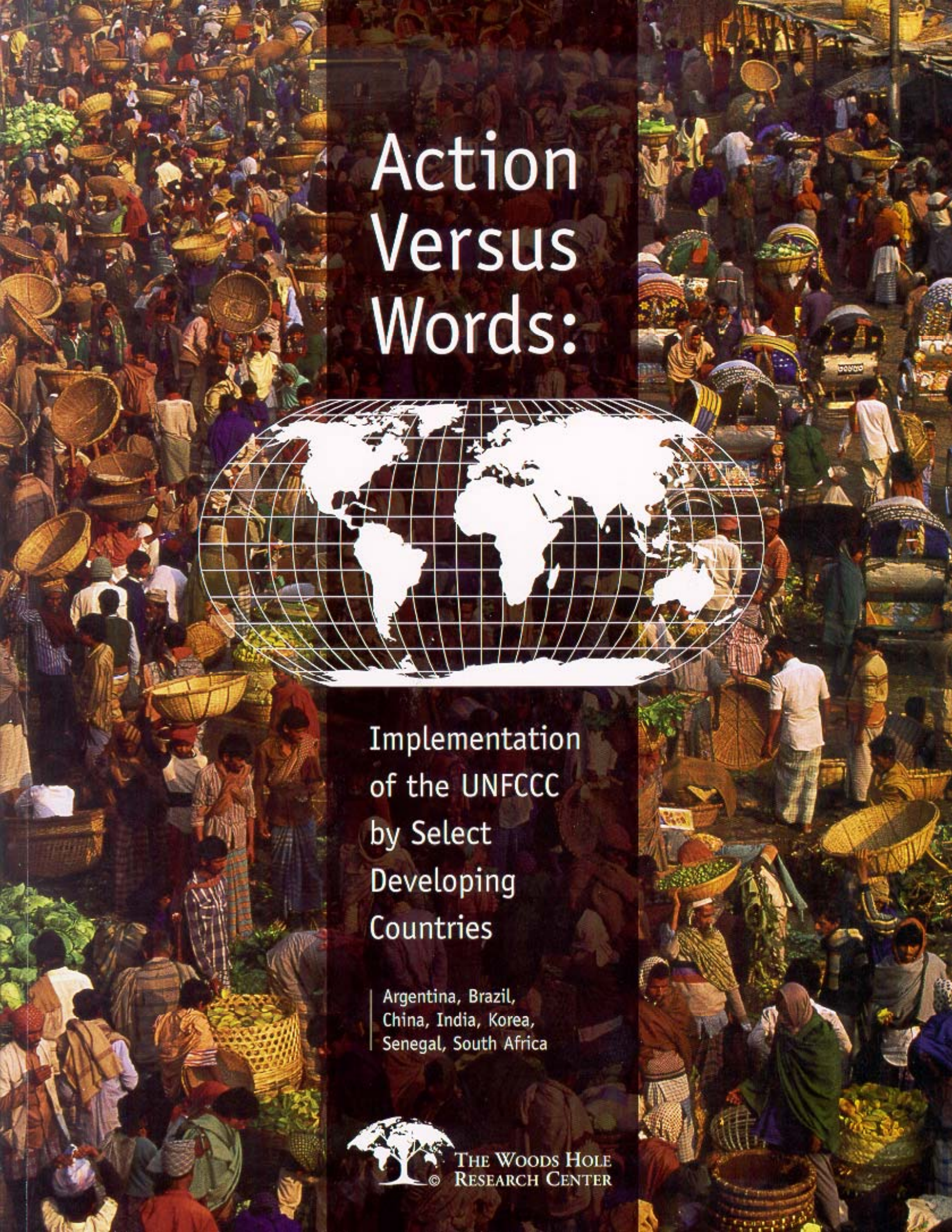
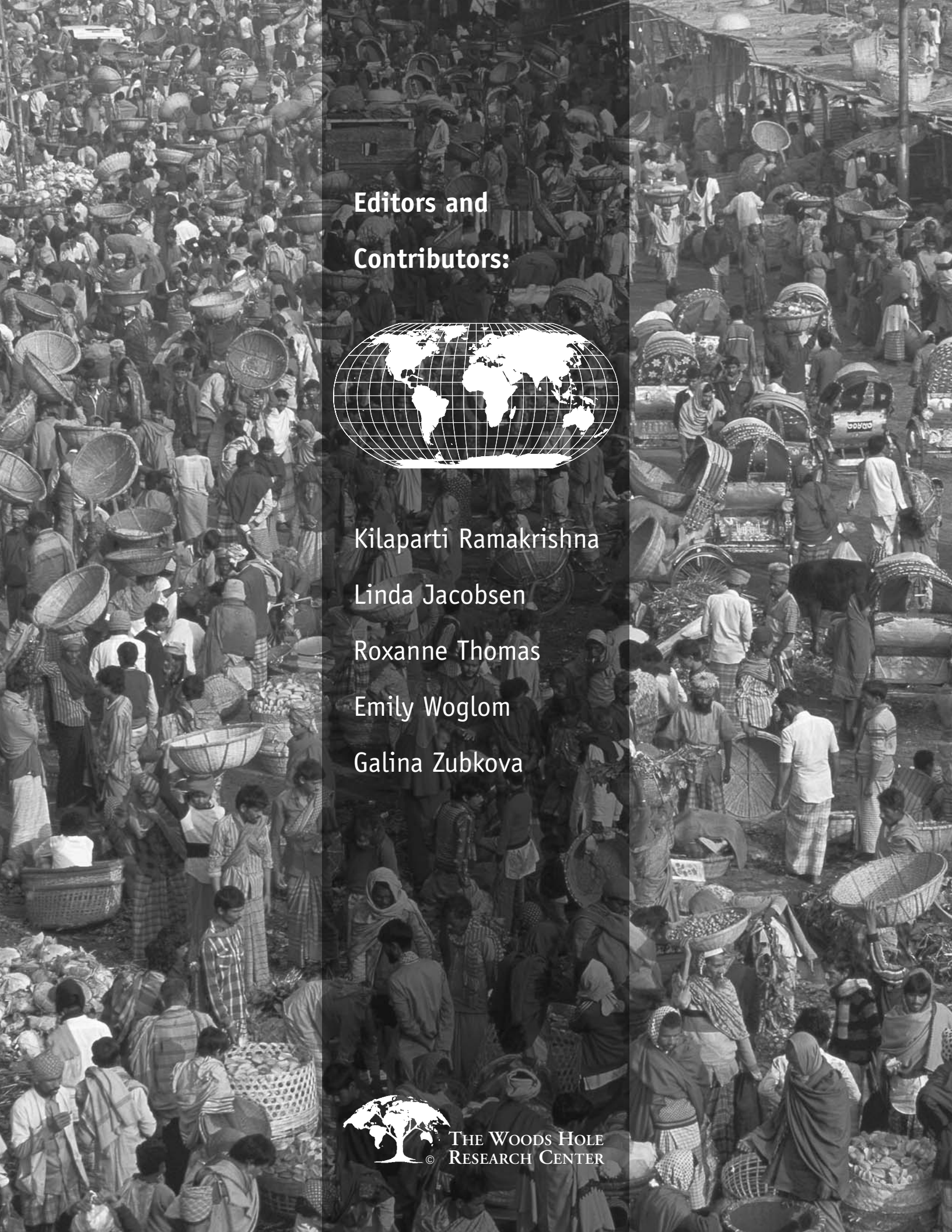


Action Versus Words:

Implementation of the UNFCCC by Select Developing Countries

Argentina, Brazil,
China, India, Korea,
Senegal, South Africa

The Woods Hole Research Center



Editors and Contributors:

Kilaparti Ramakrishna

Linda Jacobsen

Roxanne Thomas

Emily Woglom

Galina Zubkova

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Program on Science in Public Affairs
The Woods Hole Research Center
P.O. Box 296, Woods Hole, MA 02543

Action Versus Words:
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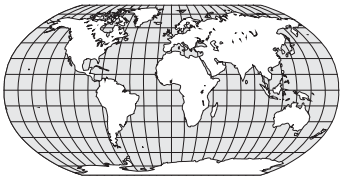
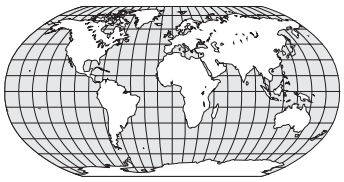


Foreword



Foreword

The Woods Hole Research Center addresses the great issues of environment through research and education and through applications of science in public affairs. Climate change and the warming of the earth are at the core of our research, and implementation of the United Nations Framework Convention on Climate Change (UNFCCC) is a major focus of our Program on Science in Public Affairs.

The issue of "participation" of developing countries in efforts to reduce emissions of heat-trapping gases has been argued extensively, and was high on the agenda during the negotiation of the Kyoto Protocol in 1997. In the end the Protocol was adopted with the industrialized countries taking the first step toward adopting legally binding commitments. The omission of the developing nations has been used by some of the developed nations, including and especially the U.S.A., as a reason for delaying ratification or even rejecting the Protocol, despite earlier approval at the negotiations at Kyoto. The argument has been that any savings made in the developed world will quickly be lost as the less developed world expands its use of fossil fuels to aid their own development. As we await the completion of the requirements for the Protocol to enter into force without U.S. support, informal discussions are underway on the next commitments beyond 2012, and the question of the responses in the developing nations arises acutely once again.

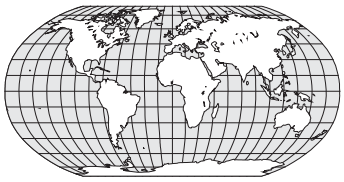
Under the UNFCCC, all countries that are party to the Convention are to participate through the regular submission of "national communications" - reports including a national inventory of greenhouse gas emissions and removals as well as a description of steps taken to implement the Convention. This volume explores the efforts of seven developing countries in implementing the UNFCCC, using the preparation of their "national communications" as a point of departure. The most interesting observation is that, far from aggravating the problem, the less developed world readily seems to be taking advantage of a variety of tools at its disposal including solar energy, thus avoiding the expensive investment in fossil fuels and equipment. The developed world need not be concerned that its savings will be squandered by the less developed world. Quite the opposite, those in the developed world should be concerned that their slow response is acting counter to all of the commitments entered into as well as contrary to their own national self interests.

We hope that the information presented here will help all those involved in the negotiations better appreciate the topic and guide them in accelerated achievement of the objectives agreed to under the UNFCCC, namely, stabilization of the heat-trapping gas content of the atmosphere at levels that will protect human interests and nature.

Dr. George M. Woodwell
President and Director
The Woods Hole Research Center
Woods Hole, Massachusetts, U.S.A.

February 2003

Preface and Acknowledgments



Preface and Acknowledgments

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is expected to enter into force this year. Parties to the UNFCCC have worked diligently in preparing the ground for the implementation of the provisions of the Protocol since its adoption in 1997. The intransigence of some major industrialized countries notwithstanding, this is a major step forward indeed. One of the unique features of this agreement is the requirement that all countries submit national communications. These reports are reviewed by expert committees and provide important baseline information against which future actions are measured. For this report, a sequel to our earlier study entitled *Asia: Looking Ahead - Initial Stages of National Communications Reporting,* we have selected seven countries from around the world, including Argentina, Brazil, China, India, Korea, Senegal, and South Africa. Our objective is to chronicle actions initiated in these countries that are consistent with their objectives of economic development and the requirements of the UNFCCC for submitting national communications.

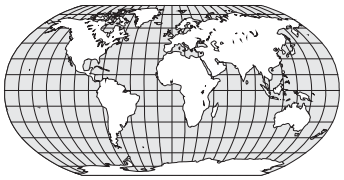
Several colleagues around the globe were asked to comment on various parts of this document, and we greatly appreciate their assistance. Although ultimate responsibility for the contents of this publication rests with the Woods Hole Research Center, we would like to acknowledge the following colleagues: José Heder Benatti, Rubens Born, Raul Estrada-Oyuela, Prodipto Ghosh, Donald Goldberg, Yonghun Jung, Irving Mintzer, William Moomaw, Paulo Moutinho, Djimingué Nanasta, Daniel Nepstad, Jyoti Parikh, Randall Spalding-Fecher, and Youba Sokona. We are most grateful for their willingness to help by providing their timely comments as well as for their many contributions to this field.

We were pleased to have three talented graduate students, Roxanne Thomas, Emily Woglom, and Galina Zubkova, join us in this project in 2002. Roxanne worked on Brazil, India, Korea, and South Africa; Emily worked on Argentina; and Galina worked on China and Senegal. Their hard work and diligence in researching and organizing background materials into excellent draft case studies proved invaluable in moving this project forward. In addition, we very much enjoyed the presence of Roxanne, Emily, and Galina during their stays in Woods Hole. We are most grateful to Linda Jacobsen for her tireless efforts in ensuring that the project was completed on time, in supervising the work of the interns during their stay in Woods Hole, and for her particular attention to detail and editorial skills. It is fair to say but for her persistence and diligence the project would have taken a lot longer to complete. Special thanks and appreciation also go out to Allison White for her swift and meticulous proofreading of the various drafts, Christine Halunen of Gallagher Graphics for her excellent graphic design and layout work, and to Katharine Woodwell for timely encouragement.

This project was made possible by the generous support of the Educational Foundation of America, the Henry Phillip Kraft Family Memorial Fund of the New York Community Trust, and the Winslow Foundation.

Dr. Kilaparti Ramakrishna
Sarah Shallenberger Brown Chair in Environmental Policy & Deputy Director
The Woods Hole Research Center

Notes on Editors



Kilaparti Ramakrishna, Ph.D.
is Sarah Shallenberger Brown Chair in Environmental Policy and Deputy Director at the Woods Hole Research Center. Ramakrishna is an expert in international environmental law and directs the Center's Program on Science in Public Affairs. He is responsible for international issues including law and policy aspects associated with global climatic change, conservation and utilization of world forests, biodiversity, environmental governance, and developing country perspectives. He teaches international environmental law at the Fletcher School of Law & Diplomacy at Tufts University. He holds a doctorate in international law of environment from the Jawaharlal Nehru University in New Delhi.

Linda Jacobsen
is Research Assistant in the Program on Science in Public Affairs at the Woods Hole Research Center. With an interest in how science is used in the formulation of global environmental policy, she has represented the Woods Hole Research Center in many international negotiations on both climate and forests. Before joining the Center, she held positions at the Center for Environmental Management at Tufts University and the Lloyd Center for Environmental Studies. She received her B.S. from Tufts University in Biology and Environmental Studies.

Notes on Contributors

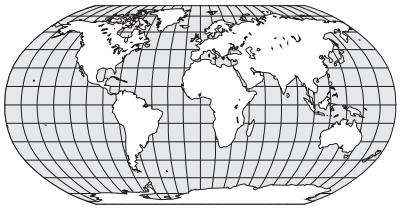
Roxanne Thomas
is a student at Duke University's Nicholas School of the Environment and Earth Sciences, where she is working toward a Masters in Environmental Management. Graduating in 2003, her concentration at Duke is in Resource Economics and Policy, with interests in business and environment issues as well as environmental policy. Before her Stanback Fellowship at the Woods Hole Research Center in 2002, she conducted research with the Quebec Public Interest Research Group and the Barbados Coastal Zone Management Unit, among other organizations. She received her B.S. from McGill University in Atmospheric and Environmental Sciences in 2000.

