




Improving The Effectiveness Of The Climate Change Convention

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Acronyms

APAR: Absorbed Photosynthetically Active Radiation

AVHRR: Advanced Very High Resolution Radiometer

AVIRIS: Airborne Visible/Infrared Imaging Spectrometer

BRDF: Bidirectional Reflectance Distribution Function

BRF: Bidirectional Reflectance Factor

BATS: Biosphere Atmosphere Transfer Scheme

DAAC:Distributed Active Archive Center

EDC: EROS Data Center

EROS: Earth Resource Observation Satellite

FASIR: Fourier-adjusted, solar zenith angle corrected, interpolation and reconstruction

FIFE: First ISLSCP Field Experiment

GCM: General Circulation Model

GIS: Geographic Information System

HTF: Humid Tropical Forest

ISLSCP: International Satellite Land Surface Climatology Project

LAD: Leaf Angle Distribution

LAI: Leaf Area Index

Landsat: Land Remote Sensing Satellite

Lidar: Light Detection and Ranging

MODIS: Moderate-Resolution Imaging Spectrometer

MSS: Multi-Spectral Scanner

NDVI: Normalized Difference Vegetation Index

NIR: Near Infrared

PAR: Photosynthetically Active Radiation

SAIL: Scattering by Arbitrarily Inclined Leaves

SAR: Synthetic Aperture Radar

SiB: Simple Biosphere model

SPOT: System Pour l'Observation de la Terre

TM: Thematic Mapper

Improving the Effectiveness of the Climate Regime Session Two Summary

David G. Victor, Abram Chayes, and Eugene Skolnikoff

Abstract

This report reflects the deliberations of an expert group that considered ways to improve the long term effectiveness of the global warming regime. Issues covered range from the transfer of financial resources to the management of non-compliance, negotiation of additional commitments, the participation of developing countries, and ways to improve systems that provide scientific advice. It develops several dozen specific recommendations for policy and research.

Five major issues highlighted in this report deserve special attention.

First, the existing state of knowledge is systematically incomplete in the area of non-market impacts, impacts of all types in developing countries, and potential catastrophes. Policymakers should be aware of these limitations, which probably understate the overall potential consequences of global warming. Further, in many countries political attention to global warming is driven by fear of potential catastrophes and surprises lurking in the climate system. Useful information is needed on the real probabilities and possible consequences of major potential catastrophes. We suggest a method and six case studies that can provide a first crucial analysis.

Second, the international system for negotiating and implementing commitments should be seen as an ongoing process of bargaining. If that process is to be well-informed, and if agreements reached are to be connected to what is actually implemented, the process must be served by mechanisms for exchanging and reviewing information about implementation and handling problems of non -compliance. Most multilateral environmental agreements do not benefit from such mechanisms and are thus less effective than they could be. In the spirit of improving the effectiveness of the Climate Convention, it is essential that policymakers give continued attention to building the system of national "communications" and regular reviews that now exist in nascent form in the Convention.

Third, participation of developing countries is essential to the long term effectiveness of the regime if global emissions are controlled stringently. But the interests of developing countries are different from those of the developed nations that have put the global warming issue on the agenda. Principals are identified to guide efforts to include developing countries in the regime. Because the policy priorities are different, although the developing countries are more vulnerable to climate change the developed world will still need to increase climate-related resource transfers by several orders of magnitude if they want to control global emissions

The existing state of knowledge is systematically incomplete in the area of non-market impacts, impacts of all types in developing countries, and potential catastrophes. Policymakers should be aware of these limitations, which probably understate the overall potential consequences of global warming.

stringently over the long term. Further, it is likely that there will be a need for a practical system that makes a finer distinction among developing countries as efforts are made to tar get control measures and distribute the currently small resources to the countries where they are most needed and effective.

Fourth, there is a massive increase under way in the participation and influence of non-state actors in making and implementing climate -related policies. Devices are explored to expand non-state influence further, but there are many problems that are already evident in the democratic societies that have opened themselves to non-state influence in the making of domestic environmental policy. Researchers need to conduct more comparative case studies of different styles of participation and influence in order to develop some governing principles. In the interim, policy makers should experiment with some different systems that allow more extensive participation and influence by non-state actors. Some of the problems can be managed - for example, the fear that NGOs are not accountable because they don't have responsibilities could be addressed by requiring NGOs to compile reports and submit them in parallel with the government reports, perhaps when the next round of reports under the Climate Convention are due in 1997.

Fifth, virtually every aspect of climate science is marked by uncertainty and the need for scientists to make subjective assessments of probability and consequences. Improvement in the communication of such assessments is badly needed - without it, policymakers have little feel for the range of possible outcomes and how they compare with other risks that society spends scarce resources to manage.

In addition to these five major issues, the AGCI group proposes some detailed changes to policy and research on the basis of its evaluation of the long term needs of the climate regime and analysis of the factors that have made other areas of international cooperation effective. These include, for example, actions needed to identify technologies for verification of future climate commitments. And they include ways to improve existing systems for transferring resources and strategies for keeping the geo-engineering option viable in case it is needed in a crisis.

Introduction

Two dozen experts met over two weeks in August 1995 at the Aspen Global Change Institute (AGCI). They considered ways to improve the effectiveness of the international agreements and institutions designed to manage the causes and consequences of global warming. The group included scholars and practitioners from industrialized and developing countries and trained in international law, political science, physics and economics. Following the long term, cumulative nature of the global warming issue, the group took a long term perspective on the climate regime. They sought to identify what can be done now with policy and research to manage climate change effectively over the next several decades.

This essay reflects the eight major themes and conclusions from the AGCI discussions:

1. incentives to act on global warming, and how research has systematically avoided what may be the most important effects of global warming

2. some special problems associated with research on potential climatic catastrophes, which are poorly understood yet the main concern driving the politics of slowing global warming

Industrialized countries are relatively invulnerable to market impacts from global warming, yet they are the countries that (currently) have the highest emissions and are being urged to take the lead by implementing perhaps costly measures to control emissions.

3. some functions that the global warming regime might perform but is not currently on track to fulfill adequately including financial transfers, technology planning and transfers, insurance schemes, and management of geo-engineering

4. relevant lessons learned about other international environmental regimes, primarily those on controlling depletion of the ozone layer and limiting acid rain in Europe

5. future climate commitments and the management of implementation and compliance

6. the factors that affect participation of developing countries in the climate regime

7. ways to improve participation and influence of non-state actors in the making and implementation of policy

8. the roles of expert advice and assessment

This account is not comprehensive on all matters related to the effectiveness of the climate regime. Rather, it follows the group's deliberations and focuses on those aspects of the problem that have tended to be neglected elsewhere. In each theme, specific conclusions for policy and research needs are identified.

The countries being urged to control their emissions don't have much rational incentive to do so. The countries most at risk have higher priorities than global warming.

1 Incentives to act on global warming
(For more see Nordhaus, Schelling, Schneider, and Somerville.)

The essence of the global warming problem is that emitters of greenhouse gases are forcing the complex natural climate system. The global, regional and local consequences of this forcing are unpredictable. Research can and has made a major contribution to under standing some of the possible and likely outcomes.

Policy on global warming is fundamentally driven by concern about the impacts of changing climates; thus the focus here is on the results of impacts research, leaving aside the costs and benefits of mitigating emissions of greenhouse gases that lead to global warming, which have been reviewed extensively by many others. The impacts fall into three categories: gradual and roughly predictable impacts on marketable goods and services, gradually and roughly predictable impacts on non-market goods and services, and potential catastrophes. The categories reflect how interdisciplinary research is done to measure the impacts. Figure i.1 shows these three categories and assesses the state of knowledge in each for "developed" and "developing" countries.

Two observations are striking. First, current research is focused almost exclusively on the impacts on marketable goods and services. The results of such research suggest that relatively little money will or should be spent to slow global warming. Industrialized countries are relatively invulnerable to market impacts from global warming, yet they are the countries that (currently) have the highest emissions and are being urged to take the lead by implementing perhaps costly measures to control emissions. In contrast, the impacts on developing countries are probably much higher, but those countries have other more pressing demands than to spend scarce resources on abating emissions of greenhouse gases. In other words, the countries being urged to control their emissions don't have much rational incentive to do so. The countries most at risk have higher priorities than global warming.

(Of course, there is an important ethical and legal argument against developed countries transmitting harm to developing countries without some form of compensation or effort to limit those harms. That issue is considered again in a later section on compensation and insurance schemes. Here, the focus is on the distribution of costs and benefits.)

The second observation is that there are sharp differences between what is known about climate impacts, what information is needed, and the forces driving policy. Quantified and monetized results of impacts research are systematically refined in the areas where the impacts of global warming are likely to be lowest: the gradual market impacts on the industrialized countries (cell 1 of figure i.1). This reflects the fact that doing research in all the other cells is extremely difficult. It is also the product of a research monoculture that is equipped only to answer that narrow set of market-oriented questions.

Some answers are needed in the other cells. The impacts on developing countries (cells 4 -6 of figure i.1) are crucial. Because resources are scarce in these countries, the decision to spend money on slowing and adapting to global warming requires much better information on the potential consequences. Presumably, the increasing awareness of the intrinsic value of nature will give growing weight to the non-market consequences of global warming in all countries (cells 2 and 5 of figure i.1). Yet there is little systematic knowledge about these potential consequences, just some illustrative examples such as the loss of biological diversity in marginal areas. Finally, the politics of global warming have and will be driven by the fear that a nasty surprise is lurking in the climate system (cells 3 and 6 of figure i.1). But researchers lack systematic knowledge about possible catastrophes and their consequences. At least one simple inventory now exists (see Elements of Change 1994, Part 2, Anticipating Global Change Surprises , Aspen Global Change Institute), but research has not attached probabilities and consequences to the possible events.

	Gradual and Roughly Predictable Impacts		Surprises & Catastrophies
	Market G & S	Non-Market G & S	
Developed Countries	1 -.5% to 1% of GDP	2 ?	3 ?
Developing Countries	4 2% or 3% of GDP?	5 ?	6 ?

Figure i.1
State of knowledge about climate change impacts

Later in this report these failings are considered in more depth, especially issues related to developing countries and potential catastrophes.

What should be done?

The observations here lead to several simple conclusions. For policy, it is essential that decisionmakers understand that current knowledge about potential impacts is improving but remains remarkably narrow. There are systematic differences in the accuracy and completeness of research results; they probably understate the consequences of global warming by emphasizing the market impacts of global warming in developed countries, which is likely to be small. Nobody knows how the understatement compares with what is known, in part because it is difficult to compare non-market and potential catastrophic consequences with gradual changes in marketable goods and services.

Scientists will be asked to make incomplete and subjective assessments because at least some information is better than none when making policy.

For research, the areas where knowledge is weakest are those where the need for information is greatest: in making policy choices in developing countries, in assessing whether the non-market consequences of global warming provide a substantially more compelling case to slow global warming, and in assessing the consequences of possible catastrophes.

For policy and research, it is essential that current efforts to integrate expert assessment continue and that much greater attention be given to the need to communicate judgments about potential impacts to the policy process, especially in the areas where current assessments are weakest but needed most. The missing areas of research all occur in areas where research is extremely difficult to do it is likely that such research will be in complete for the foreseeable future, and thus the policy community will long be in the position of needing information that is incomplete and thus surrounded by large margins of error. Scientists will be asked to make incomplete and subjective assessments because at least some information is better than none when making policy. How to gather and convey such assessments in a useful and accurate manner is discussed in the final section of this report.

2 Some observations on potential catastrophe

Catastrophe is an effective motivator. It is also a legitimate concern since possible catastrophes merit serious policy attention even when their probability is low and uncertain. Societies often spend a premium on avoiding catastrophic losses such as war and nuclear meltdowns. This issue is focused upon here because the other major gaps in impacts assessment identified in the last section are known, and some efforts are under way to fill them. In contrast, the research community has not gone far to identify and study empirically potential climate catastrophes. Yet in some countries, fear of catastrophe in the climate system may be the single most important factor driving the politics of global warming. That may be especially true in industrialized countries which are mostly not particularly vulnerable to gradual impacts. Fear of catastrophe may prove a strong motivator for these countries to implement costly measures to slow global warming. Over the long term it is essential to know whether these fears are warranted and how they compare with other policy priorities.

The way forward on catastrophe research is to conduct some detailed case studies on major potential catastrophes using a common method. Research in this field will always be unsatisfying because the list of completed case studies will always be shorter than all the conceivable catastrophic outcomes. But some studies will give a sense of the issues at stake and create a research community that is informed to make the subjective assessments about

catastrophic risks that are badly needed. An initial set of cases and a research method are proposed below. Each of the cases is paired with at least one historical analogue. None of the analogues is perfect, but all help illustrate the hypothetical case with real stakeholders, outcomes and responses.

Six cases are identified that span the range of major climatic catastrophes now discussed in policy and research circles. Two concern catastrophes in the classic sense - they are "tipping points" where a complex system rapidly shifts from one mode of operation to another:

* **Start-stop conveyor.** As proposed by Broecker and supported by some recent model runs, ocean circulation might have two or more stable forms. Climate warming may switch the oceans from one circulation to another; in particular, the "conveyor belt" that circulates heat across the North Atlantic to Europe might stop. Temperatures in Europe would drop substantially. Historical analogue: the little ice age in Europe.

* **Habitat fragmentation and collapse of biodiversity**. A small shift in climate (temperature, growing season, rainfall) can lead to dramatic changes if an ecosystem is already marginal. Currently, human activities have fragmented many habitats and stressed natural ecosystems that depend upon large uninterrupted zones within which migration can occur in response to natural variations in climate. If human-induced climate change is added to these existing stresses and marginal conditions, some habitats may collapse rather than migrate, leading to substantial losses in biodiversity. Historical analogue: response of current habitat fragmentation to additional natural and man-made pressures.

The way forward on catastrophe research is to conduct some detailed case studies on major potential catastrophes using a common method.

Four cases reflect extreme versions of the gradual and roughly predictable impacts of climate change:

* **Extreme drought.** Overall global rain fall may increase with greenhouse warming, but regional and local variations may leave some areas with substantially lower usable rainfall. Those areas may already be on the margins of deserts. Historical analogues: dust bowl of the 1930s; historical efforts to manage limited water sup plies.

* **Large increase in stormy weather.** Global warming may also lead to more frequent and more intense storms. Historical analogues: particular extreme storms (e. g., Hurricane Andrew); efforts to predict and adapt to the effects of El Niño.

* **Large increase in epidemics or disease vectors.** Warming and moisture may lead to new habitat for disease vectors such as insects, putting new human populations at risk. In general, the global capacity to respond to disease has increased dramatically in the last 50 years, but chronic under-development in some regions (e. g., Africa) may retain a low capacity to respond to additional disease threats even 50 years in the future. Historical analogue: black death.

* **Environmental refugees.** Global warming may be an additional stress on the environments that sustain people, leading to exodus and refugees. Historical analogues: war-induced refugee migration; current efforts to plan a refugee early warning system.

It is not argued that these scenarios of potential catastrophe are accurate or complete, only that they are the major catastrophes currently under discussion. They are the symbols being used to motivate more action on global warming; it would be good for the research community to provide more useful information on their likelihood and consequences.

The AGCI group's proposed methodology consists of four components.

First, each case should consist of a prescribed physical scenario. The main problem with current research on climatic surprises and catastrophes is that the social and institutional causes and responses are not adequately explored; yet they are the most important factors in most (but not all) cases. A prescribed physical scenario will help increase the focus on the non-physical factors. The scenario should reflect the range of possible outcomes and also underscore the role for natural scientific research to improve its predictive capacity.

Second, as noted, it is crucial that cases have empirical focus. The careful use of historical analogues can help sensitize the researcher to the range of stakeholders, causes and responses.

A global solution to climate warming requires international flows of resources to help poorer countries control emissions.

Third, the physical scenario should include rapid and slow modes, and research into social and institutional responses should investigate both. The rapid mode of change helps to explore how societies might react to catastrophes when they are on the doorstep. The slow mode helps illustrate how catastrophe might be anticipated. In practice, any catastrophe might catch some people by surprise while others anticipate and prepare for the outcomes. The distribution of costs from catastrophe might reflect which populations were able to anticipate and adapt.

Fourth, the entire exercise must be conducted in the spirit of imagining the world 50 to 75 years in the future when these possible catastrophes might have full effect. It is inappropriate to imagine these changes imposed on the current vision of the world or to assess all catastrophic outcomes as "caused" by global warming. Rather, the full story is the interaction of warming and other pressures with social change. Weather prediction will likely improve in the future. In turn, the improved capacity to predict the weather could make it easier to anticipate and adapt to some extreme events such as storms. Growing populations will settle new lands, thus fragmenting habitats even more than today. Climate change could exacerbate the effects of fragmentation, but affluence and growth would be the principal destroyers of natural habitats, not climate change.

What should be done?

The identified needs apply mostly to the research community. The immediate need is to conduct some case studies according to a common method, perhaps under a single integrated research project to allow comparisons across cases. The case research will demand interdisciplinary teams, great care to integrate the relevant but disparate existing research and historical studies, and extreme care to forecast the future societies that will respond to the possible catastrophes. After conducting this research, attention must be paid to communicating the results in a way that conveys what is at stake as well as the (wide) range of possible errors and outcomes (considered in the final section of this report). Implementing this style of research and communication will be extremely difficult, but without it the research community will lack answers to critical policy questions.

3 Some major long term functions of the climate regime
(For more see Bodansky, Chayes, Gutner, Hecht, Najam, Skolnikoff, Stone, and Victor.)

International regimes perform many functions. They help coordinate otherwise independent national actions. They establish systems for exchanging and assessing information. They offer fora for continued negotiations. These tasks are crucial; all are being performed in the climate regime, and this group is optimistic they will be performed well.

Here, the focus is on four other functions: (a) managing the international flow of relevant financial resources; (b) technological planning; (c) possible insurance schemes; and (d) managing geo-engineering. Each of these conceivably has a role in the long term climate regime but has received less attention than the other functions of international regimes. They are discussed in order, from the most immediately relevant and needed to the most distant.

Resource transfers

Virtually every analyst agrees that a global solution to climate warming requires inter national flows of resources to help poorer countries control emissions. In general, explicit flows of resources for environment and development are very small today. The Marshall Plan transferred money and other benefits measured in a few percent of U. S. gross domestic product to war-torn Europe. Today, explicit flows for environmental purposes, as a percentage of GDP, are several orders of magnitude smaller. Total Official Development Assistance (ODA) for all purposes is only (0.4%) of the world product. Donors today are unwilling to allocate substantial sums for international transfer through formal multilateral institutions.

This context is not ideal for considering potentially very large resource flows that might be needed to slow global warming, for example to pay the incremental costs that developing countries incur while implementing projects. If global warming proves to be a concern that merits stringent action over the next few decades those flows might ultimately be measured in hundreds of billions of dollars annually - a large sum but only a percent of world product. The regime needed to transfer those sums is radically different from what we have in place today. The group acknowledged this major shift that might be needed but did not consider its consequences further. It did explore what, in the interim decades, could be done to improve existing systems that transfer much smaller but still valuable sums.

The experience with financial mechanisms to date offers four lessons, some of which contravene conventional wisdom.

First,it is essential to couple donor and recipient interests. The large supply of new and old resources programmed for “environmental” purposes reflects mainly the greening interests of the donor community. In practice, many projects funded under “environmental” programs are camouflaged with environmental components by recipients to make them more attractive to donors. Formally that camouflage is discouraged, but in practice it is tolerated. Within limits, it should be encouraged because it leads to a larger supply of potential projects that meet donor and recipient interests.

Second, the international community discourages aid that is tied to particular conditions such as the use of certain technologies or national firms, but in practice the ties are numerous. There is some danger that formal prohibitions are not reducing ties but rather making them less transparent and perhaps exacerbating the problem. In principle, some ties might actually be welcome. They improve the fit with donor interests and thus increase the flow of resources available for environment and development purposes. Some conditions must be met for tied aid to be effective, including that ties don’t undermine multilateral lending and coordinating mechanisms and that ties don’t lead to inappropriate technologies. These conditions are well established (if not always followed), but the point here is simply that tied aid might actually be (cautiously) welcomed.

Third, often many different bilateral and multilateral lending activities programs operate in a given issue area. Competition can be healthy, but some coordination is probably also essential. Mechanisms such as the Project Planning Committee (PPC) for aid programs in Central and Eastern Europe offer useful lessons for improving coordination. The PPC encourages co-financing, dialogue and faster project cycles. Areas where the PPC has not been successful are also illustrative of the needed policy changes: it does not involve recipients, and it is unclear if the coordinating mechanism also improves the setting of priorities or supply of new resources. Nonetheless, this and many other examples underscores the role of multilateral coordinating mechanisms.

Fourth, a large number of other lessons are being learned in the systems for international resource transfers. Governance is expanding to include recipients and non-state actors both in setting policy and implementation. And there is increasing attention to "capacity building;" increasingly, the concept of "capacity" is shifting from one focused on government institutions to include non-state actors and institutions. All these lessons underscore that the international system for resource transfers is dynamic and, in general, appears to be learning how to become more effective.

The international system for resource transfers is dynamic and, in general, appears to be learning how to become more effective.

The issue of making financial transfers more effective is enormous. Some of the more de tailed observations from experience are discussed in the individual reports. (See Gutner, Gyawali, Najam, Ponce-Nava). Among the many finance-related topics that are not discussed here is the large number of market-oriented systems, such as joint implementation and tradeable permits, that might substantially increase the flows of resources related to global warming.

Technology

Technology touches every aspect of the global warming issue. Yet few studies approach the technological dimension of climate change in a systematic way. Most of the international attention to technology has concerned "technology transfer," yet donors rightly note that nearly all technologies are "transferred" through normal market channels. The long history of attempts at overt technological transfer repeatedly underscore that successful transfers envision technologies not just as hardware but also as a complex of institutional capacity and training. Technical change could be a large part of the solution for reducing emissions of greenhouse gases, but government-driven efforts to plan technology policies are mixed in their efficacy. Normal market-driven innovation is poorly understood. It is unclear which incentives best spur the innovation and diffusion of appropriate new technologies. All of these issues are at the center of current economic and technological research related to climate change.

Given the magnitude and uncertainty of the technological dimension, it is easy to despair that no single suite of technology policies seems right to implement. In the short term, at minimum, one sensible approach is to continue what nearly all industrial countries are already doing: implement so-called "no regrets" policies that help reduce market failures and reduce greenhouse gas emissions at little or no cost. Often these consist of diffusing new, efficient technologies into use. The "no regrets" options are well-known. But the success stories need more attention. Demand-side management programs such as EPA's "Green Lights" appear clearly cost-effective yet are under budgetary threat because their success is not well known.

In addition, it would be useful to identify existing technology that is applicable to monitoring and verifying compliance with possible climate commitments and for research. These include technologies developed for other purposes, such as military intelligence. Much of this is

being done already, but special attention is needed to explore the functions of monitoring and verification so that a foundation of experience can be built in time for its use in the coming decades if substantially more stringent climate commitments are agreed to. As the stringency of international commitments increases, so do the incentives to cheat and the need for verification.

Insurance Schemes

The resource transfer and technological dimensions of the global warming problem are well known. Next we turn to two issues insurance and geo-engineering that could affect the long term climate regime but are less well known.

Insurance is used in many settings as part of a package of policies and incentives for managing risk. Risks can be avoided; losses can by limited and controlled; but some risk remains. Insurance is purchased in an effort to transfer some of the remaining risk to insurance providers. Insurance premiums help sensitize risk bearers to the costs and consequences of their behavior.

At minimum, nations should implement so-called "no regrets" policies that help reduce market failures and reduce greenhouse gas emissions at little or no cost.

In domestic and international settings the law has tended to focus on incentives to avoid risks, such as through injunctions and liability. The Framework Convention on Climate Change and the general debate on climate change have mostly adopted the same philosophy of risk avoidance. But a package of avoiding some and retaining other risks might be a more integrated, efficient and fair way to deal with climate change. A climate insurance scheme would be a central part of a system to sensitize risk bearers; premiums would highlight activities vulnerable to climate change and attempt to limit those while the climate regime also attempted to limit the sources of risks: greenhouse gas emissions.

Appealing in principle, insurance schemes currently face a large number of practical problems. These include the fact that any initiative must be implemented in the con text of large existing (mostly private) insurance markets. Further, one does not insure against "global warming" but rather against particular impacts. Those impacts are not known with precision, and it is difficult to identify what fraction of a particular hazard is caused by the normal climate system and what part is the result of anthropogenic global warming. Separating the two will require research and, ultimately, impartial expert judgment. Nonetheless, separating the sources of risks is done in other contexts and not inconceivable in the case of some global warming impacts.

An interesting possibility is to couple the anthropogenic portion of the risk to a system of international compensation such as a premium subsidy. Compensating some risks of climate change could be a lot cheaper than avoiding risks entirely through abatement of greenhouse gases, and compensation would also be more fair than the current practice of offering no compensation for international environmental hazards. Politically, compensation might be impossible to implement, but coupling it with an insurance scheme might make it more attractive.

Clearly an international insurance scheme is not ready for practical application in the near future, but the contribution to efficient management of the climate problem is potentially enormous. One conclusion for the research community would be to elaborate and test some possible schemes. In the interim, one conclusion for policy is to make existing insurance markets more efficient and rational so that risk bearers in marginal areas (e. g., coastal zones) are appropriately more sensitive to possible hazards. Indeed, climate politics might be driven by premiums set in normal insurance markets by an industry wary of hazards such as storms and flooding. This is not a full solution to the climate problem, but it may help improve the connection between global warming policy and some hazards.

Geo-engineering

Finally, many observers note that geo-engineering has a potential role in the suite of policy responses to global warming, especially if a climate catastrophe occurs or is imminent. Geo-engineering options such as putting mirrors in space, sulfate in the stratosphere, or iron in the Antarctic Ocean have many problematic features. Some merely postpone climate change and demand perpetual intervention in the climate system. None of these is clearly devoid of potential harm. Thinking about such options may breed complacency. But in a crisis, geo-engineering might be needed.

Based on earlier treaties, international guidelines and customary international law, there are some loose norms that may govern the appropriate use of geo-engineering. These include the duty to prevent transboundary harm, the duty to undertake assessments prior to actions that might cause environmental harm, and the duty to consult with potentially affected states.

Under some conditions, tied aid and “camouflaged” projects might actually be welcome because they improve the fit between donor and recipient interests and in crease the international flow of resources targeted to the environment.

The Framework Convention on Climate Change says nothing directly about the use of geo-engineering. Presumably the Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Conference of the Parties would handle such issues. Other relevant international agreements such as those on Outer Space or Antarctica which are relevant to the space mirrors and iron-enrichment solutions, respectively also say little.

Given that the existing suite of international norms is only loosely relevant, would it be wise to consider developing additional norms specifically dedicated to geo-engineering now, before the geo-engineering options might really be needed? The sense of the AGCI group is that the answer is “no.” Unless the climate system faces a crisis, it is unlikely that geo-engineering options could be seriously evaluated in terms of their real need and function; presented with the choice only in the abstract, most countries would appropriately seek to ban geo-engineering. A ban might prove irrelevant in the future if geo-engineering were really needed, but in the interim it could dissuade research specially targeted at geo-engineering options. That, in turn, would leave the world less prepared.

What should be done?

The range of functions to be performed by the international climate regime is enormous. No effort is made here to be comprehensive. Rather, several conclusions that emerged from the discussions are highlighted.

Regarding financial transfers, many lessons are being learned about how to improve the existing system. Some of these are unexpected: under some conditions, tied aid and “camouflaged” projects might actually be welcome because they improve the fit between donor and recipient interests and in crease the international flow of resources targeted to the environment.

Nonetheless, the overall amount of money now transferred through official aid programs is very small compared with the amounts that might be required if there is stringent global action to manage climate change. An important observation for policy is that all the adjustments to improve the operation of bilateral and multilateral funding mechanisms discussed here are marginal changes to the existing system. There is no reason to believe that if large-scale transfers are needed that it would be wise to scale up the existing system.

One conclusion for research is that some exploratory studies might be done on the possible design of a large-scale resource transfer system, how it could fit with (or replace) the existing systems, and the relationship to private markets through which most international resources flow. Historical analogues include the Marshall Plan. Such research contrasts with most work on financial mechanisms which uses the existing system as a starting point.

Regarding technology, our main conclusion concerns policy: successful programs, such as demand-side management that promotes energy efficient technologies, need more publicity. At present there are few clear ideas of what technological responses are best. Some clear and well-documented success stories can help show the way over the short term. The longer term needs include the identification of technologies for monitoring and verification purposes and to build a verification system that can be used if substantially more stringent climate commitments are adopted.

Regarding insurance schemes, there is a strong need for the research community to develop and test some workable ideas.

Regarding geo-engineering, we have already indicated that no policy response is appropriate now it is better to wait for a clearing indication of crisis. However, research should continue. Although many participants in the climate debate fear that geo-engineering options will be treated as a panacea, it makes sense to sponsor research into the options so that they may be available if needed. Fortuitously, because geo-engineering is intervention in the climate system, most of the needed research is exactly that also needed to under stand the climate system generally.

Regarding geo-engineering, no policy response is appropriate now it is better to wait for a clearing indication of crisis. However, research should continue.

4 Lessons learned from "success" stories
(For more see Levy and Oye)

It is helpful to examine other cases of successful international cooperation to draw lessons for building an effective climate regime. Several studies are underway that do exactly that. Here we look only at the two cases acid rain in Europe and depletion of stratospheric ozone that are cited most often as "successful" and draw some lessons for climate.

Acid rain in Europe

The regime to control acid rain in Europe formally dates to the 1979 Convention on Long Range Transboundary Air Pollution. Five protocols have elaborated the terms of the Convention: a protocol to fund a system for gathering and exchanging data and model results (1984); two protocols to limit emissions of sulfur dioxide (1985 and 1994); a protocol on emission of oxides of nitrogen (1987); and a protocol to limit emissions of volatile organic compounds and other precursors of ground-level ozone (1991). Although cooperation is formally codified in these agreements, collaborative monitoring programs date much earlier a network of scientific research and monitoring activity was in place at least since the early 1970s, waiting for a political window of opportunity.

