Best Practices Guide:

Global Climate Change & Development

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Contents

Acronyms

Acknowledgments

Introduction

Contact Information

Chapter 1: The Science Behind Climate Change….……..……..……...1

Chapter 2: The Impacts of Climate Change...……...……7

Chapter 3: Adaptation Options……..……..…….……11

Chapter 4: International Policy……..……..……...….….15

Chapter 5: Climate Change Mitigation Options……..…21

Chapter 6: The Developing Mitigation Market.……...……..27

Chapter 7: Opportunities for Developing Countries……..29

Resources for Further Information…….……..…31

Glossary…….…….……..…33

Acronyms

AIJ	Activities Implemented Jointly
AES	Global Power Corporation based in Virginia
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbons
COP	Conference of the Parties
EFSC	Oregon Energy Facility Siting Council
GHG	Greenhouse Gas
HFC	Hydrofluorocarbons
IIE	Institute of International Education
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
JI	Joint Implementation
PFC	Perfluorocarbons
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development

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Introduction

The United States Agency for International Development's (USAID) Global Center for Environment has developed the Best Practices Guide Series to provide technical information on climate change and its potential impacts on economic and social development, and to demonstrate the potential costs and benefits of climate change mitigation actions to sustainable development and economic growth. This series of guides is adapted from coursework that was designed to develop technical leadership capacity in energy development and greenhouse gas emissions reduction that are both friendly to the environment and beneficial to economic growth. This guide is for senior-level policy makers drawn from the ministries of finance, energy, industry, transport, forestry, agriculture, rural development and the environment as well as leaders from related private sector and non-governmental organizations, utilities and investment banks. It provides the analytical tools and technical information necessary to raise awareness at the national level regarding the links between climate change, sustainable development, economic growth and social welfare and to help economies move toward sustainable development and mitigation of climate change.

IIE's Energy Group provides assistance and training to government and business leaders to develop the skills and knowledge they will need to succeed in meeting their energy management and national development goals.

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Chapter 1

The Science Behind Climate Change

During the last two centuries, human activities have changed the composition and behavior of the earth's atmosphere in profound ways. An important indicator of these changes is the increase in atmospheric concentrations of greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and the chlorofluorocarbons (CFCs). The buildup of these heat-trapping gases is largely the result of growing worldwide fossil fuel consumption and, to a lesser extent, due to deforestation and changes in land-use patterns. Most scientists agree that current emissions trends, if continued, will lead to rapid, human-induced "global warming."

The Intergovernmental Panel on Climate Change (IPCC) has issued the most authoritative scientific statement available on this subject. The IPCC concludes, "the balance of the evidence suggests a discernible human influence on the global climate." Although scientists continue to question the expected timing and distribution of future climate change impacts, most governments have accepted the IPCC's findings and concluded that the science underlying climate change projections is sufficiently convincing to necessitate a planned policy response.

The Natural Greenhouse Effect

Since primordial times, Earth's atmosphere has contained natural background concentrations of greenhouse gases. These gases, especially water vapor, CO_2, CH_4, N_2O, and tropospheric ozone, are transparent to incoming solar radiation in the visible region of the electromagnetic spectrum, but they absorb and re-emit the thermal infrared radiation that is released by the Earth's surface. When molecules of these greenhouse gases re-emit Earth's infrared radiation, they re-emit in all directions. Part of the re-emitted radiation is thus released in a downward direction, i.e., towards the Earth's surface. It is the warming due to this downward re-emission of energy that constitutes the natural background greenhouse effect.

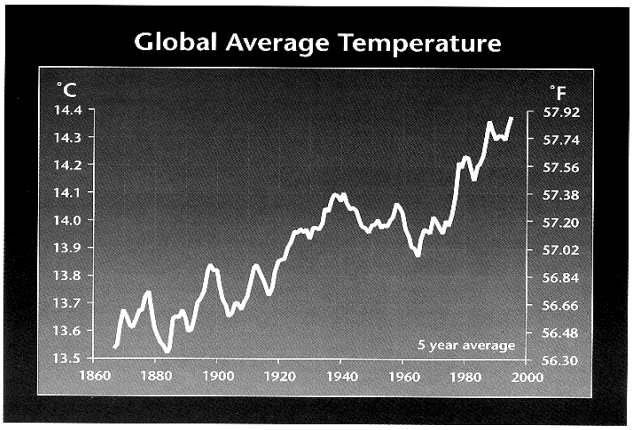
Life exists because of the natural greenhouse gas effect - In the absence of the natural background greenhouse gas effect, our planet would be a cold ice covered rock. The natural greenhouse effect warms the earth's surface by an average of 33 degrees C.

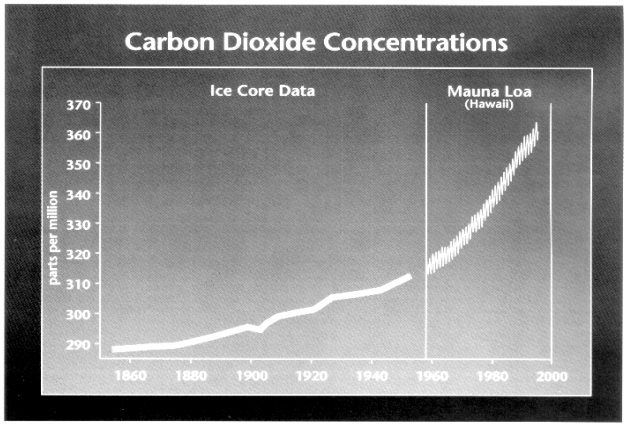
Over countless millennia, this natural background greenhouse effect has warmed the Earth's surface by approximately 33° C (59° F). It is this warming effect that has allowed water to exist on Earth's surface and made life as we know it possible on this planet.

Atmospheric CO_2 Concentration and Temperature Change

Measurements of air trapped in glacial ice indicate that, during the last 160,000 years, increases in CO_2 concentration have occurred at about the same time as increases in global temperature, and that the two changes are highly correlated. Despite intensive analysis, it is not possible to tell

from these observations whether the periodic increases in atmospheric CO_2 concentration have preceded or followed the associated changes in temperature.





In the last 200 years, atmospheric concentrations of CO_2 have risen by about 25%, from 278 parts per million (ppm) during the pre-industrial period to more than 355 ppm today. In the last hundred years, annual average surface temperature has increased by approximately 0.5 to 0.7° C (or 1 to 1.4 ° F).

If current trends continue, CO_2 levels are expected to reach double their pre-industrial concentrations by around the middle of this century. Although the effects of continued buildup are not entirely known today, most scientists believe that doubling the pre-industrial concentration of CO_2 will lead to an increase in average global temperature of between 1.5° and 3.0° C. Upper-bound estimates of the average annual warming resulting from doubling the pre-industrial concentration of CO_2 are approximately 5° C.

As a point of reference, it is useful to note that only 1° C separates today's warm, equable climate from the climate of the Little Ice Age that struck Northern Europe in the 14th to 17th centuries. During this period, the Baltic Sea periodically froze over in winter, making it possible to ice skate from Brussels to Stockholm on a bad day. An average temperature increase of only 2° C (i.e., approximately the middle of the estimates for the next century if current emissions trends continue), would take the planet outside the range of anything that has been experienced in the

last 10,000 years. A warming of 5 degrees C from today's average level would take the planet outside the range of the last 1 million years. This does not mean that human beings could not survive an increase of one or two degrees C; it does mean that there is no historical record, either written or oral, that current societies can review and ask, "What did people do the last time this happened?"