Emily Woglom
was an Edna Bailey Sussman fellow at the Woods Hole Research Center in 2002. A student at Duke University's Nicholas School of the Environment and Earth Sciences, she will receive a Masters in Environmental Management in May of 2003 with concentrations in Resource Economics and Policy as well as Coastal Environmental Management. She has conducted research in igneous petrology, taught physics and math at high schools in Switzerland and New York, and most recently has worked with a National Park to implement business planning strategies into park management. She holds a B.S. in Geology and Geophysics from Yale University.

Galina Zubkova
is a graduate student in the Environmental Studies Program at Ohio University in Athens. She is a Fellow of the Muskie Fellowship Program, awarded by the Bureau of Educational and Cultural Affairs, U.S. Department of State. She received her bachelor's degree in Meteorology from Kazakhstan State University, and she has an MPA from the Kazakhstan Institute of Economics, Management and Strategic Research, established by the President of Kazakhstan. She worked with the Woods Hole Research Center as an intern during the summer of 2002.

Introduction

Kilaparti Ramakrishna



Introduction

Climate change has been universally recognized as a global problem. One hundred eighty-seven countries have now ratified the United Nations Framework Convention on Climate Change (UNFCCC) that was adopted at the historic United Nations Conference on Environment and Development in Rio de Janeiro in June 1992. The Convention clearly stipulated that

> The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The framers of the Convention placed a great deal of reliance on climate science to help them take the subsequent steps through the creation of a subsidiary body for scientific and technological advice. In fact the very genesis of the Convention lay in scientific findings by the Intergovernmental Panel on Climate Change (IPCC). This body has produced three assessments since it was formed in 1988. The fourth assessment is currently underway. These reports have, with increasing confidence, pointed out that human actions are principally responsible for climate change.[1]

The Context

The scientific community was also explicit in its alarm that to be able to stabilize greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference, reductions in greenhouse gas emissions need to be greater than 60%.[2] Recognizing that reductions of that magnitude are infeasible, the countries agreed on incremental steps that are part of a long-term strategy. The framers agreed that this strategy will include adherence to several principles also outlined in the Convention, of which two in particular bear mentioning. The first one is often called the principle of "common but differentiated responsibility" and the second the "precautionary principle." By the first principle the Parties agreed that in order to "protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities," the "developed country Parties should take the lead in combating climate change." Accordingly, the industrialized countries agreed to bring their emissions in the year 2000 to the levels of 1990.

It was clear soon after the entry into force of UNFCCC that the voluntary approach adopted in the Convention needed to be strengthened and, consequently, at the very first session of the Parties to the UNFCCC, a decision was taken to begin negotiations to agree on binding legal commitments to reduce industrialized country greenhouse gas emissions. The result was the Kyoto Protocol.[3] Despite the legislative history preceding the adoption of the Kyoto Protocol, many were concerned that unless developing countries also agreed to binding legal commitments, it would be impossible to address this global problem. The statistic often cited is that developing country emissions will surpass those of the industrialized countries around 2030.[4] Developing countries argued passionately that they could not accept any legally binding commitments now to future emissions reductions. But the sense in the negotiating sessions has always been that the problem requires action by all countries, and eventually all need to bear legally binding commitments.

Anticipating this kind of reaction from the developing countries, the U.S. Senate adopted a non-binding resolution[5] that asked the U.S. not to enter into any legal commitment that either excluded developing countries or that would cause serious economic harm to the United States. The Clinton/Gore administration decided to sign the Kyoto Protocol, but wait until it was able to show "meaningful participation" by the developing countries to submit it for ratification. It is important to note that that administration remained engaged in the international process while at the same time trying to achieve emission reduction commitments domestically until the very end of its term. The administration was aware of the risks of presenting the Kyoto Protocol for "advice and consent" of the U.S. Senate.[6]

With the change of administration in the U.S. in 2000, there has been a drastic change in its policy toward the Kyoto Protocol. The Bush/Cheney administration first asked for more time to present its new position on the Kyoto Protocol and then eventually called it a fatally flawed document and withdrew from its future development.

The Kyoto Protocol

What did the Kyoto Protocol, adopted in December 1997, mandate the industrialized countries to do? It committed the industrialized countries and those with economies in transition to reduce overall emissions of six greenhouse gases by at least 5% below 1990 levels. It will enter into force when ratified by 55 Parties to the UNFCCC, which combined represent at least 55% of total developed country CO_2 emissions for 1990. As of January 15, 2003, 102 countries (71 developing countries and 31 industrialized countries) have ratified the Protocol, which together account for 43.9% of 1990 emissions. With Russia (accounting for 17.4% of 1990 emissions) agreeing to ratify in the near future, the Protocol is likely to enter into force soon.

While entry into force of the Kyoto Protocol will send a strong signal to the world community that, even over the strident objections of the United States, it can proceed with what it considers important, it may in the end become no more than a Pyrrhic victory. The Kyoto Protocol, if fully implemented, will reduce emissions from 1990 levels only by about 5.2%. With the United States opting not to participate and the relaxation of the rules for the implementation of "flexibility mechanisms,"[7] the eventual reductions are likely to be very small indeed.

What then is driving so many countries to march forward toward the implementation of the Kyoto Protocol? It is because they genuinely believe that global warming, with its ability to produce surprises, will overwhelm countries. By acting on it now and demonstrating that reductions can be accomplished without damaging the economic structures, confidence can be built in the measures adopted and, eventually, they can be strengthened. In other words, even a small step now in the right direction is extremely valuable in setting the right tone for future development.

Critics of the Kyoto Protocol have often said that it is such a modest first step that it hardly makes any difference in how countries and the private sector, among others, act. But the conclusion of most actors wanting to work with the Kyoto Protocol is that they need to work within its framework. First, they need to demonstrate to their legislatures and the private sector that implementing the Kyoto Protocol will not damage their economies. Second, they should work with developing countries in a meaningful way. In the first phase

Introduction, *continued*

this means identifying those initiatives currently under way that help developing countries attain sustainable development while at the same time lower greenhouse gas emissions.

What do countries that have not ratified say? Fortunately this list is thinning each day. During the Kyoto Protocol negotiations, and subsequently, there were two principal groups within the industrialized countries: one led by the European Union and the other, often called the "Umbrella Group," led by the U.S. This Umbrella Group includes the U.S., Japan, Canada, Australia, New Zealand, Iceland, Norway, Russia, and the Ukraine. With Russia confirming that it is going to ratify, the only two countries remaining in the Umbrella Group are the United States and Australia. The current U.S. position, therefore, deserves a brief examination. The U.S. says that global warming is a serious matter but considers the Kyoto Protocol fatally flawed. The U.S. also does not seem concerned that all of its allies (with the exception of Australia) have deserted it. Further, it says it will present an alternative to the Kyoto Protocol, but so far has not introduced one. The U.S. therefore supports three basically contradictory statements.

Popular Misconceptions

First, the U.S. announced a policy that stresses energy intensity per unit of GDP and assured the world community that because of the policies that it had set in place, by the time the first commitment period is over, it will have accomplished the same overall reduction as its target outlined in the Kyoto Protocol.

Second, it stated that since the commitments in the Kyoto Protocol are not global, the agreement is unfair and therefore the U.S. should not subscribe to it.

Third, the U.S. said that without meaningful actions by the developing countries, the greenhouse gas emissions from those countries will overwhelm the reductions from the industrialized countries and consequently the world will be no better off.

Let us briefly address each of these in turn. The table below[8] illustrates that energy intensity per unit of GDP has been coming down under the business as usual scenario, i.e., with no additional policy intervention in the U.S. In the decade beginning in 1990 it came down by 17.4% and current estimates show that it will come down by another 17.5% in the ten years beginning from 2002. Greenhouse gas emissions, however, continue to increase and by current estimates they will be 30.3% over 1990 levels by 2012.

Will reducing energy intensity per unit of GDP reduce GHG emissions in the U.S.?

Table 1. A Comparison Between the Growth of GDP and GHG Emissions Between 1990 and 2012

	Real GDP (Bn 2001 $)	GHG (Mt CE)	GHG/GDP (tCE/M$)
1990	7379	1678	227
2000	10146	1906	188
Change	*+37.5%*	*+13.6%*	*-17.4%*
2002	10475	1917	183
2012	14483	2187	151
Change	*+38.3%*	*+14.1%*	*-17.5%*
Change 1990-2012	*+96.3%*	*+30.3%*	*-33.5%*
Avg Kyoto Target for 1990-2012		-5.0%	

CE=carbon equivalent, Bn=billion, Mt=million tons

Second, the idea of countries being treated differently is not something that the world community created in the Kyoto Protocol. The Nuclear Non-Proliferation Treaty, for example, created different obligations for the five recognized nuclear weapon states and for the rest of the world. The United Nations Convention on the Law of the Sea applies differently to states with coastline versus landlocked countries. Numerous security agreements treat large and small states differently. Likewise trade and investment treaties apply differently to rich and poor countries. But the most relevant factor to keep in mind is that the Kyoto Protocol was negotiated with a mandate drawn from the UNFCCC. This agreement called on the rich nations to show that "developed countries are taking the lead in modifying longer-term trends in anthropogenic emissions."[9] It also recognized that the Convention needed to take into account the "difference in these Parties' starting points and approaches, economic structures and resource bases, the need to maintain strong and sustainable economic growth, available technologies and other individual circumstances, as well as the need for equitable and appropriate contributions by each of these Parties." The U.S. was one of the first industrialized countries to ratify this Convention, which was done with unanimous consent of the Senate, and it is now the law of the land.

Even if we were to revert to Clinton/Gore efforts at "meaningful participation"[10] of developing countries, the picture is not as bleak as it appears. In fact, even prior to the adoption of the Kyoto Protocol there were rumblings about whether the developing countries are doing their part to reduce the growth of greenhouse gas emissions from their countries. A series of commentators highlighted measures taken in the developing countries to this end.[11] In fact, the principal delegate who represented the U.S. in the Kyoto negotiations felt reasonably comfortable that the U.S. could sign the Protocol and would be in a position to eventually take it to the Senate for ratification.[12]

This volume focuses on this third point. In an earlier publication,[13] we demonstrated that several developing countries in Asia have been hard at work looking at their economic development plans with a view to reducing greenhouse gas emissions, without compromising their urgent need to develop. Contrary to the view that one might acquire in industrialized countries, most developing countries correctly believe that they indeed have commitments. These commitments are spelled out in Article 4 of the Convention. Article 4.1 addresses general commitments and Article 4.2 contains specific commitments. What the developing countries wanted to ensure is that there is an insurance of sorts in fulfilling their commitments. This is found in Article 4.7, which reads: "The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties."

Among the items listed in this Article, technology transfer has been the subject matter of several decisions by the Conference of the Parties as well as the topic for a Special Report by the IPCC.[14] The general feeling among developing country delegates in the climate negotiations is that precious little has been delivered under this Article. If one were to be truthful to the language of the Convention, developing countries could seek exemption from even the few general commitments that they have. An orderly course of transition

would have been one where the terms of an earlier agreement were fully satisfied before moving on to the next step. But given the urgency of action to deal with climate change, there is a sense that the nations of the world do not have the luxury to be sequential about it. The legal vacuum created by the actions of the Parties necessitated all of the measures initiated so far. For example, the Convention does not address the climate regime post 2000. Likewise the Protocol only deals with the First Commitment Period from 2008-2012, without providing a road map for the Second Commitment Period. By definition one is forced to think about the future long before any substantial evidence can be put on the table on how the world community fared on the existing commitments.

Case Studies

For this volume, we have selected seven countries, three from Asia, two from Africa, and two from South America. These seven are Argentina, Brazil, China, India, the Republic of Korea, Senegal, and South Africa. It is important to note that all seven have ratified the Kyoto Protocol (see Table 2). We chose Argentina because until recently it had been South America's richest country, and Brazil, because it is the largest country in South America and includes a major portion of the Amazonian forest within its borders. China and India have the distinction of being countries with the world's first and second largest populations. Korea is a non-Annex I country and yet a member of the Organisation for Economic Co-operation and Development (OECD) and has gone through a process of rapid industrialization. Senegal, a francophone country and a leader among African nations, is classified as a "least-developed country" (LDC) under the UNFCCC, yet was one of the first countries to submit its *Initial National Communication.* South Africa is the 14th highest emitter of total CO_2 in the world and has a disproportionate influence in Africa. In addition to being the country that hosted the World Summit on Sustainable Development, South Africa currently holds the chairmanship of the newly created African Union. Whenever there is discussion about how the developing countries are likely to overwhelm the gains made in the industrialized countries, several of these countries are often singled out as the culprits.

Our aim in this volume is to outline some of the salient actions initiated in these seven countries that have an impact on GHG emissions. This information was gleaned from the individual treatment given to each of the countries in the following chapters. The primary tools used were the national communications prepared by each of these countries when available and/or relevant materials either from country studies programs of the various bilateral aid agencies or studies initiated by the World Bank (National Strategy Studies) and regional development banks (ALGAS). Table 3 illustrates the current status of national communications preparation. It is important to note that the submission of a national communication is one of the commitments that the developing countries have undertaken under Article 4.1 of the UNFCCC.

Meaningful Participation

A survey of the Argentine *National Communication* illustrates that while, along with total emissions, per capita emissions rose between 1990 and 1997 as a result of a low population growth rate compared to the trends in energy consumption,[15] emissions intensity (emissions per GDP) decreased over this time period by almost 20%. Many of the studies cited in

this context have found historical decreases in emissions per unit of energy consumption. The United Nations Development Programme (UNDP) reported a 25% decrease in CO_2 emissions per Peta Joule (PJ) of energy between 1970 and 1985. After a brief interruption of this downward trend in 1985-1989, CO_2/PJ continued to decline through 1995.[16] In large part this is because policies were aimed at encouraging greater use of zero emissions fuels such as hydroelectricity and nuclear power generation as well as a greater dependence on natural gas, the fossil fuel with the lowest emissions coefficient.[17] Projections estimate that, had these changes in emissions per PJ of energy not taken place, Argentina's emissions of CO_2 over the period of 1970-1995 would have been approximately 500 million tons greater.[18]

Similarly the review and analysis of Brazil found that most of its electricity comes from hydroelectric power. Other efforts involving renewable energy include the Global Environment Facility-funded United Nations Development Programme project to promote solar thermal power generation through investments in production. Government efforts include *Proconve,* the program for vehicular emissions reduction, *ProArco* (the Programa de Prevenção e Controle de Queimadas e Incêndios Florestais na Amazônia) an instrument for monitoring and assessing wildfire risk in critical areas, and the *ProVarzea* project under the Pilot Program for the Protection of Tropical Rainforests in Brazil.[19] Given the fact that two thirds of Brazil's emissions are due to land-use changes including forest fires and deforestation, programs like this are particularly relevant in reducing Brazil's greenhouse gas contributions.

Several studies dealing with China have all made the point that by making a concerted attempt at keeping the population growth rate low, it succeeded in reducing the growth of its CO_2 emissions. Further, it was found that since the early 1980s, the government has emphasized energy conservation and enacted about thirty different laws. Most important of all, the Chinese government drastically reduced subsidies for energy consumption—coal from 61% in 1984 to 29% in 1995; petroleum from 55% in 1990 to 2% in 1995—with the goal of completely eliminating the subsidies. Equally of note are the introduction of the Energy Conservation Law of 1997, the Tenth Five-Year Plan's objective of reducing emissions of major pollutants 10% below 2000 levels by 2005, extensive afforestation efforts, and the promotion of non-motorized transport.

