities, etc.). The preferred approach, from this perspective, is to set a cap on aggregate emissions. Firms are then allocated a fixed amount of permits, either through grandfathering or through an auctioning process—a contentious process in itself, to be discussed in the final chapter. Firms emitting more than their assigned amount are forced to buy permits, while those emitting less can sell their permits. It does not matter where the reductions occur, equimarginal proponents argue, it is the aggregate reduction that is important.

The flexibility mechanisms in the Kyoto Protocol are all variations on this concept. The emissions trading program allows developed countries, or firms within those countries, to trade emission allowances among themselves. Experience in this form of pollution abatement is extensive; emission-trading schemes have been implemented in one form or another since the 1980's—for example, in the Montreal Protocol, as well as the U.S. Clean Air Act of 1990 (Sands, 1995:132). And there are persuasive success stories. With regards to sulfur dioxide, Stewart et al. note "as of 1996 emissions were more than 30 percent below the reduction schedule…Controls costs are less than 50 percent of the command regulatory alternative, resulting in more than $5 billion in savings" (Stewart et al., 2001:153).

The role of CDM's has also received a considerable amount of attention. For a variety of reasons, developing countries are not currently covered under Article 3 of the Kyoto Protocol, and are therefore not bound to reduce their GHG emissions or increase their carbon sink capacity. Nevertheless, it is generally accepted that their participation is vital. To that end, developed countries and private entities are able to earn credit for investing in projects that reduce emissions or enhance sink capacity in developing countries. When this is done between developed countries it is considered Joint Implementation. In line with the equimarginal principle, proponents of the CDM argue that from an ecological perspective it doesn't matter where on the globe net emission reductions occur. Equally important, "a CDM trading system would also be a major contribution to economic modernization and growth in developing countries" (Stewart et al., 2001:155).

The choice of which instrument to use, i.e. carbon taxes or tradeable emission permits, depends in large part upon the quality of the information available. If one knows approximately the economic cost of a particular activity or pollutant, then it is relatively easy to set the appropriate tax level. As we have seen, however, the costs of climate change are very difficult to determine, and so it is unlikely a pareto optimum situation could be achieved.

There are other weaknesses with a policy that relies on a carbon tax. Stone (1992) argues a carbon tax set too low would be politically feasible but would have little impact on the problem. On the other hand, a tax set high enough to have an appreciable effect would generate hundreds of billions of dollars. This raises the very thorny political question of how that money would be administered, whether through national governments or through some international body.

Tradeable allowances, however, are not without their own problems. Their effectiveness depends in large part on whether transaction costs (i.e. costs of implementation, monitoring, and certification) can be kept low enough so efficiency gains are not lost. Whether this is possible in the context of climate change remains to be seen, and there are significant reasons to doubt the overall feasibility of tradeable allowances from a cost-effectiveness perspective. Unlike ozone and sulfur dioxide, which are both relatively easy to monitor and regulate, regulating GHG emissions and sink capacity is enormously complex. GHG emissions are literally as ubiquitous as the air we breathe in, and sink capacity encompasses everything from agriculture to forestry.

While tradeable permits may be more efficient than a carbon tax, clearly there are other considerations transcending considerations of efficiency. While efficiency is an important ingredient of any sound policy, it would be a mistake to adopt a policy that works well in theory, but falls short in practice. As James Buchanan urged,

> Economists should cease proffering policy advice as if they were employed by a benevolent despot, and they should look to the structure within which political decisions are made…. [We should] postulate some model of the state, of politics, before proceeding to analyze the effects of alternative policy measures.
>
> (Wiener, 1999:160)

The next chapter takes up Buchanan's challenge and explores some of the political dimensions that characterize the climate change debate.

Chapter 3 – Political Dimensions of Climate Change

Introduction

A Gordian knot is defined as "a complex problem; an inextricable difficulty; and to cut the Gordian knot is to remove a difficulty by bold and energetic measures" (http://www.dictionary.com). The allusion refers to Gordius, King of Phrygia, who was said to have tied a knot so complex and intricate it was impossible to undo. Alexander the Great, having been told by an oracle that he who was able to undo the knot would rule Asia, tried in vain to untie the knot. Frustrated, he then drew his sword and cut the knot. The standard interpretation of this story is that it takes "bold and energetic measures" to solve complex problems and often the solutions are simple and direct.

Climate change could certainly be characterized as the Gordian knot of environmental problems, to the extent that it is a complex, intractable problem. On the surface the problem is simple—for at least several decades the amount of GHG's emitted into the atmosphere has exceeded the planet's absorptive capacity.

What makes climate change so challenging from an international relations perspective is the asymmetrical distribution of costs and benefits. One could even go so far as to say an inverse relationship exists between the two—some General Circulation Models (GCMs) have found those who currently emit the most GHG's—the industrialized countries—are likely to be the least affected by the consequences in the future. Thus, if one takes a realist approach to the problem—where States behave in a strictly self-interested way— meaningful cooperation on this issue appears unlikely.

This section will examine three post-structuralist theories and their contribution to understanding the dynamics of climate change politics. Specifically, Haas' epistemic community theory, Litfin's discursive practices approach, and Adger et al.'s use of discourse analysis will be used to illustrate how climate change was able to gain sufficient attention to warrant political action. Then an analysis of the problem will be given using neorealist theories, including Paterson's historical materialist approach, followed by a game-theoretic approach. An examination of climate change politics using these approaches will demonstrate why significant progress in mitigating climate change remains unlikely in the short-term.

Epistemic Communities

One common criticism of neorealist approaches to international politics is they "over-emphasize the dominance and unity of state actors" (Paterson, 1996:135). In other words, they treat a State's interests as a given, rather than as a dynamic process shaped by multiple groups

within the state. Additionally, they tend not to explain how short-term and long-term interests are resolved. This is particularly relevant to environmental issues, such as climate change, where the relevant time scales tend to be long. Another criticism, pertinent to the politics of environmental issues, is that these approaches do not address the role expert knowledge plays in creating consensus and influencing outcomes.

Haas (1993) and others have attempted to address some of these problems using the theory of epistemic communities. In contrast to neorealist theories, epistemic community theory offers an agent-centered, rather than institutionalist or structuralist, account of how scientific communities influence outcomes in environmental politics. In other words, using a smaller unit of analysis it attempts to explain the role individuals, and experts in particular, play in shaping environmental politics.

An epistemic community is "a network of individuals or groups who claim to have policy relevant knowledge within their domain of expertise…[and] have the following in common: 1) shared consummatory values and principled beliefs; 2) shared causal beliefs or professional judgment; 3) common notions of validity based on intersubjective internally defined criteria for validating knowledge and; 4) a common policy project" (Haas, 1992:3). While realist approaches emphasize military and economic power, this approach emphasizes the power of knowledge in terms of its persuasive ability. Thus, the political influence of epistemic communities depends on their ability to generate acceptance of their knowledge as valid. Litfin supports this belief, suggesting "scientists derive their power from their socially accepted competence as interpreters of reality" and "the power of technical experts is proportional to the trust that decision makers have in them" (Litfin, 1992:29, 40). Haas also contends epistemic communities are above the 'political whirl' and therefore the knowledge they produce has objective elements that adds to their credibility (Haas, 1992: 5). This type of power is particularly important in situations where policy makers are faced with technically complex issues, where there is significant uncertainty, and where the stakes are high.

In the context of climate change, the individuals that make up WG I and II of the IPCC could be characterized as epistemic communities. The issue of consensus was particularly prominent throughout the publications of the assessment reports. Early in the climate change debate the science of climate change was contested, rather than questions of burden sharing and emission reductions. Indeed, as noted earlier, the third assessment report issued by WG I seemed particularly cognizant of the relationship between consensus and legitimacy when it issued a separate information note. The strength of epistemic communities is their ability to put an issue on the international agenda, and to set the context within which it is initially framed. It

is unlikely climate change would have remained on the international political agenda for as long as it has were it not for the hard work and perseverance of individuals within WMO and subsequently the IPCC.

However, beyond the initial agenda-setting phase it is difficult to see how epistemic communities influence policy outcomes. Once the issue has moved out of the realm of science and into the world of politics, more traditional interests would be expected to rise to prominence. Paterson suggests the apex of the epistemic communities' influence occurred prior to the negotiations surrounding the Intergovernmental Negotiating Committee for a Framework on a Climate Change Convention (INC),

> It involved the emergence of actors who saw their primary responsibility as defending their states' perceived interest. And since the epistemic community was not politically entrenched, it was not the primary definer of state interests on global warming. There was a break in continuity in who was expressing opinions from a country on the issue.
>
> (Paterson, 1996:148)

There are other problematic aspects of this approach. Some critics have argued Haas' contention that epistemic communities are above the "political whirl" is unfounded. As the earlier section on post-normal science outlined, scientists, like other groups, engage in political activity at many different levels—whether in competition with one another for research funds, or in prescribing a given policy option, " [Haas] only discusses how science influences politics and never how politics affects science" (Litfin 1992:143). A prominent example is the battles for funding that occur between the geophysicists, whose GCM's tend to produce generalized models of climate change, and the 'ecoparticularists' (i.e. ecologists, biologists, and geographers), who tend to study the impacts of climate change at the regional and local level (Lunde, 1991:22). Skeptics like Fred Singer, Richard Lindzen, and Sonja Boehmer-Christiansen go so far as to claim that climate change is a conspiracy theory created by some members of the international scientific community in order to justify and expand their research budgets (Boehmer-Christiansen, 1993). A more sinister version of this conspiracy theory, advanced by Singer and Boehmer-Christiansen, suggests climate change is a problem created by third world 'kleptocrats' who want to see a massive redistribution of wealth from industrialized to developing nations.