In the last 200 years atmospheric concentrations of CO_2 have grown from 278 parts per million (ppm) to more than 355 ppm. CO_2 levels are expected to double from pre-industrial concentrations by the middle of this century.

We know that the Earth has, at various times in the geologic past, been at least as warm as it is today. It has also been much colder. And it has gone through large temperature swings as it passes from long, cold ice ages to warm equable periods. But in the past, transitions of 5° C (the upper limit of projections for the next century) have occurred over periods of 5-10 millennia. As a result of human intervention, we are today contemplating a transition of the same magnitude over periods of 5-10 decades. Because both human economies and natural ecosystems contain a kind of momentum of their own, it is extremely risky to assume that either one or the other could adapt smoothly to change at the projected (largely unprecedented) rates.

As Roger Revelle, the grandfather of the current international debate on the impacts of climate change noted in 1956, by setting in motion changes of this speed and magnitude, human beings are undertaking a "grand global experiment," but one which violates the most basic principles of the scientific method. We are experimenting with the future of our planet, and we have no 'control' component, no twin earth, with which to compare the results. We are, indeed, playing Russian roulette with the future of mankind, hoping that our limitless addiction for fossil fuels can be served without end and that there is no 'bullet' in any of the spinning chambers.

The Human Contribution to Climate Change

Most scientists believe that the human-caused buildup of greenhouse gases (GHGs) in the atmosphere is threatening to enhance the natural greenhouse effect, and to cause what is often referred to as global warming. The buildup of GHGs is due to the fact that emissions rates from human activities significantly exceed the ability of natural processes to cleanse or remove GHGs from the atmosphere.

In the late 1990s, industrial activities and fossil fuel consumption were the principal contributors to GHG emissions. Globally, annual emissions of CO_2 from industrial activities and fossil fuel combustion reached approximately 5.6 billion tons of carbon as CO_2 (i.e., 5.6 Gt of C as CO_2) during this period.

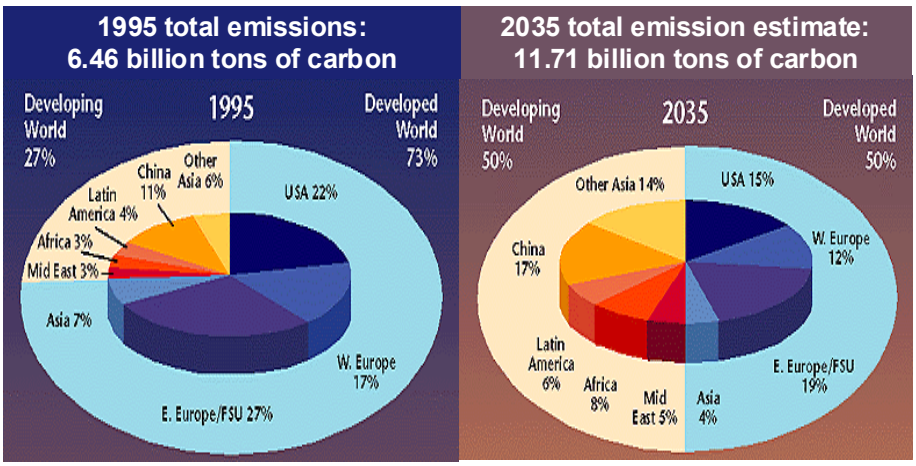
Since before the Industrial Revolution, first temperate and then tropical land-use change has been a key contributor to rising levels of GHGs in the atmosphere; about one-third of the anthropogenic CO_2 now in the atmosphere is the result of such change. Although the relative importance of land use-based emissions is declining as fossil fuel emissions continue to rise, land-use based emissions continue to be significant. Even today, human land use based activities are estimated to emit approximately 0.5 -2.5 Gt of C as CO_2 annually from the world's forests and

soils, as compared with a total global emissions of 7.5 Gt of C as CO_2 in the early 1990s. This represents approximately 6-33 percent of total fossil fuel and industrial CO_2 emissions. In many developing countries, such as India, Brazil, Indonesia, the Congo, and Colombia, land use-related emissions significantly exceed fossil fuel emissions. Land-use change also contributes to methane and nitrous oxide emissions, primarily as a byproduct of biomass burning under non-stoichiometric conditions.

Anthropogenic Sources of Greenhouse Gas Emissions

Greenhouse gas emissions result from economically important activities occurring in all countries. But not all countries have made equal contributions to the atmospheric buildup of these gases. Over the last two hundred years, industrialized countries have been the largest contributors to the buildup. In fact, over this period, industrialized countries have been responsible for more than 70% of emissions resulting from fossil fuel combustion. Not only in aggregate but also in per capita terms, emissions from industrialized countries have far exceeded those from developing countries. In 1995, emissions from industrialized countries represented 73% of total world emissions of greenhouse gases, with approximately 25% coming from the US and Canada, 20% from Europe, 15% from Japan and nearly 20% from the countries of the former Soviet Union and the countries with economies in transition to a market system. However, emissions from developing countries are likely to show the most rapid rates of increase during the next century as these countries continue the critical processes of building basic infrastructures that are so essential to economic development. Indeed, in aggregate terms, by 2035, fossil-fuel-related CO_2 emissions from developing countries are expected to equal and then exceed emissions from industrialized countries.

Global GHG Emissions



The situation concerning emissions from deforestation and land-use change is a little different. Developing countries are the principal sources of these emissions. In some cases, changes in forest management practices and changes in land use patterns have left some industrial countries in the position of absorbing more carbon dioxide in forests and soils than they currently release.

Overall, if current trends continue, the rate of atmospheric build up of GHGs will increase. Indeed, global GHG emissions are expected to rise rapidly under a "business as usual" scenario during the next several decades. Emissions from developing countries, including those resulting from the building of basic infrastructure essential to economic development, will show the most rapid increases during this period.

Scientists agree:
A doubling of the atmospheric CO_2 is projected to increase the earth's average surface temperature by 1.0-6°C by the year 2100.
- Warming will be likely to occur more rapidly over land than open seas.
- Warming tends to lag behind increases in greenhouse gases

Chapter 2

The Impacts of Climate Change

In its Second Assessment Report, the IPCC estimated that "business as usual" emissions would result in an average global temperature increase of 1 to 3.5 degrees C by 2100 and that average global sea levels would rise as a result by approximately 15-95 centimeters over the same period.

The IPCC has identified several potentially important impacts of rapid, human-induced climate change:

- Warmer temperatures will mean an increase in urban smog and local pollution. The industrial activities that lead to GHG emissions also produce considerable emissions of volatile organic compounds (VOCs) and oxides of nitrogen. In the presence of sunlight, these compounds react to form tropospheric ozone and the brownish haze that is called 'smog'. As global temperatures increase, the chemical pre-cursors of smog will become more abundant and the reaction rates for the smog formation will increase.

- As the world warms, average global sea levels will rise due to a combination of the melting of mountain glaciers and thermal expansion of the warm, upper mixed layers of the ocean. As a consequence, coastal populations could face increased threats from flooding and land loss due to erosion or saltwater intrusion. Current national studies indicate that Bangladesh could lose 17 percent of its land area if sea levels rise by one meter. The Majuro Atoll in the Marshall Islands could lose up to 80 percent of its current land area. Similar impacts may be felt on low-lying islands in the Caribbean and the Indian Ocean.