India was one of the first countries to give alternative sources of energy serious consideration. It began with the establishment of the Commission of Additional Sources of Energy in 1981, which was converted into the Department of Non-Conventional Energy Sources in 1982. In 1992, the Government of India decided to elevate the status of this Department to a full ministry and established the Ministry of Non-Conventional Energy Sources. India has now accumulated an impressive record on a range of non-conventional sources of energy. To wit: India is number one in the world in the use of biomass gasifiers and solar cookers, number two in biogas plants and improved biomass chulhas (cookstoves), and number four in biomass based power. It also utilizes wind power, small hydro power, solar photovoltaics, solar water heating systems, community solar cookers, wind pumps, solar PV pumps, an intergrated rural energy program, energy parks, hybrid systems, solar photovoltaic power, Aditya solar shops, and battery operated vehicles, as well as recovered energy from urban and industrial wastes.[20] When it hosted the eighth session of the Conference of the Parties to the UNFCCC in October 2002, delegates were impressed to

Introduction, *continued*

see that all public transportation (buses, taxis and autorickshaws) used compressed natural gas. Moreover, India has an extensive afforestation program.

The Korean government also relies on compressed natural gas. There is currently a fleet of 2,000 such buses in operation (10% of the intra-city fleet) with plans to add 1,000 more. [21] The Korean blueprint for economic development adopted in 2000 stresses that "the nation needs to improve energy efficiency while securing a safe supply of energy resources." One of the main objectives of the *2000 Blueprint* is the transition to a low energy consumption structure, which includes "the positive promotion of energy conservation policy; encouragement of an energy conservation movement by maintaining prices at an advantageous level; promotion of energy technology development; continued progress under the UNFCCC; and establishment of a National Energy Strategy to cope with economic, social, and other changes in the 21st century."[22]

Senegal, as pointed out above, is an LDC and yet it is prominent in the realm of policy analysis as well as entrepreneurial in developing ideas. It played a lead role in the African Ministerial Conference on Environment and in ensuring that climate change is prominently figured in NEPAD. It also has undertaken a regional project entitled, *Control of Greenhouse Gas Emissions through Energy Efficient Building Technology in West Africa.* The main goal of this project is to introduce energy efficient building technologies "to retrofit the existing buildings and to design, build and operate more efficient new buildings." [23] Other activities of note include programs that promote the use of solar equipment, and plans for new environmentally friendly housing developments.

While Africa as a whole is responsible for a negligible amount of greenhouse gas emissions globally, South Africa has one of the highest per capita emissions, almost comparable with OECD countries. It has been very active on a number of fronts, which have been highlighted in our case study. Of particular note is the installation of solar equipment on 50,000 individual homes by Eskom and Shell International Renewables. Efforts by the government to address the country's policies on renewable energy include the recent release of the *White Paper on the Promotion of Renewable Energy and Clean Energy Development: Part One — Promotion of Renewable Energy.* Of particular note in the *White Paper* is the adoption of a mid-term target to add an additional 10,000 GWh (0.8 Mtoe), mainly from wind, biomass, solar, and small hydro, to its total energy consumption by 2012.[24]

Table 2. Kyoto Protocol Ratification - Status of Selected Countries

Source: Kyoto Protocol. Status of Ratification. UNFCCC, 2002.[25]

Country	Date of Signature	Date of Ratification (R), Accession (Ac), or Approval (Ap)
Argentina	16 March 1998	28 September 2001 (R)
Brazil	29 April 1998	23 August 2002 (R)
China	29 May 1998	30 August 2002 (Ap)
India	—	26 August 2002 (Ac)
Republic of Korea	25 September 1998	08 November 2002 (R)
Senegal	—	20 July 2001 (Ac)
South Africa	—	31 July 2002 (Ac)

Table 3. Status of Preparation of Initial National Communications of the Seven Selected Countries

Source: UNFCCC, FCCC/WEB/2002/9, 20 September 2002.[26]

Party *(least developed countries in italics)*	**Date of Ratification of the UNFCCC**	**Date/ indicated date of submission of national communication**	**Status of preparation of initial national communication**			**Status of phase II of enabling activity project** (Expedited financing for (interim) measures for capacity building in priority areas)	**National web site**
			General status	**Greenhouse gas inventory**	**General description of steps**		
Argentina	11 March 1994	Submitted in July 1997 (Available in Spanish in hard copy only) Addendum: English Spanish	Completed	Completed (July 1997) (Base year: 1994, Methodology: IPCC 1995 guidelines) (Base year: 1994, Methodology: IPCC 1995 guidelines) (Base year: 1997, Methodology: IPCC 1996 revised guidelines)	Completed (July 1997)	No information available	No information provided
Brazil	28 February 1994	To be submitted by the end of 2002	Ongoing	Ongoing (Base year: 1994, Methodology: IPCC 1996 revised guidelines)	Ongoing	No information available	http://www.mct.gov.br/clima
China	5 January 1993	To be submitted in February 2004	Ongoing	Ongoing	No update provided	No information available	Under development
India	1 November 1993	To be submitted in November 2003	Ongoing	Ongoing (Base year: 1994, Methodology: IPCC 1996 revised guidelines)	Ongoing	No information available	http://www.envfor.nic.in/cc/index.htm
Republic of Korea	14 December 1993	Submitted in February 1998 English	Completed	Completed (May 2000) (Base year: 1994, Methodology: IPCC 1995 guidelines)	Completed (February 1998)	No information available	No information provided
Senegal	*17 October 1994*	*Submitted in December 1997 French*	*Completed*	*Completed (December 1997)*	*Completed (December 1997)*	*Project approved by GEF*	*http://www.unfccc.de/resources/ccsites/senegal/index.htm*
South Africa	29 August 1997	No update provided	Completed	Completed (December 2000) (Base year: 1990, 1994, Methodology: IPCC 1996 revised guidelines)	Completed (March 2001)	No information available	No information provided

The Way Ahead

The UNFCCC and its Kyoto Protocol are at once agreements for safeguarding the Earth from climate change as well as helping nations meet their goals of attaining sustainable development. Thus the economic component of these agreements is as strong as the environmental component. Also, action is needed not just by the governments, but by the private sector as well as people everywhere. The reach of these agreements is such, at least one commentator felt, that outside of trade agreements this issue would be an ideal target for protests by the anti-globalization movement!

Despite many of the factors that we outlined above, one reason for the overwhelming embrace of the UNFCCC and Kyoto Protocol is the universally accepted notion that industrialized countries bear the responsibility and have agreed to take the first step in correcting the situation. At the same time, all countries acknowledge that in due course emissions will increase rapidly in developing countries as they strive to meet the basic needs of their teeming populations. But unfortunately, observers of the ongoing climate debate can come away with diametrically opposite conclusions—some believing that there is no evidence, that the world community is seized by the matter, and is working in concert to address it; and the others, excited about the small incremental steps that the world community is able to take, believing these steps are likely to lead to long term solutions. Therein lies the conundrum.

One way of overcoming this is by graduating from questions about scientific uncertainty, acrimony between environmentalists and the private sector, and disagreements among and between industrialized countries and the developing countries, and moving on to increasing cooperation between developed and developing countries. It is important to explicitly recognize that both the UNFCCC and the Kyoto Protocol are not just environmental agreements but economic agreements as well. Implicit within this is a salient political concern of development policy, both for developing and industrialized countries. As long as it remains marginal to the multitude of developing country concerns including food security, poverty alleviation, natural resource management, self-sufficiency in energy development and others, we are not likely to make any progress. If the Convention and Protocol on climate change could be used for promoting sustainable development rather than as a barrier to traditional economic development, then there would be greater adherence to the subsequent steps in the evolving climate regime.[27] What is required from the industrialized countries is a realization that it is important to work with that which is already in place, as we continue to explore new ways of improving the situation.

Endnotes

[1] "The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more", See J.T. Houghton, G.J. Jenkins, and J.J. Ephraums, eds. **Climate Change: The IPCC Scientific Assessment.** Report prepared for the IPCC by Working Group 1. Cambridge, U.K.: Cambridge University Press, 1990.

"The balance of evidence suggests a discernible human influence on global climate", See IPCC. **Climate Change 1995.** Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, U.K.: Cambridge University Press, 1995.

"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities", See IPCC. Climate Change 2001. Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, U.K.: Cambridge University Press, 2001.

The National Academy of Sciences of the U.S.A. carried out its own set of studies and concurred with the IPCC. It said in a report released in 1992 that "increases in atmospheric greenhouse gas concentrations probably will be followed by increases in average atmospheric temperature". In 2001 in a report entitled **Climate Change Science: An Analysis of Some Key Questions,** it said "Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability....". It further asserted that "despite the uncertainties, there is a general agreement that the observed warming is real and particularly strong within the past 20 years".

See **Policy Implications of Greenhouse Warming: Mitigation, Adaptation, and the Science Base.** Panel on Policy Implications of Greenhouse Warming, Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. Washington, D.C.: National Academy Press, 1992; and **Climate Change Science: An Analysis of Some Key Questions.** Committee on the Science of Climate Change, Division on Earth and Life Studies, National Research Council. Washington, D.C.: National Academy Press, 2001.

[2] *Policy Makers Summary*, p. xviii. See J.T. Houghton, G.J. Jenkins, and J.J. Ephraums, eds. **Climate Change: The IPCC Scientific Assessment.** Report prepared for the IPCC by Working Group 1. Cambridge, U.K.: Cambridge University Press, 1990.

[3] See Kilaparti Ramakrishna, *The Challenge of Global Climate Change,* **Global Change,** April 1998, Vol. 4, No. 1.

[4] Ibid.

[5] Senate Resolution 98, Expressing the Sense of the Senate Regarding the United Nations Framework Convention on Climate Change, 12 June 1997.

[6] See Profile of Senator Chuck Hagel appearing in **Global Change,** April 1998, Vol. 4, No. 1. In it the Senator was quoted as saying on the Kyoto Protocol: "We will kill this if the President signs it".

[7] These include: Clean Development Mechanism, Joint Implementation and Emissions Trading. But for the inclusion of these flexibility mechanisms, the industrialized countries would not have taken the legal commitments contained in the Kyoto Protocol.

[8] Personal correspondence with John P. Holdren, Kennedy School of Government, Harvard University.

[9] See Kilaparti Ramakrishna, *Kyoto and the Developing World,* **Foreign Service Journal,** March 1999, pp. 36-39.

[10] See Thomas C. Schelling, *What Makes Greenhouse Sense? Time to Rethink the Kyoto Protocol,* **Foreign Affairs,** May/June 2002, p. 2. In this article Schelling points out that there is no likelihood that China, India, Indonesia, Brazil or Nigeria will fully participate in any greenhouse gas regime for the next few decades and that the best way for developing countries to mitigate global warming is through economic growth.

[11] See Kilaparti Ramakrishna, Andrew Deutz and Karan Capoor, *Towards Practical Implementation of Article 4.1 of the Climate Change Treaty,* in **Climate Change Analysis Workshop: Proceedings, June 6 & 7, 1996, Springfield, VA,** U.S. EPA et.al.; A. Leonard, I. Mintzer, A. Rahman and K. Ramakrishna (eds.) **A New Initiative for North-South Dialog on Climate Change. Good Practices, Technology Innovation and New Partnership for Sustainable Development: Challenges and Opportunities in Implementing the Climate Convention,** Published by the Bangladesh Centre for Advanced Studies (BCAS), December 1997; Kevin A. Baumert, Walter V. Reid, and José Goldemberg, *Developing Countries are Participating Now,* **Foreign Service Journal,** April 1999, pp. 40-44.

Endnotes, *continued*

[12] See Stuart Eizenstat, *Stick with Kyoto: A Sound Start on Global Warming,* **Foreign Affairs,** May/June 1998, p. 119.

[13] See Kilaparti Ramakrishna, Barbara Bamberger, Linda Jacobsen, **Asia Looking Ahead: Initial Stages of National Communications Reporting.** WHRC, November 2000, ISBN: 0-9706340-0-5.

[14] See **Methodological and Technological Issues in Technology Transfer: Special Report of the IPCC.** Cambridge, U.K.: Cambridge University Press, 2000.

[15] National Strategy Studies. **Study on Flexibility Mechanisms Within The Context of the United Nations Framework Convention on Climate Change and the Kyoto Protocol.** Buenos Aires: NSS Program, 1999.

[16] See Carlos Enrique Suárez. *Argentina's Ongoing Efforts to Lower Greenhouse Gas Emissions.* **Promoting Development While Limiting Greenhouse Gas Emissions: Trends and Baselines.** Eds. José Goldemberg and Walter Reid. New York, NY: United Nations Publications, 1999. pp. 15-23.

[17] Ibid., 15.

[18] Ibid., 18.

[19] See IBAMA website <http://www.ibama.gov.br/>

[20] See http://mnes.nic.in/ach1.htm. Also see P.R. Shukla, Subodh K. Sharma and P. Venkata Ramana (eds.), **Climate Change and India: Issues, Concerns and Opportunities.** Delhi, India: Tata McGraw Hill, 2002.

[21] **Environmental News: The Number of CNG Buses In Operation Reached 2000 on June 5th.** 4 June 2002. Ministry of Environment-Republic of Korea. Retrieved 16 July 2002. <http://www.me.go.kr:8080/me/front/env/bbs_read.jsp?tablename=me_envs&bbs=bbs1&pg=2&seq=31>

[22] **Energy Efficiency Policies 2000, 2001, and 2002.** October 2001. International Energy Agency (IEA). Retrieved 10 May 2002. <http://www.iea.org/pubs/newslett/eneeff/Table.htm>

[23] **GEF Projects.** Global Environmental Facility (GEF). <http://www.gefonline.org/projectList.cfm>

[24] DME. **White Paper on the Promotion of Renewable Energy and Clean Energy Development.** Department of Minerals and Energy (DME) of the Republic of South Africa, Pretoria, August 2002.

[25] **Kyoto Protocol. Status of Ratification.** 20 December 2002. United Nations Framework Convention on Climate Change (UNFCCC). Retrieved 30 December 2002. <http://unfccc.int/resource/kpstats.pdf>

[26] UNFCCC. **National Communications from Parties Not Included in Annex I to the Convention. Provision of Financial and Technical Support. Status of the preparation of national communications from Parties not included in Annex I to the Convention. Note by the Secretariat.** United Nations Framework Convention on Climate Change (UNFCCC), Document FCCC/WEB/2002/9, 20 September 2002.

[27] See William Moomaw, Kilaparti Ramakrishna, Kevin Gallagher, Tobin Freid, *The Kyoto Protocol: A Blueprint for Sustainable Development,* **Journal of Environment and Development,** Vol. 8, No. 1, March 1999, pp. 91-95.