As in most regimes, the "success" of the European acid rain agreements is a function of luck, narrow interests, and ingenuity. Here the focus is on the element of ingenuity because it informs most directly what types of policies are feasible and effective. (The full story is told in the summary of Marc Levy's presentation.) Ingenuity's contribution to the acid rain regime's "success" can be traced primarily to two elements.

First, the international legal agreements to control emissions were a framework within which national efforts to control emissions were coordinated. The framework also sponsored and legitimized scientific research, modeling and assessment activities; it helped build shared knowledge and concern about the acid rain problem.

Second, the working groups on impacts and the concept of critical environmental loads introduced in the late 1980s helped focus attention on the potential harms of acid rain. Research on the impacts on forests was not conclusive; in contrast, impacts research on lichen was better able to demonstrate harm. Even though the economic consequences of declining lichen might have been small, the demonstrable link gave human populations in affected areas a tangible reason to press for political action to control acid rain. The regime was effective in changing interests because it was effective in connecting scientific information on impacts to the political process.

Once the regime was in place, it became the focal point for a political process driven by the fear of damages and the desire to be a responsible neighbor. The regime's research and assessment activities were able to demonstrate that pollution crossed borders and caused harm. Faced with that information, nations felt an obligation and domestic pressure to control their emissions.

There are many dangers of using the ozone regime as a model for international cooperation in other areas. The rapid phase-out of CFCs can be explained largely by the distribution of costs and benefits of the phase-out.

The acid rain regime also faces many unsolved problems. It has no operational system for reviewing implementation and dealing with problems of non-compliance. It has made little use of financial transfers despite strong evidence that transfers to poorer countries would improve implementation and overall effectiveness in a cost-effective manner. Generally, the regime has not given central attention to comparing costs and benefits - its control actions have been economically sub-optimal.

Depletion of Stratospheric Ozone

The Montreal Protocol (1987) on Substances that Deplete the Ozone Layer is the legal agreement at the core of the most extensively studied international environmental regime. The regime is well-studied probably because it is widely seen as a success. However, there are many dangers of using the ozone regime as a model for international cooperation in other areas. The rapid phase-out of CFCs can be explained by the distribution of costs and benefits of the phase-out. The firms that stood to benefit from the creation of markets for CFC substitutes were the same firms that produced the original CFCs. Those who paid the costs of the CFC phase-out were CFC users and consumers - a diffuse and poorly organized group. The phase-out was rapid because this special set of industrial interests happened to overlap with interests in protecting the environment.

A more common situation (including global warming) is that those who pay the costs of abatement are well known, concentrated and well-organized (or become so), and generally opposed to stringent controls. The beneficiaries of environmental protection are diffuse and often not well organized. (However, non-governmental organizations acting on behalf of the environment are an increasingly well-organized representative of environmental interests.) This situation leads to an imbalance of political pressure and systematic failure to establish and implement environmental policies that are collectively beneficial. One strategy is to ensure that diffuse interests are well-organized and represented in the political process. (That and many related issues are considered in a later section on transparency and governance.)

Another strategy is to make more systematic use of compensation to pay the extra costs of parties that would not otherwise implement the needed changes in behavior. In contrast with extortion, where a party purposefully does something that it wouldn't do otherwise in order to extract a payment, compensation is an under-utilized tool for reaching more ambitious collective agreements. Compensation may be essential in order to build viable coalitions that favor certain environmental policies where opposition is well organized. It is most useful in environmental problems such as global warming where policymakers can predict that narrow interests will be opposed and well organized.

The ozone regime provides an example of multilateral compensation: a Fund pays the incremental cost of implementing projects to comply with the Montreal Protocol. Countries otherwise reluctant to join the Protocol have now done so because the Fund pays these costs. The Fund also illustrates some of the difficulties of international and multilateral funding: contributions to the Fund have fallen behind schedule, and the agreement that established the Fund is so delicate that few Parties want to raise these problems formally. The Fund is based on expert assessment of country programs and individual projects; such assessment help avoid inflated claims and extortion.

Unlike the phase-out of CFCs, global warming and most other environmental issues are marked by well-organized opposition to regulation. Compensation strategies can convince opposing forces and lead to better package deals while also avoiding extortion.

In addition to the Fund, some other forms of ingenuity have also contributed to the over all effectiveness of the ozone regime. Notably, multiple economic, scientific and technological assessment panels are connected to the regime, provide periodic assessments, and are responsive to particular questions that arise during the negotiations. Those panels help connect up-to-date scientific information to the actual operation of the regime - they provide legitimate answers to crucial questions such as which uses of CFCs are "essential" and thus eligible for exemptions under the Protocol. Further, the regime is highly flexible and thus able to respond to new information - the control measures agreed upon in 1987 have undergone a major strengthening in 1990 and again in 1992. Unlike the acid rain regime, the Protocol also includes a dedicated fund for financial transfers which has improved implementation of the control measures in developing countries. Finally, the Protocol has a system for handling problems of non-compliance - since 1990 that system has significantly improved implementation of the Protocol's requirement to report data on production and consumption of ozone depleting substances. That system is just now starting the more difficult task of improving implementation of the control measures - the early signs are positive.

What should be done?

Only some aspects of only two other cases are discussed here. The range of relevant lessons from "success" stories and from failures is enormous.

For policy, these cases both illustrate the importance of connecting science to the regulatory regime. The acid rain case illustrates how connecting information on impacts helps to sensitize people and nations to the issues at stake and makes abstract notions of environmental damage more concrete. The ozone case illustrates how responsive assessment panels helped to connect detailed technical and economic information to the detailed operation of the regulatory regime. In both cases, the independence of working groups and panels gave their information credibility; the formal connection to the regulatory regime gave it legitimacy. This group believes that the SBSTA of the Climate Convention is headed in this direction; however, there are dangers that the climate regime will be dominated by political representatives rather than more independent experts, which could reduce the credibility of its products.

Some body will be needed to perform the responsive assessments that proved very useful in the ozone regime. The panels being established under SBSTA will and should per form this function. They should be designed with the effective ozone panel system in mind. A critical issue that must be resolved early is the relationship to the IPCC. If IPCC works on the same issues that are on SBSTA's agenda, there is danger both of duplication and that participants in the climate debate will look past SBSTA to the more independent (and perhaps more credible) IPCC for answers.

Policy will also benefit from more attention to compensation schemes. Unlike the phase -out of CFCs, global warming and most other environmental issues are marked by well-organized opposition to regulation. Compensation strategies can convince opposing forces and lead to better package deals while also avoiding extortion.

For research, there remains much to be learned by comparative studies of other international environmental regimes. Much of that work is already underway. The two cases discussed here suggest at least one gap that researchers might fill. It is easy to over-state the importance of the lucky overlap of industrial and environmental interests. But the same situation did not necessarily exist for the phase-out of halons, which was completed on an even faster timetable than for CFCs. What were the industrial interests at stake? Did the halon phase-out proceed rapidly for the same reasons (which seems unlikely), were halons caught in the coattails of the CFC phase-out, and/or did ingenuity in the design of the regime and strong domestic pressure lead to the rapid phaseout? Answers to these questions and comparisons with the voluminous existing literature on the CFC phase-out will help identify the different roles of industrial interests, domestic pressure and regime design in the overall operation of the ozone regime. That case study has not been undertaken.

The main substantive commitment of the Convention is a loose pledge that all industrialized countries return their emissions of greenhouse gases to 1990 levels by the year 2000.

5 Implementation, compliance and future climate commitments
(For more see Charnovitz, Chayes, Hecht, Raustiala, and Victor)

The following pages review what policies and measures are being implemented by different countries and then focus on four interlocking aspects of future commitments and their effective implementation: a) the content of future climate commitments; b) translation of international commitments into domestic action; c) systems for managing compliance; and d) the relationship between climate commitments and other international commitments, primarily trade law.

Implementation of climate commitments today

The story of which countries are implementing what policies is told at substantial length in individual national communications submitted to the Climate Convention as well as a synthesis report and independent evaluations by NGOs and an especially useful report by OECD. We briefly discuss one country, the United States, to give a sense of the ways that it is trying to meet its climate commitments and then broadly review implementation in other countries.

The main substantive commitment of the Convention is a loose pledge that all industrialized countries (OECD members minus Mexico) return their emissions of greenhouse gases to 1990 levels by the year 2000. Although the commitment is modest, the United States is finding it difficult to create a "climate policy" in the current political con text which is wary of government intervention. Within this constraint, many sensible actions are being implemented:

* As with all industrialized countries, the U. S. policy gives central attention to "no regrets" actions that help control emissions and also have many other benefits, all at zero or negative cost;

* The U. S. has given very constructive attention to ensure that the process of compiling national communications gets underway properly, both by showing leader ship in preparing its own high-quality communication and in funding several dozen country studies to help developing countries prepare for their communications;

* The private sector is emphasized and involved through a large number of voluntary programs to reduce energy consumption;

* The U. S. is organizing a pilot program for joint implementation (JI) to help build awareness of JI opportunities in the private sector as well as some early (hope fully positive) experience that can be used to support arguments to create an operational phase of JI in a few years.

Individually, none of these measures makes a substantial dent in U. S. emissions. It seems likely that the U. S. will fail to meet the Convention's loose target. However, it is difficult to predict whether a particular target will be met at a distant date, or to plan definitively for that goal. Emissions are intrinsically tied to economic growth and industrial structure, so the future path of emissions is not predictable. Nor is it possible to predict exactly what policies will be implemented with what efficacy.

All other developed countries are also implementing at least some policies; a few (e. g., Denmark, Norway and Sweden) have implemented significant carbon taxes; most are relying primarily on no regrets options such as demand-side energy management. The overall level of abatement is uneven. Most share the U. S. experience that it is difficult to meet specific quantified emission targets. The only countries that will clearly meet the Convention's target are those that will over-comply.

Future climate commitments

There is no clear way forward for the negotiation of future commitments, a process that was set in motion by the Conference of the Parties in April 1995 and is slated to have a protocol of the Convention ready for signature perhaps in 1997. It is virtually impossible to calculate what types of commitments are optimal because the costs and benefits of mitigating global warming are so uncertain. Thus as with the acid rain regime and so many other areas of international cooperation (e. g. , the GATT), the style will and must be one of collective learning and consensus-building. What happens in the next few years on detailed policy measures matters less than whether the foundation is in place to allow learning and periodic review and adjustment of international commitments and domestic actions over time. In that spirit, the following principles should guide the next few formative years:

The debate over adopting new quantified targets and timetables for controlling greenhouse gas emissions is not the most important activity. Indeed, it may be especially important not to lock in a target and timetable system because that system for expressing commitments is incompatible with the low ability of countries to predict their future emissions and needed policies exactly;

The system of national communications and international review is essential be cause it offers a foundation for determining whether countries are on track in the implementation of long term policies and measures needed to reduce emissions of greenhouse gases from the economy. The

The developed countries, which are already implementing many "no regrets" options, will probably agree to even deeper cuts in emissions while low-cost options remain plentiful in other countries. Joint Implementation allows both the high- and low-cost countries to gain an advantage.

style of reviewing policies rather than focusing on end-of-pipe emissions is more consistent with the types of actions that governments will actually implement to control emissions.

The JI pilot phase should be run to build some shared experience with and trust of tradeable offset schemes. If climate commitments are made substantially more stringent, then a viable and operational JI scheme will be enormously valuable. JI is most helpful in reducing the cost of controlling greenhouse emissions when the overall emissions caps are tight and countries that are obligated to make the deepest cuts have already exhausted their "no regrets" options. That is exactly where the climate regime is now headed: the developed countries, which are already implementing many "no regrets" options, will probably agree to even deeper cuts in emissions while low-cost options remain plentiful in other countries. JI allows both the high- and low-cost countries to gain an advantage. But the crucial first step is to build trust in this concept which is currently shrouded in suspicion and to demonstrate in a pilot phase that it works.

Because governments are responsive to domestic pressure and some pressure groups have pushed hard for more targets and timetables, it will be easy for governments to slip into another round of target-making.

The AGCI group feels that the climate regime is broadly headed in the right direction. How ever, there remains a central danger: because governments are responsive to domestic pressure and some pressure groups have pushed hard for more targets and timetables, it will be easy for governments to slip into another round of target-making. In 1991, while the Convention was being negotiated, nearly every OECD country unilaterally announced a domestic target to limit greenhouse gas emissions; that round of target-setting was in tended to induce the Convention to adopt a quantified target (it didn't) and show that these countries were taking to lead to slow global warming. Yet in the intervening years it has become clear that there is actually little relationship between the declared targets and the policies these countries actually implemented. Over the next two years while a 1997 protocol is being negotiated it seems likely that countries will engage in another round of unilateral target-setting in an effort to influence the content of the Protocol. That would not be intrinsically bad, provided that it does not detract from the main mission of building a long-term system for learning and adjustment rather than chasing short-term political advantage through good-looking targets.

Domestication of international commitments

The process by which international commitments are translated into domestic action varies across countries. Some of the major issues are discussed elsewhere. (See Raustiala) The following observations relate to how the international system of setting and adjusting climate commitments should be viewed.

First, nearly all of the actions required to control greenhouse gas emissions are at the domestic level where legislation, programs and incentives are created and implemented. Effective international commitments must be negotiated on the basis of whether they can be given domestic effect. Otherwise a gap will develop between international law and domestic action; countries will be reluctant to ratify binding international agreements that they can't implement; international law will become empty of influence. Consequently, building a system for gathering and reviewing information about domestic implementation is crucial; without a shared base of information there is no foundation for setting international commitments that can be effective domestically. As international commitments become more stringent, the process of domestication will become even more difficult yet crucial.

Second, the state-centric international system requires that states give their consent for international commitments to have effect. Although it is complicated and cumbersome, the process of domestication is the source of legitimacy for international law. It is now popular to

discuss ways to avoid domestication, especially the formal process of ratification - systems of adjustable annexes, for example, offer a quick fix to the often long delays in ratification. It seems appropriate to use these devices where detailed or technical matters are at stake and ratification may not be essential, but we caution that for larger issues such quick fixes are counter productive.

The process of domestication might benefit from more transparency which will assist in comparisons of national efforts and compliance. Making domestication part of a system of periodic reviews of policies and measures will promote more complete learning about the types of commitments that governments can actually undertake.

Managing compliance

The existence of some system for handling compliance problems is essential to an effective international regime that keeps international commitments connected to domestic action. Parties that don't implement their commitments are scrutinized and cajoled by the operation of compliance reviews into doing more. Systems for managing compliance are part of a style of effective international governance that sets, adjusts and re views commitments on a regular basis.

In managing non-compliance, the goal is to develop plans and timetables for bringing problem states back into compliance and to preserve the integrity of international commitments.

International environmental agreements have generally not given much attention to the management of compliance. Experience elsewhere shows how the system can operate. The OECD conducts regular policy reviews of its members, including reviews of environmental policies. The GATT Trade Policy Review mechanism operates in the same spirit of reviewing overall trade performance and highlighting specific areas for improvement. The International Labour Organisation (ILO) has a long standing system of supervision that reviews national implementation of ILO commitments and has been effective in identifying cases of inadequate implementation and in nearly all instances convincing countries to bring domestic actions into conformity with their international commitments.

Two environmental agreements have some significant form of compliance review. The Convention on International Trade in Endangered Species (CITES) handles about 100 cases per year of suspected non-compliance. In each, the Convention's secretariat communicates with the affected party and then forwards a report to the Conference of the Par ties for action.

The Montreal Protocol has had a non-compliance procedure and Implementation Committee in operation since 1990; it is active on most issues of compliance and has convinced many parties to meet their international obligations. In all these systems the style of managing non-compliance is less to confront an accused and more to discuss and manage problems of compliance as they arise. Tough actions such as expulsion from a treaty are rare; the goal is to develop plans and time tables for bringing problem states back into compliance and to preserve the integrity of international commitments. Some observers lament that these systems are not tough enforcers of the law, but in practice tough systems are rarely used in international law. Dispute resolution systems, for example, are omnipresent in international environmental treaties but have never been used.

The climate regime is developing a compliance review system in the same spirit as discussed here. The process for elaborating that system will be slow because Parties are unlikely to agree to compliance review without knowing more about their commitments - willingness to adopt tough commitments may be inversely related to the perceived effectiveness of compliance

review. However this issue evolves, for now it seems on the right track. Two functions are underscored as essential foundations for compliance review:

* There must be an effective and useful system for gathering and exchanging information about national performance. The system of national communications is logically that system. The first round of communications (submitted starting in 1994) was a good first start, but much remains to be done to improve the communications individually as well as to improve the overall capacity to compare policies and measures reported in different national communications.

* There should be an effective review system conducted on a regular basis to scrutinize all national communications. Regular review is a first step to identifying potential compliance problems on a systematic basis. No major international environmental agreement has such a system of regular and comprehensive review, but the ILO and OECD experiences both show how it can be done and its overall contribution to improving implementation. Indeed, the existence of a regular review mechanism will probably deter many issues of non-compliance before they actually become cases that must be managed through a dedicated non-compliance procedure.

Trade agreements are a crucial part of the international economic system. Given their important role, there are many potential linkages.

Relationship to other international regimes

Climate change is primarily caused by burning fossil fuels for energy, which is (presently) an integral part of modern economies. Not surprisingly, climate policies overlap with many other aspects of national and international policy. Here we focus on one: the international trading system.

Trade agreements are a crucial part of the international economic system. Given their important role, there are many potential linkages. Rewards of membership or other privileges in trade agreements could be linked to membership in the climate regime. Trade sanctions could be threatened to enforce compliance with climate commitments (although that is rarely done in other environmental agreements). Commitments in trade and climate agreements can be coupled to avoid competitiveness problems from implementing climate commitments while trading partners do not.

There are also many potentially beneficial common interests between free trade and climate protection. Reduction of subsidies on dirty fossil fuels (especially coal) help level the terms of trade while also favoring cleaner and more economic energy sources. Harmonized international standards for technologies or agricultural practices can create uniform reductions in greenhouse gas emissions while also leveling technical barriers to trade. Trade liberalization promotes growth and the efficient use of resources, perhaps also lowering the intensity of greenhouse emissions per unit of economic output.

Unfortunately, in practice few constructive links actually exist. Conflict between environmental and trade regimes has been the norm and is likely. The “trade and environment” debate has had a chilling effect on the willingness of environmental treaties to use trade measures and links. Concern about the trade consequences of using trade measures in environmental agreements has led to a conflict between regimes. In general, the trade community has prevailed.

What should be done?

The issues of setting future commitments, domestication of international commitments, managing compliance and building links with other international agreements have been considered together because they are inseparable. They must be viewed as a system for establishing, implementing and adjusting international commitments and domestic policy. The fundamental goal of the system is primarily to change domestic policies and actions; doing so in a cost effective manner requires that the international system be able to gather, review and assess information about domestic policies and measures in parallel with negotiating and adjusting international commitments.

The most important conclusion for policy is that in the absence of a clear way forward on climate commitments it is important to view the climate regime as a focal point for learning, negotiation and coordination. Building this spirit over the long term depends crucially on a good foundation of information about what countries are implementing. A future system for managing non-compliance also requires such a foundation. Thus the central tasks for the next few years must be to ensure that the system of national communications remains useful and informative and that a system for regular reviews of those communications develops properly. Other tasks such as negotiating new commitments can also be pursued, but it is important that they not interfere with the foundation. Nearly every other international environmental agreement has failed to develop active and useful systems for reviewing and exchanging information.

In addition, both the policy and research communities are aware of the potential linkages between trade and environmental measures. So far, efforts to forge the links have been incomplete. If those communities were to elaborate some criteria to define when trade linkages are useful for environmental purposes without impeding the trade regime. That could help identify some common ground.

Finally, the policy and research communities should elaborate some criteria to define what types of international commitments demand what styles of domestication. At one extreme, international agreements are not well served if any change even to a technical annex requires time-consuming national ratification. At the other, fast track procedures that allow major substantive changes to international commitments without domestic consent are likely to be illegitimate. (They are also likely to be ineffective because consent through ratification often includes the creation of legislation that gives domestic effect to international commitments.) But what mix of commitments is likely to be most effective and legitimate in the middle ground? The research community can contribute to this task by conducting case studies and comparisons - there are many historical examples of different types of international commitments and styles of domestication.

At one extreme, international agreements are not well served if any change even to a technical annex requires time-consuming national ratification. At the other, fast track procedures that allow major substantive changes to international commitments without domestic consent are likely to be illegitimate.

6 Participation of Developing Countries
(For more see Gyawali, Najam, Ponce-Nava, and Smil)

The most important long-term issue in climate management is the involvement of developing countries. Fifty years in the future the largest share of emissions will come from these countries. The poorest nations suffer the greatest vulnerability to changing climate. Aware of the hazards of discussing hundreds of different national circumstances as a single group of "developing countries," some basic issues and trends are identified below.

Efforts to involve developing countries in the climate regime must begin with acute awareness of the context in which they would participate. There is a rapid increase in concern about environmental issues, reflected in the creation and rising status of environment ministries. Non-governmental organizations have also arisen to address these issues. But the phenomenon is recent in comparison with the developed countries. Many environmental issues, especially global ones such as greenhouse warming, have been put on the agenda by outside pressure. Local and immediate issues such as air pollution and access to safe water have a much stronger domestic constituency.

Most important is that the policy priorities appropriately reflect mostly local needs and interests. Local pollution and resources (e. g. , water) dominate the environmental agenda. Climate change may resonate strongly with some of these priorities such as controlling burning of dirty fossil fuels or managing water resources but in general the climate issue is mostly disconnected. In many developing countries, the productivity of safe water and agricultural resources is al ready under stress and thus especially vulnerable to additional stresses caused by climate change. There is at least some need to start planning for possible impacts of climate change, and especially there is a need for the developed countries that are causing global climate change to assist in that prudent planning.

In developing countries, global warming has been put on the agenda by outside pressure. Local and immediate issues such as air pollution and access to safe water have a much stronger domestic constituency.

The prospects for decision making are relatively good. Science is generally held in high esteem, and scientists are increasingly engaged in making policy. As in the developed countries, setting coherent priorities for managing environmental risks remains a problem.

Seven principles should guide and condition efforts to improve participation of these countries in the climate regime over the next several decades:

* Concern of developed countries about climate change is leading to a small but significant new source of resource transfers. Those resources should be coupled with the local priorities of developing countries. The tie should be welcome because there is a large number of potential projects that benefit the global climate and fit local interests as well.

* The motivations of developing countries to participate in international environmental negotiations and to implement international norms are different. Because these issues have been put on the agenda mostly from the outside and often don't fit with local needs, developing countries often sign agreements to look good. If the international community wants signature to be followed by implementation then much greater attention must be given to compensation as well as to matching global and local interests.

* In many developing countries (and elsewhere) there are concerns about the legitimacy of the state. Increased concern about environmental issues by states is welcome, but resource flows through the states create powerful but inefficient monoliths. Brittle states built on coalitions of special interests and not democratic authority may find implementation most difficult when it requires changes in the constituencies that keep illegitimate rulers in power. Non-state channels for distributing resources are often more effective, but it is unclear how extensively those channels can be used.

* As everywhere, in practice implementation is a negotiated process. Because financial resources to pay incremental costs are essential to implementation in developing countries, most of that negotiation will take place through financial mechanisms. Thus it is essential that those mechanisms be designed with the process of proposing, negotiating and revising projects

in mind. That is a time-consuming process but an essential one if financial mechanisms are to remain legitimate, to fit international and domestic interests, and be effective. The presence of NGOs through out this process raises the standards of performance and accountability.

* Information about the impacts of climate change in developing countries remains very poor. Yet that information is what is needed in order to anticipate climate changes and fold them into the regular process of planning. It may be that the value added to the overall knowledge of the climate system is systematically higher for research on climate in developing countries which, so far, has been much less studied than the climate in developed countries. Local information is not only needed for planning in developing countries: as the climate system is viewed on a global scale but predictions of regional and even local effects are sought, more information at finer resolution will be needed.

* Many choices made today will have consequences far into the future as technologies, infrastructures and interests are locked in. Many of these pertain to modes of transportation and sources of energy. The variance in choices leads to wide variation in greenhouse emissions over time. The principle of avoiding inappropriate lock-ins is appealing; in practice, there has been little willingness to plan and pay for the alternatives. Yet low-cost shifts today could have huge cumulative benefits if stringent climate controls are adopted in the future. Many of the greatest opportunities for these changes are in developing countries.

Information about the impacts of climate change in developing countries remains very poor. Yet that information is what is needed in order to anticipate climate changes and fold them into the regular process of planning.

* Finally, and most important, all aspects of developing country participation demand close attention to fairness. Already developing countries are appropriately aware that the bulk of greenhouse emissions have come from developed countries. Further, although developing countries may ultimately be more vulnerable to climate changes, concern about global warming is currently dominated by developed country interests. The developing countries did not put the issue on the agenda. Some have made it a high priority (e. g., the low-lying island nations), but most have other more pressing demands on their resources.

What should be done?

For policy, a long term goal is to improve substantive participation of developing countries in the climate regime. That does not preclude much swifter and more stringent action by developed countries. But over the long term an integrated approach to climate change increasingly can't ignore the contributions and vulnerability of the developing world. The seven principles identified above should be kept in mind as policymakers adapt the international regime and national policy to include developing country interests.

It is striking that every analysis underscores that "developing countries" are not a homogeneous group. Yet international environmental treaties have not made much progress in differentiating countries beyond "developed" and "developing," often in the form of long lists of countries in each category. (Now there is a third group of "economies in transition" that view themselves as part of the "developed" category but deserving special treatment.) In the context of managing global warming, it could be useful to develop some additional categories within "developing countries" to distinguish countries that should be on a faster track to implementing some climate policies in comparison with other developing countries. Currently the concept of "middle income" countries is used, but in practice it is unclear which countries fit into that category. It might be productive to extend the type of system used in Article 5 of the Montreal Protocol: to define countries according to whether they are above or below a per capita emissions threshold. Unlike the Protocol, where there is a clear dividing line and relatively few countries on the borderline, a more continuous measure might be useful than a single threshold.

7 Improving Participation and Influence in Governance

In addition to increasing the involvement of developing countries, the system of international governance increasingly faces the need to involve a wider range of non-state actors from all countries. At the national level, many failures of governance can be traced to the failure of government to respond to its citizens. The consequences are misplaced priori ties and resources and unfair distributions of costs and benefits in the society. Failure to involve constituents often leads to policies that are ineffective - broad participation gives policy legitimacy, especially where the consent of constituents is crucial to effective implementation. Democratic states have embraced these notions of expanding participation.

The same arguments may apply at the international level. International governance could benefit from broader participation and influence in at least three areas:

* assessment of policy needs (e. g., scientific assessment panels);
* making of policy (e. g., international negotiations);
* implementing policy (e. g., through public and private projects).

Many choices made today will have consequences far into the future as technologies, infastructures and interests are locked in. Many of these pertain to modes of transportation and sources of energy. Low-cost shifts today could have huge cumulative benefits.

The rapid increase in participation by non-governmental organizations (NGOs) in all three of these areas reflects these ideas at work. Some of these issues are explored be low. First, ways to improve participation and influence are considered. Later some of the many unanswered questions and problems of opening the policy process are reviewed.

In practice, participation depends on access to the process of making and implementing policy as well as information. There are several ways to increase both:

* open rules of accreditation can allow a wider range of participants;
* transparency of government as well as NGO actions, notably through systems of reporting;
* capacity-building in a broad sense to include support for NGOs and non-state institutions as well as state administrative capacity.

Participation does not automatically lead to influence. However, at least three devices might increase the influence of non-state actors:

* International agreements often include requirements to report national policies. If those reports are used as the basis of real national planning and implementation then it will be easier for layers of non-state actors, from the local to international levels, to make informed comments on the plans. Such a style does not necessarily lead to influence, but it is an essential condition.
* At the international and national levels, requirements to respond to comments can focus dialogue and provide some measure of assurance that efforts by non-state actors will be met by genuine consideration of state representatives.
* Continued roles for non-state actors as implementing organs, notably under multilateral and bilateral financial mechanisms.

In practice, the system of international environmental governance is only at the earliest stages of addressing issues of participation. Participation of non-state actors has grown dramatically, but influence remains generally low and variable.

Among the many problems and challenges that remain, some are: First, open participation easily leads to gridlock and inefficiency. Indeed, exclusion of certain groups is often "effective" in achieving particular policy out comes. Systems with no formal capacity to exclude typically do so through informal de vices such as back room deals. If open participation leads to gridlock then the use of informal devices may become more frequent; on balance that could undermine the goal of good governance that wider participation has sought to achieve. Second, open systems are vulnerable to regulatory capture. Third, there are dangers of allowing groups to influence outcomes when they don't have responsibilities as well. States enjoy the privilege of control over the international system because they also have the responsibility of implementing what they agree to and representing their citizens. Fourth, allowing NGOs or other representatives to influence international policy immediately raises the question of who they represent. Are some groups more "representative" or democratic than others? Should they be granted greater influence?

What should be done?

The extent to which wider participation leads to more or less environmental protection, and at what cost, depends on the particular case.

The goal here is to make the system of governance more responsive to a broad range of interests, not just those interests expressed by state representatives. If states were perfectly representative then wider non-state participation and influence would be superfluous, but states are not.

The goal here is to make the system of governance more responsive to a broad range of interests, not just those interests expressed by state representatives.

Many opportunities for wider participation and influence, but these attractive principles need practical expression. The obstacles are numerous. There are no clear design principles and no consensus that a more open system of governance would be more efficient, more effective, or even more just. More experimental programs and comparative re search are needed.

Regarding policy, international regimes might experiment with different criteria and devices for overcoming the most serious problems of wider non-state participation and influence. For example, lack of transparency about NGO activities, constituencies and responsibilities might be offset by requirements that NGOs submit reports. Whether that system could work in practice is worth an experimental effort, perhaps on a voluntary basis in con junction with the next round of reports due from the governments of developed countries in 1997.

Regarding research, the major need now is to conduct some case studies of governance at the domestic and international level and to ask at least two questions in each study:

1. What are the points of transparency and porosity in the system of governance?

2. How have NGOs and states used those opportunities for participation and influence, and what have been the practical consequences?

The goal of these case studies would be to gain a sense of the criteria that affect participation and influence. For example, how do different rules of access lead to different out comes? Case studies conducted with a common method and research questions would allow comparisons that are crucial to building more general conclusions. Ultimately the goal may be a set of constitutional principles to govern non-state participation; some might be drawn from theory, but at present the weak link is systematic information about what works in practice.