Litfin also criticizes how epistemic theory treats knowledge as a unifying force in political discourse. She argues knowledge can be used in a variety of ways; sometimes it leads to political consensus, while other times it simply reinforces existing policy positions. In the context of the climate change issue, opponents of a climate change treaty, such as the Global

Climate Coalition (a consortium of fossil fuel and automotive companies) were able to justify their position by pointing to the uncertainties in the science of climate change.

The release of the third assessment report from WG I has largely silenced this group, although it apparently still holds sway in the halls of the White House, if the comments made in 2001 by United States President George W. Bush are to be believed, when he suggested the scientific underpinnings of climate change were "unsettled" and "our working group study has made it clear we need to know a lot more" (http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html). He must have been somewhat surprised then, when the National Academy of Sciences (NAS) reported a short while later that the conclusions of the IPCC were in fact accurate, and in many ways understated the threats posed by climate change because they focused only on the impacts within the next hundred years, rather than adopting a longer time horizon, echoing similar sentiments made by William Cline almost ten years earlier (Gelbspan, 2001:11). Given that his father used essentially the same argument more than ten years earlier, these statements beg the question: At what point is the science settled?

Discursive Practices

A more useful analysis concerning the role knowledge plays in environmental politics is found in Litfin's approach using discursive practices. While she focuses on discourses concerning stratospheric ozone depletion, many of her arguments can be applied to the climate change debate. Like Haas, she argues realist explanations of power based on domination and control by states are not very useful for knowledge-based conceptions of power (Litfin, 1992:16).

One aspect of discourse analysis is particularly relevant to climate change politics, which is the way *frames* are used to delineate the issue. Litfin emphasizes their manipulative potential, noting frames are "analogous to varying visual perspectives on the same scene; the apparent size of an objective (*or problem)* varies with the observer's distance from it. A frame is also a boundary that *cuts off* something from our vision" (Litfin, 1992:35 emphasis added). Language also plays an important role in framing an issue. For example, exposure to a chemical might increase the risk of cancer; in absolute terms this increase might be expressed as an increase from one in a million probability to three in a million probability, while in relative terms the same data could be expressed as a 300 percent increase in carcinogenity. Two ways in which frames are used in the climate change debate are described below.

Firstly, different actors within the debate use different time frames depending on their perceived interests: policy makers and environmentalists take a long-term perspective, and as such are concerned with the long-term integrity of the environment; business and industry,

however, adopt a much shorter time-frame as they are concerned with the immediate impacts mitigation and adaptation measures would have on the marketplace.

The second point, alluded to in the previous chapter, is that most conventional studies, including the ones done by IPCC, use the CO_2 doubling equivalent forcing as the benchmark, which is likely to occur by 2050. There are many practical reasons for using this benchmark, including the fact that it is difficult to forecast the role of technology, or population scenarios, too far into the future. However, while this might make sense from a practical perspective, it nevertheless prejudices opinions about the potentially catastrophic consequences of sustained warming over the next few centuries.

This raises a related aspect of discourse analysis: how metaphors are used to frame environmental issues. Environmentalists and industry on a number of issues have done this very skillfully in the past. 'Acid rain', and the 'hole' in the ozone layer are two examples from the 1980s. More recently, the controversy surrounded genetically modified foods has been presented by Greenpeace and other environmental non-governmental organizations as a debate about 'Frankenfoods'.

As previously noted the original metaphor describing how gases heated the atmosphere was 'hothouse'. In the 80's and early 90's the term 'global warming' and 'green house effect' gained currency, both in policy circles and the popular media. Nowadays the more common term is 'climate change'. On the industry side, the Kyoto Protocol has been referred to in the past as a 'job killer'. This is not a trivial exercise in semantics: metaphors have a direct impact on how the public perceives the problem, and in turn how it is dealt with at the state level.

It is therefore important to distinguish between the terms 'global warming' and 'climate change', since the choice of terms greatly influences the framing of the issue. The former suggests the issue is whether the planet is warming or will warm in the future, whereas the latter term simply suggests a change in climate. Climate change is also a more conservative term than global warming—warming may or may not occur, what is important is the climate system is being altered. Climate change is more accurate as well: it is possible some regions may cool, even if global average temperatures increase. Ultimately, however, the choice of terms is based more on political rather than scientific considerations.

Ungar (2000) suggests the public used the earlier and simpler problem of ozone depletion as a model for understanding climate change, a process known as syncretism, where "the availability of cogent templates from popular culture rendered the ozone problem potentially understandable. These bridging metaphors lowered entry costs and speech barriers" (Ungar, 2000:305). The bridging metaphor he emphasizes in the ozone problem is the "penetration"

metaphor, coupled with the idea of a "shield", a common feature of many video games, science fiction television and movies, including the immensely popular *Star Trek* series and *Star Wars* movies. These choices of metaphors are important for two reasons. Firstly, they are easy to understand and so reached a wide audience. Secondly, they effectively convey a sense of urgency other metaphors were unable to do; most people know intuitively a breach in the shield is not a good thing (taking their cues from Scottie from *Star Trek*, for example). By contrast, no similar metaphors encapsulate or explain the indirect, nonlinear effects common to the phenomenon of climate change.

Litfin also notes metaphors often take a normative leap from description to prescription. A particularly relevant example, originally used to describe chlorine loading in the atmosphere but is equally relevant to the climate change issue, is 'the time required to stop a loaded freight train or a supertanker'; one climate scientist argued the term 'greenhouse effect' has favorable overtones, particularly in the northern hemisphere, and so it should be replaced with a term like 'global heat trap' (Litfin, 1994:39). On a continuum, the term 'climate change' can be seen as occupying the middle ground; it implies change, and therefore uncertainty, unlike global warming, which implies a warmer world—a favourable outcome to many inhabitants in the northern hemisphere. This is an important and likely conscious distinction made by the scientific community, who are becoming increasingly cognizant of the ways in which the knowledge they produce is communicated in the public sphere. Indeed, an important aspect of climate change discourses is how they are communicated by the mass media, and how the public discourse differs from the policymaking and expert discourse.

Agenda Setting

Earlier it was asserted the importance of epistemic communities is measured in terms of their agenda-setting ability. However, an equally important question is to what extent does the mass media perform this function? Shanahan and Good (2000) argue the literature on media influences is also inconclusive. General concepts such as 'environmental protection' may take a long time to grow in the public agenda, whereas awareness of topical events, such as the meltdown of the Chernobyl reactor, may change within a few days or weeks (Shanahan and Good, 2000:286).

The correlation between media coverage and environmental concern is more ambiguous, depending on the issue in question. For example, Mikami et al. (1995) found the more respondents watched TV news about general environmental problems; the more likely they were to identify environmental problems as important. However, they also found television and print coverage of the United Nations Conference on Environment and Development

(UNCED) did not yield significant agenda-setting results, suggesting the agenda setting impact of television and print is long-term and cumulative rather than event-driven and short-term (Shanahan and Good, 2000:286).

While there are correlations between press coverage and environmental concern, it is by no means clear which is the dependent variable, i.e. does higher environmental concern generate more press coverage or vice-versa? For obtrusive environmental issues such as air pollution, press coverage is the dependent variable since people are motivated by personal experience, whereas for unobtrusive issues such as biodiversity loss or climate change the amount of press coverage would be the independent variable. The emerging literature on agenda-building suggests "rather than actively filtering the world, as much of the agenda-setting has proposed, the media actually take their cues *from* the world and transmit, or mirror those cues back" (Shanahan and Good, 2000:288).

Climate Change Discourses Within and Between the Spheres of Science, Politics, and the Mass Media

Others have challenged this view of the mass media. Weingart et al.. (2000) explore communication among the spheres of science, politics, and the mass media with respect to climate change. They challenge the assumption that as information flows from one sphere to another, the content of the information passes on unchanged. They argue for a broader conception of communication, which includes "notions of credibility, legitimacy, authority, entertainment, newsness, etc" (Weingart et al., 2000:262). Furthermore, they argue the norms of communication within each sphere are different.

In the sphere of science it is commonplace for initial findings to be uncertain and hypothetical. This is particularly true for climate change, characterized by complex relationships, multiple feedback mechanisms, and variable time lags. This is problematic for political action; in the past, the shear scale of the climate change problem led many politicians to simply suspend judgment on the issue and instead call for more research. The prospects for adequate and informative media coverage is also slim, since scientific information is relatively unattractive unless it can be linked to threats to human well-being (see Ungar (2000) for a detailed discussion on this point).

Weingart et al. (2000) see three separate discourses on climate change in the spheres of science, politics, and the mass media. They use discourse analysis to analyze the climate debate within the German context, relying on scientific publications, parliamentary minutes, and media reports.