> In the News:
> Coral bleach-out in Belize
>
> "The highest sea surface temperatures ever recorded, related both to the 1997-1998 El Nino/Southern Oscillation and to global warming, caused severe bleaching of corals worldwide in 1998. This thermal anomaly induced mass mortality of corals on reefs in Belize is the first time that a coral population in the Caribbean has collapsed from bleaching. Cores extracted […] showed that these events were unprecedented over at least the past 3,000 years."
>
> (Nature May 4, 2000)

- Climate change will "lead to an intensification of the global hydrological cycle and can have major impacts on regional water sources." Reductions in natural water availability could result in chronic shortages in some regions that are already under stress and for which there is already significant competition for average annual runoff among the riparian states. Changes in precipitation patterns could lead to reductions in water quality as well as water availability in these regions. In other regions, increased rainfall may result in the greater frequency of flooding and storm events, as well as the contamination of water supplies and the increased possibility of the spread of water-borne disease.

While global production of food and fiber is not likely to change significantly, the unequal regional distribution of production losses could result in major shortages in some countries, especially in the tropics, if changes are not made in agricultural practices and crop selection.

Compared to agriculture, the energy, industry, and transportation sectors may be more resistant to climate change. However, these sectors may still be susceptible to sudden changes and increased frequency of extreme events. The insurance industry, already stressed from a series of "billion dollar" storm events every year since 1987, is vulnerable to impacts of further extreme weather patterns that may result from additional climate change.

The effects of climate change on human health will include increases in the potential transmission of vector-borne diseases (malaria, dengue and yellow fever, West Nile virus and schistosomiasis) via extension of the geographic distribution of disease vectors. Dengue fever has already been found to spread to higher altitudes in South America than had previously been observed. West Nile Virus may now be a permanent condition in areas of New York and other mid-Atlantic states of the USA. In addition, rising temperatures and resulting increased air pollution may threaten the lives of those susceptible to heat. More extreme weather events may contribute to increased mortality, injury, and psychological trauma.

While the impacts of climate change are expected by many to occur gradually over an extended period of time, scientists suspect that a number of changes could occur quite suddenly with very disruptive impacts. For example:

- Even a slight change in ocean temperature could dramatically reduce the strength of ocean currents in the North Atlantic, leaving Europe suddenly colder;
- Minor shifts in seasonal temperatures could cause entire ecosystems to unravel by eliminating one or more key organisms;
- Some regions could experience severe and prolonged droughts, hurricane seasons, or flooding, greatly diminishing the world food supply.

Recent News:
Second Mass of Ross Ice Shelf Ruptures

"Washington - A second giant iceberg has broken off from Antarctica and is bumping into a huge iceberg that broke off the Ross Ice Shelf last week [...]. [The new iceberg] is 130 km by 20 km. The larger iceberg is […] roughly the size of Jamaica. (Reuters News Service - April 3, 2000)

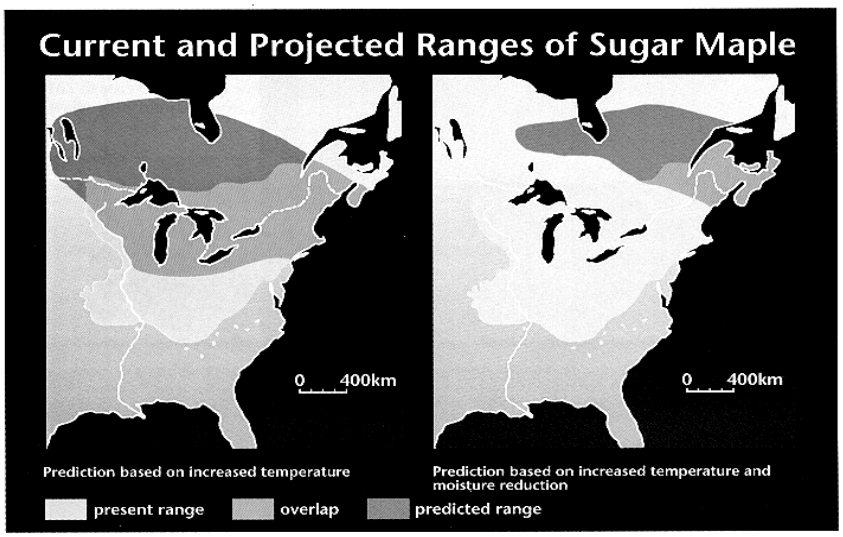


Figure 18. Climatic shifts will force some species to migrate northwards or to higher elevations in order to stay in the appropriate climatic zone. The climatic zone for sugar maple, for example, could shift northwards into Canada. This would compromise the maple syrup industry and the fall foliage colors, both of which make New England famous.

Predicting the impacts of climate change on a regional basis, however, remains difficult due to the fact that existing models are not sufficiently accurate to produce detailed predictions in which scientists can have much confidence. But the current models are more than adequate to suggest the magnitude and the directions of likely change, and to warn us about the limited ability of existing institutions to cope with the changes ahead.

Chapter 3

Adaptation Options

Even if drastic efforts to cut GHG emissions were enacted immediately, future climate change will not be completely avoided. Thermal inertia is inherent to the global climate system, and thus, many of the effects of greenhouse gases emitted in the past are only presently being felt. Over time, the impacts of these earlier emissions will be realized and visible, and it will be necessary at that point to adapt to these impacts.

In 1993, Barry Smit of the University of Alberta (Canada) observed that "adaptation involves adjustments to enhance the viability of social and economic activities and to reduce their vulnerability to [changes in] climate, including its current variability and extreme events as well as longer term climate changes." This observation remains pertinent and meaningful today. Preparing our social and economic infrastructures, as well as our natural resources, to adapt to the impacts of climate change is an integral part of a healthy approach to climate change issues. While many countries will be able to adapt easily with less preparation, the countries most vulnerable to climate change are those in damage-prone areas of the developing world that lack resources to prepare for and adapt to unexpected weather events. Furthermore, the ecosystems most vulnerable to the effects of climate change are those that are already under duress. Finally, the impacts of climate change are expected to vary by region. In some areas, there may be an increase in rainfall, and response may require flood control planning. In other areas, a decrease in rainfall could lead to drought and its accompanying agricultural and land use impacts.

How do these economies and ecosystems prepare for the varying impacts of climate change? Successful strategies will be interdisciplinary, drawing on expertise and innovations in law, finance, economics, technology, public education, and training and research. They will be intuitively sensible, even if climate change impacts are not expected to be a concern.

Exploring and designing successful adaptation options is made more difficult because of the uncertainty surrounding the potential effects of climate change. As well, detecting the early impacts is complicated, and unexpected changes cannot be ruled out.

However challenging the design of successful adaptation options can be, they are important to consider. Questions to ask that help determine the selection of options are:

- Adapt to what?
- Who and what is it that adapts?
- How does adaptation occur?
- When does adaptation take place?
- What are adaptation measures?
- Adaptation at what level?