8 Expert advice and assessment
(For more see Moss and Schneider)

Expert information is essential to the long term efficacy of the climate regime. In particular, three functions must be performed:

1. periodic general assessment of the science and possible responses;

2. responses to particular queries as they arise during negotiations and implementation;

3. technical support for analyzing national communications submitted as required under the Climate Convention.

There is a need for more high forcing scenarios. The model benchmark is 2xCO2, but virtually every emission scenario projects actual forcing to be much higher.

The Climate Convention establishes subsidiary bodies to perform each function. What should be their relationship to the IPCC? For the first function it is possible to have only a thin formal relationship. In the past the IPCC's assessments have been influential through many diffuse channels. Its credible assessments have been the centerpiece of debates within and among governments, firms, and NGOs. IPCC's reviews of the natural science issues have been consistently good; its reviews of impacts research are improving; the social science assessments remain problematic. This range in quality reflects the fields of research themselves and not a systematic failure of IPCC. The IPCC process has focused attention on the nature of the global warming problem, possible consequences and policies. This can continue with periodic assessments that have little or no formal relationship to the Convention.

The other two functions demand a closer formal relationship to the Convention. Ad equate developing country participation will require such a relationship to avoid a proliferation of uncoordinated meetings. A formal link will also help keep work timely and relevant. Such a link brings the danger of institutional monoculture and rigidity, but on balance it is essential for sustaining the legitimacy of expert assessment (which so far has been high). The European acid rain regime began with monitoring and research programs initially separate from the Convention but brought within the Convention within a few years. The link helped make the science legitimate and influential. It also helped to make data and models more transparent, allowing complementary independent efforts to flourish (e. g., the RAINS model at International Institute for Applied Systems Analysis (IIASA), which played a crucial role in analyzing the critical loads concept). The expert panels in the ozone regime gave useful and timely advice because they were formally connected to the regulatory system in the Montreal Protocol. Independent expert roles for panel members sustained the credibility of the panels despite the close connection to the political elements of the Protocol.

What should be done?

For policy, a close relationship to the Convention can work well, especially for question - specific advice and technical support. That relationship will be most effective if:

* transparency in the deliberations of expert bodies allows independent efforts as well as Convention-specific work. Independent efforts will help introduce new ideas, avoid monoculture, and make the work of the Convention accountable.

* independence of expert advice is preserved. Independent roles will be difficult to achieve, but it is worth fighting for without independence the scientific credibility of the work will probably be lower. Without credibility the work probably won't be useful or legitimate.

* the lessons learned during the IPCC process are incorporated. Principally, these include: the crucial role of developing country participation to ensure both legitimacy and a range of views; peer review; extensive review and input by stakeholders; and reports that reflect the full range of scientific controversy.

* Perhaps it will prove important to subject the work of the independent panels and the IPCC to a periodic external review to sustain the legitimacy and credibility of the endeavor. One candidate for organizing and performing such a review is the Inter national Council of Scientific Unions (ICSU).

In addition, the research community can make several changes that would yield research and assessments more useful to policy:

* Future IPCC or similar assessments should be sequenced, starting with the basic natural science reports and emission scenarios which are essential foundation to other analyses of social factors and climate impacts. Conducting all aspects of the assessment simultaneously reduces the opportunities of the different components to inform each other in an integrated fashion.

* There is a need for more high forcing scenarios. The model benchmark is 2xCO2, but virtually every emission scenario projects actual forcing to be much higher. The models are much less credible at high scenarios, but some runs are needed to explore the possible consequences (including possible catastrophes).

* As mentioned earlier, policy is driven especially by fear of climatic catastrophe; yet credible and systematic research on catastrophes remains very thin.

Finally, and this is one of the most important conclusions relevant for policy and research, the research community must do a better job of gathering, evaluating and communicating subjective assessments. Most of the major impacts of global warming are poorly known, but the policy process needs at least some information on likely outcomes as well as the range of possibilities. The IPCC has made some efforts along these lines through careful wording and assigning "stars" to statements according to confidence levels.

The research community must do a better job of gathering, evaluating and communicating the subjective assessments of experts to policymakers.

But much more can be done to convey the full range of subjective information that scientists are developing. Notably, more information is needed on the tails of the distribution of potential impacts, especially catastrophic impacts. Those low probability but high consequence events are crucial, but few policymakers have a good feel for what is at stake (good or bad) and the probabilities. Nor do they know how these risks compare with other hazards on the policy agenda. Some graphical representation of these issues would complement the current technique that relies primarily on negotiated text in IPCC reports.

It is probably too late in the current (1995) IPCC assessment to develop and implement such a system. But it would be constructive for some independent group to convene some lead authors from the IPCC process and develop a methodology for conducting and presenting subjective assessments. That group could apply its method to the major conclusions of their IPCC chapters. The potential benefits of developing an effective system for communicating information to policymakers are enormous. Notably, it could improve on the current system where advocacy science communicates through the media and offers alternative views, but non-experts are left only with the sense of controversy but little idea about the range of opinions and likely outcomes. The method is perhaps most useful to the natural sciences, but social sciences would also benefit from the rigor of having to assess the mode and range of their research conclusions.

Legal Issues Related to Geo-engineering

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The fact that geoengineering is an intentional activity with global effects raises the issue of who should decide whether to proceed.

For the purposes of this talk, Bodansky defines geoengineering as large-scale, intentional efforts to change the climate system. Climate engineering proposals include those aimed at removing GHGs from the atmosphere, for example, through afforestation or iron fertilization of plankton in the oceans and those aimed at screening out sunlight by injecting aerosols into the atmosphere to create cloud condensation nuclei and hence more clouds, by injecting dust into the stratosphere to screen out sunlight, by launching reflective balloons into the stratosphere, or by space mirrors or screens to act as a constant shield from the sun.

Proponents of geoengineering claim that its benefits include technical feasibility (injecting dust in the stratosphere with airplanes or cannons), relatively low costs ($30 billion to inject dust), and administrative feasibility (wouldn't require complex regulatory regime; could be done unilaterally without collective action problems).

Problematic features include the fact that it is intentional (and thus attracts greater scrutiny), has global effects, involves high uncertainties (with an indeterminate risk of some thing going wrong), and non-uniform effects (winners and losers result). These features of geoengineering raise several governance issues. The fact that geoengineering is an intentional activity with global effects raises the issue of who should decide whether to proceed. Should all countries be able to participate in decision making since all will be affected and there will be both positive and negative impacts? Also, how should liability and compensation for damages be addressed?

There are not many precedents for how to address geoengineering in international law. Weather modification activities that took place in the 1970s are one precedent. In 1980, the United Nation Environment Programme (UNEP) produced a set of Weather Modification Guidelines. Weather modification was defined as "Any action performed with the intention of producing artificial changes in the properties of the atmosphere for purposes such as increasing, decreasing or redistributing precipitation or cloud coverage, moderating severe storms and tropical cyclones, decreasing or suppressing hail or lightning or dissipating fog." Recommendations of the guidelines included:

* States should undertake prior environmental assessments of prospective activities likely to affect other states or the global commons.
* States should exchange technical and scientific information on weather modification activities through the World Meteorological Organization.
* States should provide timely notice to and consult with potentially affected states.
* Weather modification activities should be conducted in a manner designed to ensure that they do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction.

The second precedent was prompted by the use of weather modification by the U. S. in Vietnam for military purposes. The Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) was adopted in 1977. It prohibits any hostile use of environmental modification techniques, but was neutral regarding the use of such techniques for peaceful purposes. Relevant provisions

* recognize the potential of environmental modification techniques to preserve and improve the environment for the benefit of present and future generations.
* state that ENMOD does not hinder the use of environmental modification techniques for peaceful purposes, and is without prejudice to the generally recognized principles and applicable rules of international law concerning the use of environmental modification for peaceful purposes.

A number of general norms in international law provide background and set the terms of the debate on whether climate geoengineering or similar activities should be allowed to proceed. These include:

* Duty to prevent transboundary harm
* Precautionary principle, which states that if there is a potential for irreversible or catastrophic harm, the burden of proof should be on those proposing the action.
* Principle of intergenerational equity
* Duty to undertake prior assessments
* Duty to provide notice to and consult with potentially affected states

The precautionary principle says, in essence, "when in doubt, don't," and this would probably be the general response to geoengineering.

The United Nation (UN) Framework Convention on Climate Change (FCCC) is silent on the subject of geoengineering. In general, it promotes scientific cooperation and mentions a duty to minimize adverse effects from projects to mitigate climate change. Most importantly, it creates a governance structure to address climate issues, including a Conference of the Parties (CoP) and a Subsidiary Body for Scientific and Technological Advice (SBSTA).

In addition to general international norms and the FCCC, there are a number of specific norms that relate to climate engineering proposals. With respect to afforestation, if a country is planting trees in its own territory, then as a matter of international law this is a permissible exercise of national sovereignty because it takes place entirely within the country's borders. But when one country wants to offset emissions by planting trees in another country, sovereignty and internal political issues may arise. For example, a national government may approve a tree planting scheme as part of an international agreement, but the local people may not want the trees planted in their area since it may have the effect of hindering development.

On the subject of ocean fertilization schemes, the 1982 UN Convention on the Law of the Sea generally provides for freedom of the high seas for research and other peaceful uses. There is also the Antarctic Treaty System which contains no specific prohibition on ocean fertilization but establishes an effective governance system through the Antarctic Treaty Consultative Meetings.

Regarding the space mirrors proposal, the Outer Space Treaty of 1967 applies. It says that outer space is the "province of all mankind" and any state is free to engage in peaceful uses. There is a duty to avoid adverse environmental changes and to consult with other potentially affected states if there is any question about adverse effects.

Schemes to inject dust or release balloons into the atmosphere are the most problematic of the geoengineering proposals in terms of existing international law because the atmosphere above a country, including the stratosphere, is part of its air space. Nations have claimed this area and acted on their claims (e.g., by shooting down aircraft). Geoengineering proposals involving the atmosphere thus could be viewed as an infringement and incursion on national territory.

Although existing international legal norms are generally permissive, they are unlikely to be a reliable guide to how the international community will react if geoengineering schemes are seriously proposed. Instead, there is likely to be a great deal of resistance. Absent some crisis, there will probably be a drive for the regulation of these activities, and perhaps for their prohibition, because it is very difficult to discern what the inadvertent consequences of such proposals might be. The precautionary principle says, in essence, "when in doubt, don't," and this would probably be the general response to geoengineering. Some international precedents that might be relevant to geoengineering include:

Thus, the ultimate obstacles to geoengineering may not be technical or economic, but may instead be political.

* Ban on Antarctic mineral activities
* Ban on commercial whaling and driftnet fishing
* Ban on ocean incineration and ocean dumping of low-level radioactive waste

Thus, the ultimate obstacles to geoengineering may not be technical or economic, but may instead be political.

Linkage of Trade Policy and Environmental Policy

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As a voluntary transaction, trade (of goods or services) is expected to be beneficial to both buyer and seller, but it can have harmful consequences to a variety of parties.

Harm from trade can be divided into three categories:

* The traded product causes physical harm, for example, relocation of invasive species, pesticides, or fruit harboring pests.
* Trade engenders economic harm through the market, for example, by causing unemployment or harming industries that compete with imports.
* Trade engenders physical harm through the market, for example, if trade leads to a market reaction that then causes physical harm like causing coal to be mined or trees to be cut.

Many environmental problems are trade-related so there is not a clear distinction.

Because trade can cause such harm, governments may find it appropriate to use trade measures to limit certain cross-border transactions. Trade measures are applications of tax or regulation exclusively to a traded good (typically to imports but also to exports). Trade measures can be discriminatory (e. g., anti-dumping duties) or non-discriminatory (e. g., tariffs). Discrimination means that "like" products from different countries are treated differently. In terms of international trade rules, it is not always simple to determine what is a "like" product. Is ivory from a country with an elephant protection regime a "like" product as ivory from a country without such a regime; is dolphin-safe tuna a "like" product as that caught with dolphins?

For all three categories of harm from trade, trade measures can be used to forestall or reduce the harm. Questions to ask regarding trade measures are, are they economically appropriate, will they work, and what is the most appropriate policy tool for the purpose? It is conventional wisdom that trade measures are not likely to be effective in dealing with environmental problems. The United Nation's Agenda 21 counsels governments to use more direct measures to address the root causes of environmental problems.

In considering when trade measures should be used, it is helpful to start by dismissing the simplistic notion that trade measures should address trade problems while environmental instruments should be used to address environmental problems. First, many environmental problems are trade-related so there is not a clear distinction. Second, the definition of trade versus environment instruments is ambiguous. Taxes, regulations and quotas are instruments of both trade and environmental policymakers, not belonging to one group more than the other.

In addition, trade instruments authorize or require the use of trade measures. For example, the Convention on International Trade in Endangered Species (CITES), requires a trade measure by imposing import bans contingent on foreign and domestic government certification. A treaty that

authorizes trade measures is the Wellington Convention which states that the parties may take measures, consistent with international law, to prohibit the importation of any fish caught using a driftnet. Another example is the Global Agreement on Tariffs and Trade (GATT), which states that parties shall be free to use trade measures in cases of serious injury.

Trade measures in treaties can be discriminatory or non-discriminatory. For example, the Phosphorus Match Convention of 1906 is non-discriminatory in that it banned the importation of all phosphorus matches regardless of the source. The Bamako Convention, on the other hand, is discriminatory, prohibiting the importation of waste from non-parties. This convention is not open to countries outside Africa, and is intended to prevent importation of hazardous waste from outside Africa to inside Africa. The Montreal Protocol also prohibits imports from non-parties but is open to universal membership.

Trade regimes can help tear down environmentally-destructive subsidies, but traditionally they have not distinguished between good and bad subsidies.

On this subject, there was some discussion about China and GATT. China is not a party to GATT and it appears that it has been blocked by the U. S. and others from joining. There are questions about whether China has done enough to gain entry. For example, has it lowered its tariffs enough, and changed its intellectual property rights laws enough? The opinion was expressed that it is short-sighted to keep China out of the GATT regime and that bringing it in would be more productive.

Trade measures are used in treaties in order to facilitate multilateral cooperation. The aim of trade measures is variously to deflect, halt, reduce or increase international trade. Most trade measures are aimed at affecting the policies of governments. Some motivations for treaty-based trade measures are to:

* encourage joining
* encourage conformance with and harmonization of policies
* encourage compliance with rules
* prevent diversion or leakage of trade outside of the rules of the regime
* prevent competitiveness problems from free riders outside the regime and not bound by it (first success 1906 phosphorous match ban)
* assist countries in enforcing their own laws
* prevent physical harm from/to a product
* prevent economic harm through the market
* prevent physical harm through the market

Charnovitz discussed 30 international treaties over the past 100 years that have made use of trade measures and matched these measures to the various motivations listed above.

In reviewing these cases, we can see that a number of them involve the use of trade discrimination, contrary to arguments by the trade community that this is not appropriate in trade regimes. Charnovitz believes that sometimes discriminatory trade measures are appropriate and may be relevant for the climate regime.

Trade policy can only do a limited amount to promote environmental protection. What it can do is the following:

1. No-regrets liberalization: It can help eliminate protectionist polices that keep countries poor. (It is not known whether this will actually help or hurt the environment; for immediate local issues, increased trade is believed to hurt, but for longer-term, larger problems, it is unclear.)

2. Subsidies: Trade regimes can help tear down environmentally-destructive subsidies, but traditionally they have not distinguished between good and bad subsidies. Good ones address market failures, while bad ones transfer money from one part of the population to another for political reasons. The Uruguay round of Climate Convention negotiations has made some progress in this area by providing for the right of complaint as a means of objecting to subsidies in other countries. Should there be special penalties for the use of bad subsidies? Should countervailing subsidies or export bans be imposed on good subsidies?

3. Non-interference: Some believe that trade regimes should not interfere with environmental issues. Can trade regimes enforce too-rigid disciplines? Are the trade bans in treaties like the Montreal Protocol (CFCs) and CITES (endangered species) inconsistent with World Trade Organization (WTO) principles?

4. Make the WTO less parochial: This could be accomplished by providing more input into dispute settlement problems and including a greater variety of participants in review panels.

5. Standards: Trade regimes can raise environmental standards through harmonization. It is unclear whether the new agreement on technical barriers to trade will focus on national standards that are too low.

6. Generalized System of Preferences decarbonization: As a condition for receiving duty-free benefits, should certain environmental requirements be imposed, as intellectual property issues are now imposed in the U. S. program?

Environment and Trade Relationship

There is an inverted U pattern of environmental degradation that follows development. At first, as countries increase in wealth, the environment gets dirtier; followed by a period in which it becomes cleaner. There is a correlation between wealth and a cleaner environment, but it is not clear whether increased trade creates wealth in a country if one takes environmental values into account. More important than trade policy are a number of other factors including what industrial processes are used, what technologies are promoted, how good the laws are, what the education level of public is, and the amount and quality of research. The Organization for Economic Cooperation and Development (OECD) has identified technology effects as one of the influences of trade on environment under the assumption that trade liberalization will help the developing world acquire new technologies and thus benefit the environment.

Where are we headed? Will trade regimes reach more deeply into domestic scenes? Can we expect growing clashes between trade regimes and environmental regimes? And if so, which will win and what will be the impact? The trade-environment debate has had a chilling effect on the use of trade measures in new environmental treaties and this could make these new regimes weaker than they might otherwise be.

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Compliance With International Environmental Agreements: Reporting, Review and Assessment

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Compliance is the test of the efficacy of international agreements. Do countries simply act in their own best interests or is their behavior influenced by the existence of international laws? There seems to be a growing convergence of opinion on the notion that international laws and agreements have some impact on states' behavior, but there is enough non-compliance to cause us to seek ways of improving the pattern of compliance. Most people think the obvious way to do this is to give teeth to international agreements by specifying sanctions to deter violations and induce compliance. By sanctions, we generally mean strong, coercive measures.

How can we induce compliance under the constraint that strong, coercive measures are substantially unavailable? The force and obligation of law carries its own power, which is not dependent on coercive measures.

But such strong measures are substantially unavailable as methods of enforcement in the international system. Military force is inappropriate except in the case of the most egregious violations of basic international norms. In fact, unilateral military action is outlawed under the United Nations (UN) charter, except in the case of self-defense against armed at tack. Multilateral sanctions are only permitted when authorized by the Security Council, which happened only twice between 1945 and 1992, in the cases of Korea and Iraq. So military force is not appropriate as a means of enforcement.

Multilateral economic sanctions, on the other hand, are sometimes available and appropriate, but have not been widely effective. Economic sanctions may have helped somewhat, over a period of twenty years, to bring an end to apartheid in South Africa. Such sanctions may have some effect, but in all current cases, remain fairly weak as a means of enforcement. Sanctions often create a backlash against the world community by the population of the sanctioned country. Further, economic sanctions often hurt the wrong people: the poor rather than the leadership. Unilateral sanctions are not very effective as no one market, no matter how large, can cause a great enough impact. In addition, the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) make most unilateral economic sanctions illegal, so a country would be guilty of using an illegal means to punish an illegal act. In sum, sanctions are generally not available to enforce international agreements. So how can we induce compliance under the constraint that strong, coercive measures are substantially unavailable?

Chayes contends that the coercive element in any legal system is really much smaller than we commonly assume. The force and obligation of law carries its own power, which is not dependent on coercive measures. A system that actually depends on coercive force is known as a tyranny, and is not the kind of system we would desire. There are some penalties we can apply, short of sanctions, that can be somewhat effective in inducing compliance. There is a strong social component in defining an acceptable level of compliance. For example, it is generally assumed that it is acceptable to drive up to ten miles per hour faster than the posted speed limit. In the international legal system, there are similar gray areas within which the question of violation is a question of subjective judgment. The acceptable level of compliance is set by the community of states which are all subject to the same process.

The conception of compliance is more complex and ambiguous than is generally recognized. There are clear examples, such as Iraq invading Kuwait, and North Korea developing an atomic weapons program, of states acting deliberately to violate international norms, but these cases are rare. Most deviant behavior in the international system does not result from intentional actions to violate international law. First, there is ignorance. Governments are often not aware, at the level at which the action is taken, of the existence of the international norm they are violating. One way of dealing with this problem is increased transparency: offering more information to the actors about the norm and about what other players are doing to remain in compliance. For example, Chayes says, we place more emphasis on lines on the road and instructional signs to provide information to drivers about what behavior is expected than we do on enforcement by police.

A second source of deviance is lack of capacity do the governments that undertake certain obligations have the capacity to carry them out? Can the government control emissions of CFCs or greenhouse gases, for example? In these cases, the state is used as a vehicle to access the behavior of individuals. Regulatory agreements often deal with deep patterns of individual and corporate behavior, and so are very difficult to enforce. A third source of non-compliance is ambiguity in the law. A fourth is that states often have other priorities that take precedence over the norm in question. Incentives, subsidies and inducements can sometimes be used to help change these priorities. A fifth source of deviant behavior is that it takes time to move toward compliance. Phase-ins and "grandfather" clauses can be used to address this. Such measures result in a process of moving toward compliance.

Measures to induce compliance may be more effective if the objective is not to assign blame or punish, but rather to improve performance.

Measures to induce compliance may be more effective if the objective is not to assign blame or punish, but rather to improve performance. Participants are under an obligation to justify their conduct in light of their commitment. There is an implicit linkage to other issues in the regime and to issues in other parts of the legal system. There is evidence that reviews of compliance generate pressure for change in government policies because nations operate in a dense social and institutional context. Membership in good standing in the world community is essential for states to reach other goals that are important to them. This is their principal incentive for compliance.

Reporting, Review and Assessment

Reporting, review and assessment provide a performance-based way of looking at compliance. Such a process has some significant antecedents, for example, the Organization for Economic Cooperation and Development's (OECD) environmental policy review. This review asks, among other things, how well nations are fulfilling their international commitments on environmental policy. Countries are reviewed every two years. The first two or three reviews are very gentle and then the intensity of the review is ratcheted up. Such international processes can also help players to accomplish their goals in the domestic arena.

Another such process is the informal trade policy review mechanism established under GATT and taken over in full by the WTO. In this process, the U. S. and the European Union countries are reviewed every two years, while other countries are reviewed less frequently, thus concentrating on the countries that have the most effect on the global economic system. The process begins with self-study by the country up for review. In cases where there is a capacity problem, the country may be provided with help. One method of providing help is placing trained personnel in the relevant ministries of countries with capacity problems. After each country's internal review, the secretariat makes a study (in OECD cases, an independent

study) based on background information. The secretariat makes comments and gives the country under review a chance to modify its report. The report is then forwarded to a committee of representatives of the parties.

The secretariat defines the most important compliance issues. The main critique is by government representatives with a significant understanding of the issue and staff to brief and prepare them. The purpose of this process is simply to make each country's plan better; there is no blame involved. The final step is some form of memorialization (the level of documentation varies). Memorialization usually takes the form of the chairman's summary of the discussion. These final reports do not contain formal or legally binding commitments. In future reviews, performance is measured against what the country said the last time it was reviewed, and what they have done since that time. This is not so much an incremental approach to an objective standard as it is a continuing bargain, with the terms of the bargain changing as the undertaking gets more specific.

Reviews of compliance generate pressure for change in government policies because nations operate in a dense social and institutional context. Membership in good standing in the world community is essential for states to reach other goals that are important to them.

A detailed study of the reporting, review and assessment process is needed at many levels. States are increasingly aware of the power of this process and for this very reason, there is some resistance to it. The Framework Convention on Climate Change (FCCC) has en countered some of this resistance. The current FCCC treaty obligation is to "communicate" certain information to the conference of the parties (CoP) for review, but this language obscures the question of whether compliance is to be reviewed country by country or just generally. The term "report" would imply a more formal process than the term "communicate." This issue arises again in the implementation stage of the treaty. The direction seems to be toward a significant reporting and assessment process, but some countries are worried about this. It is precisely because this process is powerful that many countries are concerned about it.

Language in Article 7 E says that the CoP will "assess on the basis of all the information made available to it ... the overall effect" of steps taken to comply with the agreement. Reporting requirements for Annex 1 (i. e., industrialized) countries are fairly elaborate. They are to report on "policies, programs, and measures undertaken with the aim of reducing emission of greenhouse gases (GHGs) to 1990 levels by the end of the century." In addition, they are asked to report on current GHG inventories and projections for future emissions of all GHGs. Less developed countries have fewer reporting requirements but in order to secure funds from the Global Environment Facility's (GEF) Climate Fund, they will have to report in some detail. The GEF has $3 billion over the next three years allocated to high priority areas, one of which is climate.

The OECD and the Intergovernmental Panel on Climate Change (IPCC) developed very elaborate standards for Annex 1 country reporting. Guidelines for making reporting comparable were adopted four months before the CoP meeting in Berlin, but these guidelines apply primarily to GHG inventory reporting. There is still no single set of guide lines for the other reporting requirements. At the CoP in Berlin, there was also some discussion about the depth of review. The issue is still an open one but a fairly deep paper review is what is implied so far.

Trade Restrictions for Environmental Purposes

There are precedents for the use of trade restrictions for environmental purposes but it does not seem as though such restrictions will become part of the FCCC. Examples of such restrictions can be found in the Convention on International Trade In Endangered Species (CITES), the Montreal Protocol on Substances that Deplete the Ozone Layer, and U. S.

unilateral restrictions to protect marine mammals from tuna drift nets. The Montreal Protocol restricts trade in controlled substances with non-parties; this is essentially not a sanction for violation but an anti-free-rider provision designed to bring non-members into the treaty and to protect participants' markets against non-participants' markets.

It is not expected that trade restrictions will be accepted as part of the FCCC. Trade incentives may be included, but the notion of customs-like restrictions for keeping out particular products is not likely to be acceptable to the parties. There may, however, be boycotts of certain products, organized by non-governmental organizations. In addition, social pressure can be a powerful force. For example, CITES wouldn't hold its meeting in Kyoto if Japan opted out of the ivory ban.

Effects of Financial Transfer Mechanisms on Environmental Policy and the Natural Environment: Lessons From International Aid Programs

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While environmental policy reform and clean-up were initially a priority of East Central European recipients, these priorities shifted as the challenges of economic restructuring came to dominate the political agenda.

Gutner discussed how effective flows of money from rich to poor nations have been in terms of influencing environmental policies in recipient countries and improving the quality of the natural environment. There are few examples of unqualified successes. There are many cases in which funding is insufficient, donors and recipients have different priorities, organizational inertia abounds, and turf battles arise among institutions. Problems related to capacity building exist on the parts of both donors and recipients. Financial transfers rarely achieve donor goals when they conflict with recipient priorities. Even when priorities coincide, donors' own interests and operating practices can divert them from their goals. Donors must also work to build their organizational capacity so that they can do what they have promised to do. In addition, there are problems that result in translating from macro strategies to micro level impacts, and problems with turning environmental concern into action.

Gutner examined the problem of capacity building within donor institutions by discussing the impact of the largest donors providing environmental assistance to East Central Europe from 1989 to 1994. The institutions examined were the World Bank, the European Bank for Reconstruction and Development (EBRD), the European Union's PHARE program of grant-based assistance to Eastern Central Europe, and bilateral aid. The case of East Central Europe is an example of a region of the world facing serious environmental problems. However, the ways in which donors have selected distinctly different solutions to apply provides an illustration of how organizational inertia can thwart donor goals.

When the major donor agencies providing assistance to Eastern Europe were confronted with new or additional environmental problems, they tended to apply a familiar set of preferred solutions, constrained by institutional interests, organizational structure, and the financial tools available. Because institutions tend to do what they do best, they took old solutions and tried to make new problems fit them. This, of course, has consequences for how effectively aid is provided.

Organizational inertia results in:

* poor fit between financial mechanisms and the specific environmental problems identified
* practices providing more economic benefits to the donor countries than environmental benefits to recipients
* institutions hampered in their attempts to fulfill their environmental mandates
* geographical gaps in coverage

As a result, the aggregate assistance is much less than the sum of its parts.

Certain priority areas are simply neglected. An example of this is particulate air pollution from low stack emissions from domestic heating and small and medium-sized enterprises. This is a major problem in terms of human health impacts, but it requires many small projects which often fall between the crack of what the multilaterals and bilaterals fund.

Donor priorities for cleaning up the environment of East Central Europe included: 1) the desire to reduce transboundary pollution, 2) humanitarian aid, 3) export benefits to donors, and 4) pressure from domestic environmental groups. While environmental policy reform and clean-up were initially a priority of recipients, these priorities shifted as the challenges of economic restructuring came to dominate the political agenda. Now, many recipients do not want loans, because they do not want to increase their public sector debt; instead, they seek grants. Overall, there is about $3 billion in assistance available for $20 billion in needs, but international agencies can be influential in keeping the environment on the agenda.

It is difficult to find loans that are attractive to both banks and recipients. Recipients don't want to increase their debt, while the banks have had a difficult time finding "bankable" environmental projects that generate revenue, have a strong local contribution, and a sufficient guarantee that the borrower will be able to repay.

Early attempts at coordinating and prioritizing environmental assistance were overcome by organizational inertia. PHARE was supposed to coordinate all bilateral donor aid but that did not work, mainly because each country wanted to promote its own interests (the French wanted to promote nuclear power and water projects; Austria wanted to reduce transboundary air pollution in their direction, etc.). The lack of shared interests made for poor cooperation. Early aid projects in the region were characterized by a great deal of overlap and a shopping list approach.

The next initiative occurred in 1990-91, when the Czechoslovak federal environment minister, Josef Vavrosek lobbied for a permanent Council of European Environment Ministers. This initiative also failed, because donors were uninterested in setting up new institutions. However, it did result in what is now called the Environment for Europe process, which is a series of biannual meetings of Eastern and Western environmental ministers aimed at better prioritizing and coordinating environmental assistance to East Central Europe.

Perhaps the most important outcome of this initiative is the Regional Environmental Action Programme (EAP) for Central and Eastern Europe, an ambitious document written largely by the World Bank, that seeks to identify and prioritize the region's environmental problems and propose policy solutions for solving these problems. The EAP was endorsed by environmental ministers at their Lucerne meeting in 1993. The EAP contained the following basic themes:

* seeking cost effective solutions
* using the level of damage to human health as the major criterion for prioritizing environmental concerns
* highest priority was particulate air pollution
* other concerns include lead in air and soil, nitrates in water, contaminated drinking water from poor disposal of hazardous and nuclear wastes

In sum, the highest priority problems identified by the EAP and endorsed by the ministers are primarily local, not transboundary problems.