Within the sphere of science, Weingart et al. (2000) distinguish between three phases: the initial discovery of anthropogenic impacts on the climate, politicization and scientific closure, and finally, the institutionalization and diversification of scientific advice. The first phase began approximately in 1976 and ended in the mid-1980s. The discourse during this phase was characterized by uncertainty regarding the possibility of anthropogenic influence on the earth's climate.

The second phase was characterized by a distinct politicization of science, with many German scientists advocating aggressive action to avert a climate *catastrophe.* The following quote by meteorologist Hermann Flohn captures this sentiment: "It is not a matter of arguments for an election in the short-lived time scale of politics, the fates of our children and grandchildren on the whole earth are at stake" (Weingart et al., 2000:268). The authors note later publications tried to moderate the tone of the discourse by substituting the term 'climate change' for 'climate catastrophe', yet the latter term remained entrenched in the German discourse.

The third phase, from 1990 to present, has seen the institutionalization of the climate change problem, and the proliferation of managerial and technocratic approaches. In addition, there has also been a trend within the German scientific community to merge climate change solutions with the larger goal of sustainable development.

In the sphere of politics similar phases can be observed. Between 1975-1985 climate change was viewed as a potentially serious problem that deserved more research and vigilance. During the second phase, between 1986-1992, there was a noticeable increase in catastrophic pronouncements by political representatives: "[if] there is a climate catastrophe it will not only be terrible, it will be apocalyptic" (quoted in Weingart et al., 2000:271). The complexity of climate change was simplified and at the same time translated into "a field of political action by very few discursive elements: a rise in global mean temperature of 1.5 to 4.5°C, a rising frequency of extreme weather events, a set of responsible greenhouse gases to be reduced" (Weingart et al., 2000:272). The authors contend the third phase saw the transformation of the climate catastrophe into an object of routine political regulation. Much of the discourse in this phase centered on how to implement carbon dioxide reductions, and whether nuclear energy should be part of the German climate protection policy (Weingart et al., 2000:273). The authors contrast this period, where climate change is perceived as part of the broader problem of sustainable development with the initial phase, when climate change was perceived as a meta-problem of unknown scope (Weingart et al., 2000:273).

The authors discourse analysis of the German media vis-à-vis climate change is particularly insightful. They begin with the observation that the primary interest of the media is

to capture the *attention* of targeted publics (again, see Ungar's (2000) analysis of the attention economy). Furthermore, the media is aware "when reporting on science, the vagaries and uncertainty of scholarly hypotheses do not lend themselves to interesting 'news'" (Weingart et al., 2000:274). They distinguish between two phases in media reporting on climate change. During the first period, from 1976-1987, there was relatively little coverage of climate change. However, the coverage that did occur sensationalized the early warnings by scientists, and so headlines such as: 'Death in the Greenhouse', 'All Over in 50 Years', and 'Heading for Catastrophe' were commonplace (Weingart et al., 2000:275).

The second phase, from 1987 to present, showed a quantitative increase in coverage with the peak occurring around 1992, the same year as the UNCED summit in Rio de Janeiro. On a qualitative level during this period the term 'climate catastrophe' was still used, but now it was also accompanied by calls for concrete action by political institutions. The authors also note the quantity of coverage at the Conference of Parties (COP) in Berlin in 1995 was lower than in 1992. This is indicative of the effects of an 'issue career':

> The limited time span during which a particular issue captures attention [suggests] the media are fickle. Unfortunately their attention and concern rise and fall without much relationship to changes in the physical state of the world.
> (Weingart et al., 2000:276)

The authors then focus on the physical characteristics of climate change and the difficulties they present for communication from a mass media perspective. Because climate change is gradual and hidden beneath seasonal and yearly fluctuations, the mass media translates this into a format accessible to the public by representing climate change as a "sequence of events with concrete examples relevant to everyday experiences" (Weingart et al., 2000:276). In addition, the mass media use time horizons based on generations and human life times, rather than on centuries, or millennia. While this may broaden public understanding, it also prejudices people to the long-term consequences of climate change. Finally, the media helps relate climate change research to everyday life by linking it to everyday patterns of behaviour, such as power consumption in modern societies (Weingart et al., 2000:278).

The Knowledge-Ignorance Paradox

Another interesting facet of the relationship between scientific knowledge and public discourse is what Ungar (2000) calls the 'knowledge-ignorance' paradox, the process by which increases in specialized knowledge simultaneously increase the amount of ignorance. A useful metaphor of this situation is of a flashlight shining on a flat surface. The area illuminated by the flashlight represents the knowledge of a particular subject, while the perimeter between light and dark represents areas of ignorance. As the flashlight is raised, the area of the circle

increases, but so does the perimeter. Ungar laments that most mass media outlets do not provide “sufficiently accurate, detailed, sophisticated, or concerted coverage to take someone much beyond simple awareness of the issue” (Ungar, 2000:297).

Challenging the conventional approach to how public knowledge is communicated and received, Ungar argues ignorance is the norm and that pockets of observed public knowledge are exceptional. Metaphorically, "scientific issues that manage to break through the veil of ignorance are akin to beacons that spark obsessive interest or distress signals" (Ungar, 2000:298). The ozone hole was successful in garnering public attention because it was relatively easy to understand metaphorically, and it was a 'hot crisis' generating a sense of immediate and concrete risk with everyday relevance (i.e. increased risk of skin cancer). Climate change, by contrast, is not as easy to understand or express metaphorically, and the risks it presents are distant and uncertain. Consequently, it has not generated the same level of concern in the public.

Ungar also notes increasing specialization within the sciences over the last hundred years has created spheres of knowledge surrounded by 'spaces of ignorance', creating experts ill informed about related knowledge domains outside their area of expertise. This is particularly troubling for a problem as complex and interdependent as climate change. One of the reasons for this, aside from the sheer volume of knowledge that exists is that the entry costs of obtaining new knowledge outside one's area of expertise are prohibitively high, often requiring years of study. If one cannot reasonably expect experts to become informed about related disciplines, then it is hardly likely the public will either.

It is also important to distinguish between the kinds of information popular culture is interested in. There is pragmatic knowledge people seek out, such as information about health, investments, etc., and there is information of little pragmatic value, except as a conversational resource—what Ungar calls 'celebrity facts'. These consist of sports trivia, television shows, movies and so on. In this context, science-based issues are poorly equipped to compete with ‘infotainment’. Add to this the high entry costs of gaining scientific knowledge, and it is hardly surprising the majority of the population is scientifically illiterate. However, this does not mean the public is incapable of understanding the relevant aspects of climate change. Indeed, there is ample research suggesting people can very quickly learn and make informed decisions about complex scientific issue (see for example Doble, 1995). The problem is scientific issues are poorly equipped to compete with the other types of information listed above in what Ungar calls the attention economy.

Uncertainty and Rhetorical Boundaries

An enduring feature in climate change discourses is uncertainty about the science, uncertainty about the economic costs, and uncertainty about the scope of political cooperation. Zehr (2000) restricts his analysis to the ways in which scientific uncertainty regarding climate change is constructed in the popular press, and then how it is used to create a rhetorical boundary between 'experts' and the lay public. Journalists will often create controversy where none previously existed, or else sustain it by "soliciting opposing arguments by expert scientists" (Zehr, 2000:86). This serves at least two purposes: on the one hand, it creates drama, and drama sells; on the other hand, many journalists would argue it creates an impression of objectivity.

Uncertainty has been used to different effect during the climate change debate depending on the audience in question. Within the scientific community it rhetorically creates a demand for scientific research, while in political contexts it has often been used to justify the status quo, or a wait-and-see approach.

Earlier it was noted scientific uncertainty was used in the popular press to foster controversy and drama. It is also used to maintain novelty about the problem of climate change. Zehr contends that for the most part a generic format was used to report stories,

> A new research study or technique was introduced and described in some detail. Then the author cautioned that there were insufficient data or some uncertainties associated with the research. Each study took on increased significance with its association with global warming, but at the same time more scientific uncertainty about global warming was constructed.
>
> (Zehr, 2000:92)

Zehr acknowledges that this uncertainty must be qualified and so he includes a passage from a *New York Times* article, which explicitly makes a distinction between short-term weather and long-term climate fluctuations,

> The media seize on any hint of controversy with intemperate zeal. And climate experts offer scant relief, insisting that the day-to-day fluctuations *ordinary* people notice aren't nearly as significant as the long-term trends about which they themselves seem to agree.
>
> (Zehr, 2000:89 emphasis added)

The distinction between 'ordinary' people and 'experts' is important here. The implication is experts are able to understand and distinguish between uncertainties inherent in precise short-term predictions about the weather and more general long-term predictions about the climate, whereas ordinary people are not. The boundaries created between science and a 'misinformed' public contributes to inaction among the public. On the one hand is a need for scientists and

journalists to collaborate together to produce information that *accurately* reflects the consensus, or lack thereof, within the scientific community. On the other hand, journalists and scientists must consider how public perception of scientific uncertainty weakens the scientific community's influence.