Strategies for adaptation are as varied as the disciplines from which expertise is drawn. They vary in approach as well as in time, energy, and financial investment. Several adaptation options are offered below:

- **Bear the losses as they occur.** This approach is the simple baseline approach of "doing nothing." This could, however, be the most costly approach in the end.
- **Share the losses.** Communities can distribute the effects of climate change throughout the community so that one sector or region is not devastated by bearing the entire brunt of the problem. This distribution could be achieved by means of taxation and federally funded relief and rehabilitation.
- **Modify the threat.** The potential impact could be scaled back, perhaps by constructing dams and dikes for flood protection.
- **Prevent the effect.** All-out prevention could be pursued wherever possible. Crops could be managed so as to head off the possibility of experiencing the effect. Potential crop management tools include fertilizers and irrigation methods.
- **Change land use.** Agricultural land potential could be maximized, possibly by rotating croplands to pasture.
- **Change location.** Communities and vulnerable assets could be relocated away from danger to avoid being flooded should sea levels rise as projected.

Sectoral Approaches

As seen in the preceding chapter, the effects of climate change will be felt across sectors and across regional boundaries. Applying the general adaptation strategies above, different sectors can design specific approaches to adaptation.

With regard to human health, general adaptation measures include improved medical care services (especially for infectious diseases), health surveillance and sanitation programs, improved water purification and pollution control, and public education. To combat the increased occurrence of vector-borne diseases, pesticide use could be increased, and vaccination efforts could be pursued – particularly for vulnerable population groups. To head off increased instances of heat related illnesses, communities could explore options for making their environments cooler (i.e. shade trees, white roofs, etc.).

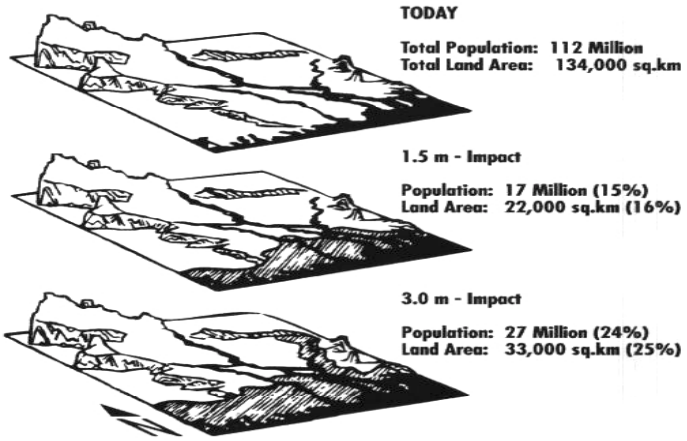
In agricultural sectors, farmers can change the crops and/or crop varieties that they are planting to more drought and salt tolerant species. Water management and irrigation systems could be updated and improved, and the use of fertilizer could be increased. Farmers could adapt their planting schedules and tillage practices, employ better watershed management and land-use planning, and improve food storage and distribution systems.

Forest managers and those who work with wildlife and biodiversity also have adaptation options that are open to them. For managed forests, managers can change the species and varieties of wildlife planted and harvested to be more adaptable to potential climate change effects. Additionally, efforts could be made to increase the efficiency of raw forest material use and

change the product mix to utilize other species. Forest managers could also use Integrated Pest Management (IPM) to manage species' resistance to potential or probable increases in their exposure to harmful pests. Regarding wildlife and biodiversity, managers could assist with species migration (i.e. establishing corridors for species) or the reintroduction of species, ecosystems could be restored and/or reforested, and more aggressive steps could be taken to control disease and invasive species.

Because water resources are at risk in some regions, water managers and policy makers could choose to put into place any number of supply and demand adaptations or policy tools that would prepare for the effects of climate change. Supply adaptations include constructing new water infrastructure, modifying existing physical infrastructure, and designing alternative management techniques for existing water supply systems. Demand adaptations could range from conservation efforts and improved efficiency in households, agriculture, and industry, to changes in technology, to market and price-driven transfers of water to other activities. Policy tools for adaptation include demand-side management, taxation, removing subsidies to foster conservation, and improving water-management regulations.

Bangladesh: Population and Land Area at Risk from Sea-Level Rise



Those who live in coastal regions, or are dependent on coastal resources, are facing a very visible threat due to rising sea levels. For example, low-lying countries such as Bangladesh are at risk of losing up to 25% of their most highly productive land if sea levels were to rise by the projected three meters. Adaptation options for coastal resources include protecting the resource by constructing dams, restoring dunes, and creating wetlands; accommodating the change by designing new building codes and protecting threatened ecosystems; planning retreat from rising sea levels and perhaps enacting regulation against new coastal development; strengthening fisheries management; and finally, improving the design standards for offshore structures that may be at risk with rising sea levels.

Because climate change could alter sea levels and oceanic circulation patterns, delicately balanced

marine ecosystems are at risk. Potential impacts include changes in biological productivity, the geographic distribution of species, and regional plankton activity. The species themselves will need to adapt, along with the man-made economies that rely upon them. Fisheries are an example of businesses that will be affected. Governments may need to negotiate the allocation of international catches; substitute fisheries may need to be identified, or new ones developed; fisheries may need to reduce their current catches to restore the health of the fish populations. With regards to ecosystem management, wetland construction and restoration could be pursued, and coastal zone and land use management could be re-evaluated.

As indicated in the previous chapter, all aspects of human life are at risk of being affected by the impacts of climate change. From health to agriculture, forestry to energy and industry, all sectors will experience some change, find it necessary to adapt, or will rely heavily upon the adaptation of another entity in another sector. Exploring adaptation options, for that reason, is of primary importance. The negative impacts of climate change can be averted, avoided, or reduced in magnitude should communities, governments, industries, and other necessary entities take the appropriate steps now. The challenge will be in identifying low cost options that can be implemented immediately, and financial resources for the more expensive options.

Chapter 4

International Policy

Development of an international climate change regime has been quite rapid. The United Nations Framework Convention on Climate Change (UNFCCC) was signed by 156 heads of state or government in 1992, at the U.N. Conference on Environment and Development in Rio de Janeiro, Brazil. In March of 1995, the Convention entered legally into force. The short-term targeted goal of the Framework Convention was to reduce emissions of GHGs in industrialized countries to their 1990 level by the year 2000. The overall objective of the Convention was to stabilize the atmospheric concentrations of GHGs at a safe level. The Convention's objective was also to stabilize these concentrations in a way which allowed ecosystems to adapt naturally to any unavoidable changes while promoting sustainable development in both industrialized and developing countries.

The pressure to go beyond a short-term aspirational goal and to fix binding emissions targets for industrialized countries manifested itself quickly. The first Conference of the Parties to the Convention (COP-1, Berlin, Germany) issued the "Berlin Mandate" in April 1995; the Mandate was intended to lead through a process of negotiations to a binding protocol that would strictly limit emissions by industrialized countries.

The Kyoto Protocol was adopted by the Parties to the UNFCCC at their third annual meeting (Kyoto, Japan, December 1997). With a total of 27 Articles, the Protocol has many interesting features. Undoubtedly, the most significant of these is the provision for binding emission reductions by industrial countries. In aggregate, industrialized countries (i.e., those countries listed in Annex B of the Protocol) committed themselves to reduce their emissions of six key greenhouse gases by just over five percent from 1990 levels as an average for the period 2008-2012. The gases covered by the Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). The last three gases are CFC substitutes not regulated by the Montreal Protocol.