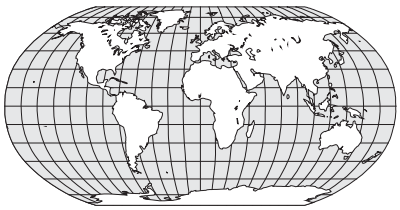
Country Case Study: Argentina

I. Introduction

Until recently Argentina, held up as an example of successful free-market reform, was Latin America's richest country and third largest economy.[1] Between 1991 and 1997 the Argentine economy grew at an annual average rate of 6.1%.[2] In 2000 the national GDP was $296.29 billion (1995 U.S. dollars), corresponding to a per capita GDP of $7,933.[3,4] Nearly 90% of the 37.5 million population lived in urban centers with an adult literacy rate of 97%.[5,6] In 1999 the ***Revision of the First National Communication of the Argentine Republic*** *projected GDP growth rates in the range of 2-5%.[7] However, after defaulting on its $155 billion public debt, the Argentine government is projecting a 4.9% contraction in GDP in 2002, while others are estimating the decrease at almost twice that amount. Unemployment has risen close to 25%, and 44% of the urban population lives below the official poverty level.[8]*

While most aspects of Argentina's future development are uncertain, its history shows a commitment to controlling greenhouse gas (GHG) emissions while achieving significant economic growth.

I. Introduction, *continued*



As one of the first non-Annex I countries to submit a national communication under the United Nations Framework Convention on Climate Change (UNFCCC), Argentine officials have compiled comparable GHG inventories for three different years and have taken steps toward establishing a voluntary national emissions reduction target. As a developing nation that has taken considerable early action on climate change issues, Argentine efforts have been closely studied and well documented. Despite recent economic changes, Argentina's efforts in addressing climate change serve as a useful example of the role developing nations can play in the international effort.

Table 1. Argentina Summary Statistics*

Sources: World Bank, 2000[9] and International Energy Agency, 2001.[10]

External Debt, Total (DOD, current USD)	146,172,000,000
IBRD Loans and IDA Credits (PPG DOD, current USD)	8,789,100,000
Commercial Energy Use (kg oil equivalent per capita)	1,727 (1999 value)
GDP (billion 95 USD)	296.29
GDP-PPP (billion 95 USD)	426.55
GDP Per Capita (95 USD)	7,933
GDP Growth (annual %)	-1
GDP Per Capita Growth (annual %)	-2
Agriculture (% of GDP)	5
Industry (% of GDP)	28
Services, etc. (% of GDP)	68
Population (millions)	36.58
Population Growth (annual %)	1
Urban Population (% of total)	89
Fertility Rate, Total (births per woman)	3
Life Expectancy at Birth (years)	74
Adult Illiteracy Rate	3
Sanitation (% of population with access)	85
Improved Water Source (% of population with access)	79
Internet Users	2,500,000
Surface Area (km^2)	2,780,400
Land Use - Permanent Cropland (% of land area)	1 (1999 value)
Forest Area (% of land area)	13
CO_2 Emissions (Mt of CO_2)	142.74
CO_2 Emissions Per Capita (t CO_2/population)	3.90
CO_2 Emissions Per GDP (kg CO_2/95 USD)	0.48
CO_2 Emissions Per GDP (kg CO_2/95 USD PPP)	0.33

** All figures are from the year 2000, unless otherwise indicated.*

II. Argentina's Participation in the UNFCCC

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An active member of the UNFCCC, Argentina ratified the Convention in 1994 and the Kyoto Protocol in 2001.[11] Argentina was one of the first non-Annex I countries to submit a national communication, with funding from the Argentine Science and Technology Department, the Ministry of Foreign Affairs, and additional support from the Global Environment Facility (GEF).[12,13,14] The project involved more than 60 experts from Argentine universities and public and private bodies. In particular, the Buenos Aires and La Plata Universities completed research to produce the three separate GHG inventories.[15]

Table 2. Timeline of Participation in the UNFCCC

Date	Action
March 1994	Ratified the UNFCCC
July 1997	First National Communication submitted
October 1999	Revision of the FNC submitted
September 2001	Ratified Kyoto Protocol
March 2002	Proposal submitted to the GEF for funding for enabling activities leading to the Second National Communication
April 2002	Project approved by GEF

The *First National Communication of the Argentine Republic* contained GHG inventories for 1990 and 1994, as well as studies on mitigation options and Argentina's vulnerability to climate change.[16] In November of 1999 an addendum to the communication was submitted that contained a GHG inventory for 1997 as well as revisions of the 1990 and 1994 estimates. Emissions data for land-use change and forestry, as well as several subsectors of the agriculture sector were included.[17] Moreover, the emissions estimates for the 1990 and 1994 inventories were revised in order to conform to the 1996 revised IPCC guidelines and thus be comparable to the 1997 estimates.[18] As part of the addendum Argentina also examined setting a voluntary emissions target or "Federal Emissions Goal."

III. Emissions Estimates for Argentina

III. Emissions Estimates for Argentina

A summary of the emissions reported for 1990, 1994, and 1997, measured in millions of metric tons of carbon equivalent (MMTCE), is shown in Table 3. As expected, the majority of the emissions reported is due to the burning of fossil fuels and primarily to the emission of CO_2.

Table 3. Total Emissions Reported
(Unit: MMTCE)

Source: Revision of the First National Communication - Argentine Republic, 1999.[19]

Category	1990	1994	1997
Energy	29.15	34.66	38.18
Burning of Fossil Fuels	25.22	29.90	33.11
Fugitive emissions	3.93	4.76	5.07
Industrial Processes	1.72	1.78	2.43
Solvent and Other Product Use	NE	NE	NE
Agriculture and Livestock Production	29.97	31.50	31.42
Land Use Change and Forestry	-9.37*	-9.37*	-12.80
Waste Management	2.48	4.04	4.44
HFC, PFC, and SF_6	NE	NE	0.31
Total	53.97	62.61	63.96
Total excluding Land-Use Change and Forestry	**63.32**	**71.98**	**76.77**

Note: Columns may not sum to the total due to independent rounding

NE = Not Estimated

** Does not include the Land-Use Change and Forestry Subsector.*

III. Emissions Estimates for Argentina, *continued*

A comparison of the emissions data from Argentina's *First National Communication* with similar estimates made by the International Energy Agency (IEA) shows that the estimates in the communication are somewhat lower. Table 4 shows the *National Communication* and IEA estimates for CO_2 emissions from the combustion of fossil fuels. Based on regularly compiled data on total fuel consumed, carbon content of different fuels, and the emissions factors for each fuel type, the quantity of emissions from the combustion of fossil fuels is a common statistic. Moreover, these emissions account for over 96% of the CO_2 emissions in each inventory and approximately 40% of the GHG emissions overall, measured in MMTCE. Both sets of data were compiled following 1996 IPCC guidelines and include aviation bunker fuels.

Table 4. CO_2 Emissions from Fossil Fuel Combustion (Mt CO_2)

Sources: Revision of the First National Communication - Argentine Republic, 1999[20] *and IEA, 1997*[21] *and 1999.*[22]

Source	1990	1994	1997
National Communication Total	91.844	108.951	119.016
Combustion of Fossil Fuels	90.848	107.567	118.854
Aviation bunkering	0.996	1.384	0.162
IEA	100.33	125.86	137.75
% Difference*	- 8.45	- 13.4	- 13.7

** % Difference = (NC-IEA)/IEA*

III. Emissions Estimates for Argentina, *continued*

Both sets of data were calculated using IPCC estimates of average fuel emission factors. However, a number of possible reasons exists for the differences in these numbers. Primarily, IEA estimates were made using average net calorific values for each fuel source, whereas the researchers working on Argentina's *National Communication* may have used more specific values for calculating the heat content of each fuel.[23] In addition, IEA does not have access to detailed information about non-energy uses of fuels, which could potentially lead to an overestimation of the amount of fuel burned and therefore the emissions released.

Similar numbers from the Carbon Dioxide Information Analysis Center (CDIAC) approximate the numbers developed by the IEA. These estimates were primarily derived using energy statistics on fuel production and consumption compiled from annual questionnaires distributed by the UN Statistical Office and official national statistical publications.[24] The CDIAC numbers represent the CO_2 emissions from the combustion of solid, liquid, and gaseous fossil fuels and have been adjusted so as not to include any international bunker fuels. Again, the estimation of the quantity of non-energy use fuels, fuel specific carbon contents, and emissions factors could easily lead to the differences in the estimates shown in Table 5.

Table 5. Emissions from Fuel Combustion in Mt CO_2

Sources: Argentine Republic, 1999[25]; IEA, 1997[26] and 1999[27]; and CDIAC, 2001.[28]

Source	1990	1994	1997
National Communication	90.848	107.567	118.854
CDIAC	102.755	121.715	130.013
IEA*	100.33	125.86	137.75

** Includes aviation bunkering.*

Emission Trends

Table 6 shows the emission trends based on the numbers reported in the revised *First National Communication.* Along with total emissions, per capita emissions rose between 1990 and 1997 as a result of a low population growth rate compared to the trends in energy consumption.[29] Emissions intensity (emissions per GDP) however decreased over this time period by almost 20%. Other studies have found historical decreases in emissions per unit energy consumption. The United Nations Development Programme (UNDP) reported a 25% decrease in CO_2 emissions per Peta Joule (PJ) of energy between 1970 and 1985. After a brief interruption of this downward trend in 1985-1989, CO_2/PJ continued to decline through 1995.[30] In general these trends resulted from policies aimed at encouraging greater use of zero emissions fuels such as hydroelectricity and nuclear power generation as well as a greater dependence on natural gas, the fossil fuel with the lowest emissions coefficient.[31] Projections estimate that, had these changes in emissions per PJ of energy not taken place, Argentina's emissions of CO_2 over the period of 1970-1995 would have been approximately 500 million tons greater.[32]

Table 6. Emissions Trends Revealed by the National Communication*

Sources: Argentine Republic, 1999[33] and IEA, 1997[34] and 1999[35]

	1990	1994	1997
Total emissions excluding forestry and land-use change (MMTCE)	63.32	71.98	76.77
Per capita emissions (tons of carbon equivalent per person)	1.95	2.11	2.15
Emissions intensity (tons of carbon equivalent per 1000 1990 USD)	0.448	0.379	0.359

** The emissions numbers in this table are taken from the GHG inventory in the National Communication. The numbers used are those that exclude land-use change and forestry because they are the most comparable. GDP and population figures were taken from IEA publications, CO_2 Emissions from Fossil Fuel Combustion for 1990 and 1994 and Key World Energy Statistics (1999) for 1997.*

III. Emissions Estimates for Argentina, *continued*

Future Emissions

The Argentine government has shown some willingness to establish voluntary national emissions targets. At the fourth session of the UNFCCC Conference of the Parties (COP4), held in Buenos Aires in 1998, Carlos Menem, then President of the Republic of Argentina, declared that Argentina would develop targets for mitigating GHG emissions for the period of 2008 to 2012. The National Commission for the Formulation and Proposal of the Greenhouse Gas Emission Target was then established by presidential decree with the Secretary for Natural Resources and Sustainable Development designated as its president in order to meet this commitment.[36]

The uncertainty in the macroeconomic scenarios gives rise to a considerable range in future emissions estimates. As a result, Argentina investigated a dynamic voluntary emissions target that is proportional to some measure of GDP. Specifically the emissions target was to be set at $E = I^*\sqrt{P}$. Emissions (E) are measured in tons of carbon equivalent and GDP (P) is measured in 1993 Argentine pesos.[37] The index factor (I) was chosen as 151.5 in order to produce an effective GHG reduction under the majority of economic development scenarios considered.[38]

Emissions projections for 2008-2012 were based on macroeconomic scenarios that estimate a range of annual accumulative GDP growth rate between 2.2% and 5.2%.[39] Given this range, the emissions for 2008-2012 are estimated to be between 95 MMTCE and 122 MMTCE. These numbers correspond to approximately 50% and 81% increases from 1990 levels. The voluntary target announced in the *Revision of the First National Communication,* submitted at the fifth session of the UNFCCC Conference of the Parties (COP5) in 1999, could achieve a 2-10% reduction in the rate of growth of emissions during 2008-2012 based on three different GDP growth scenarios.[40] Argentina stated that this target would become an international obligation when the Kyoto Protocol entered into force and when new alternatives were produced to allow non-Annex I countries that adopt voluntary goals to participate in the mechanisms established by the protocol.[41] In April of 2000 Argentina's Natural Resources and Environmental Policy Department (SRNyPA) announced that it would adhere to this "Federal Emissions Goal."[42]

A number of other studies have been conducted that make emissions projections based on the development of macroeconomic scenarios. As part of the *National Strategy Studies Program* carried out by The World Bank, with support from the Canadian government, a report on Argentina was drafted entitled *Study of Flexibility Mechanisms within the context of the United Nations Framework Convention on Climate*

III. Emissions Estimates for Argentina, *continued*

Change and the Kyoto Protocol. This project developed a base scenario for 1997-2015 with an annual growth in GDP of 5% starting in the year 2000.[43] Projections from this study indicated that CO_2 emissions would rise by more than 100% with respect to 1997 values and by more than 150% with respect to 1990 values.[44] Even without explicit policies implemented to mitigate emissions, technological advances, switches to "cleaner sources," and changes in economic activity were projected to lead to a 16% decrease in emission intensity.[45] A study published by the United Nations Environment Programme (UNEP) and Risø National Laboratory in Denmark, *Economics Of Greenhouse Gas Limitations,* developed a socio-economic baseline scenario for Argentina in which sustained economic growth produced annual GDP growth rates of 4% to 5% from 1995 through 2030.[46] Given the macroeconomic assumptions and projections in the study, GHG emissions were projected to rise at an increasing rate that averages out to 3.5% a year from 1995 to 2020 for a total emission of 98.74 MMTCE in 2020.*

IV. Emissions Reduction Initiatives

IV. Emissions Reduction Initiatives

The Argentine government has played an active role in climate change research and training activities as well as passing a number of climate change related regulations (see Table 7). Their success in controlling greenhouse gas emissions is, in part, tied to the fact that Argentina has one of the lowest dependencies on fossil fuels for generating electricity in the world.[47] Energy policies established by the Energy Department have pursued replacing oil and coal with greater use of hydroelectricity and nuclear energy sources. In addition, considerable emphasis has been placed on using the country's large natural gas resources. Natural gas, though not a zero emissions fuel source, has the lowest emissions factor of all the fossil fuels. Several policies have been implemented to further this shift toward low emissions fuels and to improve energy efficiency.

Table 7. Argentine Government Institutions Involved in Climate Change Issues

Source: Bouille, Girardin and Di Sbroiavacca, 2000.[48]

Institution	Regulations	Research & Training
Environmental and Sustainable Development Policy Coordination Office	X	X
Natural Resources and Sustainable Development Department	X	X
Energy Department	X	X
Electricity Regulatory Agency	X	X
Transport Department	X	
Ministry of Foreign Affairs, Foreign Trade, and Church Affairs		X
Science and Technology Department		X
Argentine Nuclear Energy Commission		X
Argentine Meteorological Service		X
Argentine Agricultural and Stockbreeding Technology Institute		X

**Calculation: 362052 Gg of CO_2 equivalent *(12/44) *(1/1000) = 98.74 MMTCE*

IV. Emissions Reduction Initiatives, *continued*

The *Natural Gas Vehicle Program,* initiated in 1984, promoted the use of compressed natural gas in vehicles through the elimination of the gasoline tax on natural gas and through support of new filling station construction and vehicle conversions. Over 500,000 cabs and private vehicles changed to natural gas supplied by close to 600 filling stations.[49,50] With close to 10% of automobiles using natural gas, Argentina now has the largest fleet of natural gas vehicles in the world.