Earlier it was suggested journalists often present competing viewpoints on a particular issue to create controversy, and to provide the appearance of objectivity. This last proposition is problematic with respect to climate change because certain climate change skeptics have received a disproportionate amount of media coverage. Zehr notes one group of climate change skeptics, including Richard Lindzen, Fred Singer, Patrick Michaels, and Robert Balling Jr., have received an inordinate amount of attention in the mass media, and suggests their connections to the energy industry may have been a factor (Zehr, 2000:91). This bias is not reserved to the United States either. In Canada, for example, David Gutstein (2001) analyzed the *National Post*'s coverage of the climate change between January 2000 and June 2001 and found the *Post* published 53 opinion pieces (unsigned editorials, columns and guest opinion pieces) on climate change and global warming. Of these, three were neutral while 48, or 90 percent, deny that global warming is occurring, that it is caused by burning fossil fuel or that it will have harmful consequences (Gutstein, 2001: http://newswatch.cprost.sfu.ca/monitor/issue8.html).

The above examples are not meant to suggest all mass media coverage of climate change is biased in favour of right-wing conservatives; indeed, it may be that left-leaning media outlets overstate the problem and understate the economic costs of mitigation. However, it is reasonable to question the level of influence corporations have in determining the nature of media coverage of a particular issue. And there can be no doubting their influence —most mass media outlets are utterly dependent on advertising revenue from corporations for their operations. Would a newspaper chain suppress a story that tied climate change to the low fuel efficiency of SUV's, for example? The issue here is what kind of filters and blind spots exist in the mass media, and how they influence politics and society at large (for an extensive study of this issue see Hackett et al., 2000). While discourse analysis might shed some light on this question, more conventional realist and structuralist approaches are potentially more informative.

This does not in any way invalidate the post-structuralist approaches explored thus far. Approaches that focus on the role of the individual are useful. For example, in Canada the recent driving force behind the federal Government's imminent ratification of the Kyoto Accord has been attributed to directly to the Prime Minister, who wants to leave with an admirable, pro-

environment legacy. And yet how Canada's commitments will be met is still uncertain, and will likely be shaped by more mundane political and economic considerations than by the wishes of the Prime Minister.

Post-structuralist approaches are best seen as providing a complementary role to more traditional realist approaches when examining the political dimensions of the climate change issue. Litfin recognizes the limitations of the agent-centered nature discursive practices in the context of climate change, and so offers a structuralist comparison of climate change and stratospheric ozone depletion.

Table 1: Comparison of Two Global Atmospheric Environmental Problems

Characteristic	Ozone	Climate
Scientific uncertainty	High	High
Predicted damages	High	Very high
Distribution of costs and benefits	Fairly even	Uneven
Cost of controls	Moderate	Very high
Sources of pollution	Few	Very many
Major actors	North	North and south
Visible crisis	Yes	No
Human health issue	Yes	Yes

(Source: Litfin, 1994:193)

Of the characteristics listed above, three are particularly important from a realist perspective; they suggest solving the problem of climate change will be much more difficult than stratospheric ozone depletion. First and foremost the distribution of costs and benefits are uneven (earlier it was suggested there may in fact be an inverse relationship been the two). Two other important factors are the numerous sources of pollution – making regulation and mitigation very difficult – and the high costs associated with controlling the pollution.

Historical Materialism

There are several other enduring features of climate change politics more aptly explained by realist approaches. Using what he terms 'historical materialism', Paterson sees three critical factors influencing state interests vis-à-vis climate change: 1) differences in levels and types of dependence on energy resources; 2) influence of the international political economy, and states' positions within it and; 3) differences in states' perception of the their

vulnerability to climate change (1996:78). With respect to energy dependence, Paterson identifies three influential groups.

The first group consists of the states that make up the Organization of Petroleum Exporting Countries (OPEC) whose primary revenue is derived from the export of fossil fuels. In light of this it is hardly surprising these countries have been the most vocal opponents of the Kyoto Protocol, since the protocol calls for a reduction in carbon dioxide emissions, which would lead to a drop in demand for oil, causing prices to go down, and therefore reducing the revenues of OPEC countries. During the initial negotiations OPEC members consistently highlighted the uncertainties in the science of climate change, and the importance of a cautious approach. Now that implementation of the protocol seems likely by many countries, it has modified its tactics by pressing for some form of compensation in lieu of lost oil revenues. These calls have generated predictable resistance from a variety of developing and developed countries alike, including the United States. Saudi Oil Minister Ali al-Naimi suggests this resistance is based on a misunderstanding, "I believe there is a misunderstanding of what compensation means. What we are asking for is assistance in helping to diversify the economies of OPEC countries" (http://www.csmonitor.com/atcsmonitor/specials/climatechange/2001/0720dispatch.html).

The second group consists of countries that are relatively dependent on imported energy. Most of Europe (with the exception of Norway and the UK) and Japan are included in this group. Paterson argues this group is generally in favor of significant emission reductions for a number of reasons. Firstly, a global reduction in emissions would likely reduce overall energy demand, which would in turn lead to lower the energy prices, thereby improving their balance of payments. Dependency on energy imports has also influenced the energy efficiency of industries in Europe and Japan–they tend to be more efficient than their North American counterparts. For example, the ratio of energy consumption to GDP in the U.S. is 0.28, while in Japan it is only 0.18, a difference of nearly 30 percent (Paterson, 1996:80). Another feature distinguishing this group is a political atmosphere where environmental regulation is commonplace and dealt with by business in a cooperative manner. Consequently, European industries and business interests likely feel they have a competitive advantage in adopting and developing abatement technologies for both domestic and international markets.

The third group Paterson identifies is made up of countries with large energy resources, and has either industrialized using cheap energy in the past, or anticipates doing so in the future. The United States, China, India, Russia, Brazil, and Mexico fall into this category. For these countries a climate change treaty would be costly since it would depress energy prices for

exporters, while at the same time restricting the ability of developing countries to use conventional energy sources to industrialize. This partly explains the EU's objection to the inclusion of carbon 'sinks' –such as in meeting emission reduction targets, as they would allow these countries to maintain their energy consumption, and thereby maintain energy prices. The most influential country within this third group is the United States. Paterson notes the political atmosphere in the United States is vastly different than in Europe. On the one hand, extensive and frequent government regulation and market intervention is commonplace in Europe and Japan, and a relatively energy efficient culture exists in those countries. On the other hand, in the United States the historical abundance of cheap energy has contributed to a 'gas-guzzler' culture that seemingly prides itself on using as much energy as possible, and the political atmosphere is dominated by a neo-liberal ideology that is decidedly hostile to government regulation and intervention. The historical importance of the energy industry has also led to a situation where the fossil fuel lobby is far more influential in political circles in North America than it is in Europe. Indeed, one need not look very far for evidence of the fossil fuel lobby's power—President Bush, like his father before him, comes from an oil industry background, as does Vice-President Dick Cheney, as do a large number of Bush's closest advisors. Indeed, one could argue the United States is addicted to fossil fuels just as a junkie is to heroin. With this in mind, it is hardly surprising the current President would be unsupportive of the Kyoto Protocol, regardless of the scientific evidence.

It is interesting to note the positions of the U.S. and Europe were essentially reversed on the ozone depletion issue, with the former pressing for an aggressive, preventative action, while the latter argued for a more cautious, gradual approach. This difference can be explained, in part, by the fact that the chlorofluorocarbon (CFC) industry in the United States, led by DuPont, was well positioned for the phase out of CFC's because it had already made substantial investments in research and development of more benign substitutes. This seems to validate the observation that states that are 'leaders' on one environmental issue are often 'laggards' on others (Haas et al., 1993:451), and suggests economic considerations often take precedence over public environmental attitudes, since public concern about ozone depletion was approximately the same in both countries.

Paterson argues the position a state will adopt on the climate change issue also depends on its perception of the costs and impacts. On one end of the spectrum there is the Alliance of Small Island States (AOSIS), whose very existence is threatened by rising sea levels. They are followed by Europe, which is also vulnerable to sea level rise and the disruption of the Gulf Stream, but has the financial and technical resources to adapt. Near the

other end of the spectrum are countries such as Canada, the U.S, and Australia, who perceive the costs of mitigation to outweigh those of adaptation. Finally, there are countries belonging to OPEC where concerns about vulnerability to the impacts of climate change are overridden by their dependence on revenues from oil exports (Paterson, 1996:86).

The position taken by developing countries is more ambiguous. As noted earlier they are far from being a homogenous group. The 'giants' include China, India, Brazil, Indonesia, and Mexico; with their large populations, they expect to industrialize using their abundant fossil fuel reserves. Their central concern is development and access to technology, and they sense a certain amount of leverage (in the near future they will account for the majority of GHG emissions) on the climate change issue, which they do not normally have in other international forums.

There are also the poorer developing countries of Central and South America, and Africa, who simply do not have the resources to combat climate change in any meaningful way because they lack the financial and technological resources—and they are likely to be the hardest hit, as the report from WG II pointed out. In addition, they are preoccupied with the more immediate problems of poverty and hunger, rather than with an issue that might affect them in the future. While they recognize the impacts of climate change will be significant in the future, they argue the developed countries must provide the financial and technological resources to deal with it, as they are the ones that are largely responsible for creating the problem in the first place.

Paterson's analysis is certainly supported by recent events around the world concerning the Kyoto Protocol's ratification, and is particularly insightful with regards to Europe's staunch support of the Protocol, where economic interests are for the most part in sync with the electorate's environmental views.