Many important features of the Kyoto Protocol remain to be fully fleshed out:

- The role that forestry, in particular (and carbon sequestration, in general) will play is unclear, both in terms of estimating net national emissions and as a mitigation option.

- The Protocol contains no specific regime to ensure compliance and enforcement. International treaty enforcement is always a tricky issue and enforcing an instrument as broad-ranging and complex as the Kyoto Protocol will not be easy.

- Rules and guidelines must be developed and agreed to in order to implement all three of the "flexibility mechanisms" in the Protocol (International Emissions Trading, Joint Implementation, and the Clean Development Mechanism).

Kyoto's Flexibility Mechanisms

Among the interesting components of the Kyoto Protocol are the Protocol's flexibility mechanisms, which provide for both project-based and country-to-country emissions trading. The three flexibility mechanisms are:

- *Article 6*: **Joint Implementation,** for emissions reduction projects occurring with the participation of two industrialized countries;
- *Article 12*: **Clean Development Mechanism,** for projects occurring with the participation of developing countries; and
- *Article 17*: **International Emissions Trading,** for countries with emissions reduction obligations under the Protocol.

Joint Implementation (JI) projects under Article 6 will qualify for crediting in the first budget period (2008 - 2012). These projects will be pursued between two industrialized countries, with one country basically transferring a portion of its national emissions allocation to another country in exchange for assistance in accomplishing the emissions reductions. Although government approval will be required, most of these projects are likely to be pursued by private-sector companies.

Under Article 6, Joint Implementation projects may be carried out "provided that:

(a) Any such project has the approval of the Parties involved;
(b) Any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur;
(c) It does not acquire any emission reduction units if it is not in compliance with its obligations under Articles 5 and 7; and
(d) The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments under Article 3."

The Clean Development Mechanism (CDM) was negotiated at COP-3 and is described in Article 12 of the Kyoto Protocol. Unlike JI projects, projects approved through the CDM will qualify for crediting and banking starting in the year 2000. According to Article 12, the purpose of the CDM is to "assist Parties not included in Annex I ("non-Annex I," or the developing countries) in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I (industrialized countries - including countries with economies in transition) in achieving compliance with their quantified emission limitation and reduction commitments under Article 3." The language of Article 12 is vague, allowing the CDM to be interpreted differently by different interest groups.

The concept of project-based mitigation activities was proposed in an effort to allow industrialized countries to achieve cost-effective emissions reductions outside their own borders. Such activities have the potential to dramatically reduce the overall cost of curbing emissions, since countries with limited or expensive mitigation options would be able to pursue less expensive opportunities elsewhere. On the other side, project-based activities have the potential to advance national development priorities by delivering targeted investment resources to key sectors and regions of developing countries. Many potential criteria have been discussed in the context of project-based mitigation efforts. Developing country observers have stated that it is imperative that criteria for such projects are created to assure that the process is efficient and equitable and that it accounts for economic, social, and environmental concerns. Three specific criteria are commonly mentioned:

- projects should be compatible with and supportive of national environmental and development priorities;
- projects must acquire "acceptance, approval or endorsement" by the Parties' governments; and
- projects should bring about real, measurable, and long-term environmental benefits.

While cost-effectiveness has been a primary selling point for project-based mitigation efforts, the proponents of the CDM and JI have also argued that the CDM could transfer technology and "know how" to developing nations concerning up-to-date methods of meeting energy demand, methods for improving transportation systems, sustainable forest management techniques, and other technologies that could improve local and regional development capabilities.

Finally, country-to-country emissions trading (the only non-project based mechanism) under Article 17 of the Protocol, while not explicitly sanctioned by the Protocol, was referred to later COPs for development of implementing guidelines; emissions trading is widely expected to be available for countries' use in meeting obligations under the first budget period (2008-2012). At its simplest, international emissions trading will allow countries to trade against their national allocations under the Protocol. For example, if Russia emits fewer than it is allowed to under the Protocol, it can trade the remaining tons to another country.

Since Kyoto, work on interpreting the Protocol's flexibility mechanisms has been slow and contentious. While some countries wish to rely heavily on the flexibility mechanisms to meet their emissions targets under the Protocol, other interests have wanted to require that a majority of any emissions target be met domestically. Increasingly, however, developing countries see the potential of the flexibility mechanisms, particularly the CDM, for financing energy and sustainable development investments and initiatives that they otherwise may not be able to afford.

Under the terms of the Protocol, final decisions relating to development of operational rules for the flexibility mechanisms are to be made at the first Meeting of the Parties (MOP) to the ratified Protocol. Because the MOP will not occur until after the Protocol has been ratified, it is not likely to occur for several years. In an effort to reduce economic uncertainties associated with the flexibility mechanisms, a great deal of work toward pinning down their functioning is now

underway. It is hoped that COP-6 in November of 2000 will help clarify many of the uncertainties.

So Where are We Now?

The Kyoto Protocol will enter into force after it has been ratified by 55 countries and by countries representing 55% of the emissions from Annex 1 Parties to the Convention. The arithmetic of current emissions indicates that entry into force will almost certainly require ratification by both the U.S. and Russia. If the U.S. and Russia do not ratify this agreement, then virtually every other Annex 1 Party MUST ratify, or the Protocol cannot legally enter into force. Although other Annex 1 countries are already moving toward domestic actions, ratification of the Kyoto Protocol is stalled in the U.S. Senate. The Senate is unlikely to take up the issue for a vote during this year.

The Sixth Conference of the Parties to the UNFCC (COP-6) will be held in The Hague, the Netherlands, in November 2000. Many observers and participants expect that COP-6 will be the venue for many critical decisions on implementation of the Convention, including an agreement on rules for the flexibility mechanisms, on capacity building, and on technology transfer.

There are a number of important unresolved issues on the table for the Subsidiary Body meetings in Lyons and for COP-6 in the Hague. These include:

- Guidelines for implementation of the Kyoto flexibility mechanisms;
- The role and treatment of forests and other vehicles for carbon sequestration;
- National communications and future commitments for emissions reductions by non-Annex 1 Parties;
- Capacity building and financing for technology transfer to developing countries and economies in transition; and
- The adequacy of commitments for emissions reductions by industrialized countries.

Most experts now agree that the commitments for emissions reductions contained in the Kyoto Protocol are not sufficient to achieve the Objective of the Convention. Developing countries want to re-open the discussion of commitments to emissions reductions by Annex 1 Parties. Annex 1 Parties insist that by themselves they cannot make any commitments that will achieve the Conventions Objective; therefore, nothing will be sufficient without agreed participation in commitments for emissions reductions by developing country Parties. Developing countries say they will not take on any new commitments until Annex 1 countries themselves demonstrate "progress" in achieving domestic emissions reductions.

What can be done in the short term?

Based on the Chairman's draft developed at the 12th Session of the Subsidiary Bodies, it may be possible in Lyons to agree on a negotiating text for the decisions to be taken on the Kyoto mechanisms. It may be possible to work with developing countries to establish criteria for a "prompt start" on the Clean Development Mechanism. It may also be possible to establish the guidelines for national registries to track projects undertaken now which may subsequently qualify

for inclusion under either the Clean Development Mechanism or the Joint Implementation regime, once the Kyoto Protocol enters legally into force.