EAP policy recommendations include:

* policymakers/donors should support win-win economic reform policies with environmental benefits

* establish framework of incentives/institutions to discourage emissions of pollutants
* and biodiversity loss in cost-effective manner
* environmental spending should go to projects with the highest benefit-cost ratios
* "modest" expenditures should be set aside for programs that have long lead times from start to finish, but still have high benefit-cost ratios.

Pros and Cons of EAP

Pros

* set regional priorities for the first time
* produced a Project Preparation Committee and Task Force, which may be a catalyst for cooperation
* The Sophia conference of environmental ministers, which takes place in October 1995, may produce additional results including a possible joint implementation project for Eastern Europe on GHGs, an effort to phase lead out of gasoline, and a working group on private sector involvement in Eastern Europe.

Cons

* no additional donor funding was attached to it
* national priorities still differed from regional priorities
* challenge of implementing such a broad document

Very few stand alone environmental projects are being funded by either the World Bank or the EBRD. Instead, they do what they do best - lending for large supply side energy projects with a lack of emphasis on demand side management or end-use efficiency.

Gutner also examined the sources of organizational inertia within specific donor institutions. The multilateral development banks are hampered by difficulty in finding loans that are attractive to both banks and recipients. Recipients don't want to increase their debt especially for environmental projects. The banks, in turn, have had a difficult time finding "bankable" environmental projects that generate revenue streams, have a strong local contribution, and a sufficient guarantee that the borrower will be able to repay the loan.

In sum, very few stand alone environmental projects are being funded by either the World Bank or the EBRD. Instead, they do what they do best lending for large supply side energy projects with a lack of emphasis on demand side management or end-use efficiency. The banks - particularly the EBRD - are also starting to fund waste water treatment plants, although there is some question about the relative human health benefits of these projects.

There are, however, a few sources of innovation. Within the World Bank, geothermal heating projects are planned in Poland, Slovakia and Hungary. Integrated forest development projects are planned in Poland and Albania, but the jury is still out on whether these will happen or have the desired environmental benefits. A Polish $18 million environmental management project is viewed as a success, and is the basis for a similar $100 million Russian project. A $25 million environment project planned for Slovenia will focus on building and expanding district gas heating networks as a means of reducing ambient concentrations of particulates and sulfur dioxide. The EBRD, in turn, recently created a new Energy Efficiency Unit to help fund small energy efficiency projects.

PHARE and the bilaterals, in turn, rely more on small grants, meaning that they lack the financial tools to implement projects requiring significant capital. Instead, they tend to fund small technical assistance projects such as studies, training, technical expertise, legislative

assistance, and small grants for equipment purchases. They have been criticized for spending money on expensive Western consultants who often write feasibility studies not linked to specific investments. Most bilaterals are also very self-interested in developing their own export markets.

Given these examples of organizational inertia, what are the positive and negative attributes of the Project Preparation Committee, which was set up to act as a matchmaker to bring together bilateral grant money and multilateral bank loans for projects consistent with the EAP?

Pros

* encourages formal efforts at co-financing, which can enhance coordination and reduce duplication
* encourages ongoing dialogue between bilateral/multilaterals
* greater likelihood of bilateral feasibility studies leading to concrete investments
* appears to speed up project cycle

Cons

* does not formally involve recipient countries
* appears to bring bilaterals into multilateral projects
* unclear whether any "new" ideas will be funded
* no sign yet of bilateral/bilateral projects
* is it meeting the goals of EAP? The majority of matched projects to date are in waste water treatment.

In conclusion, the case of Eastern Europe highlights the ways in which donor institutions are constrained through their interests and mechanisms from pursuing an optimal strategy for tackling the regions environmental problems. The pattern is often one step forward, two steps back, Gutner says. Any environmental improvements will occur on the margin, but indeed, some of these are occurring.

The pattern is often one step forward, two steps back, Gutner says. Any environmental improvements will occur on the margin, but indeed, some of these are occurring.

An Extreme Climate Event in Nepal and its Implications for a Climate Change Regime

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For much of South Asia, 50% of the monsoon rainfall comes in just 15 hours, in spells of 50 to 100 mm per hour intensity. How can such an event be managed?

Gyawali brings lateral thinking, specifically from a Third World perspective, to discussions of responses to climate change. He described an extreme climate-related event and how its lessons might apply to the current debate regarding a climate change regime.

In August of 1993, a cloud burst over central Nepal resulted in the highest recorded rain fall in the Kingdom, wiping out much of the infrastructure in the central area of the country. All four major bridges leading to the capital and the nation's largest power plant were severely damaged, eliminating 40% of the nations' power supply and leading to shortages of essential items such as food and fuel in the capital city. The loss of life directly at tributable to the cloud burst is estimated at 2,000 people. In addition, 38 irrigation systems on which agricultural production depends were destroyed, and many paddy fields in the valley plains were left filled with huge boulders, rubble and sand.

The agricultural production of India, Nepal, Bangladesh, China, and other countries in the region are dependent on the rainfall brought by the monsoon from the southwest Indian Ocean. The reversal of the Trade Winds, which blow generally from the northeast, due to a strong low pressure zone in the Punjab Rajasthan plains, brings this periodic feature which is the life blood of these areas and feeds all the major rivers of the region. On average, the region receives 1000 to 1600 millimeters of rain per year, with some local areas receiving as much as 4000 mm. Of this annual amount, about 80% falls during the three months of the monsoon, resulting in a permanent situation of alternating drought and flood. Recent analyses of data show that, for much of South Asia, 50% of the monsoon rainfall comes in just 15 hours, in spells of 50 to 100 mm per hour intensity. How can such an event be managed? How should an attempt be made to provide for storing this water? Should local ponds be built to collect water where it falls, or should high dams at river valley gorges be constructed to collect water where it concentrates?

The location of the "monsoon trough" - the place where the winds actually reverse direction - is critical for determining exactly where the rain falls. The location and amount of rainfall is related to the position of this trough. A 15 kilometer shift in the position of the trough can signal drought or flood for particular localities. This is important because some 500 million people are dependent upon the agriculture of this area. A delay of a monsoon by just 15 days can take people in one locality or another from affluence to poverty. A system of bonded labor has developed over the ages in the feudalism of this area in which several generations of a poor family are required to work to pay off the debt that can result from such a shift in the monsoon trough. Such is the level of vulnerability of the people in this region, most of whom live at the precarious margins of existence.

The cloud burst event that resulted in the extreme rainfall on August 20, 21, and 22 of 1993 is, with recent analysis, considered to be a natural phenomenon that could occur every 10 to 15 years in a given place. However, the intensity of the precipitation was such that measurements were extremely difficult to make. Among the debris carried by the raging torrents of a previously small, nondescript stream was an 8,000 ton boulder which smashed the penstock and intake of the largest powerplant in the country. It was impossible to walk to the gauging station to take readings with the storm intensity so high and continuous lightning flashes and thunder.

The rainfall began suddenly and produced three high level spikes of cloudburst totaling 540 mm. The country's only major hydropower reservoir filled 20 meters in 9 hours. The first spike was characterized by 50-60 mm per hour rainfall, followed by a second burst of 69 mm per hour and then a third of similar magnitude which actually did the most damage. Trees felled by the first two spikes created watercourse obstructions. The last spike uplifted this debris and "bulldozers" made up of trees, rocks and debris moved through the area and wiped out roads, bridges and entire settlements.

It is very difficult to know whether events like this are being exacerbated by climate change or not.

A number of lessons involving technology arise from this event. Much of the Third World is in non-temperate zones where violent climatic events are "normal" and require a different kind of technology. On one hand, it is necessary to build infrastructure to withstand extreme events, but on the other hand, this is very expensive. All too often, social pressures determine what is built rather than what managing extreme events requires. The Bagmati irrigation barrage lower down on this river was built with a design flood level of 8000 cubic meters per second even though there was one outlier event on record that reached 12,000 m3/second. The August 1993 event reached 15,000 m3/second and the flooding left huge tree trunks on top of the barrage gates and gantries.

The siltation rate for the Kulekhani hydropower reservoir, consisting of the biggest dam in country with 126 square kilometers of catchment, was estimated by the design study to be 400-700 cubic meters per hectare per year in the original design report done by Japan International Cooperation Agency (JICA). The World Bank appraisal reduced it to 400 and it was built accordingly. A survey conducted immediately before the flood showed that the actual 13-year siltation was 4000 m3, ten times the design criteria. Then came the massive flood, and with it came 40,000 m3, 100 times the design figure. In general, dams in the Himalya regions of India and Pakistan have been found to accumulate 4 to 16 times the siltation of the design figures. Much of the siltation comes in pulses of great magnitude every couple of years.

The task of conducting an economic analysis is obviously daunting. The costs of restoring people to their state of well being before an event such as this flood are so enormous that no one has even begun to estimate them for central Nepal.

Social repercussions of the event have been very large. For example, one community which lost its water system to the cloud burst is located in the middle of a national park. This village of very poor, marginal people is extremely vulnerable to such events. The women now have to walk through a national park full of armed guards to collect water, and there have been many instances of abuse and rape connected with this. The community is essentially at war with the state, and such micro political dynamics may provide important lessons of what can follow such events. These kinds of dynamics can overshadow international agreements, especially regarding arrangements such as joint implementation.

Important lessons for climate change include the fact that our scientific understanding of many natural processes, especially those that occur in non-temperate zones, is very poor and must be improved. Such basic science has practical application as it can help with decisions such as how to conduct intervention measures such as building dams so as to avoid damage from extreme events. Another lesson is that it is very difficult to know whether events like this are being exacerbated by climate change or not. Learning more about these processes should help to understand and tackle such questions much better.

In addition, Gyawali believes that social limits to growth will arrive long before physical limits and therefore, we must concentrate on these social challenges or they will make the physical problems moot. “The last man will have eaten the last woman long before the last tree falls,” he says.

Important lessons for climate change include the fact that our scientific understanding of many natural processes, especially those that occur in non-temperate zones, is very poor and must be improved.

These social issues are driven by marginality. Marginality, Gyawali says, means having no options. To be marginal means if you don’t find a job that day you don’t eat that night. Third World governments are so pressured by their many marginal people that they cannot conform to international treaties that will hurt them, even if they sign them. The pressure to do something about poverty is huge. The transition to democracy means that the government has to cater to this constituency (which actually votes).

Gyawali also stressed that in the Third World, the nation state as a unit of discourse is only one of a coalition of loyalties. People also have loyalties based on village, religion, ethnicity, region, language, etc., and the nation state loyalty may not be their highest one. Especially if the state does not serve the interests of the people, their loyalty will be transferred to these other units that often transcend national boundaries, and when that happens, the treaties and discourses based on the nation state unit may become totally irrelevant.

One major difficulty in tackling these realities in the South (and perhaps in the North) is the issue of institutional inflexibility and built in filters that do not allow new ideas through until it is too late. Thompson (Water Nepal 1994 , Vol. 4 , No. 1) says there are early warnings that a technology is headed for entrenchment rather than flexibility. He identifies four indicators of technical inflexibility; beware of projects which 1) are large scale, 2) have long lead times, 3) are capital intensive, and 4) have a need for major infrastructure early on.

He further identifies four indicators of organizational inflexibility; be wary of 1) single mission outfits, 2) closure to criticism, 3) hype (as in “If we don’t cover the Himalaya with trees Bangladesh will sink forever beneath the waves”), and 4) hubris (often in the form of over-confidence as to what the future holds, or categorical certainty that “there is no alternative”). Together, these eight factors form a collage of rigidity that makes change very difficult. Implementation of the Climate Change Convention protocols will also be faced with transcending these indicators of inflexibility.

Development of U. S. Climate Policy

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Alan Hecht discussed the evolution of U. S. climate policy, beginning with a review of its history. In the early days of climate policy, from 1960 to 1976, science played a dominant role, with an initial focus on weather modification, climate/weather variability (droughts, floods), and long term trends (initially, concern about climate cooling).

Beginning in the 1980s, policy questions related to climate change came to the fore, driven by concerns regarding adequacy of future food supply, energy policy, cost of policy actions (wide ranging estimates), type of actions (voluntary, individual responsibility, Federally regulated), financing (how to deal with developing countries), North-South issues (sustainable development, partnerships), and politics (certain politicians seized the issue, etc.).

In the 1990s, the policy debate led to several proposed actions. The U. S. resolved its political issues by focusing on a "no regrets" strategy and voluntary actions. International agreement settled on an aim to reduce greenhouse gases by the year 2000 to 1990 levels. Developed countries agreed to some financing for less developed countries to assist in the inventory of greenhouse gases and in mitigation strategies.

The ability of the U. S. to reach its emission reduction goals depends on Congressional funding of the President's Action Plan. The House of Representatives is now taking measures that will have a large impact on current and future carbon emissions, i. e., cutting funding for EPA and DOE programs that improve energy efficiency and development of renewable sources of energy. If the U. S. relies solely on its voluntary action plan, it will fall short of its goal of reducing emissions to 1990 levels by the year 2000 by an estimated 95 million metric tons of carbon. Actions proposed by the House will reduce the EPA budget by 33%, eliminate energy-related programs, prohibit new appliance standards, and cut research on energy efficiency and renewable energy. If this effort succeeds, the U. S. will fall further behind in its effort to reduce carbon emissions and will also lose ground in international competitiveness. Reductions of this magnitude will likely hamper the United States' ability to achieve its carbon reduction goals with voluntary programs. New plans, currently under revision, will address options for greenhouse gas reductions after the year 2000.

Within the Framework Convention on Climate Change (FCCC), the EPA's Country Studies program has assisted many developing countries with $150 million in grants for carrying out analyses and assessments and for developing products (usually in the form of well-documented reports) for distribution to the international community. The studies also help establish a basis for forming and updating national programs that contain measures for mitigating climate change and facilitating adaptation to climate change as required by the FCCC. Through this program,

Policy issues should not be abandoned while waiting for more scientific certainty.

carbon emissions inventories have been produced in Russia, China, Nepal, Mexico, and dozens of other countries. The initial program is coming to an end but an additional $2 million is budgeted for phase two to assist countries in developing national action plans.

Regarding the science of climate change, there has been a renewed effort to challenge the premise of human-induced climate change. The Marshall Institute and others argue against taking any policy action until the science of climate change is better understood. This suggestion is fundamentally at odds with the "process" oriented approaches of international agreements which depend on taking a suite of actions and continuously making revisions as appropriate. Policy issues should not be abandoned while waiting for more scientific certainty.

The first meeting of the FCCC Conference of the Parties (CoP) in Berlin resulted in an agreement to discuss, on an ad hoc basis, emission reduction after the year 2000. This is an important step which will keep the process and momentum going. The CoP in Berlin also agreed to a pilot program on Joint Implementation (JI). The U. S. Initiative on Joint Implementation (USIJI) relies on Article 4.2 (b) of the FCCC which discusses reducing GHG emission "jointly with other parties." Criteria used by the U. S. for JI projects are:

The central principle of JI is that it is often easier, more cost effective, and achieves the same goal to help a developing country become more efficient and less polluting than to get further reductions in a developed country.

* acceptance by the national government of the host country
* "additionality" of emissions reductions, demonstrating reductions above and beyond what would occur under the host country's national planning program
* monitoring and verification of emission reductions
* non-GHG environmental impacts
* development impacts
* efforts to reduce domestic emissions by U. S. participants
* efforts by the host country to ratify the convention, develop climate programs, and reduce emissions

Under the IJI, the U. S. government acts as a broker and endorser to facilitate private companies' agreements with other governments. At this point, there are no international credits given for JI projects but many companies involved are betting that there will be a credit system of which they will become a part. So far, private U.S. companies have come up with $40 million for eight projects which meet the criteria of USIJI. These projects include an effort in Costa Rica to stabilize and expand forest cover, a project in the Czech Republic for fuel switching for district heating, a rural solar electrification project in Honduras, and an afforestation project in Russia. The central principle of JI is that it is often easier, more cost effective, and achieves the same goal to help a developing country become more efficient and less polluting than to get further reductions in a developed country.

Within the context of the FCCC's Climate Technology Initiative, the U. S. EPA will create international centers to promote regional energy efficiency and renewable energy in order to advance technologies that will reduce GHG emissions.

In terms of current and future actions related to climate change, the U.S. is aiming to:

1. Promote a long term view

2. Support a strong science program

3. Promote domestic action plan a) executive orders (such as the energy efficiency retrofit of the White House), b) voluntary programs in climate action plan, c) state actions

4. Shift emphasis of country studies from inventories to national planning

5. Show leadership in the FCCC, with emphasis on the reporting process

6. Support broad international social science agenda (population conference, etc.)

7. Enhance bilateral cooperation to complement and supplement the FCCC effort, with an emphasis on Big Emerging Markets (export promotion, high investment potential, commercial diplomacy with sustainable development objectives)

8. U.S. Technology Initiative to showcase and demonstrate environmentally friendly technologies that are to everyone's benefit

9. Support environment-trade linkages, especially efforts in industry to do environmental accounting and eco-efficiency

10. Promote greening of commercial diplomacy, i.e., activities to promote sustainable development, pollution prevention, and "twinning" of non-environmental and environmental sectors.

Is there enough in this general approach of technology assistance, private sector ventures, technology promotion, and trade, for individual countries to take "no regrets" actions which will, in the end, have a significant impact on GHG emissions? Isn't it in all countries' best interests to do things that make sense for many other reasons without even raising the climate change flag?

A domestic debate is going on within the administration regarding possible effects of actions to reduce climate change on economic growth and jobs. What might be the cost to the U.S. economy of taking action, and when should such action be taken? How much should the federal government regulate action? Will working with industry on an export promotion strategy be effective? The overall U.S. strategy is to look for levers and fulcrums, such as trade policy, for advancing the cause of mitigating climate change. While it was suggested that targeting the pricing of resources such as energy, water, and agricultural products worldwide, in an effort to reduce subsidies and include externalities, would be an effective policy, these actions lack political support at present. More general, "international no-regrets" actions across all economic sectors may be a more viable greenhouse gas reduction strategy in the short run.

The overall U.S. strategy is to look for levers and fulcrums, such as trade policy, for advancing the cause of mitigating climate change.

Lessons Learned from International Cooperation to Combat Acid Rain in Europe

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The acid rain treaty turned what was a two country problem (Sweden and Norway) into a world issue.

Levy discussed lessons relevant to the climate issue we might learn from the acid rain case, specifically the Long Range Transboundary Air Pollution Treaty (LRTAPT)? The acid rain treaty turned what was a two country problem (Sweden and Norway) into a world issue. It provides a:

* case study of effective translation of macro-level effects to micro-level impacts.
* case study of strategies that effectively overcame the problem of contrary political elements.
* model for generating politically influential scientific evidence and advice.
* model for coping with compliance and implementation problems.
* model for handling the participation question.
* cautionary tale of what happens when neglect capacity bottlenecks, equity problems arise, and financial transfer issues arise (or what happens when ingenuity is applied to transnational understanding and not transnational action)

Effectiveness is a function of ingenuity, luck and circumstances. It will not work to simply look at the acid rain case and copy what worked and avoid the mistakes and hence solve any other problem. Many of the positive outcomes, as well as the failures in the acid rain case, are a function of circumstances. Therefore, lessons are focused on the marginal impact of ingenuity as manifested in creative institutional design and political strategies, and in the absence of potential institutional and strategic choices.

Social problems are a function of low levels of the three Cs:

* concern (interests, understanding)
* capacity (technical, administrative, legal)
* contractual environment (ability to strike productive bargains)

Effective institutions intervene and raise the levels of the three Cs so that social progress is possible.

Evolution of the European Acid Rain Problem

1872 - Robert Angus Smith discovers a local-level phenomenon resulting from the practice of sending sulfuric acid into the atmosphere, and coins the term “acid rain.” The problem disappears as this practice died out.

1**950s** - Interest was sparked in the transboundary flow of sulfur and nitrogen from pollution sources as agricultural nutrients. This was thought to be a good thing as it replaced fertilizer by providing free nitrogen. A monitoring program began to help recipients know how much they were receiving so they could adjust fertilizer applications.

1968 - Svante Oden hypothesizes long range transport as source of Swedish aquatic acidification, and accuses the rest of Europe of launching an "insidious chemical war" on Scandinavia.

1971 - Stockholm conference. Bolin authors Swedish case study on acid rain. Organization for Economic Cooperation and Development (OECD) establishes comprehensive monitoring and modeling program of long range transport.

1977 - Bruntland and Brezhnev agree to seek European convention to limit acid rain.

1979 - Convention on Long-Range Transboundary Air Pollution was signed by all countries eligible to sign it.

Signatories to the 1985 Sulfur Protocol have reduced their emissions by over 30% while non-signatories reduced by less than 10%.

Less than one-quarter of the signatories to the treaty had any interest in the environmental problem, and only Sweden and Norway had a direct interest. A large part of the reason the other 32 nations signed it was because of the timing, coinciding with East-West détente and the move to deepen international understanding. It was two years after the Helsinki conference that there was finally action on this even though Sweden had been trying to get action since 1968. Also, there was new domestic research in Germany that first made the link between acid rain and forest die off.

Table 7.1, arranged by totals, shows total and per capita sulfur emissions and reveals that Sweden and Norway, which suffered most from the problem, had some of lowest levels of per capita emissions. The estimated cost of damage was much higher than the cost of abatement, but since transnational acceptance of cost figures was poor, these analyses had little or no political effect. OECD figures showed that human health effects were very large, but since health effects are local, these studies had little effect politically.

Legal Instruments of LRTAPT

* 1979 Framework Convention
* 1985 SO2 Protocol (30% cuts)
* 1988 NOx Protocol (freeze)
* 1991 Volatile Organic Compounds (VOC) Protocol (freeze, cuts; a wider variety of chemicals covered)
* 1994 Revised SO2 Protocol

The 1985 Sulfur Protocol is an example of politics over science. It required 30% reductions in SO2 emissions (from 1980 levels) by 1993. While 17 parties signed the Protocol, 11 eligible parties did not. Signatories have reduced their emissions by over 30% while non-signatories reduced by less than 10%. Overall, European emissions were reduced by about 25%. Table 7.2 shows percent change in sulfur emissions by ratifiers and non-ratifiers of the SO2 Protocol. There are no penalties for not meeting the targets.

Table 7.1
Sulfur Emissions by Country (1980)

	Total (thousands of tons)	**Per Capita** (kilograms)
OECD Countries		
United States	23,780	107
United Kingdom	4,897	88
Canada	4,643	196
Spain	3,377	91
France	3,348	63
Italy	3,211	58
Japan	1,263	12
Belgium	828	84
Finland	584	108
Netherlands	502	36
Sweden	489	59
Denamrk	449	88
Austria	397	53
Norway	141	34
Switzerland	126	19
Former Soviet Bloc		
USSR	25,000	95
East Germany	4,323	257
Poland	4,100	119
Czechoslovakia	3,100	204
Hungary	1,633	168
Bulgaria	1,094	119

Sources: EMEP figures, printed in World Resources Institute, (1994, p. 367). USSR figure is UNECE figure for 1982, quoted in McCormick (1989, p. 14).

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During Protocol negotiations, when it appeared difficult to engineer compliance, the agreement was reworked to make it easier. For example, when the Soviets resisted reducing sulfur emissions by 30%, language was added allowing either the 30% reduction or a 30% reduction in transboundary fluxes. This enabled the Soviets to comply by simply moving some coal and oil plants further from their border, and much of this movement was happening anyway for other reasons. (They were also moving nuclear plants closer to their border.) Moving the fossil fuel plants to Siberia caused Arctic haze but that wasn't a concern at the time.

Table 7.2
Percent Changes in Sulfur Emissions, 1980-1992

Ratifiers of the SO_2 Protocol	
Austria	-81
Sweden	-80
Norway	-72
Finland	-67
France	-64
Belgium	-62
Netherlands	-62
Switzerland	-53
Slovakia	-47
Denmark	-46
Bulgaria	-45
Hungary	-45
Italy	-43
Germany	-40
Russia	-39
Ukraine	-38
Czech. Republic	-32
Canada*	-29
Non-ratifiers	
Poland	-31
Spain	-28
UK	-27
Romania	-22
Ireland	-20
USA*	-13
Yugoslavia	-4
Portugal	+7
Greece	+27

*Change between 1980-91
Source: Calculated from EMEP data in Agren, 1994e.

Factors contributing to reductions in acid deposition included coincident industrial change, reaction to local health problems, and national self-interest. The total amount of reduction directly attributable to the LRTAPT through 1985 is probably quite small.

The convention took over the OECD monitoring network and collected deposition data, linked it with historical meteorological data, and used diffusion models to determine impacts. This allowed sources and recipients of emissions to be pinpointed. Two centers handle this effort, one in Oslo and one in Moscow, and this duplication and checking increases political confidence.

In broadening and deepening the scope of the monitoring program, scientific working groups were set up aimed at effects on forests, crops, freshwater ecosystems, and materials. This process integrated monitoring and created new knowledge in a politically motivated way. It also served to actively broaden the base of contributors as well as improve existing information. In a similar way, one major goal in creating the Intergovernmental Panel on Climate Change (IPCC) was to ensure broadening of participation (especially from the Soviet Union) and get buy-in from as many nations as possible.

To what can the reductions in acid deposition be attributed? One key factor was coincidental industrial change (including switching to different fuels). Another factor was the reaction to human health problems at the local level, which coincidentally reduced long range emissions. And many reduction measures were undertaken for reasons of national self-interest. The total amount of reduction directly attributable to the LRTAPT through 1985 is probably quite small.

Regarding the contribution of scientific evidence, while there was scientific consensus on the effects of acid rain on fresh water ecosystems, there was less of a consensus regarding effects on forests and other impacts. Interestingly, the largest political impact came from an area in which the science was the least clear, namely, the effects on forests.

Integrated assessment models like the RAINS model from International Institute for Applied Systems Analysis (IIASA) used critical levels, transport and emission data, and reduction cost data to create optimum reduction scenarios. "Critical load" is defined as the highest load that will not cause chemical changes leading to long-term harmful effects on the most sensitive ecological ecosystems. "Load" refers to the amount deposited from air to ground, while "level" refers to the atmospheric concentration. Using a concept from toxicity, impact and deposition load are determined and the level at which impact goes to zero is aimed for.

In the end, the Protocol that was signed was simply a codification of the status quo, representing improvements that nations were going to make anyway.

Mapping activities were undertaken in which the most sensitive receptor was selected (excluding the 5% most sensitive organisms) and dose response data was used to find the critical load (assessed consensually and revised as needed). A mapped distribution of receptors was prepared and transformed into a map of critical loads/levels (following consensually agreed upon methodology). Total damage is defined as a function of both the amount of deposition and the sensitivity of receptors. This information results in an exceedence map which reveals the areas that exceed the acceptable level and are thus damaged by deposition. There is political power in publicizing results of these mapping efforts. For example, a black triangle on the map downwind of the United Kingdom implicates British emissions.

What is the process of moving from such a mapping activity to a regulatory framework? With the goal of reducing the dark areas on the map, a first order analysis of differences in abatement costs is performed and then simulations of emission reduction scenarios and then deposition scenarios are performed. More reductions will take place where they are less expensive; this is the basis of the tradable permits idea. Variance in abatement cost is largely a function of available fuel supplies and how much reduction had already been done. The RAINS model scenario aims at reducing the gap between a total absence of acid rain and the status quo by 60%; a goal of no acid rain is not deemed feasible for political and economic reasons.

Critical loads in practice turned out to be different than critical loads in theory. After the signing of the Protocol, scientists were dissatisfied because political compromises resulted in environmental harm (as in, for example, the agreement to eliminate consideration of the most sensitive 5% of organisms). In addition, countries adopted different target years for political expediency, measurement errors were exploited, and countries with large land masses (including the Soviet Union and Norway) were permitted to exempt some areas.

Because of such loopholes, critical loads failed as a policy tool. In the end, the Protocol that was signed was simply a codification of the status quo, representing improvements that nations were going to make anyway. According to one observer, this was "a humiliating blow to the scientific effort that has under pinned the running of the Protocol. The replay delivered to the scientists has been: 'No, you are wrong, there is no role for science in international negotiations,

we are going to ignore you, you might as well not have bothered to carry out this work'." So, some believe, not only was science irrelevant, but there was no change from the status quo in policies.

But Marc Levy believes that is not the full story. He believes that the European acid rain experience led to an alteration of the political landscape in North America that advanced the cause of reducing acid rain. Further, Levy believes the 80% reductions by the British would never have happened without the Protocol process. In the Netherlands, the Protocol was taken seriously and integrated into domestic law. The Dutch looked for additional sources of pollution, lowered critical load levels, and changed internal laws as a result of LRTAPT.

Positive lessons from LRTAPT that relate to CO2 emissions reductions

* Contrary political elements can be dealt with via "toteboard diplomacy" (a big obstacle was the United Kingdom's government, which continually opposed action on acid rain). The Sulfur Protocol set forth a toteboard on which responsible and irresponsible countries could be identified. The clear 30% reduction figure set forth a simple standard for assessing this.
* Combine knowledge assessment activities with knowledge creation activities.
* Place dominant focus on effects rather than causes.
* Cast a broad net for relevant impacts to avoid getting stuck in inscrutable ones ("if trees don't work, switch to lichen" as the bioindicator).
* Don't insist on full participation for legally binding instruments; let the variety of a pluralistic processes apply pressure to reduce emissions.
* Concentrate scientific assessment on politically useful outputs (calculation of local impacts and cost-effectiveness).
* Sophisticated science can be politically influential even when the political outputs are scientifically crude.
* Disprove outlandish hypotheses helps.

Negative lessons from LRTAPT that relate to CO2 emissions reductions:

* No effective international/transnational efforts were made to assist in implementing measures to reduce emissions (developing new technology, matching technology to local circumstances).
* No effective efforts were made to link financial transfers to emissions reductions (rich and poor countries on same legal footing).
* No attention was paid to collaborative work on coping with impacts.
* Thought and action on issues of importance were sacrificed on behalf of issues of concern.