Game Theory

Based on Paterson's analysis, an effective international treaty to combat climate change seems unlikely. Prospects are even bleaker using game theoretic approaches, where each state rationally pursues it own self-interest. Two of the most common situations in game theory are the "Prisoners Dilemma" and "Chicken". Each situation shows how individuals acting in a self-interested manner leads to a sub-optimal outcome where both are worse off. Interestingly, this completely contradicts the popularly accepted notion, first advanced by Adam Smith, that the socially optimal result occurs when individuals are motivated by self-interest. The prisoner's dilemma was originally formulated as a situation where two prisoners area interrogated separately. There are three possible outcomes in this game: 1) both prisoners testify against

one another and each receive five years; 2) one testifies against the other, and is pardoned, while the other remains silent and gets 10 years and: 3) both remain silent and get one year. The dilemma here is neither prisoner wants to be the 'sucker', and so out of self-interest will testify against the other.

In the context of climate change, one can use this model to describe the situation between the U.S. and developing countries. As mentioned earlier, the U.S. feels the costs of mitigation outweigh the benefits, and would be better off spending resources on adaptation to climate change later on. At the same time developing countries feel industrialization and eradication of poverty in the short-term must take priority over reducing emissions for long-term benefit. From a game-theoretic perspective, each of them view the situation in terms of CD > DD (where C represents cooperation, and D represents defection). In other words, they fear the possibility of a situation where they cooperate and the other defects more than the situation where both of them defect. In U.S. republican circles this is framed in terms of competitiveness of the economy. They argue the U.S. economy would be at a competitive disadvantage if countries like China and India were not also forced to reduce emissions.

The situation vis-à-vis Europe and developing countries is better explained in the context of the 'chicken' game, based on the classic scenario in which two drivers are speeding towards one another, each hoping the other will steer out of the way. Here DC > CC is the dominant strategy of each player; with Europe hoping China and India will recognize the mutual benefits of an aggressive climate change treaty, and so sign on without asking for substantial side payments. For both, the consequences of mutual defection could be disastrous. One question this approach raises is whether Europe even has the financial resources the developing countries would require to secure cooperation.

If one accepts the description of the relevant states' interests outlined above as accurate, then the problem can essentially be reduced to one where those who seek to mitigate climate change lack the resources to offer sufficient side payments to those who are indifferent to, or would benefit from the impacts of climate change. More specifically, the side payments necessary to secure cooperation from one state might be unacceptable to another state. So, for example, exempting developing countries from any binding obligations until 2012 was necessary to secure their cooperation, and yet it was also the principal reason given for the United States' withdrawal.

While optimists insist the Protocol can still meet its stated objectives, this seems unlikely given that the U.S. accounts for over a quarter of global GHG emissions, and the Protocol has to be ratified by at least 55 countries that account for at least 55 percent of total GHG emissions

in order to enter into force. The U.S. administration has argued that without the participation of the largest developing countries the treaty would be ineffective and fundamentally unfair. The developing countries have typically responded in two ways. First, they refer to the principle of 'common but differentiated responsibilities' contained within the preamble of Article 4 of the UNFCCC, which implies developed countries are obligated to take a leadership role in mitigating climate change because they have the financial and technological resources to do so.

More importantly, the reason they have these resources is in large part due to the fact that they industrialized by burning enormous amounts of fossil fuels. Therefore, asking developing countries to limit their emissions is unfair at best and hypocritical at worst. There is another argument that the most vulnerable developing countries have used, contained in the United Nations Charter and explicitly stated in principle 2 of the Rio Declaration:

> States have the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction.

Opinion polls in industrialized countries suggest the public recognize their moral obligation to address climate change and want their governments to take measures to do so. This sentiment is arguably driven by a universal sense of fairness – those who cause a problem are responsible for its remedy. However, as the next chapter will show there are multiple views of fairness vis-à-vis climate change, which dramatically affect how one approaches questions of burden sharing, intergenerational equity, and international law.

There is nowhere else on Earth that can substitute for our God-given homeland in Tuvalu. The option of relocation as mooted by some countries is, therefore, utterly insensitive and irresponsible.

–Speech by the Prime Minister of Tuvalu at the third Conference of the Parties in Kyoto, Japan, 1997.

Chapter 4 – Ethical Dimensions of Climate Change

Introduction

For some people, climate change is perceived as a minor environmental problem that will be adequately dealt with by future generations. The costs of mitigating climate change greatly outweigh the benefits, and therefore financial resources and policies should focus on adaptation rather than mitigation measures. Others, such as the Prime Minister of Tuvalu take an opposite view, arguing no amount of compensation can replace their homeland if it is submerged by rising sea levels, and therefore every possible measure must be taken to mitigate climate change.

At its core, this can be seen as a clash of philosophical doctrines. The former view articulates a utilitarian perspective, where the goal is aggregate welfare maximization, whereas the latter view articulates a Kantian perspective, where people should never be treated as a means to an end. Where the former is consequentialist in its perspective, the latter is procedural. These tensions and others reverberate throughout the debate about 'greenhouse equity'.

Multiple Views of Fairness

Before looking at the ethical dimensions of climate change it is useful to examine the different philosophical approaches that inform the debate. Three schools of thought can be distinguished: utilitarianism, deontology, and contractualism. Utilitarianism, first expressed in the writings of Claude-Adrien Helvétius, and later by John Stuart Mill and Jeremy Bentham, measures social welfare in terms of the greatest happiness of the greatest number. Thus, utilitarianism is a consequentialist doctrine, concerning itself with judging the rightness of actions based on outcomes rather than on procedures.

The term 'maximization' is important in this respect. Maximization implies quantification and efficiency, and so it is hardly surprising many economists, particularly those who focus on welfare economics—which seeks to maximize aggregate well-being—use a utilitarian perspective to analyze the rightness or wrongness of different policy actions. The policy that efficiently maximizes the welfare of the group in question is therefore the best policy. It was precisely this kind of logic that, in February 1992 lead Lawrence Summers, then chief economist

and vice president of the World Bank, to suggest hazardous waste be exported to developing nations',

> I think the *economic logic* behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that…I've always though that under-populated countries in Africa are vastly under-polluted, their air quality is probably vastly inefficiently low compared to Los Angeles or Mexico City.
> (cited in Marbury, 1995:143)

Summers reached this conclusion using a cost-benefit analysis that valued human life based on future earning potential. Similar logic also prompted him to suggest in the same memo that an African would be better off dying at age 50 from cancer than at age 2 from starvation or disease (for the full text of the memo see http://www.globalpolicy.org/socecon/envronmt/summers.htm). On one level he is correct: most people, if forced, would chose 50 years of life and the possibility of cancer over 2 years of life and the certainty of starvation. Other less controversial measures used in welfare economics include willingness to pay and willingness to accept in order to measure people's preferences. In short, welfare and utility are reduced to monetary functions that require maximization. Objections to this practise of reducing everything to monetary equivalents are not new. In his seminal work, *Small is Beautiful,* E.F Schumacher wrote:

> In the market place, for practical reasons, innumerable qualitative distinctions which are of vital importance for man and society are suppressed; they are not allowed to surface. Thus, the reign of quantity celebrates its greatest triumphs in 'the market'. Everything is equated with everything else. To equate things means to give them a price and thus to make them exchangeable. To the extent that economic thinking is based on the market, it takes the sacredness out of life, because there can be nothing sacred in something that has a price.
> (Schumacher, 1972: 41)

These thoughts echo the objections of the Prime Minister of Tuvalu quoted earlier— some things are beyond price. The utilitarian might argue it is unreasonable to ask the developed world to spend billions of dollars on mitigation efforts simply to protect the homeland of a few million people, (although the risks posed by climate change are far greater). Put another way, if the impacts of climate change were relatively small, then global welfare would be maximized by focusing on adaptation measures and providing financial compensation for people directly threatened by rising sea levels, and other costs related to climate change.

The argument typically used against this line of reasoning relies on notions of duties and responsibilities. The deontological view, based on the Aristotelian notion of responsibility and the writings of Immanuel Kant, maintains the central concept of ethics revolves around questions of duties and rights. The most important element of this school of thought is what

Kant called the 'categorical imperative' which among other things requires "we treat people as *ends* and never simply as *means,* or as *subjects,* and never simply as *objects*" *(*Des Jardins, 1997). In contrast to the utilitarian tradition, this philosophy is concerned with procedural equity rather than consequential equity. Kant also argued justice requires that we respect the rights of others at all times and under all conditions (hence the term categorical). In Western societies, this principle is often enshrined in constitutional law. So, for example, in Canada people accused of committing crimes have the right to legal counsel paid for by the public. In practise, then, rights often trump utilitarian considerations. Presumably, most would agree this is a good thing; otherwise, it is conceivable, for example, that the elderly, the mentally disabled, and the infirm would be denied care, since providing medical services for them could be construed as an *inefficient* expenditure of resources, given they do not earn wages or produce goods for the economy.