Table 8. The Four Largest Natural Gas Vehicle Fleets in 1997

Source: Suárez, 1999.[51]

Country	Vehicle Conversions	Filling Stations
Argentina	427,000	580
Italy	290,000	280
Russia	205,000	187
USA	40,000	1,102

In 1994 the Argentine government began efforts to reduce emissions from the flaring of natural gas. Regulations were passed that required the reduction of flaring from 12.1% of gross production in 1994 to 3.0%, a level similar to that of most industrialized countries, by mid 1998.[52] As shown in Table 9, total production of natural gas increased from 1990 to 1997 but the volume of flared natural gas in fact decreased.

Table 9. CO_2 and CH_4 Emissions from Venting and Flaring of Oil and Natural Gas

Source: Argentine Republic, 1999[53] *and Suárez, 1999.*[54]

Year	CO_2 (Gg)	CH_4 (Gg)	Production of natural gas (million m^3)	Volume of flared natural gas (million m^3)
1990	4,638	70.7	23,018	
1994	5,729	88.1		3,363
1997	4,390	153.1	37,076	1,957

Argentina has undertaken a number of projects to promote clean and efficient energy use. One such project, funded by the GEF and World Bank and implemented by the International Finance Corporation with support from the International Institute for Energy Conservation, is the *Efficient Street Lighting Program.*[55] The project aims to increase the energy efficiency of Argentina's street lighting systems and to extend these services to underserved areas. Inefficient incandescent and mercury vapor street lighting will be replaced with high-pressure sodium fixtures for a nationwide energy savings of over 400 megawatts. This translates into an estimated 152,000 tons of abated carbon emissions each year.[56]

IV. Emissions Reduction Initiatives, *continued*

Research

As one of the only non-Annex I countries with three comparable GHG inventories, Argentina has been the subject of a variety of climate change mitigation studies. A number of these studies have identified significant potential to control GHG emissions in both energy and non-energy sectors.[57] The *National Strategy Study* considered a variety of options for mitigation efforts. Greater use of hydro and wind sources for electricity generation were estimated to reduce emissions by 7.9% from the baseline scenario.[58] Efficiency measures in household lighting and food preservation were found to potentially produce a 2% reduction from the baseline.[59] Finally, greater use of natural gas in automobiles was projected to yield a 1.5% reduction in CO_2 emissions by the horizon year of 2015.[60]

The Instituto de Economía Energética - Fundación Bariloche has also conducted a number of mitigation studies in Argentina. One, published by UNEP and the Risø National Laboratory, looked at a larger set of mitigation options in electricity generation, the transportation sector, and major energy consuming industries likely to experience medium and long-term growth.[61] The results of the study suggested a reduction in expected growth rate of CO_2-equivalent emissions from 3.5% in the baseline to 2.6% per year. This change corresponds to a 20% reduction in CO_2-equivalent emissions compared to the baseline scenario's horizon year.[62]

Argentina is also participating in ongoing efforts to monitor and assess GHG emissions. Currently, Argentina has a national network of GHG monitoring stations and also participates in a regional network for systematic observation of GHGs including ozone and UV-B radiation that will result in a regional databank on meteorological and environmental data.[63] In addition, Argentina, in cooperation with Uruguay and Paraguay, is installing monitoring stations in the "Southern Cone" region. Internationally, Argentina is part of global observation networks including working in cooperation with the International Atomic Energy Agency, Max Planck Institute (Germany), and the Comparative Institute for Research in Environmental Sciences (France), as well as participating in various cooperative projects under the World Meteorological Organization.[64]

V. Future Directions

V. Future Directions

Argentina's *First National Communication* identified several areas where further assistance might be needed in order to integrate climate change concerns into long term planning in the pursuit of sustainable development. These needs were primarily in the area of capacity building activities such as those that might facilitate the implementation of certain climate change adaptation and mitigation options or improve Argentina's capacity to develop integrated energy plans and other climate change related legislation.[65] The *First National Communication* also specified the need for financial assistance for strategy and planning development in the areas of agriculture, forestry, and transportation.[66]

Plans have begun to develop Argentina's second national communication. A proposal has been submitted to the GEF for U.S.$1.14 million in support of *Enabling Activities Leading to the Second National Communication of the Argentine*

V. Future Directions, *continued*

Government to the Conference of Parties to UNFCCC.[67] The second communication will update and improve the GHG inventories by including data for 2000 and establishing national emissions factors for the energy sector, land-use and forestry, and methane emissions from cattle enteric fermentation. A comparative analysis of current and previous GHG inventories will also be included in the communication. The *First National Communication* reported on vulnerability assessments of the impacts of climate change on Argentine coasts, the oases in the Andean Mountains, and agriculture. The second communication proposes to expand these assessments to consider:[68]

- Further vulnerabilities of coastal zones—specifically an area north of Bahia de San Borombon, including the Gran Buenos Aries and Paraná Delta
- Potential impacts to the Pampa Bondaerense
- Effects on water resources
- Possible changes in agricultural production in the Humid Pampa region
- Socio-economic impacts of climate change
- Impacts from precipitation increases in the Patagonia region
- Climate change effects on the energy system and energy infrastructure

The proposal submitted to the GEF also outlines plans for the development of a National Mitigation Plan, which will include mandatory and voluntary emissions reduction measures. The proposed mitigation plan would include assessments of opportunities in demand sector management, increasing efficiency in the transport sector, increased use of renewable energy technologies, and CO_2 sequestration. Finally the proposal outlines plans for the promotion of public awareness of national climate change issues. The aim is to encourage environmentally responsible individual and group behaviors by increasing awareness, knowledge, changing attitudes, increasing abilities to respond to climate change problems, and increased participation in climate change mitigation efforts. Public awareness projects will focus on capacity building and providing assistance for planning and conducting future public awareness campaigns.[69]

Given the recent economic crisis in Argentina, much of the future is uncertain. In 1999 the *Revision of the First National Communication of the Argentine Republic* projected GDP growth rates in the range of 2-5%.[70] After defaulting on its $155 billion public debt the Argentine government is projecting a 4.9% contraction in GDP in 2002, while others are estimating the decrease at almost twice that amount.[71] How these events will affect long run emissions scenarios is unclear. What is clear, however, is that Argentina has historically shown a serious commitment to addressing climate change. Many of the government's actions and policies as well as the numerous mitigation studies carried out in the country can serve to guide current thinking about opportunities for the meaningful involvement of developing nations in international efforts.

Endnotes

[1] *A Decline Without Parallel.* **The Economist.** 28 February 2002. Retrieved May 2002. <http://www.econ.upenn.edu/econ2/2002A/knowles/Readings/Argentina.pdf>

[2] Ibid.

[3] International Energy Agency. **Key World Energy Statistics from the IEA: 2001 Edition.** Paris: International Energy Agency (IEA), 2001. p. 48-57

[4] **SIMA Quick Query Database.** 2000. World Bank. Retrieved 16 May 2002. <http://sima-ext.worldbank.org/query/>

[5] **2001 World Population Data Sheet.** 2002. Population Reference Bureau. Retrieved May 2002. <http://www.prb.org>

[6] Op. cit., World Bank.

[7] Argentine Republic. Secretariat for Natural Resources and Sustainable Development. **Revision of the First National Communication. 1999.**

[8] Op. cit., The Economist.

[9] Op. cit., World Bank.

[10] Op. cit., IEA (2001).

[11] **Convention Parties and Observers: Argentina.** 2002. United Nations Framework Convention on Climate Change. Retrieved 31 July 2002. <http://unfccc.int/resource/country/country.html?10>

[12] **Table of National Communications.** 2002. United Nations Framework Convention on Climate Change. Retrieved 15 May 2002. <http://unfccc.int/resource/natcom/nctable.html>

[13] Bouille, Daniel Hugo, Leonidas Osvaldo Girardin and Nicol·s Di Sbroiavacca. *Argentina.* **Confronting Climate Change: Economic Priorities and Climate Protection in Developing Nations.** Ed. B. Biagini. Washington, DC: National Environmental Trust, 2000. 223-250.

[14] **National Communications From Parties Not Included in Annex I to the Convention: Provision of Financial and Technical Support, Information on Activities Taken by the Global Environment Facility**. 2002. United Nations Framework Convention on Climate Change. FCCC/SBI/2002/INF.1. Retrieved May 2002. <http://unfccc.int/resource/docs/2002/sbi/inf01.pdf>

[15] Op. cit., Bouille, Girardin and Di Sbroiavacca, 237.

[16] Ibid., 241.

[17] Op. cit., Argentine Republic, Section 3.

[18] Ibid.

[19] Op. cit., Argentine Republic, 1997 Inventory.

[20] Ibid.

[21] International Energy Agency (IEA). **CO_2 Emission from Fuel Combustion: A New Major Basis for Comparing Emissions of a Major Greenhouse Gas.** Paris: OECD/IEA, 1997.

[22] International Energy Agency. **Key World Energy Statistics from the IEA: 1999 Edition.** Paris: International Energy Agency (IEA), 1999. p.48-49.

[23] Op. cit., IEA (1997).

[24] **Global, Regional, and National Fossil Fuel CO_2 Emissions.** 2001. Carbon Dioxide Information Analysis Center. Retrieved May 2002. <http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm>

[25] Op. cit., Argentine Republic, 1997 Inventory.

[26] Op. cit., IEA (1997).

[27] Op. cit., IEA (1999).

[28] **National CO_2 Emissions from Fossil Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-1998.** 31 July 2002. Carbon Dioxide Information Analysis Center. Retrieved May 2002. <http://cdiac.esd.ornl.gov/ftp/trends/emissions/arg.dat>

[29] National Strategy Studies. **Study on Flexibility Mechanisms Within The Context of the United Nations Framework Convention on Climate Change and the Kyoto Protocol.** Buenos Aires: NSS Program, 1999.

Endnotes, *continued*

[30] Suárez, Carlos Enrique. *Argentina's Ongoing Efforts to Lower Greenhouse Gas Emissions.* **Promoting Development While Limiting Greenhouse Gas Emissions: Trends and Baselines.** Eds. José Goldemberg and Walter Reid. New York, NY: United Nations Publications, 1999. 15-23.

[31] Ibid., 15.

[32] Ibid., 18.

[33] Op. cit., Argentine Republic, 1997 Inventory.

[34] Op. cit., IEA (1997).

[35] Op. cit., IEA (1999).

[36] Op. cit., Argentine Republic, Introduction.

[37] Ibid.

[38] Ibid., Executive Summary.

[39] Ibid., Introduction.

[40] Ibid., Executive Summary.

[41] Ibid.

[42] Op. cit., Bouille, Girardin and Di Sbroiavacca, 237.

[43] Op. cit., National Strategy Studies, i.

[44] Ibid., 19.

[45] Ibid., ii.

[46] Instituto de Economía Energética (IDEE/FB). **Economics of Greenhouse Gas Limitations - Country Study Series: Argentina.** Denmark: UNEP Collaborating Centre on Energy and Environment, Risø National Laboratory, 1999.

[47] Op. cit., Bouille, Girardin and Di Sbroiavacca, 229.

[48] Ibid., 223-249.

[49] Lopez-Silva, Juan Andres (Team Leader). **Enabling Activities Leading to Second National Communication of the Argentine Government to the Conference of Parties to UNFCCC - Project Concept Document.** Argentina: Government of Argentina-Ministry of Foreign Affairs, 2001.

[50] Op. cit., Suárez, 19.

[51] Ibid.

[52] Ibid., 20.

[53] Op. cit., Argentine Republic.

[54] Op. cit., Suárez, 20.

[55] International Finance Corporation (IFC)/Global Environment Facility (GEF). **Concept Paper: GEF Medium-Sized Grant Proposal - IFC/GEF Argentina Efficient Street Lighting Program.** Argentina: IFC/GEF, 1998.

[56] Ibid., 4.

[57] Op. cit., National Strategy Studies, ii.

[58] Ibid., 23-24.

[59] Ibid., 25.

[60] Ibid., 24.

[61] Op. cit., IDEE/FB, 161-162.

[62] Ibid., 205.

[63] **National Communications From Parties Not Included in Annex I to the Convention: Third Compilation and Synthesis of Initial National Communications From Parties Not Included in Annex I to the Convention.** 5 October 2001. United Nations Framework Convention on Climate Change. FCCC/SBI/2001/14/Add.1. Retrieved May 2002. <http://unfccc.int/resource/docs/2001/sbi/14a01.pdf>

[64] Ibid., 87.

Endnotes, *continued*

[65] Ibid., 13.

[66] Ibid., 107.

[67] Op. cit., Lopez-Silva, 1.

[68] Ibid., 8-14.

[69] Ibid.

[70] Op. cit., Argentine Republic, Executive Summary.

[71] Op. cit., The Economist.

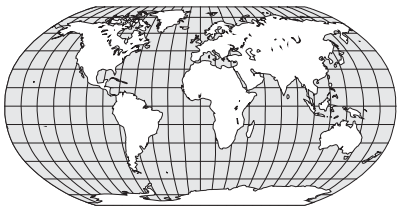
Country Case Study: Brazil

I. Introduction

The Federative Republic of Brazil is the largest country in South America, occupying almost 50% of the continent. Geographical zones vary greatly, from dense rainforests and semi-arid scrubland to rugged hills and mountains, rolling plains, and coastal zones. Brazilian territory is dominated by the great Amazon rain forest and the central highlands, and contains ten of the world's twenty largest rivers. Indeed, the Amazon River is the largest by volume and one of the longest in the world.[1]

Indicators of living standards are relatively sound when compared to those statistics of other developing countries, but Brazil still faces many of the difficulties associated with the developing world. The Brazilian population is quickly growing, and has become rapidly urbanized over time. In fact, the population today is over 80% urban as compared to 40% just forty years ago. Such fast rates of urbanization have stressed housing and sanitation conditions. Examining rates of education, literacy rates are substandard, and high dropout rates and grade repetition are widespread. Health care has improved over the last decade for some wealthier sections of the country, but many rural areas and poor urban

I. Introduction, *continued*



strata are still plagued by high infant mortality rates, malaria, leprosy, AIDS, and other infectious and parasitic diseases. And finally, despite a relatively low amount of open conflict on a national level, daily life in some parts of Brazil is frequently marked by thefts, break-ins, assaults, and kidnappings.[2]

The Brazilian economy experienced intermittent periods of rapid growth over the last century, and remains significantly diversified and strong today, despite arguable structural problems. The industrial sector has grown steadily, producing a wide range of goods both for domestic consumption and export. Since the 1970s, weapons, aircraft, computer manufacturing, and other technologically sophisticated industries have become well established. Agriculture remains an important part of the economy, and practices vary from primitive and intensive to modern and dynamic. Indeed, Brazil remains one of the leading agricultural exporters in the world—number one in coffee, orange juice concentrate and tobacco exports, and number two in sugar and soybean exports.[3] *However, agriculture contributes less than 10% of the annual GDP, while services contribute the largest share (64% in 2000).*[4]

In spite of the strength of the Brazilian economy, it cannot be considered developed. Capital investments in transportation, communications, and energy infrastructure have spiraled between periods of growth and decline throughout the years.[5] *While GDP growth is solid, GDP per capita remains nominal (U.S.$4,624 in 2000). Additionally, although economic growth and output has been considerable, wealth and opportunities continue to be inequitably distributed in drastic proportions.*[6]