The European acid rain experience led to an alteration of the political landscape in North America that advanced the cause of reducing acid rain. Further, Levy believes the 80% reductions by the British would never have happened without the Protocol process.

Mechanisms for Providing Scientific Information to the Climate Convention: Lessons from the IPCC Experience

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If scientific information is to continue to play a key role, changes will need to be made in existing institutions, and new bodies within the Convention itself will have to be structured to use the information that is made available.

Scientific research has played an important role in establishing climate change as a public policy issue and in helping to set the stage for the implementation of the Framework Convention on Climate Change (FCCC). Many other factors have also shaped the negotiation process, and perhaps have had even more important roles, as one would expect with an issue as far-reaching as climate change. Now that the convention has entered into force, an examination of the type of information needed and the means for providing it is required. If scientific information is to continue to play a key role, changes will need to be made in existing institutions, and new bodies within the Convention itself will have to be structured to use the information that is made available. In this context, Moss discussed four general issues:

1. What types of information are needed to move the Convention process forward?

2. What processes/mechanisms should be used to produce this information?

3. How has the Intergovernmental Panel on Climate Change (IPCC) performed to date?

4. What roles should IPCC and the Conference of the Parties (CoP) Subsidiary Body on Scientific and Technical Advice (SBSTA) play, and how should these bodies interact?

In addressing the issue of what type of information is needed to move the Convention process forward, Moss emphasized three categories. The first is information regarding targets and timetables that deals with the question of what level of commitment is required from the signatories. In this respect, effective information at the international level is needed with regard to:

* the overall magnitude, patterns and rate of expected climate change due to anthropogenic influences
* detection and attribution of human-induced climate change
* sectoral and regional-to-subcontinental scale impacts of climate change
* estimates of the costs of damage in different sectors and regions
* integrated assessments of the implications of climate change and its impacts for land use (e. g., what are the large-scale ecosystem and managed system responses to elevated atmospheric carbon dioxide concentrations?)
* assessment of case studies and literature on processes of diffusion of new and emerging technologies
* estimates of the costs of mitigation
* further development and assessment of methodologies for aggregating national actions and for projecting the effects of national programs.

The second category of information is that needed for evaluating national communications and commitments at the international level, where issues of comparison, verification and common methodologies come into play. Will national targets be met? What are the economic and environmental implications by region and sector?

If scientific information is to continue to play a key role, changes will need to be made in existing institutions, and new bodies within the Convention itself will have to be structured to use the information that is made available.

The third category is information for implementation of the Convention commitments and coordination with other bodies effectively supplied at the international level. Issues include:

* What technologies and practices should be emphasized within the Convention? Answering this question involves scientific and technical evaluation of options, evaluations of experience in implementation in different circumstances, and evaluation of different international cooperative mechanisms.
* What mechanisms should be used to overcome market barriers and encourage diffusion? This will include evaluations of national case studies and international programs and initiatives.
* What would be the implications of various resolutions of specific technical issues (e. g., choice of emissions baseline, accounting of international transportation fuels)?

The information discussed above can be derived from several different types of products: comprehensive "state of the science" assessments, special reports keyed to particular decisions and delivered on a "rapid response" basis, and national communications, assessments, and evaluations. There are a number of processes and mechanisms that are desirable in these products. First, they should be based on the work of independent scientific and technical experts at universities, laboratories and institutes worldwide; pluralism is important. Second, they should encompass a broad range of significant scientific opinions. Third, there should be a open process which is transparent, accessible, and communicated to all interested parties. Fourth, the products should undergo scientific peer review to make sure the advice is sound and credible. Fifth, stakeholder input and review should involve groups such as non-governmental organizations (NGOs) and industry. And sixth, the process should involve developing countries, enhancing their participation and cooperation, and helping to build their analytical capacity.

There are a number of specific entities discussed in the Convention for provision of information. One is SBSTA, characterized by the CoP as the link between the scientific, technical and technological assessments (i. e., the IPCC) and the policy needs of the CoP. The Subsidiary Body on Implementation (SBI) is to assist the CoP in the review and assessment of implementation of the Convention and in the preparation and implementation of decisions of the CoP. The Intergovernmental Technical Advisory Panel on Technologies (TAP-T) is to provide advice to the SBSTA on technologies, including advice on related economic aspects. The Intergovernmental Technical Advisory Panel on Methodologies (TAP-M) is to provide advice to the SBSTA on methodologies. And there is the IPCC. Increased clarity is needed on roles of these entities and how they should interact.

The IPCC was established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). The purposes of the IPCC are to:

* assess the scientific information related to various components of the climate change issue
* identify which components of the issue deserve priority attention

The impacts research is currently based mainly on a doubled carbon dioxide level of 750 ppmv. Many do not believe CO2 concentrations will stabilize at that level, and feel that unfortunately, we should be looking at 1000 ppmv or greater.

* identify a menu of potential responses and evaluate their respective costs and benefits
* involve stakeholders in report preparation and review.

Moss discussed the accomplishments of the IPCC and the schedule of upcoming meetings and reports. He believes that this is a defining moment for the IPCC; in the near future, we will see how the technical bodies of IPCC will evolve and what role they will play in transferring information to the FCCC. The IPCC view is that is not their role to recommend levels of emissions or to make value judgments, but rather to provide information about what the results of various levels of greenhouse gases will be and the scientific uncertainties involved.

Currently, Moss says, the IPCC is doing inverse calculations to see what greenhouse gas emission levels correlate with what atmospheric concentrations, but this does not involve impacts assessments. The impacts research is currently based mainly on a doubled carbon dioxide level of 750 ppmv. Many do not believe CO2 concentrations will stabilize at that level, and feel that unfortunately, we should be looking at 1000 ppmv or greater. Moss believes more efforts such as that led by Tom Karl using complex indices that detect climate change earlier and better than simple temperature measurements are needed, along with good integrated assessment models.

More efforts such as that led by Tom Karl using complex indices that detect climate change earlier and better than simple temperature measurements are needed, along with good integrated assessment models

With regard to policies and measures, the IPCC can provide information about methodologies but some other body will be responsible for carrying these out. Completely standardized reporting procedures seem unlikely for national reports, though some parts of the procedure may have standardized methodologies for nations to follow. There are political and practical obstacles to standardized reporting.

This is a defining period for the FCCC in which baselines on emissions inventories and reporting mechanisms should be established. There is a need to pin down such standards now or many years of useful data may be wasted. The Association of Small Island States and the European Union are concentrating on targets and not paying as much attention to reporting mechanisms that are important to set up now, Moss says.

There is a bicameral structure to IPCC; government representatives act as an extended governance panel, but the 150 lead authors, nominated by governments, are all scientists, and they actually write the reports' chapters and the summaries for policymakers. There is some debate about how to telescope down from the whole report to the summary. It is difficult to reflect all of the essential information in a 12-page summary, and much controversy stems from this summarizing process.

The IPCC is making an attempt to improve the expression of subjective probability estimates by experts with a new system of rankings. "Subjective Probability Rankings" place scientific theories and findings into four categories: well-established, well-posed controversy, probable, or speculative.

There seems to be a lack of sensitivity on both sides as to the importance of the IPCC to the FCCC. The timing of IPCC report releases has been out of synch with the FCCC process. Though this is not intentional, it is problematic. On the other side, the CoP never even referred to the IPCC reports in their deliberations.

During Moss' presentation, an important discussion ensued regarding the legitimacy of the IPCC as an independent body. The opinion was expressed that the IPCC was created in an anarchic way, that it continues to be out of synch with the FCCC process, and that it should

become a subsidiary organ of the FCCC. It was further suggested that developing country scientists were largely left out of the IPCC process as they could not keep up with ~60 meetings a year requiring international travel. Moss acknowledged that these problems existed in the early days of the IPCC, particularly in Working Group I, but felt that the IPCC had since greatly increased the participation of developing country scientists. For example, IPCC now pays the travel and subsistence expenses of hundreds of developing country scientists for writing team meetings, working group meetings, plenaries, etc.

Questions were raised as to whether the CoP will rely on internal scientific bodies or the IPCC. Should the IPCC be placed under the FCCC CoP or should IPCC remain independent? Comparisons were made between the IPCC and the Montreal Protocol's scientific panel. Some feel the scientific panel of the Montreal Protocol is better accepted than the IPCC because its work is accomplished in a bureaucratic manner inside the formal treaty process. Some feel that the Montreal Protocol panel is also more responsive to specific questions of the treaty than the IPCC.

Some feel that the Montreal Protocol panel is also more responsive to specific questions of the treaty than the IPCC.

Environmental Implementation in Developing Countries

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The international environmental agenda is primarily the North's agenda. The priorities of the South are generally different, often having to do with basic survival, poverty eradication and economic development.

Najam presented a framework within which the behavior of the developing countries in international environmental politics might be understood - why they behave as they do and what this means for the implementation of international environmental accords.

Beginning with the observation that most international environmental accords treat the developing countries of the South differently (i. e., developing countries are often required to do less, over longer compliance periods, and are promised resource or technology transfers as precursors to implementation), Najam develops the argument that implementation of international environmental regimes in developing countries is also likely to be different - and more difficult - in the South.

Differences that are more significant at the regime formulation level include:

Motivation: Developing countries do not go through the same "negotiation curve" that industrialized countries do. They often view environmental regimes as another forum for fulfilling their larger interests a greater say in the international system and their continuing concern for development.

"Southness:" This is not simply a case of being poor but is a political behavior depending on a) a perception of political vulnerability and being at the periphery of the international system; and b) a sense of alienation from the global environmental agenda which is driven by the North.

Contractual Environment: A transfer of financial or technological resources from North to South is implied, expected, or promised in most treaties. Developing countries view the fulfillment of this "international" commitment as a necessary pre-requisite to any domestic implementation on their part.

Capacity: International environmental negotiations are often technically complex and time-consuming (therefore costly); the South's capacity to invest the required time and human resources is increasingly constrained.

Another set of differences, perhaps more significant at the domestic implementation level are:

Capacity: "Capacity building" is a widely used but poorly understood concept. That developing countries often lack implementation capacity is widely accepted; however, simply beefing up personnel or equipment will not necessarily improve the "capacity" to implement.

Priority/Agenda: The international environmental agenda is primarily the North's agenda. The priorities of the South are generally different, often having to do with basic survival, poverty eradication and economic development. Moreover, even if those from the South who participate in international negotiations become socialized to the global agenda, the priorities of those at the street-level remain different and make implementation problematic.

Actors: Developing countries are far more influenced by external actors - donors, Northern NGOs, the international scientific community, multinational corporations etc. - than are industrialized countries.

Weak States: Most developing countries are weak states; however, they are weak states imbedded in highly stratified but strong societies. In such states, governments are often balanced amidst complex webs of social bargains - implementation (or lack thereof) of particular policies become components in such bargains.

All international commitments have to be "domesticated" before they are actually implemented. Another way of looking at how implementation of international environmental commitments is likely to be different, and potentially more difficult, in developing countries is to begin by looking at what we can learn from research on domestic implementation (in both industrialized and developing countries).

A review of this research suggests that implementation is a dynamic process of negotiation between multiple actors, operating at multiple levels, within and between multiple institutions. As policy moves through the maze of implementation, it is adapted, co-opted, and redesigned by those who actually implement it. Policy, therefore, is both defined and redefined in the act of implementation. While this process is complex, research suggests that we can identify five critical clusters of variables which are likely to influence implementation (figure 9.1).

As policy moves through the maze of implementation, it is adapted, co-opted, and redesigned by those who actually implement it.

The variables in figure 9.1 are equally relevant to developing and industrialized countries. However, in comparing these five variables which influence implementation with the already defined factors that make developing countries "different" one can begin outlining how implementation in developing countries is likely to be more difficult.

For example, the differences in contractual environment will directly influence the "Content" variable with the possible effect of putting off any domestic implementation until international commitments of financial and technological transfers are fulfilled.

Similarly, the institutional "Context" in most developing countries is directly influenced by their being weak states which makes governmental institutions as much conduits of social bargains as avenues of policy implementation.

Importantly, the greater influence of outside actors within the "Clients and Coalitions" variables can, in fact, help more effective implementation where these outside actors (especially donors and international NGOs) are inclined to push particular policies by providing assistance in their implementation.

Implementation depends not only on what treaties say, but on how this relates to local realities.

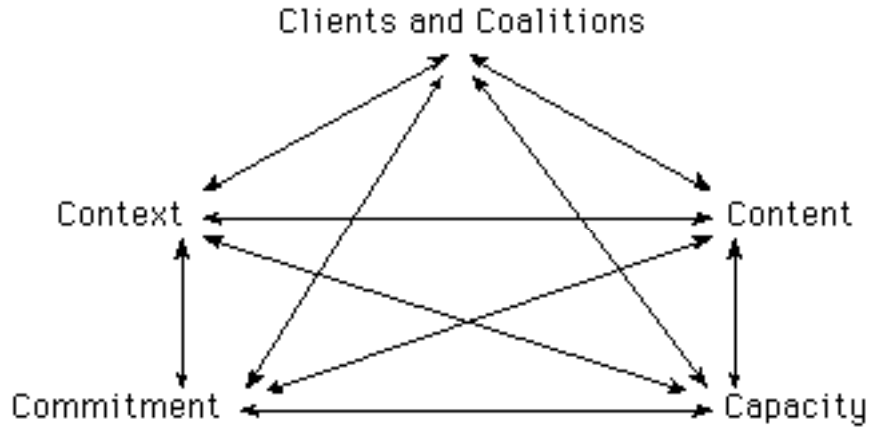

Figure 9.1: The SC Protocol

*The **Content** of the policy itself what it sets out to do (goals); how it "problemizes" the issue (causal theory); how it aims to solve the perceived problem (methods)*

*The nature of the institutional **Context**-the corridor (often structured as operating procedures) through which policy must travel, and by whose boundaries it is limited, in the process of implementation.*

*The **Commitment** of those entrusted with carrying out the implementation at various levels to the goals, causal theory, and methods of the policy.*

*The administrative **Capacity** of implementors to carry out the changes desired of them.*

*The support of **Clients and Coalitions** whose interests are enhanced or threatened by the policy, and the strategies they employ in strengthening or deflecting its implementation.*

The importance of the "Commitment" variable in implementation design is particularly acute in developing countries which are different both in the motivations that bring them to environmental agreements and in the priority they attach to environmental issues even when they are parties to treaties. The disconnect between international and local priorities and agendas is most acute at the grassroots level, especially in issues which concern the survival relationship of the poorest and most marginalized populations with natural resources (e. g., forestry, biodiversity, desertification).

The importance of "Capacity" factors has already been highlighted as a major difference.

As one of many examples of how implementation is likely to be more difficult in developing countries especially where the differences mentioned above are not recognized - Najam mentioned tiger protection in India. This is a case where the government is genuinely committed to fulfilling its international commitment and stopping legal smuggling of tiger parts to East Asia. Furthermore, international financing, both through governmental and NGO donors, is

significantly available. Yet, the priorities of those at the street-level - both the so-called poachers and the wildlife rangers - are so different and so focused on everyday economic survival that smuggling has continued all but unchecked. Compounding the problem has been a deficiency in understanding exactly what "capacity" needs to be built - the effort has been at strengthening the organizational capacity of the higher strata of government departments rather than, say, the options available to local populations involved in poaching tigers or ranger pay structures.

Najam concluded that:

* implementation is likely to be more difficult in developing countries than in developed countries;

* domestic implementation in the South will depend to a large and significant extent on the international implementation of environmental accords, especially as they pertain to financial and technological transfers; and

* implementation in all countries, but especially developing countries, will depend not only on what treaties say but more importantly on how this relates to local (as opposed to merely national) realities. Understanding these realities should be the focus of more research and a necessary element in designing and financing specific implementation programs and projects (especially those funded by international organizations).

The importance of "Capacity" factors has already been highlighted as a major difference.

Estimating Economic Impacts of Climate Change

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Economists estimate the economic effects of climate change by measuring impacts on consumption goods. They evaluate differences anticipated to take place in consumption over time and then compare costs and benefits.

Nordhaus discussed efforts to model climate change response at the macro economic level. Economists estimate the economic effects of climate change by measuring impacts on consumption goods. They evaluate differences anticipated to take place in consumption over time and then compare costs and benefits, taking into account maximization of social welfare by including some social welfare function.

Impact analysis involves two distinct tasks: measuring the physical changes and valuing them. The really controversial part of impacts analysis is valuation. Impact analysis in practice is based on the value of market goods and services and the value of environmental (non-market) goods and services. Economists try to determine what one would have to compensate people for, in terms of market goods and services, for deterioration of the environment. Because this is a matter of individual preference, they aggregate over people and time to come up with an average response.

First, economists look for market or other experiments in which consumers are faced with different prices or quasi-prices and observe their choices. Estimates are made of what the changes will be and prices are assigned to value those changes. A price line is then fit to the observed choice curve. In cases where the factors are appropriately estimated, Nordhaus says, this technique offers a good approximation of the true loss in real income according to the preferences of the consumer.

How is the indifference curve or price line measured? First, major distinctions are made between market and non-market goods and services. Market goods and services include food and energy, while non-market goods include such things as public schools and parks. A major distinction is also made between private and public goods. In the case of private goods, individuals can appropriate all the benefits and others can be excluded, whereas in the case of public goods, others are not excluded from joint consumption and benefits accrue to a variety of people, for example, radio signals, coastal light houses, or defense measures. In general, it is possible to use individual behavior to infer preferences about private goods, but there is no reliable behavioral information about genuine public goods (such as culture, biodiversity or wet lands).

Direct measures are used by economists for marketed goods and services estimates. For farming, for example, economists estimate loss of output and use market prices to determine the loss. Alternatively, they use the direct measure of effects on land values. In measuring economic impacts of sea level rise, they can estimate the change in land in different categories or value by market land prices. When adaptation responses are included, Nordhaus says, economic losses due to sea level rise are reduced by two to three orders of magnitude, according to the work of Yohe.

Three techniques for estimating impacts of climate change are: production function approaches, which do not treat adaptation; time series approaches, such as standard studies of agriculture where trends in temperature, farm output and U. S. GNP are tracked; and hedonic approaches, where only impacts to the value of the underlying asset are considered.

There is a bias inherent in production function studies, Nordhaus says, illustrating with an example about how farmers might adapt to changes in climate by altering the crop varieties they plant or other techniques they could employ to increase their yields. Nordhaus explains that by leaving out such expected adaptation, production function studies assume "dumb farmer" scenarios, in which farmers do nothing to adapt to climate change and thus, losses due to climate change are overestimated. In a hedonic approach based on land values, only the impact to the land value is considered and so there is a disconnect with biological and other factors. In sum, Nordhaus says, most economic evaluations lead to the conclusion that the net economic effect of climate change is basically zero. There has been a study by Adams et. al., however, which shows significant losses, Nordhaus noted.

There are indirect measures for non-marketed private goods. For publicly-provided private goods (recreation, schools), we can examine effects of "quasi-prices" such as travel costs on behavior. To assess "amenity effects," we assume that labor is mobile and requires a "compensating differential" for unpleasant locations or tasks. Then we look at wage differentials across regions, jobs or climates and infer the value people place on amenities. Such an analysis has not yet been done for climate change, but Nordhaus expects that amenity effects will dominate all other effects (Viscusi's analysis on the value of human lives is based largely on wage differentials).

There are problems with determining values placed on public goods. Because of free riding, we cannot rely on private behavior to reveal preferences. One alternative is to examine voting behavior by legislatures to reveal some function of voter preferences. Another is to use preference-revelation mechanisms, but these seem to work better in theory and in the lab than in practice. A third alternative is to use "contingent valuation" which offers a direct statement of preferences, but is subject to the severe criticism that there is no budget constraint or cost of not revealing genuine preferences. Nordhaus does not believe contingent valuation gives reliable estimates for these reasons.

Nordhaus offered a few suggestions as to why nobody believes the economist's approach to impact analysis. At the core, there is a disagreement on what the impacts of climate change, or other environmental problems, might be. In principle, he says, this is resolvable by further research. However, there are also deep-seated differences in outlook on mechanisms such as adaptation, use of technology, and the price system. For example, it is often said that economists don't understand the complexity of ecosystems or how vulnerable human systems are to changes in natural systems.

Nordhaus pointed out basic disagreements concerning values. Whose values should be adopted: individuals, George Bush's, Al Gore's, Joe Lumberjack's? And how should we treat distribution of income? Should we accept the current market's distribution? Should we try to change it? How should the claims of future generations versus those of the present, or North versus South claims be dealt with? Should certain items be sacrosanct and fall outside the market place? Where do we draw the line around the market? Should environmental quality be absolute or balanced against costs? Who is included in the social welfare function? Do non-human life forms count?

How should the claims of future generations versus those of the present, or North versus South claims be dealt with? Who is included in the social welfare function? Do non-human life forms count?

There are a number of especially difficult issues that arise when attempting to assess economic impacts of climate change. One of these involves the fact that people's tastes are endogenous, and are subject to change over time, and therefore, we may overestimate (or underestimate) future impacts based on current tastes. Similarly, technologies are endogenous, but we generally think of the future in terms of current technologies as we can not predict future technologies. Other difficult issues involve an endogenous population and shifting national boundaries, as well as whether we view nature as dumb or benign (trees) versus smart or competitive (bugs).

Nordhaus says there is a good deal of confidence among economists that climate change will not have large effects on the market economies of the developed world. He estimates these impacts between 0 and 1/2% of GDP, plus or minus 1%. But with regard to non-market goods in the developed world and both market and non-market goods in the less developed world, these are all areas in question where no significant research has been performed.

Nordhaus says there is a good deal of confidence among economists that climate change will not have large effects on the market economies of the developed world.

Self-Interest and the Common Good in International Environmental Agreements

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Viewing the Montreal Protocol as a model for handling climate change may create expectations that will not be fulfilled. The Montreal Protocol is the exception and not the rule in international environmental policy. Oye provided a perspective on this by comparing a variety of international agreements on environmental issues.

Viewing the Montreal Protocol as a model for handling climate change may create expectations that will not be fulfilled. The Montreal Protocol is the exception and not the rule in international environmental policy.

Table 11.1 summarizes eight examples of transboundary environmental externalities. It summarizes the distribution of environmental and abatement costs, the uncertainty of estimates of environmental and abatement costs, and associated compensation mechanisms for each problem. Concentrated externalities cases were at the top and diffuse externalities cases were at the bottom. Levels of uncertainty over environmental and abatement costs were generally higher in more complex global cases than in local cases. The global cases were more difficult to handle than local cases because diffuse externalities raised risks of free riding and because uncertainty levels were higher.

The two riparian cases were the most straightforward, with environmental externalities (literally) channeled in predictable directions and with abatement options well understood. In the Rio Grande case, untreated waste water from Mexico threatened public health in both Mexico and the U. S.. It was in the U. S. interest to build sewage treatment plants in Mexico. Since the abatement costs would otherwise have been borne by Mexico, the role of compensation was significant. Financial transfers from the U. S. to Mexico made it possible for Mexico to build treatment facilities that reduced the threat of disease for both countries.

The case of chloride emissions on the Rhine involved the leaching of salts into the river from French mining facilities, many of which had ceased operating but were still leaching salt. This was a simple case of upstream emissions from France affecting downstream neighbors. The effects were well known, and the distribution of costs was private and focused. Rivers, unlike air, carry emissions in one direction. The solution involved the downstream victims paying the polluter, France, to reduce emissions. It was in the self interest of the downstream parties to do this, making it possible for those who can help to help.

The cases involving oceans are somewhat more complex, as the consequences of pollution were more regional than local. One such case is that of sewage and industrial waste in the Baltic Sea. This problem is regional in terms of both sources of pollution and those affected. Eastern European nations were the primary source of the problem. All nations on the Baltic coastline, including Finland, Sweden, Germany, Poland and the Baltic Republics, were adversely affected by pollution. Assistance to polluting countries helped to a limited degree. However, the modest scope of the program of international payments and the limited indigenous capacity of Eastern European nations have not been commensurate with the scale of problems.

Managing Transboundary Environmental Externalities

POLLUTANT AND VENUE	ENVIRONMENTAL EFFECTS Distribution	Uncertainty	INITIAL ABATEMENT COSTS Distribution	Uncertainty	COMPENSATION MECHANISMS
LOCALIZED EXTERNALITIES					
Untreated waste water discharged in Rio Grande	Mexico US	Low	Mexico State Gov	Low	US-->Mexico to Construct Treatment Plants
Chloride leakage into Rhine River	Netherlands France	Low	France Firms	Low	Neth-->France to Reduce CL Leakage
REGIONAL EXTERNALITIES					
Untreated waste water into Baltic Basin	Baltic Littoral	Low	East Eur Firms & Govs	Low	Nordics-->East Europe to Treat Discharges
Nuclear waste dumping into Sea of Japan	Japan, Korea, & Russia	Moderate	Russia Gov	Low	Japan->Russia to Condition and Store Nuclear Waste
SO2-NOX-VOCS Eastern Europe	East, North, & Central Europe	Moderate	East Eur Firms & Govs	Moderade	Scandinav & EU-->East Euro Govts to Reduce Emissions
SO2 China	China, Japan, & Korea	Moderate	China Firms & Gov	Moderate	Japan-->China for Demonstration Projects
GLOBAL EXTERNALITIES					
CFC AICS and DCS	Global	High Moderate	Dupont-ICI Win Diff AIC and DCS	High	Montreal Protocol Multilateral Fund
Greenhouse gases AICS and DCS	Global	High	Oil Coal Lose Subst Conserv Win	High	GEF - Climate Fund Joint Implementation?

Table 11.1
Managing Transboundary Environmental Externalities

Another regional sea case involved Russian dumping of radioactive waste into the Sea of Japan. Though this could have affected Korea, Russia and Japan, only Japan acted on the issue. This may have been due to understandable Japanese concern over radiation. In this case, the prospect of obtaining compensation may have encouraged the Russians to dump waste openly so as to encourage payments for ceasing the practice. Was this extortion? The fact that Russia could offer other reasons for the dumping (i. e., it was the cheapest method of disposal) makes it less clear. Oye defines this type of environmental extortion as follows: If you demand payment for not taking an action that would provide no benefit to you while hurting someone else, that is extortion or blackmail. If you demand payment for not taking an action that benefits you while harming another, it's simple exchange or backscratching. The point here is that the Russians may have dumped waste in the Sea of Japan in order to secure payments from Japan. Oye noted that such examples of environmental extortion are very rare.

In the two acid rain cases, the effects of emissions of sulfur dioxide were concentrated downwind. (See Levy for a discussion of international acid rain agreements in Europe.) Sulfur emissions from China were deposited on Korea and Japan, as well as parts of China itself. Moderate payments of compensation were made, primarily in the form of demonstration plants financed by Japan in China. Was this a true win-win situation, providing environmental benefits to China and Japan and generating orders for Japanese producers of pollution abatement

equipment? Was the level of technology appropriate to the application? Were there costs to the Chinese of operating the demonstration facilities? The environmental programs should be viewed as both environmental compensation and part of a larger program of foreign aid. In the past five years, Japanese loans, grants and export credits to China exceeded all multilateral aid to China.

If diffuse environmental externalities encourage free riding and undercut cooperation, then what made global cooperation possible in the case of Montreal? The Montreal Protocol case differs from other global cases in several respects.

First, uncertainty over the global environmental consequences of chlorofluorocarbon (CFC) discharges was lower than uncertainty over the consequences of discharges of green house gases (GHGs). Uncertainty declined between the mid-1970s and the conclusion of negotiations in 1988. Atmospheric observations in 1988 suggested that earlier models underestimated the magnitude of ozone depletion from CFC use.

Uncertainty over the global environmental consequences of CFC discharges was lower than uncertainty over the consequences of discharges of GHGs.

Second, the distribution of costs of abating CFCs contrasts markedly with the distribution of costs of abating emissions of GHGs. The phaseout of CFCs may have actually benefited producers of CFCs. Dupont and ICI were the major producers of CFCs and had also invested heavily in the development and production of substitutes including HCFCs. Demand for simple CFCs was falling even before the Montreal Protocol's phaseouts. Even before the U. S. ban on CFCs in aerosols, companies were making the switch to alternative propellants. These voluntary shifts, the U. S. aerosol ban, and entry of other producers of CFCs contributed to the development of worldwide excess capacity in CFCs. The Montreal Protocol and London revision had the effect of forcing consumers to substitute more specialized, higher cost HCFCs which Dupont and ICI were well-positioned to produce for standard CFCs that many could produce.

Oye noted that this coincidence of producer interests and a ban is unusual. More commonly, producers of a regulated substance are harmed by bans and lobby against regulations. On the other hand, those who would benefit from regulation may not know that they would benefit and will have no trade associations or other organizations to represent their interests. For example, the creators of new technologies or substitutes for a regulated product may not even exist at the time of a regulatory change. This produces a bias toward resistance to regulation. In the case of the Montreal Protocol, this bias was absent since the major CFC producers, Dupont and ICI, also had an interest in switching to substitutes. In the case of restrictions on carbon emissions, the resistance of coal and oil suppliers is only partially offset by nuclear and soft energy suppliers.

Compensation played a role in the Montreal case. A strategy of using "selective bribery" to bring on board those who would be harmed helped move things along. The phase-out of CFCs came at the expense of developing countries that would have produced and used the cheaper CFCs. So stretching out the phaseout schedule for developing countries and providing compensation to those countries, especially under the London revision's more stringent standards, was critical. But the sums of money being provided to developing countries are low not enough to help them make the switch. The National Environmental Protection Agency (NEPA) of China claims to have over 100 CFC abatement projects ready to go, but anticipates external funding for only a handful. NEPA hopes that pilot projects will have strong demonstration effects. For example, a Chinese-German joint venture plant in China may produce high quality CFC-free refrigerators. If quality comes to be associated with these newer

technologies, then other private producers may develop a private interest in following the lead of the pilot project. But the combination of limited international funding and modest national enforcement authority in a decentralized provincial and municipal system will make progress difficult in China.

Under current conditions, it is unlikely that we will see substantial resources flowing into a strong multilateral response to the problem of global climate change. Uncertainty over global environmental effects and costs of abatement and tendencies toward free riding cut against effective multilateral action. To what extent can bilateral agreements take the place of what would ideally be global responses? There are possibilities, particularly when parties have a parochial interest in taking actions that would also protect general environmental concerns. It may be possible to identify ways of reducing greenhouse gases (GHGs) and also serving the self interest of parties. Identifying private win-win situations and exploiting them could help on the climate issue.