More recent criticisms of economic prescriptions based solely on utilitarian doctrine have been leveled by Rawls, who felt,

> A theory, however elegant and economical, must be rejected or revised if it is untrue; likewise laws and institutions no matter how efficient and well arranged must be reformed or abolished if they are unjust.
>
> (Rawls, 1971:3)

Like Kant, Rawls' conception of justice revolves around duties and responsibilities to others. His famous thought experiment of a just society, where individuals sit behind a 'veil of ignorance' and set about creating laws and institutions for a future society, rests upon the principle of reciprocity, articulated in Christian tradition in the maxim "do unto others as you would have them do to you". The veil of ignorance is important because each individual in the 'original position' does not know where they will end up in the society—they are ignorant of their physical endowments, their class position and their social status (Rawls, 1971). Here pure procedural equity is thought to lead to a just society, and so a social contract is formed. For this reason this school of thought is often referred to as contractualism. The other important aspect of this school of thought is that it is essentially egalitarian in nature. This is embodied in what is known as the 'maxi-min principle', which stipulates a just society is one that minimizes the hardships of the least well off.

More than thirty years have passed since Rawls first presented his ideas. During that time many academics, ethicists, and political theorists have sought to cosmopolitanize his ideas by extending the veil of ignorance temporally as well as spatially. Whereas Rawls originally intended the veil and original position to apply to the scale of a nation in a particular time period, others have since argued for a truly just society the individual in the original position must also

be ignorant of *when* and *where* they are born (Weiss, 1993). This is particularly relevant to the problem of climate change, which is both global and intergenerational in its implications.

Three other ethical principles are worth noting in relation to climate change equity. The principle of proportionality, originally articulated by Aristotle, rests on the belief that "what is just is what is proportional, and what is unjust is what violates the proportion" (Muller, 2001). When this principle is combined with the notion of responsibility, the result in the context of environmental policy is commonly known as the "polluter-pays-principle", which will be discussed in greater detail later. The second principle is the parity principle, which in the case of emission rights suggests, "each inhabitant of the earth has the right to an equal use of the atmosphere" (Young, 1993). Finally, there is the priority principle, which in legal circles is also known as 'squatter's rights' and is the guiding principle in patent law. The priority principle suggests that the first to use or develop a resource is entitled to using it by virtue of being the first one to do so. In the context of climate change, this principle contends developed nations have earned the right to emit at higher than per capita allowances because they were the first to have historically high emission levels.

The preceding discussion was not meant to argue one theory as ethically superior to the others, but rather to illustrate the multiple, often diametrically opposed notions of what is equitable, and that in practise we use a combination of all of them in policy deliberations. The last fifty years, though, has seen a steady rise in the prominence of utilitarian approaches to environmental problems. Rayner et al. (1999) suggest utilitarianism lends itself well to the descriptive approach of the natural sciences, where high levels of aggregation and large-scale global analyses are possible. This in turn makes the utilitarian approach particularly attractive to the issue of climate change, which is clearly global in scale. However, the authors feel while this may be useful for issues of diagnosis, it may not be an appropriate method for prescription.

In contrast to the descriptive approach is the interpretive approach, which "tends to produce local level analyses, [where] local-level decisions tend to be more susceptible to equity considerations than global debates in which efficiency predominates" (Elster, 1992, cited in Toth et al., 1999:13). When evaluating differing views of fairness, it is therefore also important to recognize that questions of scale will influences which view will predominate. While acknowledging the importance of local level analysis, the following section focuses on a global level analysis of equity issues raised by the problem of climate change.

One final point is worth making before examining the specific equity issues of climate change. Thus far all of the principles of equity discussed have been framed in an anthropocentric manner. As a result, other ethical systems that encompass non-human beings,

such as biocentrism, or zoocentrism, have been neglected. Moreover, alternative applications of utilitarianism (see for example, Peter Singer's *Animal Liberation)* have been omitted. While these omissions are intentional, they are not indicative of a disdain for these theories. There are two reasons why these theories have been avoided. Firstly, the vast majority of literature dealing with the ethical implications of climate change has relied on an anthropocentric perspective, and so for the sake of consistency this analysis will do the same. Secondly, the concerns for non-human beings is in many ways equivalent to concern for future generations, to the extent that neither group is able to voice their preferences or influence policy outcomes.

Mitigation, Adaptation, and Intergenerational Equity

Henry Shue (1994) suggests there are three aspects of fairness vis-à-vis climate change: what is a fair cost allocation to prevent further global warming; what is a fair cost allocation to cope with the social consequences of the global warming that will not, in fact, be avoided; and; what is a fair allocation of greenhouse gases emissions over the long term and during the transition to long-term allocation? To date most of the debate has focused on the first and last aspects Shue identifies. All of these questions focus on issues of intragenerational equity, and leave the question of intergenerational equity aside – a significant omission. Others have offered alternative sets of questions addressing this omission and include questions about posterity. Helm lists five aspects of equity in climate change ethics: international equity in coping with the impacts of climate change and associated risks; international equity in efforts to limit climate change; equity and social considerations within countries; equity in international processes; and, equity among generations (Helm, 1999).

Thomas C. Schelling (2000) presents a provocative argument on how much effort should be spent by the international community to limit climate change. He contends instead of directing resources towards mitigation efforts, the West should use those resources to help developing countries industrialize, thereby improving their ability to adapt to climate change in the future. The logic behind this proposal seems sound: developing countries will disproportionately benefit from climate change mitigation – they are far more vulnerable to its impacts – and so given the choice they should choose immediate aid to tackle the more pressing issues of poverty, health, and so on, over aid which would only benefit their descendents. Schelling states: "[if] we, the developed, elect carbon abatement for their benefit, it is we who choose their descendents over themselves" (Schelling, 2000:837).

This is a dubious argument, however, for a number of reasons. Firstly, Schelling mistakenly constructs an either/or situation where developing countries have to choose between aid in the present or aid in the future. Developing countries would likely ask for financial aid now

to deal with poverty, *and* financial aid in the future to deal with climate change. There is historical precedent for this position. The Montreal Protocol, widely praised for its fairness and effectiveness, incorporated the principle of additionality, stipulating that developing countries would get *additional* funding for phasing out CFC's over and above what they normally received in the form of development assistance (Litfin, 1994). Linnerooth-Bayer also notes this argument rests on a number of important 'ifs':

> If natural and man-made capital are substitutable and climate change adaptation is possible without large social costs, for example from catastrophic consequences, and if a stable climate does not have value divorced from its impacts on human beings, and if we accept intergenerational consumer sovereignty.
>
> (Cited in Toth, 1999:48)

The problems of substitutability and the possibility of catastrophic consequences have led some authors to argue cost-benefit analyses not adjusted for risk aversion, i.e. those that assume risk neutrality underestimate the benefits of mitigation and the costs of adaptation (Hammitt and Harvey, 2000).

Procedural Equity and Consent

Implicit in this assumption is the notion that risks are only equitable when consent has been given, which is one aspect of procedural equity. Indeed, there is a whole set of ethical considerations that arise when the problem is framed in terms of risk and consent. Table 2 illustrates how different ethical positions treat the issue of consent vis-à-vis risk.

Table 2: Valid consent as framed by three ethical positions

	Market-Utilitarian	Rawlsian	Kantian
Consent	Revealed	Hypothetical	Explicit

Source: Rayner et al., 1999

The market-utilitarian approach assumes the market accurately reveals people's preferences. For example: there are three models of cars, and the only difference is the amount of safety built into them; if a consumer picks the mid-priced car, then the consumer is deemed to have consented to the additional risk that results from not purchasing the costliest car (Rayner et al., 1999). According to this logic the observed increase in sales of low mileage automobiles, such as sports utility vehicles (SUVs), would indicate people are willing to accept the risks associated with increased carbon dioxide emissions. However, it is more likely people are buying SUVs because they are perceived to be safer or they are simply in fashion; the

choice is thus made regardless of the risks to the global climate. So, while the market-utilitarian assumptions about revealed preferences may be valid for some situations, such as cars, it does not necessarily hold for risks associated with climate change, which are distributed temporally and geographically. Another problematic aspect of this approach is it assumes people have money to spend on safer alternatives—in many developing countries many people don't have money to buy any food or water, let alone safe food or safe water.

The Rawlsian, or contractarian, approach assumes the citizen has given hypothetical consent, to the extent that they accept the will of the decision-making institutions of their society. This approach is clearly only valid in democratic societies, and so is of limited use globally. Moreover, governments typically get elected on platforms that include a series of policy issues ranging from health care, education, the environment, and so on. Furthermore, a minority of the population elects many governments, including Canada's. Thus, it is certainly plausible citizens have not necessarily consented to their government's positions on climate change. Indeed, most research suggests people in Western democracies are particularly dissatisfied with their government's policies on climate change (see for example, Byrne et al., 1999).

The Kantian approach holds that, in order to be ethical, consent must always be explicit with respect to the imposition of risks. This presents a problem when future generations are considered, since it is obviously impossible to obtain consent from them. Consequently, the egalitarian approach to consent is the most risk averse of the three approaches, and so would likely favour aggressive mitigation strategies over strategies that relied on adaptation to climate change.