The UNDP Human Development Index ranks Brazil at a level of medium human development, in the upper half of the 162 listed countries.[7] *While the economy and society flourishes and shows promising signs of progress and development, the standard of living remains low for much of the population. Table 1 on the following page illustrates the current state of development with some significant summary statistics.*

One of the twenty highest CO_2-emitting countries worldwide, Brazil does recognize its status both as a rapidly developing country with growing greenhouse gas contributions, as well as a country vulnerable to the ominous impacts of the changing climate.[10] *Deforestation*[11] *and intensification of energy use, both resulting from its development efforts, make the country one of the more prominent global actors in the issue of climate change. Additionally, particular sections of the country, such as the arid northeast and central areas, are highly affected by climatic variations. Thus, despite a legitimate preoccupation with such issues as poverty, economic development, political scandals, crime, air and water pollution, and climatic disruptions caused by El Niño and the Southern Oscillation, climate change continues to be addressed by a handful of academics, officials, research groups, and environmental organizations in Brazil.*[12] *Indeed, Brazil was the first country to sign the United Nations Framework Convention on Climate Change (UNFCCC) at the beginning of the Earth Summit in Rio de Janeiro on June 6, 1992. The agreement was ratified two years later on February 28, 1994.*[13] *Brazil also signed the Kyoto Protocol on April 29, 1998, and ratified the accord on August 23, 2002.*[14]

One of the most notable contributions Brazil made in the global effort to combat climate change came in the creation of what is presently known as the Clean

I. Introduction, *continued*

Table 1. Brazil Summary Statistics*

Sources: World Bank, 2000[8] and International Energy Agency, 2001.[9]

External Debt, Total (DOD, current USD)	237,952,900,000
IBRD Loans and IDA Credits (PPG DOD, current USD)	7,376,600,000
Commercial Energy Use (kg oil equivalent per capita)	1,068 (1999 value)
GDP (billion 95 USD)	752.27
GDP-PPP (billion 95 USD)	1127.55
GDP Per Capita (95 USD)	4,624
GDP Growth (annual %)	5
GDP Per Capita Growth (annual %)	3
Agriculture (% of GDP)	7
Industry (% of GDP)	29
Services, etc. (% of GDP)	64
Population (millions)	167.97
Population Growth (annual %)	1
Urban Population (% of total)	81
Fertility Rate, Total (births per woman)	2
Life Expectancy at Birth (years)	68
Adult Illiteracy Rate	15
Sanitation (% of population with access)	77
Improved Water Source (% of population with access)	87
Internet Users	5,000,000
Surface Area (km^2)	8,547,400
Land Use - Permanent Cropland (% of land area)	1 (1999 value)
Forest Area (% of land area)	63
CO_2 Emissions (Mt of CO_2)	305.55
CO_2 Emissions Per Capita (t CO_2/population)	1.82
CO_2 Emissions Per GDP (kg CO_2/95 USD)	0.41
CO_2 Emissions Per GDP (kg CO_2/95 USD PPP)	0.27

** All figures are from the year 2000, unless otherwise indicated.*

Development Mechanism (CDM) in the Kyoto Protocol. Under this innovative policy option, Annex I Parties to the Protocol may earn credit for lowering emissions in non-Annex I countries.[15] The CDM was first proposed at the seventh meeting of the Ad Hoc Group on the Berlin Mandate by the Brazilian delegation in July 1997. This plan, outlined among other ideas in a document known as the ***Proposed Elements of a Protocol to the UNFCCC****, suggested the creation of a "clean development fund" with revenue from a per-metric-ton charge on greenhouse gas emissions from Annex I countries in excess of their emissions targets.[16] And so, in an attempt to produce a quantitative method for allocating responsibility and emissions limits among parties to the Protocol, Brazilians created a sophisticated and objective policy mechanism that has been lauded by even the most vocal Kyoto critics.*

II. Brazil's Participation in the UNFCCC

Brazil has made notable efforts to comply with UNFCCC requirements. Under the accord, Brazil is classified as a non-Annex I country, meaning that it is not obliged to make greenhouse gas emissions reductions in light of its more pressing need for development. However, one of its major responsibilities, outlined in Article 12 of the agreement, is the submission of a national communication, a report which accounts a national greenhouse gas emissions inventory and a catalog of steps the country is taking toward reducing emissions.[17]

Preparing a National Communication Report

As a non-Annex I country, Brazil is eligible for funding from the Global Environment Facility (GEF) to support the completion of its national communication. Indeed, the *Climate Change Enabling Activity* was approved in 1995, and U.S.$1.5 million was allocated for the specific purpose of enabling Brazil to meet its reporting requirements under the UNFCCC, as written in Article 12.[18]

Difficulties arising during the construction of a national communication have been prevalent. Primarily, the issue of climate change has never been a top priority for the country of Brazil. Attention has been devoted to other political, economic, and environmental issues, with climate change receiving focus usually in response to external pressures and by a small number of government officials representing the country in international negotiations.[19]

Within the government, the Ministry of Science and Technology (MCT) handles climate change related affairs, including execution of the *Climate Change Enabling Activity* mentioned above.[20] Additionally, in July of 1999 the Interministerial Commission on Global Climate Change (ICGCC) was created under the MCT in order to aid in the implementation of the Convention.[21] However, there exists no governmental research group devoted exclusively to climate change impacts or mitigation possibilities. Research projects that do concern climate change exist because of the interests of individual scientists and researchers, or because of other priorities such as weather prediction, biodiversity protection, and resource management in the Amazon. For example, massive sugar cane and hydroelectric development projects were not linked to climate change during their inception, despite the decrease in carbon dioxide emissions they would bring, simply because either the proponents were not aware of the Convention or climate change was not considered a worthy mention. Leaders did become anxious to spotlight the issue preceding and during the Earth Summit in 1992, but interest dropped after the conference when other political issues earned more attention. Since the mid-1990s, most climate change efforts, such as the creation of the ICGCC in 1999, have been focused on completing a national communication report according to UNFCCC requirements, but no more than that.[22]

Most climate change related research that has been conducted has been made possible through joint efforts with foreign governments, NGOs, and research groups. Furthermore, the environmental, natural resource, and economic departments of the Brazilian government are short of staff committed exclusively to the issue of climate change. For these reasons, the technology and training necessary to model the carbon cycle or construct a national greenhouse gas inventory may be lacking, public awareness is low, and continuous attention to the issue of climate change has

II. Brazil's Participation in the UNFCCC, *continued*

been deficient. Other difficulties in constructing a greenhouse gas inventory arise from an inability to coordinate government ministries, agencies and sectors and from uncertainty in the measurement of emissions, particularly with respect to biomass density, rates of deforestation, and land use of cleared forest areas.[23]

In an effort to raise awareness of the climate issue in all sectors of government and civil society, the Brazilian government, by presidential decree, established the Brazilian Forum on Climate Change on August 28, 2000.[24] The Brazilian Climate Change Forum, as it is now called, includes all ministers of state, representatives of civil society knowledgeable in the issue, and other invited participants such as mayors of state capitals and governors. According to the decree, it is also to be integrated with the ICGCC.[25] The Forum states the following objectives:

- To promote a broad dissemination of the climate change issue
- To identify the key social players, in the private and public sectors, to implement the Convention and the Protocol
- To make the key social actors aware of the problem of global warming and to alert them as to the role of citizens and each sector in the implementation of the Convention and the Protocol
- To coordinate the key social actors, of both private and public sectors, to implement the Brazilian Climate Change Forum
- To make public opinion makers aware of the issues, targeting research centers, universities scientific institutes and associations
- To promote in the press and mass media in general circulation of issues related to climate change
- To promote the relationship among the sectors with the most potential for developing projects that qualify for the CDM (Clean Development Mechanism)[26]

Also, the Center for Integrated Studies on Climate Change and the Environment was created that same year by the Ministry of the Environment and the Institute for Research and Graduate Studies in Engineering of the Federal University of Rio de Janeiro. In addition to providing support for the Brazilian Climate Change Forum through the dissemination and generation of knowledge, the Center will also provide technical support with regard to Brazilian activities under the CDM.[27]

Originally scheduled for submission in 2000, Brazil's national communication has not yet been released (although draft elements are available[28]), most likely due to the circumstances outlined above.[29] However, the report is currently in the final stages of review and preparation by government authorities, and its release is expected shortly.[30]

III. Emissions Estimates for Brazil

III. Emissions Estimates for Brazil

Current Greenhouse Gas Inventory

The Ministry of Science and Technology has already released several comprehensive estimates of greenhouse gas emissions, calculated during the compilation of its national communication. The table below lists some of these emissions estimates by sector for the base year 1990. Note that some values are not yet available for particular sectors, preventing an accurate figure of total emissions to be estimated for each gas.

Table 2. Greenhouse Gas Emissions and Removals, 1990 (Unit: Gg)

Source: Ministry of Science and Technology, 2002.[31]

Sector	CO_2	CF_4	CH_3F	CH_4	CO	NMVOC	NO_X	N_2O	SF_6	SO_2
1. Energy	**75,867**									
Fossil Fuel Use	55,167									
Liquid FF	42,872									
Solid FF	10,232									
Gaseous FF	1,889									
Other Primary Sources	174									
Nonrenewable Biomass	20,700									
2. Industry	**14,581.84**	**0.308***	**1.243**	**5.024**	**32.108**	**48.330**	**10.363**	**11.91**	**0.0162****	**87.479**
Cement	12,853									
Aluminum		0.308*								
Chemical										
Petrochemical				5.024	1.784	33.65	0.0713			0.553
Chemical	1,728.84				10.20	1.384	4.9014	11.91		61.10
Electricity									0.0162**	
Production & Imports of HFCs			1.243							
Pulp & Paper					20.1239	13.2961	5.3903			25.8264
3. Solvents						**1229.95**				
4. Waste				**657.29**						
Solid				617.95						
Liquid				39.34						
5. Land-Use Change & For.	**-127,340**									
Forest & Grassland Coversion										
Planted Forests	-127,340									
Abandoning of Managed Lands										
Hydroelectric Resevoirs										
6. Agriculture & Livestock		**8855.6**			**2542.1**		**218.9**	**6.06**		
Livestock										
Enteric Fermentation		7940.99								
Animal Wastes		306.02								
Rice Production		487.56								
Burning Agriculture Residues										
Sugar Cane		116.89			2454.74		208.43	5.77		
Cotton		4.16			87.39		10.47	.29		
Fertilizer Use										
Prescribed Savanna Burning										

** 1994 value (1990 value not available)*

*** 1996 value (1990 value not available)*

III. Emissions Estimates for Brazil, *continued*

Commonly known greenhouse gases, such as carbon dioxide (CO_2), non-methane volatile organic compounds (NMVOCs), carbon monoxide (CO), methane (CH_4), nitrous oxide (N_2O) and other nitrogen compounds (NO_X) have been included for various sectors. The greatest emissions by weight reported here are carbon emissions from fossil fuel combustion and biomass burning, followed by carbon emissions from cement production.[32]

Total fossil fuel-derived CO_2 emissions from Brazil have grown rapidly during the last century. Liquid fossil fuel use comprises the bulk of those emissions at approximately 70%, while coal burning accounts for about 15%. Natural gas consumption has steadily increased, now composing approximately 4% of fossil fuel-derived CO_2 emissions.[33] However, at about 1.82 kg CO_2 per capita, Brazil's carbon dioxide emissions per capita is less than half of the global average, and only about 16% that of OECD countries, on average. Similarly, with 0.27 kg CO_2 per GDP-PPP, Brazil's carbon intensity is less than half of both the world average and the OECD average.[34]

In fact, Brazilian energy use is configured ideally for climate change mitigation strategies, albeit not consciously set up with climate change in mind. Over 95% of Brazil's electricity is produced from hydroelectric power. Incredibly, much of the country's hydroelectric potential remains unexploited. Furthermore, Brazil's access to domestic fossil fuel resources is limited, comprised only of some deposits of oil located offshore and low-quality, high-sulfur coal beds concentrated in the South. Industries such as mining and smelting have been fueled by charcoal from forests, a renewable resource if managed sustainably. Finally, well-developed sugar cane-based alcohol programs also supply a renewable energy source.

Some figures for infrequently named greenhouse gases have also been included in Table 2. Carbon tetrafluoride (CF_4), a perfluorocarbon emitted during aluminum production, has a global warming potential about 6,500 times that of carbon dioxide, and an extremely long atmospheric lifetime.[35] Sulfur hexafluoride (SF_6) is currently the most potent greenhouse gas yet discovered by the Intergovernmental Panel on Climate Change (IPCC). Like carbon tetrafluoride, SF_6 has an extremely long lifetime, making its accumulation in the atmosphere virtually irreversible once emitted. The SF_6 figure included in Table 2 was calculated for the electricity sector, where the chemical has been developed for use in advanced electrical equipment. Increased SF_6 consumption is expected in Brazil as such projects and installations become more frequent.[36]

Methodologies used to compile the figures listed in Table 2 follow those recommended by the IPCC in 1996, except in some specific areas that are inapplicable or unique to Brazil.[37] Sources of data used to calculate the national greenhouse gas inventory differed for each sector, and are listed in Table 3.

Table 3. Sources of Data for National Communication Greenhouse Gas Inventory

Source: Ministry of Science and Technology, 2002.[38]

Sector of Inventory	Source
Energy	Brazilian Energy Balance
	Information System for the Energy Balance
	National Petroleum Agency
	Ministério da Aeronáutica
	Copersucar Technological Center
	Ministry of Science and Technology
	United Nations Development Programme
	Sindicato Nacional da Indústria da Extração do Carvão
Industry	
Cement	National Association of Cement Producers
Aluminum	Association of Brazilian Aluminum Industry
Chemical	United Nations Development Programme
Pulp and Paper	Brazilian Pulp and Paper Association
	Successor of National Association of Pulp and Paper Producers
	Brazilian Pulp Exporters Association
Electricity (SF_6)	Department of Technological and Industrial Development
	Department of High Tension - Electric Central Furnace
Hydrofluorocarbons	United Nations Development Programme
Solvents	United Nations Development Programme
	EMEP/CORINAIR
Agriculture and Livestock	Ministry of Agriculture and Food Supply
	Brazilian Agricultural Research Corporation
	National Research Center for Environmental Monitoring and Impact Assessment
Land-Use Change and Forestry	National Institution for Space Research
	Brazilian Institute for Sustainable Development
Waste Treatment	Environmental Sanitation Technology Company
	Development and Transfer of Technology Management
	Global Climate Changes State Program
	Environment Secretariat of the State of São Paulo
	Development and Capacity-Building Department
	Global Issues Division

III. Emissions Estimates for Brazil, *continued*

Projected Greenhouse Gas Emissions

Composing the bulk of Brazilian greenhouse gas emissions, carbon dioxide projections provide a reasonable proxy for future emissions estimates. Table 4 on the following page shows CO_2 projections for Brazil, as compared to other developing countries and industrialized countries.