Under current conditions, it is unlikely that we will see substantial resources flowing into a strong multilateral response to the problem of global climate change.

In discussion, the group divided over the wisdom of accepting nationalistic political criteria and private market criteria in allocating resources. Some argued for pursuit of environmentally optimal as distinct from politically and economically optimal policies. Others noted that we should not allow the search for the best to rule out the acceptance of second best technologies or projects that could advance the cause at least somewhat. Oye asked the group to search for regional and bilateral packages that might reduce GHGs. He suggested that much attention is being paid to multilateral funds, global quotas, and joint implementation and not enough to regional and bilateral deals.

"Minilateral" approaches to climate change were suggested in discussion. Oye countered that this was simple re-labeling - that people use terms like "minilateral" because they feel uncomfortable using "bilateral." This may be because of a tendency to avoid "bilateralism" with its connotations of discrimination and exploitation. But bilateral agreements can provide second best solutions to global problems. These piecemeal approaches are imperfect, but are better than nothing.

In further discussion, it was noted that piecemeal approaches are alright unless they lock in an infrastructure with a lifetime of a generation or more, making the problem even worse over time (for example, locking in coal power plants in China instead of gas). Discussion turned to how either piecemeal bilateral or global multilateral means might alter Chinese incentives to invest heavily in coal.

It was also argued that an unconventional set of lessons from the Montreal Protocol are relevant to the climate issue and that the lack of participation and an undemocratic process was for the better in the case of the Montreal Protocol. Under the multilateral fund, donors gave up political power to manage the fund. The benign autocracy of experts produced effective projects to reduce emissions of CFCs because experts were insulated from narrow economic and political forces.

Oye disagreed, noting that insulation may have perverse side effects. A lack of donor participation may have the effect of reducing total contributions. Programs that serve the parochial interests of donors will be better supported than programs that do not serve the interests of donors. The greater effectiveness of each dollar disbursed from the fund may be offset by fewer dollars contributed to the fund. This is a real tradeoff.

Implementation Issues in Mexico and Other Middle-Income Countries

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Middle income countries are identified by per capita income data from the World Bank and health standards determined by the World Health Organization. Middle income countries include Mexico, Brazil, Egypt, China, India, and the oil-producing countries of the Middle East. The rate of industrialization in these countries was very rapid, and as a result, they were taken by surprise by environmental issues and have often ended up with serious pollution problems.

Like everywhere else in the world, in these countries, the first approach to environmental issues was from a human health perspective. Sanitary rules governing air and water pollution were the first step. After this came a greater concern for protecting natural resources including forests and a wide variety of animal species. In the 1980s, a world trend toward concern over global environmental issues began.

Climate change is not a political or policy issue in Mexico at this stage. While no one in Mexico is opposed to the global environmental dimension, it is out of the reach of the science and policymakers there. After the first IPCC meeting, Mexico's Minister of Environment simply did not believe that the climate change problem was real. The leading Mexican scientist would not participate in the IPCC process on behalf of the government so Ponce Nava, an international lawyer, represented Mexico in Working Group III of the IPCC and contributed to the climate change negotiations. During the process, Mexico became a member of the Organization for Economic Cooperation and Development (OECD), but is an annex three country in the Convention because it was not yet in the OECD when the Convention came into force.

Significant institutional development is underway in Mexico. Environment now has a ministry of its own including renewable natural resources and all other environmental issues. University scientists are now in charge of the Environment Ministry for the first time in Mexican history, and are able to decide environmental policy and find ways to implement it. Bridges are being built between the scientific and technical community and the politicians. There has been a learning process in both communities. Mexican leaders are learning that they need a scientific and technical basis for their political decisions or they will not be able to sustain these decisions. And scientists are learning to speak in terms that are understandable to politicians and realize that they have to relate their data to social and political concerns.

Another institutional change is the one taking place in the academic community. Until ten years ago, universities outside Mexico City were offering just basic degrees, and were unable to contribute to scientific discussions or policies at the international level. An isolated few scientists were reaching out internationally but they were not important nationally. There was

Water shortages are significant in Mexico and will become critical in the next 20 years. But potential climatic effects on the water supply are not a priority when basic issues of access and water treatment are a problem.

no structure in which a Mexican scientist could do advanced research. For example, Nobel laureate Mario Molina was from Mexico but had to leave there to advance his research on CFCs and ozone depletion. There is now a move in Mexico to change this situation and to support scientists.

There is also a move to strengthen NGOs and other institutions that are important to environmental advancement. In 1989, Mexico requested a loan from the World Bank to strengthen environmental institutions but the Bank did not want to loan money for "institutional development," (salaries). This request coincided with the signing of the Montreal Protocol and the beginnings of the Global Environment Facility (GEF). Mexico was the first country to do a project under the Montreal Protocol fund. Finally, the World Bank agreed to grant this loan, coincident with the first pilot phase of the GEF, but it was associated with biodiversity projects. Sometimes, camouflaging development projects with environmental projects is necessary to secure international funding. Part of building institutional capacity is developing a group of people who can get a project going and the country can gain something from this. This loan has served as seed money for Mexico to raise a billion and a half in international funds for environmental/development projects.

Of course, oil and water have everything to do with climate change, but no one is worrying about those connections. Everyone realizes that climate change is relevant but there are more important issues to solve first.

The signing of the North American Free Trade Agreement (NAFTA) also brought international funding to strengthen Mexican environmental enforcement. Before 1990, there were only 18 inspectors for 3000 km of border. With NAFTA, this number increased to 800 using World Bank money. Mexico's new OECD status could hurt its ability to get these kinds of funds. The new approach is trade not aid.

Ponce Nava used economic and social data about Mexico to explain why climate change cannot be a top priority issue in Mexico. Though Mexicans know it's a problem, it is near the end of a long list of higher priorities. Mexican population statistics reveal a nation with:

* 85 million people
* 55 million under 22 years old
* 10 million illiterate
* 5 years average education
* 40 million living below poverty line (under 80% of basic needs satisfied)

In terms of biodiversity Mexico is the world's fourth richest country. Mexico is:

* 1st in reptiles
* 4th in amphibians
* 1st in cactuses
* 10th in mammals
* 5% of territory under natural protected regime (Management plans and resources are needed for these; only 3-5% of the protected areas have plans.)

The needs of natural areas must be associated with the needs of local peoples. Development issues and protection of biodiversity must be linked.

NGOs are a middle class phenomena. People must have satisfied their basic needs in order to have the time and resources to raise funds and undertake projects. Also they must also be affluent enough to have access to communication technologies, such as fax machines.

Climate change connections:

About 75% of the fresh water in Mexico is concentrated in one area. On the border with the U. S., there is no regime to distribute groundwater so it's done on a first come-first served basis. Water shortages are significant in Mexico and will become critical in the next 20 years. This will be even more true if climate change predictions come to pass.

Veracruz contains 25% of the fresh water resources in the country, and only 5% of its waste water is treated; the rest is discharged raw into the sea. Potential climatic effects on the water supply are not a priority when basic issues of access and water treatment are a problem.

Some 60% of Mexican revenue is from oil and most oil extraction takes place in this same area. Of course, oil and water have everything to do with climate change, but no one is worrying about those connections. Everyone realizes that climate change is relevant but there are more important issues to solve first.

Veracruz contains 25% of the fresh water resources in the country, and only 5% of its waste water is treated; the rest is discharged raw into the sea.

In discussion, it was pointed out that a number of factors are improving Mexico's flexibility and capability to respond to climate change, including:

1. the growth of scientific institutions in Mexico

2. the rising political profile for environmental issues in Mexico

3. international financing used well (but capacity building grants unexplored)

4. OECD membership pushes Mexico toward higher environmental standards

5. NAFTA directions of free trade and the role of the environment serve the purpose of moving toward higher environmental standards

Translating International Commitments Into Domestic Law

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There is significant variation from country to country in ratification and transformation processes. These differences reflect domestic, not international law.

International commitments must be "domesticated" to give them legal force at the domestic level. This process involves a number of steps from ratification to interpretation to implementation to enforcement. Some factors influencing the process of domestication include:

* rules for ratification of treaties
* requirements for action by the legislature
* the status of treaty commitments vis-a-vis normal statutory law
* rules for interpretation of treaties
* participation rights and rights to challenge (standing)

In the U. S. and most other advanced industrial democracies, major environmental agreements require action by the legislature. The Framework Convention on Climate Change (FCCC), for example, generally requires ratification and a formal process of implementation. To come into force internationally, the FCCC requires ratification by 50 nations. This was achieved in March, 1992.

In terms of how they are treated under domestic law, international agreements fall into three main categories. One type is the informal, "housekeeping" accord which does not require ratification; this includes executive agreements. Another type is a ratifiable treaty with direct effect, requiring no transformation into domestic laws. A third type requires both ratification and transformation. Most environmental accords are of this third type, though some can be implemented (transformed) through prior existing legislation.

The primary purpose of ratification is to grant consent. Until ratification occurs and is received, a state is not fully bound by treaty obligations. Ratification also allows a government to review the terms of an accord. It reinforces the principle of consent embodied in national sovereignty. In addition, it provides time for the party countries to enact any necessary changes in domestic laws needed to enforce the treaty domestically. It typically gives legislatures a formal and important role in the process of international cooperation (this role varies with the institutional structure of the political system).

There is significant variation from country to country in ratification and transformation processes. These differences reflect domestic, not international law. For example, in the U. S., "treaties" must be consented to by the Senate, but often, major agreements are handled as executive or congressional-executive agreements. Treaties are the equivalent of domestic law, and can therefore be thwarted by later laws. They cannot violate the Constitution. Executive agreements have an unclear status; they can be overturned more easily than by legislation.

In the United Kingdom, the making of a treaty is an executive act (called "Royal," though not actually undertaken by the Queen), but the carrying out of treaty obligations requires an Act of Parliament. Treaties have the same status as in the U. S.

In France, major treaties need parliamentary approval, and have a higher status than normal domestic law. Under French law, in order to carry domestic obligations, a treaty must be reciprocally in force in the other parties. This is something of moving target; it is not always clear if other countries are reciprocating. France maintains this loophole in all its international agreements.

In the Netherlands, international treaty obligations are superior to both prior and later domestic law. This is novel approach among nations and shows the highest level of deference to international law. With a two-thirds majority vote, treaties can even overturn Constitutional rules. Major treaties are subject to parliamentary approval in the Netherlands.

Though there are clearly significant institutional differences, these differences can sometimes fade away in practice as governments and courts can choose to apply different rules or precedents in different cases. In reconciling international treaties with domestic laws, most countries seek to reconcile the two whenever possible. This is also sometimes selectively applied.

More transparency is needed in how each country undertakes implementation of treaties so the international community can learn from the various processes.

Some countries, such as Italy, take the treaty and lay it directly into a domestic act. Other countries reword it and create new domestic legislation with the rewording. In enforcing such legislation, a court can look at the treaty or the rewording of it. In the U. S., the courts will usually look to the implementing or enabling legislation if there is a conflict between that legislation and the original treaty. Typically, enforcement by the courts is not of the treaty, it is of U. S. laws that implement the treaty.

For example, in the FCCC, some obligations may be able to be enforced domestically under existing U. S. legislation while others measures, such as a proposed carbon tax, would require implementing legislation. No new legislation has been needed for most major recent international environmental treaties. For example, the Montreal Protocol was domestically implemented through the Clean Air Act. Though the U.S. has so far not ratified the Biodiversity Convention, it could do so without any new legislation. On the other hand, the international convention on dumping waste at sea did required new implementing legislation.

The need for ratification and transformation poses obstacles for the effective implementation of international commitments. There are some ways of possibly getting around problems of domestication. It is possible to create annexes which can incorporate change in obligation without ratification. Another possibility, with a negative rule, is to oblige states to actively opt out of altered commitments, rather than opt in. It is also possible to design commitments which can make use of already-existing legislation in important nations. Finally, wholly executive or soft-law (non-binding) agreements can be used.

These methods pose a number of normative and constitutional problems, however. They make use of the fact that foreign relations and policy decisions are concentrated in the executive branch in all cases. The executive has enormous discretion in international affairs under the Act of State doctrine in which normal rules don't apply.

In the cases of the North American Free Trade Agreement and the World Trade Organization, distinctions are blurred between domestic and international authority. New rules are established at the international level that will be binding nationally, but these rules are not passed in the usual democratic manner. In such cases, that level of executive power may be troublesome. Hence there may be a tradeoff between effectiveness in international regimes and democratic principles and procedures.

With the FCCC and other new treaties coming into force in the near future, the situation will get more complicated as such treaties get more in depth in terms of domestic laws. More transparency is needed in how each country undertakes implementation of treaties so the international community can learn from the various processes.

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Who Benefits from the Long-Term Effort to Slow Global Warming and Who Should Participate?

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If the potential damage to developed countries due to climate change over the next 100 years is estimated and expressed as a percentage of Gross Domestic Product (GDP) to the nearest percentage point, the effect is zero, Schelling says. In almost no segment of the economy will the impact of climate change on the marketable part of production be noticed (though effects may be noticed on some non-market activities). The exceptions to this are forestry, fishing and farming, and these are tiny parts of the economies of the developed countries. Even the worst climate scenario would only set the economic growth of a developed country back by one year, according to Schelling.

Damage to non-material goods, such as elements of nature that are not part of standard economic accounts may be an order of magnitude higher, but would still be small. There are three important unknowns in this regard. We don't know what the climate change will be. We don't know what the effects on ecosystems will be. And we don't know how to value damage to natural systems.

Why is it that climate change would have almost no effect on the economies of developed countries? Developed countries are not particularly dependent on outdoor conditions anymore, Schelling says, pointing out that much food production has moved indoors, sports are moving inside, artificial snow is becoming the norm, and health effects of climate change would be insignificant. Comfort depends mainly on what people are used to; if the change comes slowly, people can choose where to live to deal with the comfort issue. Climate change will have incremental effects on other problems like water scarcity, but such problems are not really climate change problems.

Climate change, from the point of view of the welfare of people in the developed world, does not make Schelling's list of the top ten things to worry about and may or may not make it into the top 20. One caveat is that global change surprises would falsify all this, but we don't know what they might be so we can't make predictions based on them.

As for the developing countries, they are more dependent on farming and other outdoor activities and so are more vulnerable to climate change. Regardless of this fact, for no developing country is it worthwhile to make a significant contribution to preventing climate change because they have more important priorities. Their best defense against climate change is to invest in furthering their development (educating children, investing in public health, improving infrastructure, etc.), thus making them less susceptible to weather effects. Investments of this type would give them more of a margin above subsistence living and hence make them less vulnerable to climate change. The effects of climate change on human health

If developed countries have no self interest in investing to stop climate change, and if the poor countries have higher priorities, who would invest? Will the rich countries want to invest for the benefit of the poor countries?

may in developing countries be quite serious with changes in disease vector range (such as mosquitoes and tse tse flies occupying higher latitudes) as well as changes in temperature and humidity.

Africa may be the only part of the world that does not fit into either of the above categories. Africa may be the continent that development left behind, and this could become a problem for the whole world.

So if developed countries have no self interest in investing to stop climate change, and if the poor countries have higher priorities, who would invest? Will the rich countries want to invest for the benefit of the poor countries? And what is the cost of abatement?

It will be the political process and fear of the unknown that will generate the needed response by developed countries to mitigate carbon emissions worldwide, if this response is generated at all.

One trillion dollars (1/10 to 1/20 of the economies of the rich countries) could replace all China's coal plants, coal trains, and industrial plants based on coal. It could electrify the countryside, stopping Chinese households from using fuels inefficiently. This money could come from the U. S., Japan, and other developed nations and could come in the form of donations of all necessary materials or other methods of transfer. About another trillion could do the same for India. If the U. S. did all of this, it would mean spending less on carbon abatement than it currently spends on cat food, Schelling says.

The question then arises, would this money best be spent on carbon abatement or on investments that will make life more tolerable for people in developing countries 50 years from now, such as education, infrastructure, and health care. What would the developing world want? They would surely opt for these types of investments over carbon abatement. If the money went into the education of young women, perhaps that would be the optimal investment in carbon abatement, by slowing human population growth.

What is the opportunity cost of investing in carbon abatement through methods such as replacing fossil fuel power plants? There are many other important possible uses of this money. We should be alert to side benefits of some carbon abatement investments like improving infrastructure. But what would make the developed world want to make the necessary investment to abate climate change? Schelling simply says he does not think they will.

The natural world is not included in this calculation. In rich countries, income elasticity of demand for outdoor beauty is high and interest in the natural world will likely rise. This is not true in poor countries.

In discussion, others in the group pointed out that economies are composed of regions that will have extensive disturbances. For example, many wheat growing areas of the world are marginal and only four countries export wheat. Even small changes in temperature or precipitation could wipe out much of the world's wheat-growing capacity. And forest fires brought on by a hotter, drier climate could make living unbearable in some regions. Schelling replies that these things are not nationally or globally significant and that the developing world would do best by concentrating on becoming less dependent on agriculture.

Developed countries may learn over a decade or two how to decarbonize their own energy sectors and then perhaps will think about helping the developing world do the same. If people believed that large scale migrations of displaced poor people could hurt developed countries, or that educating girls and young women in the developing world is one of the best methods of limiting human population, perhaps developed countries would then see the self-interest in investing in education, health, etc. in the developing world.

Electric power generation and electrification of locomotives are risky ventures due to the effects of local politics and regulations on profits, and this is one thing that keeps private investors from pursuing such projects.

Climate change may just be too big and too vague a problem for people to want to invest in trying to solve. People like to fund things they know will work. It will be the political process and fear of the unknown that will generate the needed response by developed countries to mitigate carbon emissions worldwide, if this response is generated at all.

Climate change may just be too big and too vague a problem for people to want to invest in trying to solve. People like to fund things they know will work.

The Evolving State of Climate Science and Scientists

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Projected human-induced changes are on the order of degrees per century instead of per millennium. The concern is not so much over the magnitude of change but rather over the rate of change.

The carbon dioxide content of the atmosphere has increased by 25% and methane has increased 150% since the industrial revolution. It is not controversial that this is the result of human activities. World population and methane concentration trends are closely correlated up to the present (but this need not necessarily always be the case). The existence of the greenhouse effect is a well established scientific fact; how much it will be enhanced by human activities is what is at issue. In attempting to predict how the climate system will respond to this enhancement, the net effect of all the positive and negative feedbacks is the greatest scientific unknown.

Global temperature change scenarios to 2100 AD range by over a factor of ten because they confound uncertainties in feedbacks and in population/affluence/technology scenarios. Scientists have only recently begun to allow themselves to voice subjective probabilities based on their expert knowledge. Such scientific estimates of how much the climate will change are not based primarily upon extrapolations from the past, but rather on an understanding of climate system dynamics and how it might change based on future conditions which may never have occurred in the past, at least not at the accelerated rates we observe today.

Globally, the vast majority of mountain glaciers are receding. This fact is not intended to be diagnostic of global warming. Scientists are not using this as political "evidence," but rather as part of their observation of overall Earth system response. But such facts are often viewed as "evidence" in the media and political fora. Ice core data show that CO2 concentration and temperature are highly correlated over the past 160,000 years. There has been a relatively high degree of stability in global average temperature over the past 10,000 years. Sustained average rates of natural surface temperature change are about one degree per thousand years. Projected human-induced changes are on the order of degrees per century instead of per millennium. The concern is not so much over the magnitude of change but rather over the rate of change.

How do we gain a perspective on something as complex as the climate system and tap into the expert judgments of knowledgeable scientists? Scientists' usual mode of "truth seeking" can be very different than that of other groups. Advocacy is not an acceptable motive for scientists, but motive is certainly a significant factor in weighing evidence in the political process.

An increasing fraction of the knowledgeable scientific community believes that the evidence for global climate change is becoming convincing, but regionally, we have less certainty regarding what may happen. For example, aerosols are regional while greenhouse gas effects are global. Even if there were to be no net global average climate change, there could be enormous regional climate change.

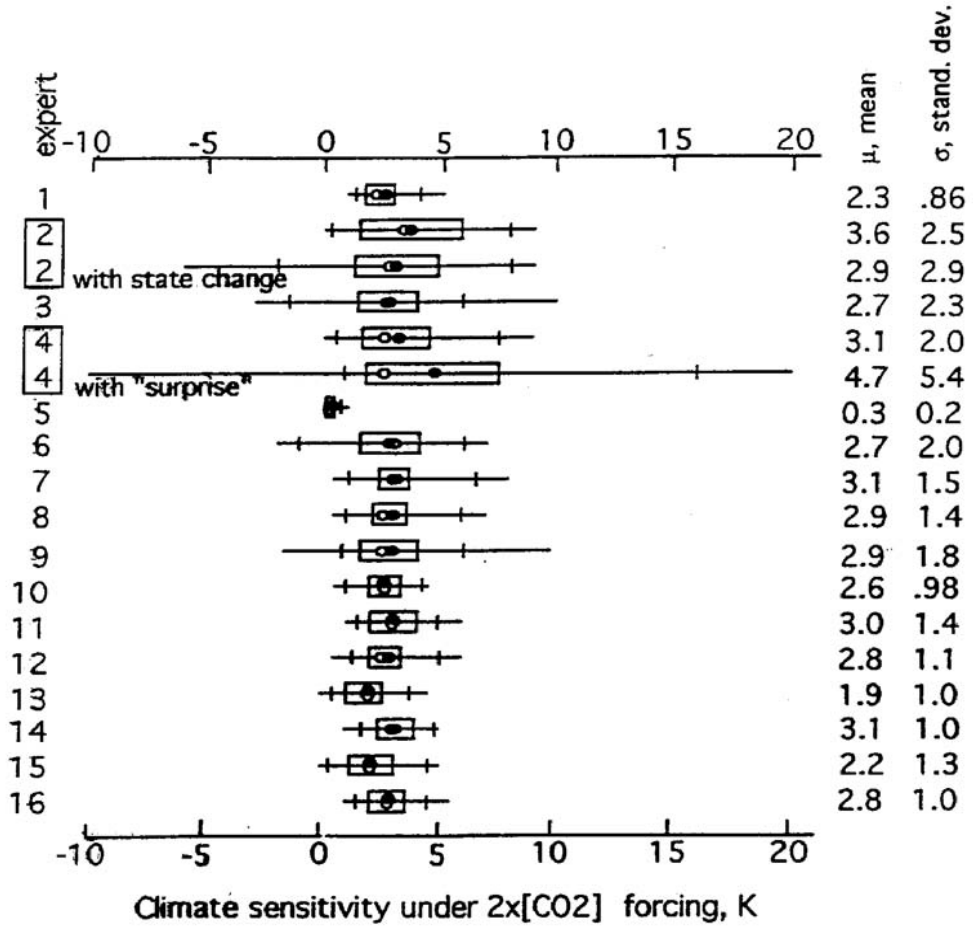

Figure 15.1
Climate Sensitivity under 2x CO2 forcing, °K

Box plots of elicited probability distributions of the change in global average surface temperature resulting from a doubling of CO2. The horizontal lines denote the range from minimum to maximum assessed possible values. Vertical marks indicate the locations of the lower 5th and upper 95th percentiles. The boxes indicate the interval spanned by the 50% confidence interval. The solid dots indicate the mean and open dots, the median. The columns of numbers at the right report values of mean and median standard deviation of the distributions.

Reference: M. Granger Morgan and David Keith, Subjective Judgements by Climate Experts, in Environmental Science and Technology, 29 :468-476,1995.

Scientists, like all people, have value systems, and it is better to have them be explicit than implicit. Statements of probabilities and consequences are needed from scientists. And scientists must not consciously distort what they believe to be the probabilities of the case or leave out any important potential out comes. Scientists should more consistently identify outliers potential outcomes with low probabilities but large consequences. There is a need to define consensus broadly. It is no longer unrespectable to be involved in assessment and even advocacy. On the subject of advocacy, Schneider says the contrarian side is better funded and they are out to "win" for their "clients." They represent a small portion of scientists but unfortunately are given equal scientific status by the media.

How do we gain a perspective on something as complex as the climate system and tap into the expert judgments of knowledgeable scientists?

Schneider says the popular press provides a poor information base on global change issues. For example, Greg Easterbrook's book A Moment on the Earth is laden with scientific inaccuracies, some of which are detailed in a paper by the Environmental Defense Fund. Much of the public, as well as elected officials, get the majority of their information from sources such as this and popular television programs and magazines.

The IPCC Process

In 1990, the Intergovernmental Panel on Climate Change (IPCC) assessment predicted that a doubling of CO2 would produce an equilibrium temperature rise of 1.5° to 4.5°C with a "best guess" of 2.5°C. The current draft of the summary for policymakers in the IPCC's second scientific assessment says that research since 1990 has served to confirm many of the basic conclusions of that report and its updates in 1992 and 1994. Furthermore, it points out that important progress has been made in predicting transient climate change using coupled atmosphere-ocean models, quantifying the role of aerosols in climate change, characterizing the trends and relative roles of greenhouse gases, and attributing climate change to its various causes.

There is growing confidence that a significant part of the observed climate warming can be attributed to human activities.

There are several key new conclusions in the current draft IPCC report. One of these is that the probability that the observed half degree warming trend since last century is part of the natural variability is low, probably less than 1 in 10. More importantly, there is evidence of an emerging pattern of climate response to forcings by greenhouse gases and sulfate aerosols in the observed climate record. This is evident in the geographical, seasonal, and vertical patterns of temperature change in the atmosphere. Taken together, these results provide growing confidence that a significant part of the observed climate warming can be attributed to human activities.

It is clear that the system is highly nonlinear and difficult to credibly predict at the regional level. Since 1990, there is more confidence in global predictions but perhaps less confidence in regional predictions. The decreases in growth rates of CO2 and methane in the early 1990s have largely disappeared, not affecting the long term trends in a significant way. Increased CO2 and sulfate aerosols affect the pattern of warming/cooling. When aerosols are factored into the models, they reproduce reality far more closely, with the correlation increasing over time. Interhemispheric asymmetry also shows up well in the models forced with both CO2 and sulfate aerosols. This is a case where the evidence is still circumstantial but growing.

Polling Experts on Climate Questions

David Keith and Granger Morgan of the Carnegie-Mellon cross-disciplinary group conducted extensive (4 hour) interviews with 16 scientists considered experts on the climate issue. While the results reveal a diversity of expert opinion, Schneider believes that they show more agreement than is portrayed in the media. Figure 15.1 shows the answers given to the question of how much the equilibrium temperature change will be under doubled CO2 conditions. The experts polled responded with subjective probability assessments. Schneider also points out that the basic opinion of the knowledgeable community is pretty close to a consensus that the 20th century warming trend is unlikely to be wholly natural. Important questions in such studies include how to select which experts to ask, and on what questions are they truly expert.

Another example of eliciting expert opinion comes from William Nordhaus' research on the economic value of climate change. Figure 15.2 shows what a group of experts thought the economic impact of a doubling of atmospheric CO2 resulting in 3°C of warming by 2090 AD

would be as a percentage loss of gross world product. Overall, it was clear that the economists generally believed there would be less impact while ecologists believed there would be a much greater impact on the economy. Still, the best guesses of most of the experts were tightly clustered, supporting Schneiders' view that there is more agreement among experts than is portrayed in the media. In Nordhaus' study, it was left to each respondent to determine the value placed on various categories. In his response, Schneider placed a significant fraction of the total loss value in non-standard accounts because factors such as biodiversity may be valued more highly in 100 years than they are now.

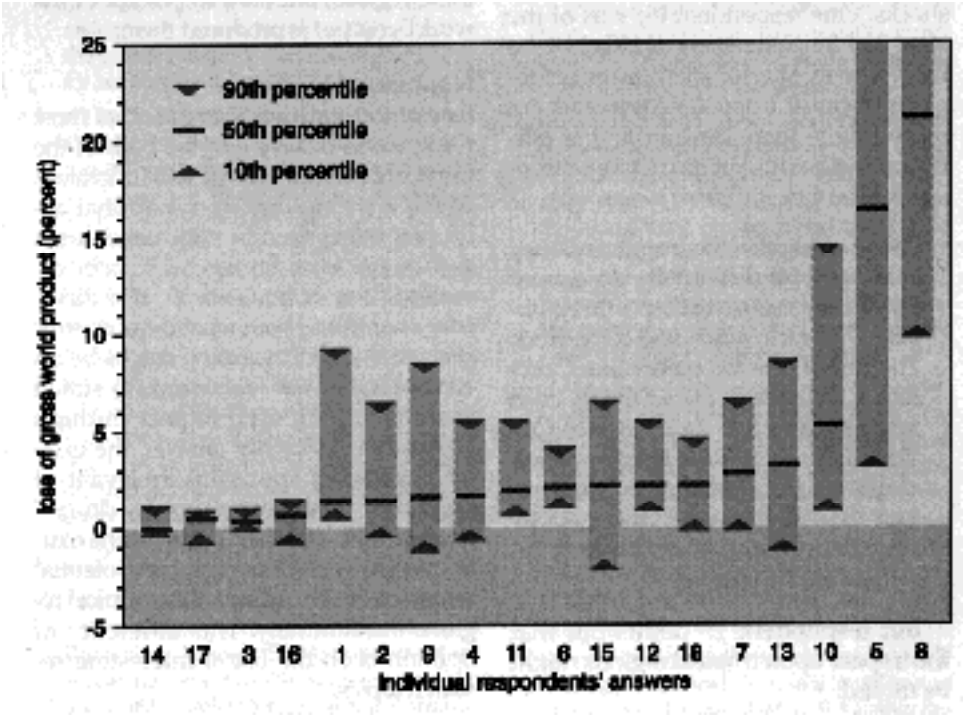

Figure 15.2

Opinions of various experts on the impact of 3°C of warming by the year 2090 as a percentage loss of gross world product. Each respondent's best guess of impacts is shown as the 50th percentile. Chart reprinted with permission, W. D. Nordhaus, Expert Opinion on Climatic Change, American Scientist, Jan-Feb 1994, 82 :45-51, 1994.

The question remains as to how to translate this kind of information into responsible sound bites and hearing testimony so that the public and policymakers can learn what a representative cross section of experts actually believe. One problem is that our educational process teaches that the answers come from the front of the room and that scientists give us "right" answers rather than subjective probabilities. When attempting to forecast future scenarios of something as complex as Earth's climate, the most we can expect is the subjective probability estimates of experts. And, Schneider stresses, there is an extreme disconnect between what scientists' believe and what the public knows.