What is not possible at COP-6 in the Hague is to resolve all the uncertainties associated with the implementation of the Kyoto Protocol and the Framework Convention. It will also be impossible to develop full rules of procedure for all possible cases that arise during the implementation of the Kyoto mechanisms. But it is possible to reach agreement on the kinds of activities that could be important in achieving a prompt and effective start to investments in technology transfer and capacity building under these mechanisms. This much can be done by the close of COP-6.

Progress *is* possible but only under certain circumstances: if Parties do not require a perfect system from the outset; if Parties recognize that operational failure in some projects is a necessary attribute of systems that value "learning by doing"; and if the Parties can agree that the credibility and operational integrity of the overall system for the long-term is more important than the elegance of the initial design.

The Sixth Conference of the Parties to the UN FCCC could be a climactic moment in North-South relations. If the industrialized countries of the North are prepared to fulfill the commitments they have made in the Climate Convention, and if the developing countries of the South are prepared to consider ways to slow their rates of emissions growth, the "package" of elements agreed in the Hague could make the Buenos Aires Plan of Action a reality. It could also open a new era of expanded, environmentally sustainable trade among industrialized countries of the North, between industrialized and developing countries, and among the developing countries of the South. But if political courage fails to materialize at COP-6, this meeting could signal a period of widespread disillusionment, a long and growing schism between rich and poor, between North and South, and between industrialized countries and countries with economies in transition to a market system.

Chapter 5

Climate Change Mitigation Options

Climate change is without a doubt the most complex environmental problem yet tackled through domestic policy or international negotiations, as exemplified by these characteristics:

- The Intergovernmental Panel on Climate Change (IPCC), the generally accepted scientific authority in this area, estimates that global emissions of CO_2 would have to be reduced by 70 percent to stabilize atmospheric CO_2 concentrations.
  - Almost all human activities, ranging from agricultural land-clearing to electricity production, result in the production and emission of greenhouse gases.

Understanding the Costs and Benefits of Mitigation Options

It is now generally agreed by scientists worldwide that GHG emissions from economically important activities are increasing the risks of local pollution and rapid, human-induced climate change. The costs associated with the impacts of emissions are most often externalized from market transactions for energy, forest products, transportation services or food.

Traditional, liberal, neo-classical economics treats as 'costs' all investments in emissions reducing technology or environmentally-motivated changes in production practices. It is true that modern, clean technologies often have higher initial costs than the old, out-dated and dirty technologies they replace. But these new, lower-emission technologies usually deliver multiple benefits and often yield more competitive products requiring fewer resource inputs and producing more desirable attributes in the finished goods.

The results of mitigation by design often include both local and global environmental benefits but may also, in some cases, increase efficiency benefits. For example, technologies that increase the efficiency of energy use will also reduce emissions of local pollutants as well as greenhouse gases. Measures that reduce soil erosion by winds will also lower carbon emissions while increasing agricultural yields.

Accurately evaluating the costs and benefits of mitigation measures may also require assessing the social benefits of their implementation. Many mitigation measures have significant co-benefits to society. For example, measures to reduce urban congestion will improve vehicle fuel-use efficiency, reduce driver frustrations, improve the quality of life for urban commuters and create better social environments for workers. Similarly, efforts to improve forest management through sustainable forestry can increase carbon sequestration while creating jobs and economic growth in remote rural areas. Programs to support family farms that produce high quality foods can

reinforce village social structures, reduce pressures for rural-to-urban migration, contribute to economic growth in rural areas, and reduce rates of carbon mobilization from soils. In many cases therefore, there are significant opportunities for reducing GHG emissions, where benefits, if measured completely, more than outweigh the costs of the necessary investments in a balanced and sustainable strategy of economic development.

Mitigation Strategies and Options

Emissions are generally distributed among the power generation, transportation, and industrial sectors, each roughly accounting for one third of total emissions. *There are no "silver bullet" solutions to the GHG emissions issue. Stack-based emissions controls are technically possible, but extremely costly.*

For convenience, GHG emissions reduction options are commonly grouped into three broad categories:

1. *Avoiding production (and emission) of CO_2 in the first place:* Options include improving the efficiency with which energy is produced, transferred, and consumed; switching from carbon-intensive energy sources such as coal to less carbon-intensive fuels such as natural gas or renewables; and finally, preventing deforestation.

2. *Removing CO_2 from the atmosphere:* Options include planting new trees; improving management and growth rates of existing trees; changing agricultural practices to increase soil carbon uptake; or growing and using energy crops which, by replacing fossil fuel energy - a non-renewable resource - reduces emissions from fossil fuel sources.

3. *Reducing the emissions or production of non-CO_2 GHGs:* Non-CO_2 emissions reduction options include reducing emissions of methane from coal mines, gas pipelines, or livestock; reducing nitrous oxide emissions from biomass burning or agricultural fertilizer use; or reducing the emissions of chlorofluorocarbons or similar substances. Non-CO_2 emissions reduction options are usually expressed in terms of their CO_2 emissions reduction equivalence, based on the global warming potential of different gases as defined by the IPCC.

Not all emissions reductions are equal. Different categories of mitigation options can range dramatically in terms of mitigation potential and cost-effectiveness. Indeed existing and proposed mitigation projects differ enormously in design, conformance to proposed criteria such as additionality and quantifiability, and financial and performance risk.

A Variety of Policy Tools

Opinions vary regarding both the appropriate degree of governmental intervention required to meet future emissions targets and the best policy tools to use for the job. Policies and measures proposed by participants to the climate change policy debate include: carbon taxes, domestic and international GHG emissions trading, tax and other fiscal incentives, tightened fuel economy and building standards, increased technology research and development spending, expanded carbon sequestration efforts, mandatory offsets for new emissions sources, and expanded voluntary mitigation programs.

The Offset Concept as a Mitigation Strategy

Greenhouse gases have fundamentally different characteristics than most air pollutants, and would be very expensive to control if approached in the same manner. Indeed, the case for flexibility in pursuing greenhouse gas compliance strategies is particularly compelling. For example:

- CO_2 and other greenhouse gases are global gases. Any given molecule of CO_2 can be anywhere in the world within about 8 days. This dramatically expands the geographic range within which emissions reductions are effective in accomplishing a national or global mitigation target.

- Unlike NO_x and SO_x, greenhouse gases are not an immediate health or environmental threat to human populations or sensitive ecosystems. The problem of pollution "hot spots," which constrains most emissions offset programs, plays no role with greenhouse gases.

- The primary source of greenhouse gas emissions is the combustion of fossil fuels. Unlike other pollutants, CO_2 cannot be economically removed from power plants or tailpipes prior to being emitted to the atmosphere, making normal stack-based control requirements less practical.

- CO_2 is distinct from conventional pollutants in that it can be practically removed from the atmosphere after being emitted. Green plants use CO_2 as fuel; thus, carbon dioxide can be naturally stripped from the air and converted to woody biomass through forestry and other projects.

- Because of differences among countries in the costs of reducing GHG emissions, a great deal of modeling suggests that flexibility in where emissions reductions take place can reduce the global cost of complying with any given target. One often discussed study, for example, concluded that "where" mitigation flexibility can reduce overall compliance costs by 70 percent, while adding "when" flexibility would reduce compliance costs by 85 percent.