Table 4. Carbon Dioxide Projections for Brazil and Others
(Unit: million metric tons carbon equivalent)

Source: Energy Information Administration/U.S. DOE, 2002.[39]

Region/Country	History			Projections				Ave Annual % Change
	1990	1998	1999	2005	2010	2015	2020	(1999-2020)
Brazil	62	87	88	100	130	169	213	4.3
China	617	765	669	881	1,127	1,393	1,692	4.5
India	153	231	242	298	349	410	475	3.3
South Korea	61	101	107	136	152	164	175	2.3
Africa	179	216	218	256	287	327	365	2.5
Central/South America	178	246	249	290	377	484	595	4.2
Total Developing	1,641	2,222	2,158	2,667	3,241	3,870	4,542	3.6
Total Industrialized	2,849	3,101	3,129	3,445	3,692	3,928	4,169	1.4
Total World	5,827	6,139	6,097	7,018	7,910	8,866	9,850	2.3

III. Emissions Estimates for Brazil, *continued*

According to these projections provided by the Energy Information Administration (EIA) of the U.S. Department of Energy (U.S. DOE), Brazil's greenhouse gas emissions are expected to grow faster than any one region of the world at an average of 4.3% per year. Indeed, the only listed individual country that is projected to emit at a faster rate is China, at 4.5% average annual growth rate from the years 1999 to 2020.[40] Of course, such estimates can not be determined with absolute confidence due to the large amount of uncertainty concerning land-use changes in Brazil or the amount of CO_2 emitted during such activities both at present and in the future. Ultimately, other key variables such as population and economic growth, energy intensity, and carbon intensity will determine future emissions trends.[41]

IV. Emissions Reduction Initiatives

IV. Emissions Reduction Initiatives

Brazil has undertaken numerous projects and programs under the Convention. With over 60% of its area covered in forest, carbon sequestration projects have been of particular interest.[42] The groundbreaking *Floram Project* remains one of the most carefully thought out restoration projects in Brazil today. Initiated by a group of professors at the University of São Paulo and refined by members of the business sector, the *Floram Project* was designed primarily for the purpose of carbon sequestration. However, rehabilitation of degraded areas and multiple use forests have also been part of the project's focus. Inspired by this revolutionary venture, other countries with substantial forest area, including Thailand, Mexico, Panama, Nepal, and Peru, have initiated similar projects. With such a large scope, the *Floram Project* has been somewhat unwieldy, and has been difficult to put into operation with limited capacity. Lack of funding has also forced the project to remain below its perceived potential. If ever implemented to the full extent, carbon sequestration of 154 million tons of carbon per year and the rehabilitation of many degraded forest ecosystems could be among the fortunate results.[43]

Table 5 lists other research and policy initiatives taken by the government toward building a national greenhouse gas inventory according to UNFCCC requirements, monitoring and reducing greenhouse gas emissions, and understanding the impacts and causes of climate change.

Table 5. Brazilian Climate Change Initiatives

Source: Ministry of Science and Technology, 2002.[44]

Category	Program Name
Programs Related to Sustainable Development	The Alcohol Program
	National Strategy
	National Program for Electricity Conservation - PROCEL
	National Program for the Rational Use of Oil and Natural Gas Derivatives
	Wood Gasification System for the Generation of Electricity
	Biomass Energy Generation: Sugar Cane Bagasse and Residues
	Contribution of Hydroelectric Generation to the Reduction of Atmospheric Emissions
	Situation and Perspectives of New Renewable Energy Sources in Brazil
	Program of Hydrogen Fuel for Collective Transport
	Recycling Program
	States and Municipalities Energy Development Program - PRODEEM
	Charcoal-Based Steel and Iron Industry
Programs Containing Measures that Contribute to Addressing Climate Change and Its Adverse Impacts	Electric Power System
	The Past and Future Role of Nuclear Power in Reducing Greenhouse Gas Emissions in Brazil
	Natural Gas Domestic Production
	Importation of Natural Gas from Bolivia and Argentina
	Program of Natural Gas Fueled Buses in the City of São Paulo
	Methane Recovery from Landfills in São Paulo
	São Paulo State Program for the Reduction of Fugitive Methane Emissions in the Natural Gas Distribution Network
	Program Breathe São Paulo (Reduction of Road Transport Urban Emissions in São Paulo)
Research and Systematic Observation	Large Scale Biosphere-Atmosphere Experiment in Amazonia
	Climate Change Related Research Under the Pilot Program for the Protection of Tropical Rainforests in Brazil
	Stratospheric Ozone Research
	INPE Network of Monitoring Stations for UV-B Radiation
	Extended Range Forecasts Over South America Using the Regional ETA Model
Education, Public Awareness and Training	Environmental Education Program in Brazil - PRONEA
	Energy Conservation Education Program (PROCEL and CONPET in Schools)
	Brazilian Climate Change Home Page on the Internet
	Portuguese Version of the Official Text of the UNFCCC
	Climate Change Awareness Program
Monitoring Systems and Climate Change Impacts on Terrestrial and Marine Ecosystems	Monitoring Systems and Climate Change Impacts in Semi-Arid Regions
	Monitoring Systems and Climate Change Impacts Coastal Zone Management
	Monitoring Systems and Climate Change Impacts on Agriculture
	Monitoring Systems and Climate Change Impacts on Health
	Impacts of Sea Level Rise in Brazil
	Case Study for the City of Recife in the Northeast Region
National and Regional Capacity Building	Sustainable Development and National Agenda XXI Policies Commission
	Center for Weather Forecast and Climate Studies
	Inter-American Institute for Global Change Research
	Glaciology Research Under the Antarctic Program
Integration of Climate Change Concerns in Medium- and Long-Term Planning	Program for Vehicular Emission Reduction
	National Air Quality Control Program
	Prohibition of Burning for Sugar Cane Harvesting in the State of São Paulo
	National System for Forest Fires Prevention and Suppression
	National Parks in Brazil (Conservation Units)
	Program for Deforestation Assessment in the Brazilian Legal Amazonia
	Measures to Combat Deforestation in Amazonia
	São Paulo State Program on Global Climate Change
	São Paulo State Pollution Control Program

IV. Emissions Reduction Initiatives, *continued*

As one can see, the government has initiated several climate change related activities. Programs on renewable energy are common, and research and publicity initiatives are growing. Recognizing that a true commitment to the problem of climate change will involve a greater government capacity, training, education, and planning are prominent among the programs as well.

Brazil has also played a leading role in global efforts. For example, in May of 2002, prior to PrepCom IV of the World Summit on Sustainable Development (WSSD), the Ministers of Environment from Latin American and Caribbean countries met to discuss world energy targets, among other topics. A Brazilian proposal for renewable energy targets was adopted as a resolution. The plan puts forward a target of 10% renewable energy use by the year 2010, and proposes the trading of "new renewable energy certificates" among countries.[45] This idea has the potential to follow the route of other innovative Brazilian proposals, most notably the Clean Development Mechanism, to become a groundbreaking climate change policy. While this proposal was intensely debated during the WSSD in Johannesburg, the ultimate agreement did not endorse the key elements of the Brazil plan. All the same, the proposal is very much alive and is gaining European support.

Many climate change related initiatives taken in Brazil are possible only through external assistance from nongovernmental organizations, intergovernmental organizations, foreign governments, or private corporations. For example, a project entitled *Reducing the Long-term Costs of Solar Thermal Power Generation* is being funded and implemented by the Global Environment Facility and the United Nations Development Programme. The project, which began implementation in July 2001, seeks to reduce the long-term costs of solar thermal power generation by promoting investments in solar thermal power production. Steps toward these goals included assessing local capacities to operate, maintain and manufacture different concentrating solar power technologies, as well as Brazilian economic aptitude for such technologies. The submission of a complete report of findings is expected in 2003.[46] Additional projects on capacity building, energy, impacts and adaptation, policy analysis, and other climate change related topics are among the many externally funded projects being conducted in Brazil.

It is clear that Brazil has been active in seeking to understand the mechanisms and impacts of climate change, as well as taking action toward mitigation and adaptation strategies. The activities listed above include research projects and policy plans designed to explore renewable energy, energy efficiency and conservation, air quality, climate change modeling, forest fire prevention, and forest conservation as options for climate change mitigation strategies. Many of the research initiatives have been carried out with external assistance from foreign governments, research groups, NGOs or intergovernmental organizations. Although difficulties arise, as they do for many developing countries, in areas of capacity, training and expertise, coordination and communication, and funding, Brazil has made impressive progress in climate change work, both internationally and within its own borders.

V. Future Directions

V. Future Directions

A country with a scattered environmental agenda, Brazil has demonstrated a varied commitment to global climate change efforts. With pressing concerns for development of the economy and way of life, the country continues to balance its commitments to the UN global climate change agreements with its own needs for development. Most efforts in research and policy have been motivated by events outside the country. Indeed, the compilation of a national communication in accordance with UNFCCC requirements remains the biggest motivator behind climate change work in Brazil today. Moreover, the efforts that have been conducted by domestic groups have been marked by a lack of coordination and communication between the groups involved.

Recently, however, Brazilian NGOs have come together in a renewed attempt to make their concerns heard by the government. In March of 2002, 26 organizations established a network called the Climate Observatory (Observatorio do Clima). Their focus will be on helping NGOs build capacity on climate issues, increasing participation in the debate, and contributing to scientific discussions and research, particularly with respect to criteria and indicators for CDM projects in Brazil.[47] Other major groups working on climate issues include the Brazilian Forum of NGOs and Social Movements for the Environment and Development and the Indigenous Forum on Climate Change.

As a major player in the issue of climate change, Brazilian efforts are prominent and have contributed substantially both domestically and abroad. Progress has been notable, despite the difficulties the country faces. For example, as of 1998, one third of all vehicles ran on ethanol. Energy efficiency and conservation programs are well established, and include standards for products and buildings, labels for consumer appliances, promotion of fuel switching, and financing and regulatory frameworks for grid-based renewable-energy producers. Indeed, Brazil is one of the few countries to have engaged in market transformation in order to reduce the demand for energy.[48] Such initiatives are not likely to diminish as the issue of climate change continues to press the global community.

While government initiatives are notable, joint projects, technology exchange, and support from external organizations and governments have proved successful in Brazil and in many other countries. Indeed, developing countries such as Brazil can benefit from the acquisition of "leapfrog" technology and expertise, once it has been adapted to local circumstances.[49] Continuing such efforts will facilitate further improvement in performance with respect to the UNFCCC and global climate change efforts as a whole.

Endnotes

[1] **Brazil - A Country Study.** April 1997. Library of Congress. Retrieved 3 July 2002. <http://lcweb2.loc.gov/frd/cs/brtoc.html#br0007>

[2] Ibid.

[3] Ibid.

[4] **SIMA Quick Query Database.** 2001. World Bank. Retrieved 2 July 2002. <http://sima-ext.worldbank.org/query/>

[5] Op. cit., Library of Congress.

[6] Op. cit., World Bank.

[7] **Human Development Indicators.** 2001. United Nations Development Program (UNDP). Retrieved 23 May 2002. <http://www.undp.org/hdr2001/back.pdf>

[8] Op. cit., World Bank.

[9] International Energy Agency (IEA). **Key World Energy Statistics from the IEA: 2001 Edition.** Paris: International Energy Agency (IEA), 2001, pp. 48-57.

[10] **National Fossil Fuel CO_2 Emissions.** 1998. Carbon Dioxide Information Analysis Center (CDIAC). Retrieved 3 July 2002. <http://cdiac.esd.ornl.gov/trends/emis/graphics/top20_1998.gif>

[11] According to estimates from IPAM, a research institute based in Belém, Brazil, deforestation is responsible for an estimated 200 million tons of carbon emissions annually. This represents two-thirds of Brazil's emissions of GHGs and about 2.5% of global carbon emissions. See: Naess, Lars Otto and Ane Schjolden. *Brazilian NGOs establish network to influence climate change policies.* **Cicerone,** Vol. 4, 2002; also Nepstad, D., D. McGrath, A. Alencar, A.C. Barros, G. Carvalho, M. Santilli, and M. del C. Vera Diaz. 2002. *Frontier governance in Amazonia.* **Science** 295:629-631.

[12] Lutes, Mark and José Goldemburg. **Chapter 11: Climate Change Science and Politics in Brazil.** York University/University of São Paulo. Retrieved 10 July 2002. <http://www.si.umich.edu/~pne/PDF/PMNPC/brazil.pdf>

[13] **United Nations Framework Convention on Climate Change: Status of Ratification.** 11 December 2001. United Nations Framework Convention on Climate Change. Retrieved 20 June 2002. <http://unfccc.int/resource/conv/ratlist.pdf>

[14] **Kyoto Protocol: Status of Ratification.** 20 December 2002. United Nations Framework Convention on Climate Change. Retrieved 30 December 2002. <http://unfccc.int/resource/kpstats.pdf>

[15] Molitar, Michael R. *The United Nations Climate Change Agreements.* **The Global Environment: Institutions, Law, and Policy.** Eds. Norman J. Vig and Regina S. Axelrod. Washington, DC: Congressional Quarterly Inc., 1999, pp. 210-235.

[16] Op. cit., Lutes and Goldemburg, 19-20.

[17] **National Communications from Parties Not Included in Annex I to the Convention: Third Compilation and Synthesis of Initial National Communications from Parties Not Included in Annex I to the Convention.** 5 October 2001. United Nations Framework Convention on Climate Change. FCCC/SBI/2001/14/Add.1. Retrieved 10 July 2001. <http://unfccc.int/resource/docs/2001/sbi/14a01.pdf>

[18] **GEF Project Tracking System**. Global Environment Facility (GEF). Retrieved 26 June 2002. <http://www.gefonline.org/projectList.cfm>

[19] Op. cit., Lutes and Goldemburg, 1.

[20] Op. cit., GEF.

[21] **National Communication- National Coordination.** 2002. Ministry of Science and Technology. Retrieved 27 June 2002. <http://www.mct.gov.br/clima/ingles/comunic/coorden.htm>

[22] Op. cit., Lutes and Goldemburg, 2-6.

[23] Ibid.

[24] **Decree of August 28, 2000.** (Originally published in the Federal Official Gazette of August 29, 2000, Section I, page 53.) Ministry of Science and Technology. <http://www.mct.gov.br/clima/ingles/brasil/d280800.htm>

Endnotes, *continued*

[25] Ibid.

[26] **Brazilian Climate Change Forum.** Retrieved 12 January 2003. <http://www.forumclimabr.org.br/ingles/index.asp>

[27] **Centro Clima: Center for Integrated Studies on Climate Change and the Environment.** Retrieved 12 January 2003. <http://www.centroclima.org.br/ingles/objetivos.htm>

[28] **National Communication.** 2002. Ministry of Science and Technology. <http://mct.gov.br/clima/ingles/comunic/Default.htm>

[29] La Rovere, Emilio Lèbre. *Brazil.* **Confronting Climate Change: Economic Priorities and Climate Protection in Developing Nations.** Ed. B. Biagini. Washington, DC: National Environmental Trust, 2000, pp. 210-222.

[30] Op. cit., GEF.

[31] **Greenhouse Gas Emissions Inventory.** 2002. Ministry of Science and Technology. Retrieved 27 June 2002. <http://www.mct.gov.br/clima/ingles/comunic_old/invent1.htm>.

[32] **Brazil: Trends.** 2001. Carbon Dioxide Information Analysis Center (CDIAC). Retrieved 1 July 2002. <http://cdiac.esd.ornl.gov/trends/emis/tre_bra.htm>

[33] Ibid.

[34] Op. cit., IEA, 49.