There is more agreement among experts than is portrayed in the media ... and there is an extreme disconnect between what scientists' believe and what the public knows.

Roles of Technology in the Implementation of a Climate Change Regime

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The world as a whole spends an estimated $400 to $500 billion a year on research and development of science and technology.

Technology and technological change are relevant to all aspects of global climate change, ranging from problem identification through regime formation, monitoring and verification of commitments, evasion of agreed upon rules, data management, public participation, mitigation, adaptation, and research. The world as a whole spends an estimated $400 to $500 billion a year on research and development of science and technology, including both public and private sources. Most of that is designed to develop technology to meet particular goals. What are the ways of stimulating more active and systematic uses of technology that may be relevant in this arena?

Technological possibilities can be explored in three categories:

1. existing technologies, especially those developed for very different purposes, such as military or medical applications;

2. technologies that could be imagined as developments in the near to mid-term future; and

3. the possibility of wholly new, presently unknown technological capabilities in the future.

Methods of stimulating desirable technological identification and development include:

* focused R&D (e. g., energy technology efficiency, satellite observation)
* command and control standards (e.g., zero-emission autos)
* regulations (e. g., auto miles/gal., sulfur stack emissions)
* other market incentives/rewards (e.g., patents, guaranteed markets)
* international approaches such as
* cooperative R&D (e. g., International Geophysical Year, International Geosphere-Biosphere Program, fusion energy),
* agreed international regulations (e. g., tanker hulls, fish limits)
* trade restrictions that create market incentives for technological development (e. g., dolphin-friendly tuna fishing gear)
* funding for development of technology for low-income markets (e. g., drugs for endemic third-world disease)
* exploration of exogenous technology (e. g., military, medical, consumer technologies)

Some issues associated with application of technology were identified:

Regarding transfer of technology:

* selection of appropriate and needed technologies
* requirements for successful transfer (capacity-building)
* requirements for (and value of) local R&D
* who owns the technology?
* who pays for transfer, purchase or operation?
* roles of private sector, public sector
* distribution questions (e. g., who benefits in recipient country)
* role of international institutions
* position on recipient country agenda
* possibility of continued technological dependence
* effects on trade such as competitiveness and non-tariff-barriers

Regarding management of global technologies:

* national or international ownership (e. g., Intelsat versus Global Positioning System)
* policy and decision process; who has a voice in, or determines, design and operation
* sensitivity of information: security/privacy issues
* system biased or neutral in its operations, effects or benefits, economic or other dependence on system operation (e. g., vulnerability to disruption)
* control of data stream, its reduction, and its use

Other issues:

* who carries out assessments, forecasts?
* where does liability lie for incorrect forecasts?
* over-valuation of computer outputs, models
* how to protect against technological incompetence?

Develop a set of high priority needs relevant to climate change and then scan existing or potential technologies for possible applications to these needs.

One approach to identification of technologies likely to be fruitful is to develop a set of high priority needs relevant to climate change and then to scan existing or potential technologies for possible applications to these needs. Examples of such high priority needs that technological developments could help address in the international environmental arena are:

1. Technologies that would make possible remote monitoring where on-sight measurement is now required, or for measurement of presently opaque or inaccessible environments, e. g., monitoring of fish catch on a ship-by-ship basis, tracking sources of illicit use of fertilizer, and observing exhaust plumes to identify constituents or violations of agreements.

2. Remote sensing of inaccessible or difficult environments, e. g., plankton density below ocean surface, monitoring of fish stocks and migration, and tracking transboundary pollution from low-level sources.

3. Identifying reliably and rapidly items in trade from proscribed species, e. g., ivory from Kenya or South Africa.

4. Monitoring of behavior at the level of the individual, e. g., monitoring of auto exhaust or speed on real-time basis.

5. Technologies for specific local or national situations, e.g., low-cost weather and climate observation to determine local situations and impacts, low-cost emission-control or cleansing technologies for low-income applications, and rapid detection and location of gas pipeline leaks.

6. Specific mitigation technology goals, e. g., replenishment of the ozone layer, safe and proliferation-resistant nuclear technologies, waste disposal technologies involving novel approaches or presently ignored geographical areas, geoengineering for mitigating effects of greenhouse gas emissions.

Discussions should not only focus on technologies, but should also consider some of the issues associated with technological development and applications, such as the social/political/economic impediments to the use of technology, the differing role of and impact on developing countries, the roles of international institutions, the various routes for development of technology, and the problems to be anticipated from technological externalities. It would also be useful to take a longer look ahead, to ask what environmentally-related issues are likely to be dominant concerns (e.g., drinking water) in, say, 50 to 75 years, and what technological measures ought to be considered now to prepare for them.

A collective effort by the private sector in the public domain to disseminate and promote technologies and develop an export market in environmental goods and services is needed.

The appropriate group to discuss this issue would obviously have to be quite broad. It should include some imaginative scientists and engineers, able to range outside their disciplines, economists familiar both with technological development issues and the role of technology in climate change assessment, political scientists who deal with science/technology-related policy issues and international environmental questions, possibly a historian of technology who has a deep understanding of the historical sweep of technology-induced change, and individuals from developing countries (in any of the above disciplines) who can deal with technology-related development and environmental questions.

The result of such discussions could provide specific ideas of applicable technology, institutional suggestions to improve the present process for identifying technologies and influencing technology goals, and a better understanding of how technology relates to both environmental and development objectives.

In group discussion, many interesting issues arose including:

* How can we avoid getting locked into technologies that result in half the world using one the other half using another of two incompatible technologies (like VHS and Beta formats for video tape)?
* How can we avoid technologies that turn out to be mistakes (e. g., DDT, CFCs, etc.)? Some suggested that almost all technologies turn out to have some unexpected and undesirable consequences, such as leaded gasoline.
* Data storage media, including the current electronic media, are not permanent. Physical deterioration is one problem and changing methods of reading data are another. As technologies change, older ones become obsolete, parts are no longer available, etc.

It was suggested that wider public participation, facilitated by the use of the Internet, could get more information on national plans or relevant data to more people in a decentralized way and this might stimulate new technological ideas from many quarters.

The transfer of data and technology from the intelligence community to others was suggested as a means of bringing technology to environmental uses. For example, declassification of

environmental data is allowing the study of the thickness of polar ice over time to detect change. The acoustic thermometry experiments now beginning to be used to detect changes in ocean temperatures have been made possible by the use of old defense technology. This is the proverbial beating of swords into ploughshares.

The Russian-American Space Station is an example of both technology transfer and international cooperation bringing countries together to develop environmentally useful technology. U. S. technology policy is largely focused on competitiveness. What are the comparative benefits of cooperation versus competition?

The attitude of the rich countries is that technologies are privately owned and countries can't transfer them. There is also the problem of phased-out technologies from the developed countries being sold for money to developing countries. And if developing countries buy the new technologies they are indirectly paying for the problems created by the old technologies which were used and scrapped by the developed world. Are new rules for property rights needed? There is a need to talk about these issues at the international level.

Sometimes it is not technology itself that is the problem but other related issues. For example, for the use of photovoltaics, battery technology is really more the problem. With energy efficient lighting technologies, the technologies are fine, the problems lie in implementation strategies and management issues.

Drinking water is currently the world's most significant environmental problem, especially in Africa. An organized effort is needed to develop alternative drinking water supply and delivery technologies.

Defining technology as capacity, technology can't be transferred, only built. Technology cooperation rather than technology transfer is one suggestion. What is possible? Much technology is in the public domain and can be acquired for money. What are the roles for government versus the private sector? A collective effort by the private sector in the public domain to disseminate and promote technologies and develop an export market in environmental goods and services is needed. There should be standards for this though and it should not stress the current system; it needs to be able to be absorbed. We should be able to have economic growth and environmental protection hand in hand.

Drinking water is currently the world's most significant environmental problem, especially in Africa. An organized effort is needed to develop alternative drinking water supply and delivery technologies.

Factors Influencing China's Impact on a Climate Change Regime

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The Beijing Declaration of 1991 states the developing world's position that the rich countries are responsible for the rise in greenhouse gases both in terms of current emissions and in a cumulative sense.

China is currently the world's second largest producer of greenhouse gases (emitting 11% of the global total) and its emissions will increase substantially during the coming generation. Rapid economic expansion and the continuing reliance on coal can be expected to more than double its recent carbon dioxide emissions. Providing enough food for a population which is still growing at high absolute rates will require the further intensification of farming, resulting in higher releases of methane and nitrous oxide. Consequently, China is expected to become the world's largest emitter of greenhouse gases sometime between the years 2010 and 2025. In this context, Smil provided background on China's environmental policies and discussed the country's population, agriculture and energy use, and their potential implications for climate change.

Since China "joined the world" in the 1970s, it has signed about two dozen international environmental treaties. One reason it signed these accords was to prevent Taiwan from doing so; another was to place itself in good standing in the international community. Though it signed these treaties, it has largely failed to implement them domestically. For example, though China is party to the convention on endangered species, there is a significant illicit market in these species in China. Internally, though China has set forth strict limits on pollutants, enforcement of these standards is quite poor. Actual levels are often an order of magnitude higher than the legally allowable limits. In terms of Montreal Protocol provisions, inadequate funding is hampering a transition from CFCs. In terms of the climate convention, there is nothing to enforce, as the Berlin mandate specifically calls for no new commitments by developing countries.

The Beijing Declaration of 1991 states the developing world's position that the rich countries are responsible for the rise in greenhouse gases both in terms of current emissions and in a cumulative sense. It says essentially that the developing countries will not do anything to limit their emissions until they reach the developed world's level of per capita emissions, as well as its historical cumulative emissions. This means they should not be expected to do anything in the foreseeable future. If anything is wanted of them, not only does the first world have to pay, but has to give very substantial sums over long periods of time.

In terms of climate change, there is the perception that China is the big wild card. How they will develop and how much coal they will burn are open questions. They may surprise us. Like the yin/yang symbol, China is a unity of great opposites - hope and despair, light and dark, good and bad. This can be seen by examining certain key factors: population, food, environmental problems, energy, and greenhouse gas emissions.

Population

Population has preoccupied every Chinese administration. This concern is even expressed in the Chinese language: the word for population is "the people's mouths," showing their concern for how many mouths there are to feed.

There are now 1.2 billion people in China and the population is growing at a rate of about 1.1%. While this low level of growth is a great achievement, it still results in enormous numbers of additional people. In 1950, the population growth rate in China was above 3%. The great famine of 1958-61 killed 30 million people, but made only a temporary dent in the population. During the late 1960s, population growth rose sharply. Finally, during the early 1970s, China began a massive population control effort which culminated in 1979 with the introduction of the one child program.

This program has been extremely successful in the cities where the labor unit controls many aspects of life. However, this policy does not work nearly so well in the countryside. There, fertility is still well above two children per woman.

There are 13 million new people added each year in China, so even the indisputable achievement in population control still results in the addition of more than the entire U. S. population in 20 years. Smil estimates there will be 1.3 billion people in China by end of this century, and 1.5 billion in 2020.

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Food

As far as food production, China feeds more than 1/5 of the world's population (22%) with 1/11 of the world's farmland. They are currently upgrading their farmland figures from 95 million hectares to 129 million hectares. So the good news is that China has a great deal more farmland, but the bad news is that it still is an open question if it will be able to feed all of its people in the future because its production methods are not sustainable.

Smil says that China opened up to the world in the early 1970s because it needed fertilizer to intensify its agriculture and feed its people. Geopolitical concerns were not the only motivator. They had energy to produce fertilizer but needed the most modern techniques to synthesize ammonia. The company which held the most efficient process was M. W. Kellogg of Texas and its Dutch subsidiary. The very first deal signed after President Nixon's visit to China was for the world's 13 largest fertilizer plants from this company.

China soon became the largest producer of nitrogen fertilizer on the planet, and with the boost in food production provided by these enormous amounts of fertilizer, China's average per capita availability of food rose virtually to the same level as Japan's, 2800 kilo calories per day per person. An average of 200 kilograms of fertilizer per hectare is applied to Chinese farmland. In intensively cultivated provinces, the average is 350 kg of nitrogen fertilizer per hectare. This is not a sustainable practice. The only place on Earth on which nitrogen fertilizers have been applied this intensively over long periods of time is in the Netherlands, and now a large share of Dutch underground water is contaminated by nitrates. This can be expected to occur in China in the coming decades.

In addition, China loses more soil to erosion than any other country in the world. In North China, where the largest area of loess is found, erosion losses by wind and water average

over 200 tons per hectare per year. The average for China as a whole is about 50 tons ha/yr., compared to the U. S. average of less than 20 tons ha/yr. Through soil erosion losses, China loses as much nitrogen each year as it applies in nitrogen fertilizer.

In absolute terms, China has more irrigated land than any other country. (In per capita terms, a number of nations, above all Egypt and Israel, have more.) Half of all farmland in China is now under irrigation, but only about half of this area receives all the water it needs. One reason for this is that like farmers in California, peasants in North China pay only about 1/10th the real cost of delivered water. Where there is intensive surface water irrigation, it has resulted in alkalization and salinization of soils. In average terms, China appears to be flush with water, but 3/4 of it is south of the Yangtsze. North of the Yangzi, an area in which 500 million people live, there can be a year to 18 months in which it doesn't rain at all and then it all comes down in three downpours. A massive geoengineering project to reverse the flow of China's rivers is being considered and would require a great deal of energy.

At present, and up until about 2025, the key problem is over-consumption by the developed countries. But after that time, the developing world, led by China, will swamp the rest of the world's emissions.

Energy

China has the world's largest coal deposits, the largest hydro electric capacity but a limited amount of oil and natural gas. Chinese use 25 gigajoules per person per year of total energy compared to the Japanese 100 gigajoules. Currently, 75% of China's primary energy consumption comes from coal. About half this production comes from small mines and is unsorted. Coal mined in the north must be moved south by rail, resulting in 50% of the burden on Chinese railways. Burning coal in steam locomotives is extremely inefficient (5% efficiency) and a shift is being made to burn the coal in efficient power plants (35 -37% efficient) and run the trains with electricity. In total, China now burns 1.15 billion tons of coal per year. In addition to generating over 70% of China's electricity, coal also provides more than 50% of the feedstocks for chemical industries, and 90% of heat for households.

Greenhouse Gas Emissions

In addition to the large increases in CO2 emissions expected from the continuing expansion of coal use, large increases in the other important greenhouse gases are expected as well. As China develops its natural gas reserves, more methane losses are expected to result from recovery activities. In the agricultural sector, more rice will mean more methane, and more fertilizer use will mean more nitrous oxide (N2O). N2O is 200 times more effective at trapping heat than CO2, and China is already responsible for more than 20% of the world's N2O emissions and this percentage is growing. In terms of chlorofluorocarbons (CFCs), another significant greenhouse gas, China is now the world's largest refrigerator producer, with the goal of providing a refrigerator for every Chinese family. With these increases in CO2, methane, N2O, and CFCs, China will become the world's largest producer of GHGs in absolute terms sometime between 2010 and 2020.

China seems to be operating under the delusion that there are no limitations to its development. Instead of developing efficient public transportation systems, the Chinese are building six-lane highways through rice fields, and their eventual officially-stated goal is to have a car in every Chinese family. (There are now 300 million families in China and a total of 660 million cars worldwide).

In discussing how to influence Chinese development so as to reduce expected increases in GHG emissions, Smil points out that the most dynamic sector of the Chinese economy exists

because of the U.S. In 1995, China enjoyed a $40 billion trade surplus in its dealings with the U.S., giving China an interest in maintaining good relations with the U.S.

A debate exists as to whether GHG emissions are primarily a problem of the developed or the developing world. At present, and up until about 2025, the key problem is over-consumption by the developed countries. But after that time, the developing world, led by China, will swamp the rest of the world's emissions. An obvious way to positively influence this situation is for the rich nations to help China and the other industrializing countries to develop in a more efficient manner.

A debate exists as to whether GHG emissions are primarily a problem of the developed or the developing world. At present, and up until about 2025, the key problem is over-consumption by the developed countries.

Cloud Feedbacks And General Circulation Models

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The number of GCMs and of scientists involved in GCM research is growing explosively, driven both by the growth in computing power at the workstation level and by the public dissemination of GCM codes.

General circulation models (GCMs) are the main computational tools for theoretical research on global climate variability and climate prediction. Such models are the intellectual direct descendants of the numerical weather prediction models envisioned early in this century by Lewis F. Richardson in his book, Weather Prediction by Numerical Process (Cambridge University Press, 1922). We may distinguish between atmospheric GCMs (AGCMs), oceanic GCMs (OGCMs), and coupled GCMs, which combine these two major components of the climate system. The clear direction of the evolution of these models is toward coupled, comprehensive models of the entire Earth system, including biogeochemical aspects. At present, AGCMs are the most advanced models, having now undergone four decades of continuous development. Much worthwhile climate research can be performed with AGCMs, either in stand-alone mode, driven by fixed sea surface temperature (SST) boundary conditions, or coupled to any of several types of ocean models which allow SST to vary.

The number of available AGCMs has increased rapidly in recent years. In the early 1960s, only 3 state-of-the-art models existed worldwide, and all were in the U.S. By the mid-1980s, that number had increased by at least an order of magnitude, as supercomputer resources became commonplace in many countries. Now the number of GCMs and of scientists involved in GCM research is growing explosively, driven both by the growth in computing power at the workstation level and by the public dissemination of GCM codes. These codes, which were typically treated as proprietary by their creators for many years, are now becoming widely available. For example, the AGCM recently developed in the United States at the National Center for Atmospheric Research (NCAR), known as the Community Climate Model, Version 2 (CCM2), was first ported to IBM RISC Unix workstations from its original (Cray supercomputer) development platform by NCAR staff, and then the source code for both versions was made publicly available in 1994. This code is now easily and instantly obtainable by anyone with Internet access. Thus, a 50,000 line (Fortran code) modern AGCM, representing many person-years of development effort, professionally programmed and fully documented, is now available at no cost to the entire global change research community.

As one typical example of the resulting increase in the population of GCM users, CCM2 is now running on Digital Equipment Corporation workstations at the Climate Research Division of Scripps Institution of Oceanography, University of California, San Diego. The conversion from the IBM version of the code was carried out at Scripps in 6 weeks by a postdoctoral fellow. Thus, GCM work, which formerly required not only supercomputer access, but also relatively large scientific staffs and specialized computational expertise, has now become possible for typical academic researchers, working in the mode of a single professor collaborating with one or two graduate students or postdoctoral fellows. This democratization of GCM research is

now giving rise to qualitative changes in the way the research is conducted. For example, email networks are springing up, connecting CCM2 users, who trade reports of code bugs, revised physical process parameterizations, and the like. At the same time, GCM research is becoming less conservative intellectually, as the reduced cost motivates scientists to develop and test unconventional parameterizations, modified numerical algorithms, and other departures from past practice. These trends are likely to continue and accelerate, as more codes become public and as the cost of computing continues to decline.

A second driver which is changing the way climate modelers work is the proliferation of observational data sets for the development and validation of GCMs. In the early days of GCM research, models were compared against only a few sparse data sets, typically time-averaged and in two space dimensions, representing the globally mapped or zonally averaged fields of the primary meteorological variables, such as sea-level pressure, geopotential height of standard pressure surfaces, temperatures, humidities, and winds. Today, available data sets cover a far greater array of field variables, and they span three space dimensions and time. Disparate data sources, ranging from paleoclimate data to analyzed fields from operational numerical weather prediction to specialized satellite remote sensing measurements, are being combined in heterogeneous data sets and used routinely in GCM research. Again, the clear trend is toward even larger and more comprehensive data sets, as the sources of data continue to increase. Similarly, the data produced by the GCMs themselves is also growing rapidly in size and variety, as model resolution and physical complexity both increase.

In general, the parameterizations with computed radiative properties based on cloud water budgets are better able to reproduce ERBE observations of cloud forcing.

These two factors, the proliferation of GCMs and the increase in the size and scope of the associated data sets, mandate a change in the way GCM researchers work. Antiquated ways of handling model and observational data are hamstringing researchers now, and the seriousness of the problem is certain to increase in the future. Nevertheless, the new modes of GCM research are already beginning to bear fruit in the form of new scientific insights. At Scripps, Somerville and Wan-Ho Lee have recently used an AGCM (created by using their own parameterizations to replace those of CCM2) to test a suite of alternative cloud-radiation algorithms. As is well known, most of the differences in GCM sensitivity to increased greenhouse gas concentrations, when measured by global average equilibrium surface temperature changes, are due to the differing cloud and radiation algorithms in use by the various modeling groups. The work of Somerville and Wan-Ho Lee extends and generalizes the study of Senior and Mitchell (J. Climate, 6:393-418, 1993) who used a version of the AGCM developed at the United Kingdom Meteorological Office.

The methodology of Somerville and colleagues relies on using both a coupled model (the AGCM plus their own simple ocean mixed layer model) and a set of perpetual July AGCM integrations forced by constant SST perturbations, following Cess et al. (J. Geophys. Res., 95:16,601-16,615, 1990). They have tested parameterizations including relative humidity-based clouds and several versions of schemes involving a prognostic cloud water budget. They have carried out extensive sensitivity tests with these parameterizations, in which they examine the effect of varying tunable constants and other arbitrary aspects of the schemes. They compared the GCM results with Earth Radiation Budget Experiment (ERBE) data and with observations from the U. S. Department of Energy's Atmospheric Radiation Measurement (ARM) Program, diagnosed using the single-column models developed by Iacobellis and Somerville (J. Atmos. Sci ., 48:1948-1959 and 1960-1971, 1991). In general, the parameterizations with computed radiative properties based on cloud water budgets are better able to reproduce ERBE observations of cloud forcing. They also tend to give qualitatively different cloud feed backs (for both solar and terrestrial radiation) when compared to parameterizations based on relative humidity clouds with fixed radiative properties.

Plans for future research on the development, validation and improvement of numerical climate models will emphasize the use of GCMs together with diagnostic models and field program observational data for the direct validation of physical process parameterizations. The research focuses on the parameterization of atmospheric convection and cloud-radiation interactions and has three major components:

* Utilization of stochastic radiative transfer theory (Malvagi, Byrne, Pomraning and Somerville, J. Atmos. Sci., 50:2146-2158, 1993) to develop parametric representations of cloud-radiation interactions and closely related processes for atmospheric models;

* Validation and improvement of parameterizations with field program data using their single-column models diagnostically to make direct comparisons between results from parameterizations and observations from programs such as ARM;

* Testing of the parameterizations in comprehensive global models to determine the sensitivity of the model results to all aspects of the physical parameterizations.

Plans for future research on the development, validation and improvement of numerical climate models will emphasize the use of GCMs together with diagnostic models and field program observational data for the direct validation of physical process parameterizations.

Potential Roles of Insurance Mechanisms in a Climate Regime

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Insurance has been raised as an institutional response to the threats of climate change. The Framework Convention on Climate Change (FCCC) reserves it as one of the options the parties are to consider. Yet, one finds that "insurance" has been used in the greenhouse debates to connote distinct strategies. In its most robust sense, "insurance" is applied to any precautionary undertaking. For example, there is a popular sense in which one who installs a home security system is "insuring" against robbery. If the cost of the system exceeds the expected loss, the difference might be referred to as a "premium." Some commentators on the greenhouse effect seek to justify precautionary investments in these terms. The investments are designated social "premiums" warranted to prevent low probability, highly undesirable outcomes. In its more technical usage, however, insurance applies to arrangements designed to avoid outcomes, so much as to distribute the costs of the losses that other measures fail to avoid. Both meanings of "insurance" merit consideration, although the focus of Stone's research has been on the more technical sense of the term of spreading the burden of possible losses among risk-holders.

Insurance fits naturally with the most common expectations about future climate-change: that there will be some hard-to-predict winners and some hard-to-predict losers from climate-driven phenomenon.

Stone does not tout technical insurance as a first-line response. He outlined carbon-specific and general policies which merited priority. In terms of carbon-specific or greenhouse gas-specific policies, Stone mentioned "no regrets" strategies, such as improving energy efficiency, which make economic sense from many points of view, but which are often not adopted due to a variety of institutional barriers to their implementation. General policies are those that seek to "insure" future persons against a whole range of perils that may befall them, whether climate-driven or otherwise. The best "insurance" flexibility is added global wealth. In addition, there are promising non-monetary forms of insurance, such as investment in portfolios of real assets, such as germ plasm banks. Even more important, we should provide the insurance of institutional flexibility, for example, education, and international institutions that provide relief and assure free movement of capital, people, and goods.

Conventionally, techniques for managing risk are divided into five categories: avoidance, reduction, control, transfer, and retention, all of which may be relevant to dealing with climate change. A risk managers aim is to combine them into the lowest cost combination.

Turning this model to global warming, Stone reminded that it is not "climate change" one would be insuring against, but particular local manifestations, such as floods, drought, crop loss, etc. In law, he reminded, insurance in this technical sense plays a distinctly secondary role. Ex post, that is, after the fact strategies are basically harm-based liability rules which provide compensation for victims in the event of an accident. This has the effect of reminding the actor that he is acting under the shadow of potential future loss. Ex ante, or before the fact strategies usually depend on standards, as in the nuclear safety field. Instead of waiting for damage to

occur and then having the actor compensate the victims, society decides that there are certain things we must seek to prevent before they happen. This displaces the judgments of managers with societal judgments. Both ex post and ex ante strategies are precautionary and subject to over-regulation.

Stone recited certain benefits of exploring the insurance option, which has been relatively dormant. First, insurance fits naturally with the most common expectations about future climate-change: that there will be some hard-to-predict winners and some hard-to-predict losers from climate-driven phenomenon. These are circumstances that invite commercial insurance. Indeed, insurance companies and reinsurers are already implicated (and concerned) just from the continuation of their calamity underwriting. Insurance promises to compensate risk bearers for risks that cannot be efficiently reduced further. But there is also an element of efficient deterrence. Insurance sensitizes risk bearers to the social costs of their own conduct via the premiums they bear, just as proposed carbon taxes sensitize risk creators. The behavior of both is nudged in the right direction. Moreover, the insurance industry has already assembled considerable expertise in the assessment and distribution of many of the anticipated climate-driven losses.

One of the most difficult aspects of applying the insurance theme to climate change is the subject of attribution. But one doesn't insure for "floods caused by climate change;" one simply insures against floods, so collecting is not dependent on establishing causality.

But there are serious questions about how strongly we can rely on commercial insurance (and other market mechanisms) to deal with problems as potentially vast as climate change may bring. The insurance industry has limited resources, and calamity underwriters appear to have been taking a beating in recent years. Even its statisticians are uneasy about their ability to assess climate change-driven losses. Their exposure has increased as more people have sought calamity insurance, and more wealth has moved into dangerously situated regions coastal zones in particular. Over the long periods we are considering, they face appreciable problems of adverse selection and moral hazard. Moreover, there are many "gaps" in commercial coverage. Normally, insurance covers sudden catastrophes, not gradual erosion of land or gradual loss of farmland. Also, public goods like global "commons" areas, are almost certainly beyond the range of coverage that can be made commercially available. How will future courts react to insurers who, after collecting premiums for 30 years, see which way the wind is blowing and want to cut off coverage? Public policy will resist and in anticipation of this backlash, the industry will be all the more leery about underwriting the losses.

One of the most difficult aspects of applying the insurance theme to climate change is the subject of attribution. Consider an event comparable to the recent major flood in the Philippines. Is it caused or exacerbated by human-caused climate change? Or was the "real" cause human deforestation? The difficulty of separating out a variety of possible causes and determining the proximate cause will always be challenging. This, Stone says, is one reason insurance may make more sense for climate cataclysmic events than familiar legal compensation. A contract can be written to provide that the holder of a first party insurance contract has less of a burden that a plaintiff in a civil suit who or what caused the loss. One doesn't insure for "floods caused by climate change;" one simply insures against floods, so collecting is not dependent on establishing causality.

Considering, however, the limits of the coverage the private industry is likely to provide, the question arises of government participation in climate insurance. Such participation could take a number of forms. The government could provide a subsidy for the premium payers. Alternatively, it could provide backstop coverage to fill coverage gaps (like the Price-Anderson Act does for the nuclear power industry). A tax on greenhouse gas emissions could supply the money for this backstop insurance fund. Government can also participate in more direct ways, including managing a pool to cover losses (as contemplated by the Association of Small Island States), or by insuring rejected applicants.

The Uses and Design of Targets in International Environmental Agreements

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The full package of international commitments to slow global warming will include resource transfers, technology sharing, and reporting requirements. But the debate to day has turned primarily on one aspect of climate commitments: the design of quantified numerical targets to limit greenhouse gas emissions by specific dates. Many participants in the climate negotiations, especially the states pushing hardest for more stringent commitments as well as the majority of environmental pressure groups, favor codifying targets and timetables in a legally-binding protocol to the Framework Convention on Climate Change.

The choices in designing a target are numerous. More attention should be given to non-binding measures that are more flexible, stringent and creative.

Victor's message is that the choices in designing a target are numerous; the legal status of a target is only one element of a package of design characteristics. Choosing a legally -binding target has mostly negative consequences for other characteristics that make targets effective, such as their specificity and stringency. More attention should be given to non-binding measures that are more flexible, stringent and creative. Binding and non-binding measures can work in harmony in ways suggested here, but negotiations surrounding the Climate Convention have tended to focus excessively on binding emission targets. Following that path will lead to a less effective Climate Convention.

Victor addresses three questions. 1) What are the purposes of targets? 2) What are the choices that must be made when designing a target? And 3) how does the construction of a useful system for reviewing national performance and compliance interact with the negotiation of targets? Throughout, "target" is defined as a commitment to implement specific policies or meet specific objectives. In the case of the Climate Convention, virtually all discussion has focused on quantified greenhouse gas emission targets, but some alternatives will be discussed.

The answers to these three questions have immediate significance. In late 1995 a working group of Parties to the Climate Convention will start the formal negotiations on the "Berlin Mandate" to negotiate additional climate commitments, including emission targets. Their goal is to have a text ready for adoption in 1997. Victor's thoughts suggest some specific advice for that effort.