These characteristics of greenhouse gases have led to the development of so-called carbon offsets. Carbon offsets are project-based initiatives to reduce GHG emissions that are funded by

companies or countries facing higher internal emissions reduction costs. Utilization of carbon offsets is premised on the fact that the impact of emitting a ton of carbon dioxide can be "negated" or "offset" by avoiding the release of a ton somewhere else or by absorbing a ton of CO_2 from the air that otherwise would have remained in the atmosphere. Because any given molecule of CO_2 can be anywhere in the world within a matter of days, the CO_2 "bubble" for offset purposes is global. It is irrelevant whether the CO_2 molecules coming out of the stack are the same ones absorbed or displaced through an offset project.

Carbon offset projects can encompass a very diverse range of options, including:

Supply Side Energy Options
Power train re-powering
Fuel switching (coal to gas)
Boiler upgrades
T&D upgrades
Environmental dispatch
Renewable energy development

Transportation Options
Improved automobile efficiency
Accelerated scrapping of older gas-guzzlers
Use alternative vehicle fuels
Employer subsidies for public transit

Other Greenhouse Gas Options
Coalbed methane recovery
Landfill, agricultural methane recovery
SF_6, PFCs, HFCs substitution

Land Use Options
Reforestation
Preventing deforestation
Urban forestry
Improved forest management
Low-tillage agriculture

Demand Side Management Options
Improved appliance efficiency
Efficient lighting programs
Efficient HVAC programs
Improved motor efficiency
Improved building shell efficiency
Coal ash recycling

Several variables are likely to be particularly important for long-crediting of mitigation projects. Many variables are subject to multiple interpretations by a range of interest groups. Some variables pose complex policy or technical questions for which there are not yet accepted answers. They include:

1. *Additionality of Project Funding and Carbon Benefits* - Additionality is the only project criterion specifically mentioned in the Kyoto Protocol. Projects will have to show that their CO_2 benefits are "additional to any that would otherwise occur" (for Joint Implementation projects under Article 6) and "additional to any that would occur in the absence of the certified project activity" (for Clean Development Mechanism projects under Article 12). Dealing with additionality is a vexing problem, with widely divergent opinions of how to approach it.

2. *Potential Leakage of Carbon Benefits* - In the context of project-based mitigation interventions, CO_2 leakage refers to the GHG effects of a project that occur outside the project's monitoring boundary. Leakage, to the extent it exists, results in a misstatement of the "real" GHG benefits of a project. If leakage is significant, a

project's GHG benefits will be significantly misstated. Benefit leakage typically is thought of as leading to a net loss of project benefits; leakage, however, can also be positive (e.g. demonstrating a new technology) leading to an underestimation of project benefits.

3. *Likely Reliability of Project Activities and Resulting Carbon Benefits* - Reliability refers to the likelihood of a project being implemented the way that is anticipated, and hence that the projected CO_2 benefits will occur. Critical to the success of any mitigation project is the documentation that a project will both produce returns on the carbon benefit predicted, and avoid the economic or political threats that may impede these benefits.

4. *Quantifiability of Carbon Benefits and Associated Uncertainty* - Quantifiability refers to the direct quantification of the carbon offset benefit associated with the environmental and socioeconomic effects that occur as a result of a mitigation activity. Measurability requires more than simply confirming that a protected forest remains intact or that a reforested area is still growing. Measurability requires that a baseline be established against which to measure the impacts of the project and that a methodology for quantifying the carbon benefit be in place and executed.

5. *Magnitude and Type of Project Co-Benefits* - Reducing the risk of global warming is not the only reason to pursue carbon offset projects. Forestry projects, for example, can conserve biodiversity, protect fragile agricultural lands, conserve watersheds and aquifers, reduce erosion, preserve wildlife habitat, and enhance recreational opportunities. Similarly, fuel-switching and renewable energy projects can result in a range of environmental and socioeconomic benefits beyond reducing GHG emissions.

6. *Carbon Benefit Permanence (particularly with respect to land use and forestry projects)* - Permanence of carbon benefits, particularly those associated with forestry projects, is widely perceived as a crucial issue. Permanence is considered crucial due to the fact that although carbon is extracted from the atmosphere by biotic measures, it can also be expected to be released again due to subsequent forest use. For instance, pursuing plantation or agroforestry projects in the tropics would require harvesting relatively quickly in response to market demands. Consequently, unless a lot of the biomass goes into long-term products or energy production, just a fraction of the total carbon absorbed over a 50-year period would probably actually count as having been sequestered over the long-term (or permanently).

Methods for Evaluating the Economic Costs and Benefits of GHG Mitigation

Several types of approaches are available for estimating the economic costs and benefits of GHG mitigation. The two most important approaches are called Top-Down Methods and Bottom-Up Methods.

Top-down approaches are commonly used to assess the impact of carbon taxes and other fiscal policy measures on overall rates of economic growth. These methods use aggregated economic data to assess the costs and benefits of macroeconomic measures on sectoral output, household income, and GDP. Top-down methods assume the presence of efficient markets, with equilibrium prices causing all markets to clear in each period. For most developing countries and countries with economies in transition to a market system, the data requirements of top-down models are unsupportable in today's environment. The data on long-term consumption patterns, elasticities of demand, and the ability of societies to innovate in a changing environment are unavailable today in such countries. These models are effective in capturing inter-sectoral feedbacks and other 'macro' level interactions. Typical applications of these methods include computable general equilibrium models and input-output models.

Bottom-up approaches are commonly used to assess the costs and benefits of individual projects and programs. These models use detailed data on fuels, technologies and policies to assess the costs and benefits of individual technologies and projects. These models do not assume efficient markets but they do capture the economic interactions among projects and policies. Applications of these approaches include optimization models (e.g., MARKAL), simulation models (e.g., ENPEP) and sectoral accounting frameworks (e.g., LEAP and the World Bank's EM).

Neither of these approaches to economic analysis is adequate to capture the economic value of social benefits or environmental benefits resulting from GHG mitigation measures. Thus, a complete assessment of the costs and benefits of mitigation measures would require that these economic analysis tools be supplemented with explicit techniques for assessing the social and environmental costs and benefits of the proposed measures. It might require integrating the economic analysis with the kinds of assessment techniques used by UNDP and others to produce their World Development Report.

Chapter 6

The Developing Mitigation Market

Although there is a CO_2 market, it is still in its early stages. Market players act largely as a result of voluntary actions; government programs are still in the pilot phase and are used primarily for learning purposes. Despite the lack of incentives found in established markets, the carbon market has already fostered a significant quantity of transactions, projects, and proposed projects, which have signaled various costs for offsetting GHG emissions.

Since AES Corporation's pioneering efforts in the late 1980's, more than 100 projects around the world have been characterized as climate change mitigation projects. Hundreds more are at different stages of development or are being circulated to potentially interested investors.

The Parties to the Framework Convention on Climate Change established the "activities implemented jointly" (AIJ) pilot phase at the first Conference of the Parties in 1995. As of early 1999, approximately 123 AIJ projects were under implementation or planned, 40 of which in Non-Annex I countries. Understanding the lessons to be gained from this experience is particularly important.