A controversial aspect of conventional cost-benefit analyses of environmental risks, such as climate change, which significantly affects one's perception of the costs and benefits of mitigation versus adaptation, is the choice of discount rate. High discount rates emphasize costs in the short-term and minimize costs and benefits in the long-term. Whereas the discount rate used in the private market typically varies between five and ten percent, many environmentalists argue that for problems such as climate change, where the time horizons involved are measured in decades and centuries, the use of high discount rates is inappropriate. Some even propose a zero or negative rate (see for example Cline, 1992). Nevertheless, high discount rates can be justified if one assumes corresponding benefits from capital accumulation and technological development result in greater adaptive capacity. Those who adopt a Rawlsian or Kantian perspective favour low or negative discount rates, whereas market-utilitarians favour a higher rate in line with contemporary market rates. In short, the former view

espouses a strong form of intergenerational responsibility, whereas the latter view is representative of a weak view of intergenerational equity.

The case for adaptation over mitigation is also undercut by Weiss's 'conservation of options' criterion, which requires the diversity of the natural and cultural resource base is maintained (Weiss, 1989). The ethical importance of maintaining cultural diversity is not often discussed in relation to climate change, and yet the impacts of climate change clearly threatens the very survival of several cultures around the world including, but not restricted to, the low-lying small island states. For these countries, which have formed an alliance (AOSIS) to lobby the rest of the world to adopt aggressive mitigation policies, climate change is viewed as a direct attack on their sovereignty,

> We submit, respectfully, that the willful destruction of entire countries and cultures with foreknowledge would represent an unspeakable crime against humanity. No nation has the right to place its own misconstrued national interest before the physical and cultural survival of whole countries. The crime is cultural genocide. It must not be tolerated by the family of nations. The crime is no less when it is perpetuated slowly by the emission of invisible gases.
>
> -excerpt from a speech by Kinza Clodumar, President of the Republic of Nauru at COP 3 in Kyoto, Japan, 1997

Equity, Sovereignty, and the Principle of Common but Differentiated Responsibilities

Principle 21 of the Stockholm declaration on the Human Environment places a limit on the sovereignty of nations: "States have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States" (Stockholm Declaration, 1972). While there are some precedents in international law that deal with transboundary pollution, at present it is highly unlikely a case could successfully be made for compensation for damages incurred from climate change. There are a number of reasons for this. Firstly, whom would the injured party file suit against – some industrialized nations, all industrialized nations, or simply one nation, such as the United States? Defendants would probably raise issues of "remote and speculative causality, contributory negligence and reciprocal wrongdoing" (Stone, 1992:467). The issue of contributory negligence becomes particularly murky and controversial when one considers questionable land use policies (deforestation, encouraging settlements in vulnerable areas, etc.) exacerbate natural disasters and are often the result of short-term pressures, such as overpopulation, as well as external pressures such as structural adjustment programs.

In many respects the issue of intergenerational equity has assumed a secondary role to these intragenerational questions, where the dominant themes are historical accountability and burden sharing. However, questions of liability and responsibility still remain; namely, who should pay for dealing with the consequences of climate change, on what basis, how much, and to whom? One could argue these are simply technical/legal questions to be resolved by trade and legal experts. Nevertheless, the ethical criterion one adopts will greatly influence the answers to these questions. Put another way, there is no 'objective' criterion one can use to answer these questions, much in the same way there is no objective method of selecting an appropriate discount rate, although some positions are more persuasive than others.

Two distinct but related issues arise. First is the question of mitigation. Article 3 of the United Nations Framework Convention on Climate Change (UNFCCC) states explicitly that developed countries should take the lead in mitigation efforts, and equity considerations should be respected,

> The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof.

Implicit in the phrase 'common but differentiated responsibility' is the notion that developed countries bare the brunt of the responsibility for anthropogenic emissions of greenhouse gases, and should therefore lead mitigation efforts. This is consistent with the Aristotelian principle of proportionality, and the "polluter-pays-principle" adopted by the OECD in 1972 at the Stockholm Conference on the Human Environment.

The second related issue to consider is ability to pay, as most developing countries argue they do not have additional financial resources to devote to mitigation strategies. Here, Schelling's argument is applicable; given the choice between feeding the hungry or curing the sick now and helping their descendants in the future, they would likely choose the former.

Unfortunately, the single largest polluter, the United States, has withdrawn from the Kyoto Protocol process, arguing that developing countries should do more to curb their own emissions, and that meeting the commitments set out in the protocol would hurt the American economy. Gupta (1999) notes this represents an evolution of the underlying paradigm of the climate change regime towards one of conditional leadership, where, unfortunately, the conditions for leadership are continually changing. The position of the U.S. government clearly contradicts the spirit of Article 3 of the UNFCCC. While this evolution may be understandable from a realist perspective given the vagaries of election politics in the United States, it is

nevertheless difficult to defend from an equity perspective; it not only places the immediate needs of Americans ahead of the needs of other citizens around the world, it violates the principles of intragenerational equity and international law, such as Principle 21 of the Stockholm Declaration.

Equity, Allocation of Emission Rights, and Historical Accountability

Setting aside the question of leadership, it is important to recognize that at some point developing countries must subject themselves to some kind of treaty that limits their emissions, in line with the Kyoto Protocol. And this raises perhaps the most contentious aspect of the climate change debate: how will emission rights be distributed globally?

Two extremes views are often expressed. There are those who advocate 'grandfathering' of emission rights. This priority principle approach forms the basis of the Kyoto Protocol. Under this approach Annex B countries (most western nations) are required to reduce their emissions by an average of six percent from 1990 levels by the 2008-2012 period. While this approach was adopted for the sake of political expediency, as it is unlikely that more significant emission reductions would be accepted domestically, it is not clear developing countries would accept this "grandfathering" approach since most of them are *increasing* their emissions as a result of population growth and industrialization. Instead, they believe emission rights should be distributed on a per capita basis, an approach consistent with the parity principle. This, they argue, is the only equitable distribution principle, since it gives all inhabitants of the earth equal access to the atmosphere.

Two other allocation principles are also worth mentioning. The horizontal principle dictates that nations with similar economic circumstances should have similar emission rights and burden-sharing responsibilities (Aaheim, 1999). This view represents the middle ground between priority and parity principles. In contrast, the vertical principle, which seeks to minimize inequalities between individuals and groups, is far more egalitarian in its objectives. Table 3 illustrates how these different allocation principles apply to different burden sharing rules.

Table 3: Selected equity principles and examples of related burden-sharing rules

Equity Principle	Interpretation	Burden-Sharing Rule
Polluter Pays	All should pay the same amount for each unit of emission	Uniform Charge
Priority	The present emission level constitutes the basis on which	Flat reductions

	reductions should be distributed	
Egalitarian (Parity)	All have the same right to use atmospheric resources, and the same responsibility to preserve them.	Reductions proportional to emissions per capita
Horizontal	All have the same rights to emit the same amount of greenhouse gases to achieve the same level of welfare	Reductions proportional to emission per GDP
Vertical	Income should be equally distributed among all people	Reductions proportional to GDP per capita

Source: Aaheim, 1999.

There have been a number of criticisms leveled at advocates of the parity principle. Some argue it is hypocritical of developing countries to be advocating distribution of emission rights on the basis of parity, since it is hardly the operational principle domestically, where large inequalities among the population exist. As Rayner et al. (1999) note, "it seems that vast numbers close to destitution rescue the middle classes…the so-called survival emissions of poorer countries may, *in practise*, translate into the luxury emissions of their elites" (p22, emphasis added). However, in many cases the policies of Western governments, whether through colonialism or the IMF and the World Bank, are themselves partially responsible for the inequalities in the developing world. It is legitimate to ask whether the benefits would *in practise* be distributed according to the parity principle; indeed, similar doubts plague the administration of foreign aid in general. The focus of this discussion, however, is limited to how different ethical positions compare theoretically, rather than practically. Another objection commonly leveled against the use of the parity principle is per capita allocation would encourage population growth. Grubb (1995) notes, however, there are many ways of avoiding this outcome; for example, allocation could be based on the population above a certain age.

Finally, there is the realist, pragmatic objection, which argues a per capita allocation scheme would entail enormous transfers of wealth from the developed world to the developing world, and therefore such an approach would never be politically feasible. While this may be true, it does not invalidate the ethical claim of per capita allocation. Alternatively, a "right principle is not refuted by the mere fact of not currently being politically feasible" (Neumayer, 2000:190). Other authors have attempted to reconcile equity concerns with political realities by

suggesting an allocation scheme that begins with the priority principle, but over time progresses towards a per capita allocation (see, for example Cline, 1993).

Claims for parity and against priority allocation of emission rights are also supported by the concept of historical accountability, or natural debt. Historically, developed countries used more of the atmospheric resources than a per capita allocation would dictate, and more importantly, they benefited from this excess emission, and so should now be held accountable for the negative side effects that occur as a result. There are three common replies to this charge of natural debt: 1) past generations were ignorant of the harm of excessive emissions of greenhouse gases; 2) the benefits of those excess emissions have spread beyond the original polluter; and, 3) from a practical perspective it is extremely difficult to measure historic contributions. The first objection is unpersuasive to the extent that ignorance is not a viable defense in criminal and civil law. The second objection fails because it does not show how other nations have benefited directly from the emissions of the industrialized countries. On the contrary, research exists suggesting overwhelmingly that the polluter benefits, as would be expected. Janssen et al. (1992), for example, found the relative regional contribution of carbon dioxide concentration explains two thirds of the variations in GNP per capita in 1990.