Purposes of commitments that include targets

Targets serve six purposes; in practice, any target can serve one or more (or all) of them. Here they are described in order of the difficulty of reaching a target to serve each purpose. This order may also describe a general progression of targets over time within an issue-area, from targets that are easy to reach to those that are more difficult.

1. A symbol of concern and action. Many environmental issues are put on the agenda by public pressure. Commitments that include targets, even if they are not implemented, are often adopted to show that something is being done. Symbols are not irrelevant -- they may be used in domestic debates to push for action, or may pave the way for further targets that are actually implemented.

2. As a "toteboard." International agreements with clear targets can be a device that countries use to indicate what they are prepared to implement (or are already on track to meet for unrelated reasons, which is often the case). This toteboard style of reaching agreements is an effective device for lead countries to publicly pressure laggards into committing (and hopefully also implementing) more than they would otherwise. Similarly, and perhaps more importantly, targets help organize and focus domestic debates on the policies and measures needed to achieve environmental goals, and whether those goals are adequate.

It matters less what standard is adopted and more that some standard exists.

3. As a device for coordinating national actions. Under special circumstances, international commitments (including targets) set standards for specific action, technologies or even policies. It matters less what standard is adopted and more that some standard exists. Once in place the standard tends to be followed and is self -enforcing because it is clear to all when the standard is not followed and it is in everyone's interest to follow some standard. Examples include trade-related standards for food quality and industrial practices (set by the Codex Alimentarius Commission and the International Standards Organization, respectively). This is a very special case that almost never applies to targets in pollution control regimes because targets are typically expressed in the currency of aggregate national emissions, rather than intrinsic and product-specific standards. But, there may be some role (far in the future) if such standards relevant to climate change also become part of the international trading regime and /or harmonized domestic law. Examples include possible efforts to restrict trade in automobiles to those that meet specific fuel efficiency standards. Greenhouse concerns may also become part of the general environmental concerns that inform some of the ISO 9000 and 14000 standards, especially standards related to energy efficiency. International standards already play a role in the emissions of international transport vehicles such as aircraft and ships, but so far these have not had any significant relationship to the concern over greenhouse warming.

4. As a means of indicating the long term direction of the regime. Industrial planning and investment, such as research and development, are long term enterprises that benefit from signals about where the regime is headed. If convinced that the targets won't be relaxed and must be obeyed, planners can change infrastructures over long periods of time, perhaps dramatically lowering the costs of controlling emissions. Changes made at the pace of the normal turnover of infrastructure could yield zero or even negative costs for controlling some forms of pollution. Those changes can be signaled with targets, if targets are taken seriously by planners.

5. As a device for collaboration between trading partners. A classic problem in framing international agreements is how to avoid the least common denominator when more ambitious cooperation would be collectively better. Fear of free riding requires that whatever agreement is reached be backed by confidence that trading partners are implementing similar measures. Much of the theoretical analysis of international environmental cooperation has focused on this use of targets within international agreements, especially the work by game theorists employing the "prisoners' dilemma" frame work. So much of the theory about how to slow global warming and other pollution problems has focused on free-riding, defection, and the need for enforcement. But, in practice, these issues don't seem to be major concerns in international environmental

agreements, at least there are few operational and effective systems for managing such problems and none compares with the elaborate systems developed in the world trading system (notably GATT and now WTO). This is probably evidence that few, if any, international environmental agreements have evolved to the stage where commitments are truly interdependent. Nonetheless, most analysts correctly agree that if the climate regime evolves to require deep cuts in green house gases, negotiating and maintaining targets will require this style of collaboration. If so, targets will probably play a crucial role in codifying the terms of collaboration, and so will some means of ensuring compliance with targets.

6. As a means of fixing a cap on polluting emissions, under which trading of emission rights might proceed. There are no examples of this use of international agreements, but the idea is latent in the system of "joint implementation" (JI) now in a pilot phase under the Climate Convention.

The difficulty of agreeing on targets increases as we move down the list because targets have a greater constraint on national freedom of action. For the same reasons, the need for a target to be legally binding also increases as we move down the list. Perhaps only the last two or three uses of targets actually require that targets be legally binding and thus perhaps more difficult for states to flout. The target currently in the Climate Convention falls into the symbolic and perhaps also the toteboard category. Few of the industrialized countries, for whom the current debates over new climate commitments apply, have yet to show an interest in pursuing truly interdependent commitments (and even less so a fixed cap on emissions). The infra structure is not in place to support review and enforcement of interdependent commitments. Nor is there emerging agreement on how to signal the long term direction of the climate regime. Thus the final two or three purposes of targets are not politically viable pursuits today if a target is to be agreeable to more than a small handful of industrialized countries (perhaps only Sweden, Denmark, The Netherlands and Germany). Given these political and institutional constraints, there will be little gained by pursuing a legally-binding target. Even if a target that merited being binding were viable, the negotiations needed to produce an interdependent set of targets would take longer than just a few years.

Nearly every OECD country is implementing some climate-related policies that it would not have implemented if the Climate Convention had not been negotiated; nearly all those countries are implementing policies that are not costly or actually save the society money.

Design of targets

It might still be argued that targets intended to serve only the first three purposes would be more effective if they were legally binding. Even modest targets have some element of interdependence; the line between where a target must be binding to have effect is fuzzy. Governments might shirk even modest climate targets if they are not held ac countable under international law. All else equal, governments tend to take legally binding measures more seriously than non-binding measures. These statements may be true, but all else is not equal.

The design of targets rests on six choices of which only one is its legal status. Victor re views the other five and then turns to the sixth -- the extent to which the target is legally binding -- and shows how it affects the other five. All of the choices affect all the others, and a full description of the design choices would show all the interactions. The focus is on legal status because a central issue facing the climate negotiators is whether to seek climate targets in the form of a legally-binding protocol.

The main message is that opting for a binding instrument has (mostly negative) consequences for the other choices. In the course of presenting that message Victor illustrates some ways that non-binding targets interact with binding measures. These illustrations -- drawn from

the European acid rain and North Sea experiences -- suggest some strategies for the climate negotiations. One route involves binding targets (e. g., through a protocol, perhaps in 1997) simultaneously coupled with clever and ambitious non-binding initiatives by a smaller group of countries. A binding protocol could reflect what countries are more or less willing to do already (and thus be fairly easy to negotiate); the non-binding measure could be led by a smaller group of countries eager to show that they are and will do more. That is the acid rain model. An alternative, following the North Sea experience, is to seek a broad but ambitious non-binding target first, which is later codified into more binding measures.

1 Ambition (cost of implementation)

Much of the policy debate over targets has focused on the stringency of control measures. This is a difficult issue to analyze because the costs and benefits of slowing global warming are uncertain, as is their distribution. The experience in other international environmental agreements is mixed: nearly all start with modest commitments (including targets); dynamic agreements change those commitments over time, typically making them more stringent, as the Parties learn about the problem and political interests shift in favor of environmental protection and ways around blocking interests are found. The Climate Convention's current target is no exception: although difficult to interpret, the changes of behavior that it requires are modest. Nearly every OECD country is implementing some climate-related policies that it would not have implemented if the Climate Convention had not been negotiated; nearly all those countries are implementing policies that are not costly or actually save the society money (so-called "no-regrets" policies). The exceptions include countries that are implementing carbon taxes, but upon close inspection of those taxes it becomes clear that they are written to give substantial relief to industries that are vulnerable to trade pressures (because their competitors in other countries are not similarly taxed). The style of policy making is not yet one where countries implement costly measures on the expectation that others will also implement costly measures and the trading field remains level. The international commitments are not yet interdependent.

It is probably easier to implement and monitor specific international commitments than those that are vague. Assuming that states try to satisfy their commitments at minimum cost, vague commitments make less ambitious efforts easier to justify.

2 Specificity

It is probably easier to implement and monitor specific international commitments than those that are vague. Assuming that states try to satisfy their commitments at minimum cost, vague commitments make less ambitious efforts easier to justify. All else equal, more specific targets give clearer direction, greater capacity to identify (and respond to) noncompliance, and thus are more effective (except when the target addresses the "wrong" activities). In practice, the specificity of a target is often (but not fully) a measure of the extent to which a target is quantified.

Generally agreements intended to ban substances -- such as trade in highly endangered species or consumption of CFCs or trade in hazardous waste -- can be highly specific because the exact interests of nations and their negotiators are clear. The same is true where the obligations are not ambitious, such as the case of the specific 30% commitment to reduce SOx emissions under the 1985 LRTAP sulfur protocol. Where implementation is more difficult and uncertain, commitments tend to be written in less specific terms. The protocol to control tropospheric ozone in Europe states several alternative means of defining the targets so that ozone control is more flexible and it is easier to comply with the legally binding agreement; the protocol controlling NOx emissions allows countries the flexibility to choose the baseline year. The target in the Climate Convention offers flexibility both by not specifying how to convert multiple gases into common units as well as embedding the (vaguely worded) commitments

with phrases such as "...taking into account the difference in these Parties' starting points and approaches, economic structures and resource bases, [and] the need to maintain strong and sustainable economic growth... (Article 2.a)".

3 Distribution of costs (and benefits) of compliance

Targets that require changes in behavior impose costs, but to date there has been little practical attention to the ways that those costs are distributed. Typically targets in pollution regimes are expressed as emission targets. Typically those emission targets are de signed to apply across-the-board (normally in the form of uniform percentage emission cuts). In practice this implies unequal costs as countries almost always start emission abatement from different positions. This seems to reflect four factors that weigh heavily in negotiations: 1) the (erroneously) perceived fairness of across-the-board emission controls; 2) the ease of negotiating simple targets; 3) the dominance of conventional wisdom which quickly focuses debate on this style of percentage cut; and, 4) perhaps the tendency for simple targets based on percentage changes from the status quo to keep politically powerful interests (i. e. the status quo) more or less in place and uniformly affected, and thus not as strongly opposed to the agreement. Yet most observers who think hard about the logic of uniform cuts would agree that more complex attention to cost distribution could allow more effective environmental bargains.

There are some partial exceptions to the rule of uniform emission cuts. The Montreal Protocol includes two tiers of targets -- one for industrialized countries and the same target with a ten year delay for most developing countries. But the target is uniform within each of those two groups of countries, and thus the main observation that uniform tar gets may be inefficient still applies. The recent (1994) sulfur protocol in Europe contains differentiated national emission targets, calculated with computer models mostly on the basis of "critical loads" of acid rain. This case illustrates a general observation: if pollution regimes are to move from the simple rule of uniform emission targets to more sophisticated schemes for burden-sharing, there must be some formula or tool for establishing individual shares that are perceived as "fair" and that are allocated on a sufficiently simple basis.

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In the case of climate change, there are many candidates for such a formula or tool, but none is emerging as a commonly agreed standard. Consequently, conventional wisdom prevails, and most discussion centers on some form of uniform percentage cuts for industrialized countries. Differentiation of emission cuts could make economic and political sense: nations are at different starting points, and thus differentiation of cuts might allow fairer burden-sharing and larger collective cuts. Yet there seems to be strong opposition to differentiation.

4 Participation

Who implements a target influences the overall effectiveness of a regime. Who participates in negotiating targets obviously also affects the stringency of the target and the sharing of burdens. In principle, the development of every collective agreement re quires a strategic balancing of these two choices: widespread participation might em brace wider behavior within the net of the agreement's commitments, but open participation might dilute otherwise stringent commitments and sophisticated burden sharing that could be agreed to by a smaller group of active participants. The choice between openness and discrimination is not a simple inverse: countries initially left outside the agreement are often affected by the rules that they did not influence, especially if outsiders later formally join the regime. Countries that participate in making the rules might nonetheless not implement them.

In practice, discrimination is not as widely practiced as would be suggested by the importance of this strategic choice. Environmental agreements tend to allow universal participation, perhaps because they are pursued under United Nations mandates and the UN system favors universal participation (or full regional participation in the case of the UN regional commissions). Environmental agreements are often pursued by states as symbolic efforts to mollify political pressure that put the issue on the agenda, and thus targets may tend to be modest; that also favors wide participation since the costs of joining such agreements are low and the benefits high. The Climate Convention today is also marked by widespread participation; the modest emission control targets strictly apply only to the OECD countries (except Mexico, which joined OECD only last year, and Turkey, which does not intend to implement the climate commitments). Arguably those commitments would have been stronger if a smaller group (excluding the U. S. and perhaps others) had pushed for further commitments, either in the Convention itself or through a separate declaration.

Widespread participation might embrace wider behavior within the net of the agreement's commitments, but open participation might dilute otherwise stringent commitments and sophisticated burden sharing that could be agreed to by a smaller group of active participants.

5 The behavior or substance controlled

The choice of which behavior or substance to control is very complicated. Victor's discussion touches on the major issues, giving special attention to two: what types of pollution and resource depletion tend to be addressed (and why); and under what conditions are "implementation gaps" likely to arise between the agreed international targets and the types of domestic policies actually needed to control polluting behaviors and substances.

Agreements designed to manage a resource or control pollution typically contain targets expressed in terms that conform to the common-sense notion of what causes the problem at hand. Targets in resource agreements are expressed in terms of allowable extraction of the resource such as fish harvest; tar gets in pollution agreements are typically expressed as emission of the pollutants. This approach often makes sense because it leaves participants to implement whatever policies they see fit to meet their share of the resource extraction or pollution contribution; it also makes sense because common-sense targets serve the symbolic need that many agreements provide. While it may matter whether or not the environmental problem is ad dressed, it also matters that members of the agreement can point to specific targets and other commitments in the agreement that conform with the common-sense notion of what behaviors and substances cause the pollution problem. Without such a common -sense connection, the agreement appears complicated and not directly addressing the problem at hand.

There are many exceptions to the above general statement. Especially in resource regimes the terms of agreements may be written to contain both general targets on the rate and distribution of resource extraction as well as additional targets on specific behaviors and practices that directly affect the extraction of the resource. Fisheries agreements, for ex ample, are often based on a notion of the proper level of fish catch but in practice limit the catch through limitations on length of season, fishing areas, types of gear such as nets and lines, and net mesh size. For decades the whale catch was regulated with a single quota expressed in Blue Whale Units (BWUs) calculated with an exchange rate that converts catches of different-sized species of whales into a single number. That system was abandoned in favor of some species-specific targets and regional limits as it became clear that the aggregate measure of resource extraction could not adequately protect against over-harvesting of species such as the Blue and Right whales whose commercial viability and even extinction was threatened.

That resource regimes often have targets that control a complicated mix of substances and behaviors may reflect two factors. First, they are typically older than pollution control

regimes and thus have had more time for learning and adjustment. It took at least a decade for participants in the whaling agreement to converge on the observation that a new management scheme was needed to replace the BWU system. Second, regimes are typically initiated and managed by those who are affected by degradation of the resource. In the case of resource regimes, those are typically people, firms and states who harvest the resource; they have intimate knowledge of the changes in behavior that are feasible and needed to manage the degradation and thus the agreements they initiate and manage are more closely written to match what is needed to manage the resource. Still, resource regimes are notoriously ineffective at really managing the resource, in part because they have not focused enough on enforcement and in part because quotas are often set too high in order to get all parties to agree.

In contrast, pollution regimes are typically initiated by those who are victims of degradation but may know little about exactly what changes are needed and feasible to implement. Those regimes susceptible to emission targets that have high symbolic value but not necessarily or directly connected to the policies and other measures that actually change behavior. Managing the resource is in the long term interest of affected industries; limiting pollution and other externalities typically is not. Resource regimes affect a particular industry. Pollution regimes often affect many industries; building coalitions to develop and implement pollution control policies across industries is more difficult. The major success stories in control of international air pollution externalities phase-out of CFCs in industrialized countries and massive reduction of SOx emissions in the European industrialized countries -- were all achievements of single industries operating under special conditions that allowed the industry to retain its profit-making services. There have been some losers and opponents, but generally low opposition by polluters makes it easier for regimes to be implemented and effective. All else equal, pollution regimes may be tougher to make effective be cause they require that victims successfully put the issue on the agenda but that the users of the resource either find it in their interest or be coerced to implement the needed changes in behavior; resource regimes require only that the users be involved, and typically it is in their (long term) interest to manage the resource.

Agreements to control pollution, including pollution by greenhouse gases, may often face a gap between the international commitments, typically expressed in terms of emissions targets, and the actual implementation of those commitments as specific policies and other measures that change behavior and solve the problem. The design choice of what behavior or substance should be controlled is typically decided in the international agreement to be an emission target. But usually that leaves open a train of related and more important design choices of how to meet that target. This “implementation gap” may be most severe under two conditions:

1 when the pollutant is intertwined with the economy and policy, and thus the number of actors involved (and potentially op posed) is high. Under this condition some actors will benefit from policy changes, such as the natural gas industry which stands to benefit from climate policies that moderately reduce carbon emissions. However, typically the main beneficiaries are firms that don’t yet exist or have not identified themselves as potential winners, and thus are not lobbying in favor of the policy change. Losers are typically found in the status quo and are usually aware of what they stand to lose; they lobby hard against policy changes.

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2 when the pollutant is being managed rather than eliminated. An international target of zero emissions is easy to monitor, even without institutions specifically designated to determine compliance. Many observers have noted that international enforcement is weak; nonetheless, the propensity for responsible states to abide by their commitments suggests that agreed phase-outs will tend to be implemented. Managing a pollutant with an emission target is more difficult.

Rarely is it possible to determine independently whether the actual emissions meet the agreed standard (except in the case of a zero standard, where any trace is proof). Further, targets that require substantial control in emissions are typically set far in the future; in the interim, it is difficult to know whether the policies and measures actually being implemented are on track to meet the distant target. A serious policy review mechanism can help overcome that problem, but they are rare in environmental agreements; the opportunities for such a review mechanism are discussed further below.

These two conditions apply strongly in the case of climate change.

In principle there is a wide range of choices about the behavior or substances that might be controlled with a target. In practice, pollution control regimes tend to focus on emission targets, leaving a gap between the agreed target and the specific policies and measures that are needed to meet the tar get. In principle that gap is a source of beneficial flexibility in meeting targets; in practice, it is typically unclear whether a country's implementation is on track to meet the aggregate target. Staying on track is politically and economically most difficult when the tar get applies to substances emitted throughout the economy and where the needed changes are difficult to design and implement because of opposing political interests and cost. A review mechanism can help determine whether parties are on track (and whether specific targets are actually reached). If the parties are to make commitments that are interdependent -- that is, where it matters whether or not one party complies while its trading partners do not -- then the ability to test whether or not a party is on track to comply is crucial. The roles of review mechanisms on that topic are discussed in the next section.

Some observers argue that because there is no international enforcement body, international law is not important. States and individuals follow international law only when it suits them.

The target in the Climate Convention is framed in terms of emissions of a basket of all greenhouse gases (other than those greenhouse gases that are controlled by the Montreal Protocol). The means of converting the different greenhouse gases into common units is not specified and will be difficult in practice. How to convert that aggregate basket target into actual emissions control and to close the implementation gap is the central issue facing nations as they put the Convention into practice and contemplate what types of further commitments they might be able to put into practice.

6 Legal status

Some observers argue that because there is no international enforcement body, international law is not important. States and individuals follow international law only when it suits them. Yet there is ample evidence that the status of international agreements under international law does matter. Policymakers face choices about the legal status of agreements (including targets) that they negotiate. Commitments that are binding under inter national law may be implemented more fully, especially in states that have a style of taking international legal commitments seriously and/or have domestic legal practices that give direct effect to norms that are binding under international law.

But the choice to pursue a legally binding target has consequences for all the other de sign choices considered above. In particular:

1 ambition: Efforts to control acid rain in Europe illustrate the difference in ambition created by legally-binding commitments. Both the 1985 SOx and 1987 NOx protocols were legally binding and contained modest targets, but in both cases a small group of countries made non-binding declarations to control their emissions further (60% instead of 30% cut for

SOx; 30% cut instead of a freeze for NOx). Because the declarations were non-binding the parties that signed them were willing to adopt more ambitious targets. In turn, they have made serious efforts to implement those new targets, despite the fact that they are non-binding. The advantages are at least double: not only is emission control greater, but it is greater in the lead countries (i. e., the ones that tend to join ambitious additional targets) that define the overall pace of what emission controls are possible and needed. A similar experience is found in efforts to control pollution in the North Sea. After a decade of mostly ineffective efforts through legally binding control measures a Ministerial process set ambitious non-binding targets in the mid-1980s (50% cut in most pollutants; 70% cut in dioxin and some heavy metals); those have since been translated from broad non-binding targets into legally-binding obligations.

The climate negotiations have so far suggested some parallels with the acid rain experience. Roughly a year before the legally binding loose target in the Climate Convention was adopted, 22 of 24 OECD countries unilaterally announced their own ambitious national or regional targets for controlling greenhouse gases (primarily CO2). Those targets are non-binding, and most won't be met; but most countries are also making some additional efforts to control their greenhouse gas emissions by reference to those targets. Essentially all of those targets are more stringent than the loose target in the Climate Convention. One conclusion of the present analysis is that there is more to be done with such non-binding targets, especially if targets are considered more carefully and by groups of countries rather than only as part of unilateral negotiating tactics to force the international community to adopt a target in the Convention (which was the reason for most of the unilateral climate targets announced during the negotiation of the Climate Convention). To date the only multi-country target is the European Union's target to stabilize emissions at 1990 levels by 2000, but that has come unglued because of an internal squabble over burden sharing. Such targets can be influential, but they need to be connected to what countries are actually able and prepared to implement.

Because the declarations were non-binding the parties that signed them were willing to adopt more ambitious targets. In turn, they have made serious efforts to implement those new targets, despite the fact that they are non-binding.

2 specificity: The specificity of targets is closely related to their ambition and to their legal status. Specific targets offer little room to wiggle and are easier to enforce, but those features that make specific targets effective are weakened if the commitments are also ambitious and legally binding. This triangle of design choices does not leave us with any clear answers, but the experience with the power of the non-binding targets in the acid rain and North Sea pollution control regimes illustrates how relaxing the legal status can lead to substantial benefits in terms of greater ambition and specificity. All of the non-binding targets adopted in the acid rain and North Sea regimes mentioned above were more specific and ambitious than their binding counterparts; the only exception was the SOx non-binding target, which was equally as specific as the binding SOx target (though more ambitious).

3 burden-sharing: It is unclear how other design choices affect the ways that burden-sharing schemes are negotiated and codified. However, one line of argument is suggestive. Non-binding agreements permit states to agree to targets that have higher risks of non-compliance; consequently, they may also be willing to seek new (trial) schemes for burden sharing. Given the paucity of such schemes in practice, and the potential benefits of adopting such alternatives, approaches to setting targets that make such innovation easier should be strongly welcomed.

4 participation: The legal status of an agreement interacts with participation in two ways. First, because legally-binding agreements are typically pursued under the auspices of some host (often the United Nations), it is difficult to discriminate in the formal agreement and procedures that are agreed. Yet limited participation can narrow the field just to countries that are leaders willing to go further than the less-ambitious universal agreement (e. g., as shown in the SOx

and NOx cases mentioned above) or to identify just the important countries among whom a deal must be struck. The ability to identify and include only those few essential participants makes it more likely that they will reach more effective agreements, especially agreements that require ambitious moves beyond the status quo to include tougher commitments, innovative burden-sharing, etc. Non-binding agreements allow the flexibility to shape participation more actively. Especially when there is a legally binding agreement to serve as the universal symbol of action (e. g., as the Climate Convention now does even with its modest target, or as the SOx and NOx protocols did with their modest binding targets), a non-binding agreement can move further when a smaller group of (lead) states participates in making the agreement. This is perhaps the strongest reason why a legally binding protocol might still be needed to set a climate target for the period after 2000. If so, negotiators should not worry that such a protocol is modest (or even largely ineffective); what matters most is that a small group of countries, willing to go further with more sophisticated patterns of participation and burden-sharing, convenes and agrees on a stronger course of action.

Targets can be influential, but they need to be connected to what countries are actually able and prepared to implement.

Second, binding agreements are likely to be accompanied by lower participation if they are also ambitious and specific. States won't sign agreements that they won't implement, especially states that take international law seriously. In practice, few negotiators seem willing to pay the price of lower participation, which may explain why so many international environmental targets are modest or vague or both. Conventional wisdom that favors binding international law and widespread participation automatically leads to targets that reflect the lowest common denominator.

5 behavior/substance: There is no direct relationship between the legal status of targets and the specific types of behaviors or substances they control. The tendency of pollution agreements to focus on emissions reflects the conventional wisdom that dictates how targets are framed. That wisdom is not all bad although in the case of climate it leaves a significant gap between the agreed measures (emission targets) and the actual policies and measures needed to change behavior and lower emissions. It could be much easier to negotiate, implement, and monitor a package of measures such as energy efficiency standards, population control, or other factors that contribute to emissions if the agreements sought are flexible and perhaps non-binding; nations might pick and choose which they want provided that the national sum total of effort met some emission or cost target. The point is simply that measures which go beyond emission targets could be a lot more effective in controlling climate (and at keeping the cost lower) than simple emission targets schemes. Non-binding measures offer more promise for such experiment and learning.

In sum, the design of a target is a package of interlocking choices. Here it is emphasized that the choice of a binding target has (mostly negative) consequences for other desired features of the package. The tradeoff is most direct between the legal status, ambition and specificity of the target. All else equal, non-binding targets are probably systematically more ambitious and specific than binding ones. Non-binding targets may also favor more effective patterns of participation and burden-sharing: a small group of active states operating under the flexibility of non-binding measures will likely find it easier to agree to badly needed innovations in burden-sharing. The choices should not be viewed as singular. Indeed, the examples cited here show that non-binding targets can interact with binding law. The SOx and NOx cases are examples of non-binding targets adopted by a small group of lead countries at the same time that more modest binding targets were agreed by a larger number of states. The North Sea pollution case is an example of a non-binding target that led the way with ambition and was later codified into a series of binding targets and related commitments. In all the cases, non-binding measures have been an essential part of the overall effectiveness of the targets by offering a means for lead countries to set ambitious goals.

Review mechanisms and targets

In addition to the tradeoffs in the design of targets, Victor argues that there is also a tradeoff between negotiating ambitious, legally-binding targets and the operation of an effective mechanism for national reporting and review (Nature 373:280-282, 1995). In brief, the negotiation of tough climate tar gets is incompatible with building a reporting and review mechanism because the negotiation process gives incentives, already in evidence, to undermine the completeness and transparency of national reports. During the one to two cycles of national reports and re views (three to six years) needed to build the foundation, that endeavor should be given much higher priority than targets and timetables. The point is that the commitments (including targets) in a treaty are part of a system that includes mechanisms for gathering and reviewing data on implementation, adjusting commitments over time, and dealing with problems of non-compliance. Observers who focus only on the "need" for more tough and legally-binding targets are considering only one part of the system. International environmental governance has almost completely neglected the reporting and review aspects that make the overall system effective.

The full argument and evidence won't be repeated here except to note that most countries are implementing their current climate commitments through low-cost and "no regrets" options. This is entirely reasonable at the early stages of addressing the climate problem, but it also underscores that the climate commitments are not yet beyond the symbolic and "toteboard" stages discussed earlier. Yet serious efforts to limit greenhouse gas emissions require more collaborative efforts -- namely, commitments that are truly interdependent.

As discussed earlier, if targets are used as part of interdependent collaboration between trading partners then it is probably important that the targets be legally binding (although there is still room for adoption of even more ambitious targets by lead countries through non-binding measures). Even more important is that there be some mechanism for determining whether countries are on track to meet their commitments. That is the purpose of a review mechanism and the system of national reports that is the backbone of international review. If those systems don't operate properly -- and they don't in the case of essentially all international environmental agreements -- then there is little hope for sustaining interdependent cooperation by building confidence that greenhouse commitments are being implemented. Nor is there much hope that future negotiation and adjustment of climate commitments will be in formed by accurate, shared and legitimate information about what countries can implement and which policies work. The critical time for building those systems is now be cause the initial data comprise a baseline against which the efficacy of policies and long term trends can be determined.

Today, the situation looks good for data on emissions inventories, in part because compiling those inventories is a relatively easy task and in part because the OECD/IPCC system of standards for inventories has helped harmonize the different national reports. But the data on policies and measures that nations are implementing, as well as emission fore casts, are less promising. There is no complete set of standards for these data, nor is one soon to be issued. The current set of national reports ("communications") that have been submitted over the last year illustrate the weakness: it is virtually impossible to compare the efficacy of different national proposals and even more difficult to compare across nations or to verify which nations are legitimately on track for compliance. A handful of the reports are rich in information although none is completely transparent in the assumptions that underlie critical calculations on the efficacy of policy measures and forecasted emissions.

Conventional wisdom that favors binding international law and widespread participation automatically leads to targets that reflect the lowest common denominator. ... All else equal, non-binding targets are probably systematically more ambitious and specific than binding ones.

Conclusions

Victor suggests that a central goal of environmental pressure groups and lead states, namely a legally binding target for emission of greenhouse gases, is at odds with other important features of climate targets, such as their specificity and ambition. Most of the purposes actually served by targets do not strictly require a legally binding target; truly interdependent targets would, but neither the Climate Convention process nor nearly any other international environmental agreement has yet evolved to that stage. Victor also argues that targets are part of a system for negotiating and managing international agreements. Pushing for more (especially legally binding) targets in the short term undermines other parts of the system, especially the building of effective reporting and review mechanisms which are crucial to the long -term effectiveness of the climate regime.

The critical time for building reporting and review systems is now because the initial data comprise a baseline against which the efficacy of policies and long term trends can be determined.

Legally binding targets have a role to play in the suite of climate commitments, but non-binding targets may have an even larger role. At minimum, they deserve more attention. The acid rain cases suggest that binding targets are a modest backstop and that substantial additional commitments can come in the form of non-binding targets negotiated alongside binding commitments. The North Sea pollution cases suggest that bold progress can take the form of ambitious non-binding targets, followed by more detailed specific efforts to codify commitments into binding measures. Both cases suggest that non-binding measures deserve more central attention in the climate negotiations. Indeed, it might be better for the working group aiming for a 1997 protocol to spend less time finding universal ground for a legally binding protocol and more time allowing smaller groups of states to innovate more stringent and precise targets and new systems for burden-sharing, all of which could provide a larger contribution to the effectiveness of the climate treaty system. Nearly all that very productive activity is better served by negotiations that seek non-binding measures.

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