While the specifics of the future GHG market are not clear, market experts and institutions are already preparing for a sizeable market. Futures-market expert Richard Sandor has said that the "market for emissions-control futures contracts could become the biggest futures market in the world." Sandor is affiliated with the world's largest commodities market, the Chicago Board of Trade, which currently leads the world in environmental commodity trading with its annual auction of SO_2 emission permits. The Board of Trade has begun preparing for the addition of a GHG contract. Similarly, the Sydney Futures Exchange in Australia expected to add GHG permits to its repertoire of tradable contracts by mid-2000. Chief executive of the Sydney Futures Exchange Les Hosking estimated that GHG emission trading markets could have an annual turnover of as much as $100 billion within five years.

Predicting the future market value of GHG credits is, by its very nature, a somewhat speculative exercise. For example, it is becoming increasingly difficult to define a carbon offset. Comparing carbon offsets and their costs is becoming more and more complicated, as trends in offset project development are examined for profitability alone. Offsets previously considered inexpensive, such as some forestry projects, can appear quite expensive if compared to more profitable projects for which CO_2 offset costs are zero or even negative.

Understanding the Market

It is important to view the current GHG market as being in the earliest stages of development. It is a confused market characterized by the following:

- Currently, offset costs and prices for the more than 200 current or proposed climate change mitigation projects vary over an extremely wide range, from less than $1.00 to over $60/ton CO_2.
- Project costs are often not comparable, and in effect reflect different commodities.
- Offset projects vary widely in quality based on such variables as the additionality, leakage, quantifiability, and permanence of the project's GHG benefits.
- There are no commonly accepted standards for quantifying the GHG benefits of a project.
- There are many ways used to calculate the costs of offset projects.
- The cost differentials between projects are often not documented or understood.

Key Conclusions From the Current Offset Market

One has to exercise care in interpreting today's market given the many GHG commodities being bought and sold. It is possible to identify projects and project portfolios likely to qualify for future credit in national and international regulatory systems. Offset prices, particularly for high quality offset projects, are likely to rise dramatically in coming years, creating an incentive to act early. It is unlikely that much of the confusion surrounding carbon offsets will be resolved until offsets move out of the current realm of largely voluntary programs. As the demand for CO_2 offsets increases, project developers will increasingly seek to extract economic rents for carbon offsets. Up to this point project developers have been willing to assign CO_2 offset rights for the simple cost of paying the incremental costs of the measure in question. Project developers will now increasingly seek to split the difference between the basic offset cost and the perceived opportunity cost to the entity needing to purchase offsets.

Chapter 7

Opportunities for Developing Countries

Greenhouse gas markets may end up providing developing countries with a valuable means by which to advance their sustainable development objectives. It is commonly stated, for example, that the CDM/JI could transfer to developing nations knowledge about up-to-date methods of meeting energy demand, mechanisms for transportation planning, sustainable forest development techniques, and other technological "know how" that could improve local and regional development capabilities. Potential benefits of CDM/JI funding and projects that have been suggested include the following:

- Encouraging technology transfer of newer more efficient and environmentally sound technologies, by stopping reliance on older, less efficient energy generation and utilization techniques.
- Encouraging energy efficiency improvements in developing countries, significantly benefiting the balance of payments problems associated with energy imports.
- Increasing competitiveness of countries' technological bases.
- Encouraging utilization of energy and industrial technologies that would lead to long-term environmental improvements.
- Restoring productivity of degraded, salinized, or arid lands through reforestation and other ecosystem enhancement programs.
- Contributing to rural economic development and environmental improvements through improved forest management, sustainable agricultural practices, and watershed management.
- Contributing to other social objectives including biodiversity conservation through forest protection projects and other initiatives intended to slow the loss of millions of acres of wildlife habitat per year.

In Conclusion: The Main Message

Climate change due to the greenhouse effect is not a conventional pollution problem. GHG buildup is not due to an evil few who fail to limit toxic releases to a nationally mandated standard. Rather, climate change is the result of atmospheric emissions from thousands of economically important activities in every country of the world.

No single policy or investment decision will determine the rate of future GHG emissions. Instead, many economic and political decisions will affect the rate of growth in future emissions. In addition, many economically important activities will be affected, either positively or negatively by the rate of future climate change. Thus, the attention given to risks of rapid climate change cannot be successfully limited to one ministry or one sector. To build a sound development strategy, national policymakers and corporate decision-makers must integrate considerations of climate change into all major policy and investment decisions.

Choosing a sound approach that links climate and development strategy does not mean choosing between adaptation and mitigation. Mitigation measures are needed to limit the rate of emissions growth and the extent of future impacts. Adaptive responses are necessary to limit the extent of the damages that result from future climate changes that can no longer be avoided. Investments designed to adapt national economies to long-term climate change and to reduce greenhouse gas emissions can also produce national benefits along many economic and social dimensions.

Some of these investments could be financed through the Flexible Mechanisms proposed under the Kyoto Protocol, the Global Environment Facility, private sector investors or through other multilateral or bilateral assistance programs. Finally, responding to international concerns about climate change can bring new financing and new development activities for other critical national economic development priorities. It is this opportunity that should be considered in developing national strategies for reducing the impact of climate change.

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CLIMATE CHANGE GLOSSARY

Climate Change Science

Climate Change: A change of climate, which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to the natural climate variability observed over comparable time periods.

Global warming: The popular term for climate change.

Greenhouse gases (GHG): Those gaseous elements, both natural and anthropogenic (human-caused), that tend to warm the earth's atmosphere.

Kyoto greenhouse gases: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Global Warming Potential (GWP): A measure of the relative effect of a greenhouse gas compared to that of CO_2.

Climate Change Policy

UNFCCC: The United Nations Framework Convention on Climate Change, which arose from increasing international concern about the implications of climate change and a recognition that no one country can solve this global environmental problem alone. The Convention went into effect in March, 1994. The ultimate objective of the UNFCCC is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human-induced interference with the climate system.

Annex I countries: Countries that have committed to emission abatement under Article 4.2(a) and (b) of the UNFCCC, as listed in Annex I of the UNFCCC; generally developed countries and countries undergoing the process of transition to a market economy.

COP: Conference of the Parties, the principal decision-making body of the UNFCCC, whose annual meetings are numbered COP-1, COP-2, etc.

Kyoto Protocol: A binding protocol to the UNFCCC, signed in Kyoto, Japan at COP-3. The Protocol establishes emissions targets for Annex B countries, but must be ratified in its own right before entering into force.

Kyoto first budget period: The period 2008-2012, during which time the Protocol's emissions reduction mandates for Annex B countries come into effect.

Annex B countries: Countries listed under Annex B of the Kyoto Protocol; generally developed countries and countries undergoing the process of transition to a market economy.

Emissions Targets: The emissions reductions commitments made by Annex B countries under the Kyoto Protocol.

Flexibility Mechanisms: Provisions of the Kyoto Protocol designed to allow countries with targets to take advantage of lower cost mitigation opportunities. There are 3 "flex mechs:" International Emissions Trading, Clean Development Mechanism, and Joint Implementation.

International Emissions Trading (IET): A mechanism which provides for trading of emissions reductions among countries with emissions targets under the Kyoto Protocol.

Clean Development Mechanism (CDM): A project-based mechanism that provides for the creation and transfer of credits from developing to industrialized countries. Article 12 of the Kyoto Protocol defines CDM as a means of assisting non-Annex I Parties to achieve sustainable development objectives.

Joint Implementation (JI): A project-mechanism that provides for the transfer of credits between Annex B countries.