The third objection to natural debt is correct in its premise—there are a number of technical problems associated with determining natural debt. For example, how are natural reabsorption rates factored in, what gases are included, and how far back does one go to measure natural debt? These difficulties are not insurmountable, and could likely be overcome through political compromise. The point to be made is that an *exact* measurement of natural debt is not needed to incorporate it into the argument that the parity principle is ethically superior to the priority principle.

Neumayer (2000) notes it is not currently in the interests of the developed world to accept the basic validity of equal per capital allocation, and developing countries do not have the bargaining power to enforce it. This begs the question: Do ethical considerations matter in the climate change debate? Some authors, such as Victor (1999) argue they do not. He contends equity considerations actually explain very little in international policy deliberations, and self-interest overwhelmingly decides which policies nations support (169). Others echo these sentiments. Young (1993), for example, suggests “equity is merely a word hypocritical people use to cloak self-interest, and is so hopelessly subjective that it cannot be analyzed scientifically” (quoted in Toth, 1999:81). On a certain level these accusations are correct. Nearly every nation has defended its policy as the equitable one, whether it is a low-lying island state, or an oil exporter.

Yet some arguments are more persuasive than others. Rawls principle of reciprocity and Kant's categorical imperative are deeply ingrained in the belief systems of Western democracies. There seems to be, on the surface, a contradiction: there is one set of principles of justice people apply to themselves domestically, and a different set they apply to international relations. In reality the situation is more complicated, as the conclusion of the paper will demonstrate.

Conclusion

Most polls in western democracies indicate voter dissatisfaction with their government's policies on climate change. A 1997 poll commissioned by the *New York Times*, for example, found that 65percent of respondents recognized that the United States was the largest GHG emitter and, therefore, should take significant action first to cut its own emissions *regardless* of what other countries would agree to do (Byrne and Yun, 1999:494). A similar poll done around the same in Japan found that 82percent of the respondents agreed that the government was too conservative in its approach to global environmental problems, including climate change (Byrne and Yun, 1999:494). Similarly, a more recent poll commissioned by Greenpeace found that 78percent of Canadians felt the federal government should ratify the Kyoto Protocol (*Globe and Mail,* August 19, 2002). Moreover, citizens in western democracies seem willing to forego some economic growth in order to mitigate climate change.

These findings raise two very important questions. First, why haven't governments responded to the wishes of their citizens and implemented aggressive measures to mitigate climate change? Second, given their concerns about climate change, why haven't citizens in these countries changed their consumption patterns, which are directly responsible for the emissions responsible for climate change? In other words, why is there such a large implementation gap when it comes to mitigating climate change?

While a full answer to the second question is beyond the scope of this paper, a general observation can be made—people can only buy what is offered. If, for example, the most attractive financing arrangements and the bulk of advertising budgets are reserved for oversized and inefficient automobiles—then one shouldn't be entirely surprised that people aren't driving compact, electric powered vehicles. Similarly, if cities are built to encourage auto dependency and public transit is chronically under funded, then it seems obvious people will drive more and take the bus less often.

Byrne and Yun (1999) argue the answer to the first question becomes clear if one accepts that corporate power is greater than civic power in liberal democracies, and that the power of civil society is largely confined to expressions of protest and "refusals to consume in the precise quantities that the system requires" (Mumford, 1964, quoted in Byrne and Young, 1999:498). Indeed, one of the criticisms of the anti-globalization movement—which incorporates many of the concerns of environmentalism—is that it is politically powerless relative to corporate interests. One of the practical implications of this is that corporate interests often subsume the goals of environmental sustainability, such that policies are judged almost

exclusively in terms of their impact on economic growth, rather than their impact on natural systems.

In the context of climate change this bias is evident to the extent that the majority of acceptable policy options are framed in terms of free market solutions, where the atmosphere becomes a commodity to be bought and sold in the marketplace. Glover (1999) argues the potential commodification of the atmosphere is one of the most important features of climate change discourses, noting, "as commodities come, you can't get much bigger than the sky" (Glover, 1999:501). From this perspective the debate is framed in terms of economic rationalism, i.e. using the price mechanism to regulate the use of the atmosphere, and administrative rationalism, which relies on pollution control agencies, expert advisors, and resource management bureaucracies. According to this approach, climate change is a problem caused primarily by institutional failure, where success is judged primarily in terms of the robustness of the institutional regulatory regime, i.e. development of carbon trading markets, enforcement of agreements, etc., rather than on the success in mitigating climate change,

> The issue of effectiveness of the FCCC to satisfy its own goals has become an issue of efficacy and likelihood of global cooperation by the world's sovereign states…From the perspective of the global economy, such global environmental management may be deemed effective if there is successful marketization of the atmospheric environmental resources. Thus, the FCCC's stated objective of preventing 'dangerous interference" has been supplanted by the goals of building an effective form of global managerialism.
>
> (Glover, 1999: 506)

Indeed, when governments seem to have so much difficulty agreeing on reducing emissions by six percent, and it is understood by everyone that cuts on the order of sixty to eighty percent are required to stabilize atmospheric concentrations, it is not difficult to see why so many people feel a sense of despair when contemplating humanity's prospects of preventing 'dangerous interference' with the climate. Nevertheless, it could be argued that any progress—however small—is preferable to none at all. Moreover, it seems reasonable to expect that during the initial stages of the regime formation more attention will be given to procedural questions, and that greater weight will be given to the substantive questions regarding effectiveness in the future.

Adger et al. (2001) agree global environmental management (GEM) perspectives dominate climate change discourses, but suggest another discourse based on profligacy is also influential. The profligacy discourse, often advanced by NGO's and developing countries, stresses the role overconsumption in industrialized countries has played in creating the problem of climate change, and emphasizes the moral obligation these countries have to address the

problem. Like the GEM discourse, the profligacy discourse draws on the authority of science to advance its objectives, although the two differ in the aspects of the science that are emphasized. Where the GEM discourse focuses on the technical difficulties of estimating the costs of adaptation and mitigation, the profligacy discourse highlights the agreement that exists within the IPCC concerning the potentially irreversible and catastrophic consequences of climate change.

An important shortcoming of the GEM and profligacy discourses is that they are global, rather than local, in their analyses. Consequently, they "do not inform, nor are they informed by the social processes of adaptation" (Adger et al., 2001: 699). At the same time it is important to realize that these discourses are not static. Thus, as the debate evolves from theoretical questions of scientific and economic predictions to more practical questions of implementation and adaptation at the national, regional, and local level, it is likely the global emphasis of the current discourse will wane.

Certainly, the same criticism could be leveled against the approach used throughout this paper, which has avoided questions of scale. The preceding discussion was meant to show some of the alternative ways of examining climate change discourses other than the approach used throughout this paper. However, it is important to realize that one of the objectives of the paper has been to highlight some of the important aspects of climate change that are prominent *irrespective* of scale. For example, decision makers at all levels of government will have to decide how respond to the uncertainty inherent in the scientific and economic predictions associated with climate change. Furthermore, issues of fairness, burden sharing, and intergenerational equity will inevitably surface when decision makers attempt to reconcile the interests of different regions within countries, and in various sectors of the economy.

This paper has also problematized the role scientific and expert analysis play in climate change discourses. By highlighting some of the enduring technical difficulties, the numerous methodological assumptions, and the ethical implications involved, it has challenged the notion that science and rationality can be used to produce definitive, objective analyses about the potential ecological and economic impacts of climate change.

One shouldn't infer from this that all rational analyses of complex problems, such as climate change, should be rejected outright. To do so would take the critique further than it is intended, creating a situation where it becomes impossible to evaluate competing policy options. The position articulated throughout this paper is more moderate. Specifically, rationality cannot by *itself* "solve" complex environmental problems like climate change in part

because of technical limitations, but more importantly because any solution will necessarily involve a variety of ethical considerations.

Indeed, one of the central aims of the paper has been to show the interconnectedness of the four aspects of the climate change issue, in particular, and environmental problems in general. So, for example, one cannot talk about the evolving science of climate change without also considering the political environment within which it is being deployed. Similarly, one cannot discuss the economic implications of climate change without also considering the numerous ethical considerations that inevitably influence any such analysis of the problem.

The practical implication of this is that any effective, and *appropriate* solutions require the engagement of civil society, whether through town hall meetings, referendums, elections, or consultations with grass-root organizations, for example. Recalling Beck's observation that rationality without social engagement remains blind, it follows that the inclusion of civil society will lead to a clearer vision of how society aught to deal with the challenges that climate change presents.

This paper has attempted to show that climate change is an enormously complex problem where science, economics, politics, and ethics converge to produce a seemingly intractable problem. On a more fundamental level the problem of climate change challenges the notion that the environment within which we live is infinitely resilient, and can be abused without consequence. From this perspective, climate change can be seen in terms of the larger debate of environmental sustainability, where it is a symptom of a much larger problem, characterized by overconsumption, overpopulation, and global inequality.

As a truly global problem with long lasting and potentially catastrophic consequences, climate change forces us to examine the ways in which we relate to one another and our environment in both time and space. If, as suggested earlier, climate change is the Gordian knot of environmental problems, then one thing at least seems certain—it will take more than the swing of a sword to solve it.

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