[35] **Climate Change: Greenhouse Gases.** Ministry for the Environment. Retrieved 1 July 2002. <http://www.environment.govt.nz/climate/gases.html>

[36] **SF_6 Emissions in the Electricity Sector.** 2002. Ministry of Science and Technology. Retrieved 1 July 2002. <http://www.mct.gov.br/clima/ingles/comunic_old/industr3.htm>

[37] **What Does "National Communication" Mean?** 2002. Ministry of Science and Technology. Retrieved 27 June 2002. <http://www.mct.gov.br/clima/comunic.cnacion.htm>

[38] Op. cit., Ministry of Science and Technology. Greenhouse Gas Emissions Inventory.

[39] Energy Information Administration - Office of Integrated Analysis and Forecasting. **International Energy Outlook 2002.** Washington, DC: U.S. Department of Energy, 2002.

[40] Ibid.

[41] Op. cit., La Rovere, 215.

[42] Op. cit., World Bank.

[43] Salati, Eneas, Weber Amaral, and Angelo Augusto dos Santos. *Investing in Carbon Storage: A Review of Brazilian Forest Projects.* **Promoting Development While Limiting Greenhouse Gas Emissions: Trends and Baselines.** Eds. José Goldemberg and Walter Reid. New York, NY: United Nations Publications, 1999, pp. 101-114.

[44] **The National Communication: General Description of Steps Taken or Envisaged to Implement the Convention.** 2002. Ministry of Science and Technology. Retrieved 2 July 2002. <http://www.mct.gov.br/clima/ingles/comunic_old/pem.htm>

[45] Goldemberg, José. **The Brazilian Energy Initiative.** São Paulo: Secretary of Environment of the State of São Paulo, Brazil, 2002.

[46] **Brazil - Reducing the Long Term Costs of Solar Thermal Power Generation.** Global Environment Facility (GEF). Retrieved 2 July 2002. <http://www.gefonline.org/projectDetails.cfm?projID=1121>

[47] Naess, Lars Otto and Ane Schjolden. *Brazilian NGOs establish network to influence climate change policies.* **Cicerone,** Vol. 4, 2002. Retrieved 12 January 2003. <http://www.cicero.uio.no/cicerone/02/4/brazilian.asp>

[48] Goldemberg, J., E. Martinot and A. Miller. **Energy Since Rio: Achievements and Promising Strategies.** Washington, DC: Global Environment Facility, 2002.

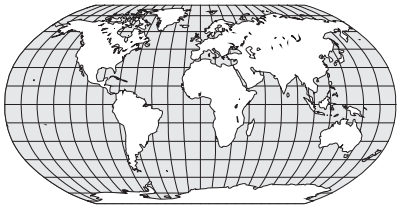
[49] Goldemberg, José. *What is the Role of Science in Developing Countries?* **Science.** 20 February 1998, pp. 1140-1141.

Country Case Study: China

I. Introduction

The People's Republic of China is the world's most populous nation with over 1.27 billion people.[1] Due to concerted policies, its population growth rate was brought down to 0.88% from 1.6% a decade ago.[2] The population forecast for 2025 made by the Population Reference Bureau is 1.43 billion.[3] China's rural poverty decreased from 250 million people in 1978 (30% of the rural population) to 42 million in 1998 (4.6% of the rural population), a point well noted in World Bank studies.[4] The World Bank also noted that China made an enormous effort in decreasing the adult illiteracy rate by more than half, from 37% in 1978 to less than 17% in 1999.[5] China has also achieved incredible economic growth over the past decade. From 1993 to 1997, the annual economic growth rate in China averaged 11%, exceeding the world average and the average of developed countries by 7.3 and 8.8 percentage points, respectively, for the same period.[6] China's real GDP grew by 7.3% in 2001, and the forecast

I. Introduction, *continued*



of GDP growth for 2002 is 7.0%. The two most important sectors of the economy are agriculture and industry, which together employ 80% of the labor force. Table 1 presents some of the development statistics of China.

Table 1. China Summary Statistics*

Sources: World Bank, 2000[8], International Energy Agency, 2001[9] and United Nations Statistic Division, 2000[10].

External Debt, Total (DOD, current USD)	149,799,700,000	
IBRD Loans and IDA Credits (PPG DOD, current USD)	19,889,300,000	
Total Primary Energy Supply (million tons of oil equivalent)	1088.35 (1999 value)	
GDP (billion constant 1995 USD)	1,040	
GDP, PPP (billion current international $)	5,019	
GDP Per Capita (constant 1995 USD)	824	
GDP Growth (annual %)	8	
GDP Per Capita Growth (annual %)	7	
Agriculture (% of GDP)	16	
Industry (% of GDP)	51	
Manufacturing (% of GDP)	35	
Services, etc. (% of GDP)	33	
Population (millions)	1,273 (2001 value)	
Population Growth (annual %)	0.88	
Urban Population (% of total)	32	
Fertility Rate, Total (births per woman)	2	
Life Expectancy at Birth, Total (years)	70	
Adult Illiteracy Rate	17 (1999 value)	
Sanitation (% of population with access)	38	
Improved Water Source (% of population with access)	75	
Internet Users	22,500,000	
Surface Area (km^2)	9,598,050	
Land Use, Permanent Cropland (% of land area)	1 (1999 value)	
Forest Area (% of land area)	18	
CO_2 Emissions (Mt)	3108.05 (1998 value),	3051.11 (1999 value)
CO_2 Emissions (metric tons per capita)	3 (1998 value),	2.40 (1999 value)
CO_2 Emissions (kg per 1995 USD of GDP)	3 (1998 value),	3.12 (1999 value)
CO_2 Emissions (kg per PPP $ of GDP)	1 (1998 value),	0.69 (1999 value)

** All figures are from the year 2000, unless otherwise indicated.*

II. China's Participation in the UNFCCC

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China signed the United Nations Framework Convention on Climate Change (UNFCCC) on June 11, 1992, and became one of the first countries to ratify it on January 5, 1993.[11] China was one of the most active countries during the negotiation of the text of UNFCCC and played a very prominent role in all of the negotiating sessions. The government is a strong believer in the principle of "common but differentiated responsibilities," and as a non-Annex I Party China is fully aware of what its rights and obligations are under the Convention. China continued to be active in negotiating the Kyoto Protocol, which it signed on May 29, 1998 and ratified on August 30, 2002.[12]

Soon after ratifying the Convention, China established a fourteen-member group called the National Coordinating Committee on Climate Change Policy. Its purpose is to address policy issues related to climate change. Its members include ministerial officials from the following organizations: the State Development and Planning Commission (SDPC), the State Economic and Trade Commission (SETC), the Ministry of Science and Technology (MOST), the China Meteorological Administration (CMA), the State Environment Protection Administration (SEPA), the Ministry of Foreign Affairs, the Ministry of Finance, the Ministry of Construction, the Ministry of Transportation, the Ministry of Water Resources, the Ministry of Agriculture, the State Forestry Administration, the Chinese Academy of Sciences (CAS), and the State Oceanic Administration. The Committee is chaired by the SDPC, which is responsible for coordinating the Committee's activities. In order to facilitate these activities, the SDPC has established an Office, which serves as secretariat to the Committee.[13] The Committee is responsible for submitting the national communication to the State Council for approval.[14]

In order to implement its commitments under the UNFCCC and to decrease impact of the longer term trends of climate change, China has carried out such national measures as population control, energy conservation, and large-scale afforestation.[15] Additionally, China participated in projects supported by various international institutions that studied China's greenhouse gas emissions, their trends, causes and consequences. These projects include:

- *Response Strategy on Global Climate Change in China,* supported by the Asian Development Bank (ADB), completed in 1993
- *China: Issues and Options in GHG Emissions Control,* supported by the Global Environment Facility (GEF) and United Nations Development Programme (UNDP) (executed by the World Bank), completed in 1994
- *China Climate Change Country Study,* supported by the U.S. Department of Energy under its *Country Studies Program,* completed in 1998
- *Asia Least-cost GHG Abatement Strategy (ALGAS),* funded by GEF/UNDP, executed by ADB, completed in 1998[16]

Summary results of these projects are presented in Table 2.

Table 2. Summary Information on Previous Inventory Work

Source: UNDP Project Proposal "Enabling China to Prepare Initial National Communication to the UNFCCC." [17]

Title of the general project or the name of report or publication	Response Strategy on Global Climate Change in China	China: Issues and Options in Greenhouse Gas Control	China Climate Change Country Study	Asia Least-cost GHG Abatement Strategy
Title of the inventory	Current Emissions of GHGs	Estimation of GHGs Emissions and Sinks in China, 1990	Preliminary Compilation of GHG Emission Inventories	GHG Inventory by Sectors
Sponsor	ADB	GEF	U.S. DOE	ADB
Performer	Energy Research Institute	Design and Research Institute of Environmental Engineering, Tsinghua University	Energy Research Institute	Energy Research Institute
Year of inventory	1990	1985-1990	1990	1990
GHGs	CO_2, CH_4, N_2O	CO_2, CH_4, N_2O	CO_2, CH_4	CO_2, CH_4, N_2O
Year of completion	1993	1994	1998	1998
Emission estimates:				
All energy				
Fuel combustion	609.2 MtC	667.64 MtC, 1.8-2.6 Mt CH_4	559.56 MtC, 2.97 Mt CH_4	559.6 MtC, 2.97 Mt CH_4
Fugitive fuel emission				
Oil and gas	0.4 Mt CH_4	0.179 Mt CH_4	0.092 Mt CH_4	0.092 Mt CH_4
Coal mining	5.3 Mt CH_4	18.45 Mt CH_4	8.689 Mt CH_4	8.78 Mt CH_4
Industrial processes	25.5 MtC	28.29 MtC	22 MtC	25.59 MtC
Agriculture	20.5 Mt CH_4	20.841 Mt CH_4	18.2 Mt CH_4	12.59-20.09 Mt CH_4
LUC and forestry	x	42.53 MtC	-86 MtC	-75.93 MtC
Waste	0.6 Mt CH_4	0.792 Mt CH_4	2.5 Mt CH_4	0.899 Mt CH_4

II. China's Participation in the UNFCCC, *continued*

To assist China in complying with its obligation under the Convention, the UNDP as implementing agency initiated the project *Enabling China to Prepare Initial National Communication to the UNFCCC.*[18] This initiative received funding from the Global Environment Facility (GEF) in May 2000.[19] The aim of the project is "to generate, analyze and communicate information relevant to the preparation and submission of China's Initial National Communication (particularly in accordance with Art. 4.1 and Art. 12 of the UNFCCC), including completion of a national greenhouse gas inventory, vulnerability assessment, an adaptation option analysis, a national plan to implement the Convention and, finally, the National Communication itself."[20] Work began in January 2001, and it is scheduled for completion in May 2003. The UNDP-GEF provided U.S.$3.5 million and the Government of China U.S.$240,000 for the preparation of China's national communication. In addition, SDPC, which is in charge of coordinating climate change work, has been involved in the formulation and implementation of the project.[21] The project has seven objectives, which it plans to meet by implementing the special

II. China's Participation in the UNFCCC, *continued*

actions. The first five objectives include the preparation of the inventories of the energy, agriculture, forestry, and municipal sectors, and industrial processes. Expected outputs are the estimated GHG emissions from these activities.[22] The next step is to organize the activities in order to draft the initial national communication and incorporate the findings into development strategies and processes. The final objective of this project is to increase "public and political awareness and action related to climate change."[23]

III. Emissions Estimates for China

III. Emissions Estimates for China

China is considered the second largest contributor to global greenhouse gas emissions and is projected to become the largest contributor. China now accounts for about 14% of global emissions of carbon dioxide from fossil fuel use, compared to 23% for the U.S.[24]

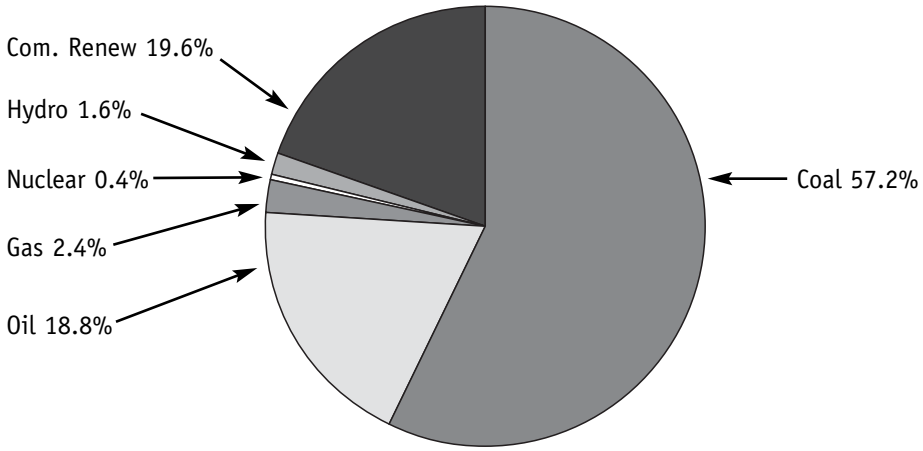
The key sectors for greenhouse gas emissions in China are energy, industry (industrial processes), agriculture, and municipal solid waste. The energy sector is the most significant in terms of total emissions. Nearly 11% of total world energy-related carbon emissions were released by China in 1999.[25] Coal is the major source of fuel in China and, thus, plays an extremely important role in the nation's social and economic development. This is particularly significant in terms of greenhouse gas emissions, because combustion of coal produces more CO_2 per unit of energy than does any other fossil fuel.[26] Coal accounted for 57.2% of the total primary energy supply in 1999 (Figure 1).[27] China's coal consumption accounts for about 30% of coal consumed worldwide.[28] Oil and gas make up the second most important segment of China's energy sector. Together they account for about 21% of China's energy supply (Figure 1).[29] Within two to three decades, the production and consumption of oil and gas is expected to increase significantly, in large part as a result of the rapid growth of the transportation sector. Thus, greenhouse gas emissions from this subsector may also increase in the future.[30] The Energy Information Administration (EIA) of the U.S. Department of Energy (U.S. DOE) estimates that China will experience a 10% annual growth of CO_2 emissions from natural gas.[31] Figure 1 also demonstrates how renewables (which includes hydropower) have increased by 2% since 1997 and now account for 21.2% of the total primary energy supply (TPES), thus contributing to the reduction of traditional fuel use.[32]

III. Emissions Estimates for China, *continued*

Figure 1. Energy Share of Total Primary Energy Supply in 1999

Source: International Energy Agency. Key Energy Indicators in 1999.[33]

Note: Excludes Electricity Trade



Historically China has been a large producer of cement, lime, iron and steel, calcium carbide, and adipic acid, all of which have production processes that are undoubtedly important sources of greenhouse gas emissions.[34] Additionally, the agricultural sector is a significant source of methane released during rice cultivation, methane and nitrous oxide released from the animal husbandry subsector by "enteric fermentation" and livestock waste, and nitrous oxide released from fertilized cropland. Between 1980 and 1995, the annual amount of nitrogen-based fertilizer consumption in China increased from 9.7 million tons to 25.2 million tons.[35] Methane emissions from municipal solid waste are considered an important contributor to greenhouse gas emissions in China in recent years.[36] Unprecedented industrial development, rapid urbanization, and growth of the urban population have given rise to high living standards. As a result, solid waste production has increased, but waste management and treatment systems are still lagging in development.[37]

In addition to power stations, industries and agriculture, household use of fossil fuels such as heating oil, biomass, and brown coal is a significant source of ambient particulate matter and sulfur dioxide (SO_2), especially in the northern regions of China.[38]

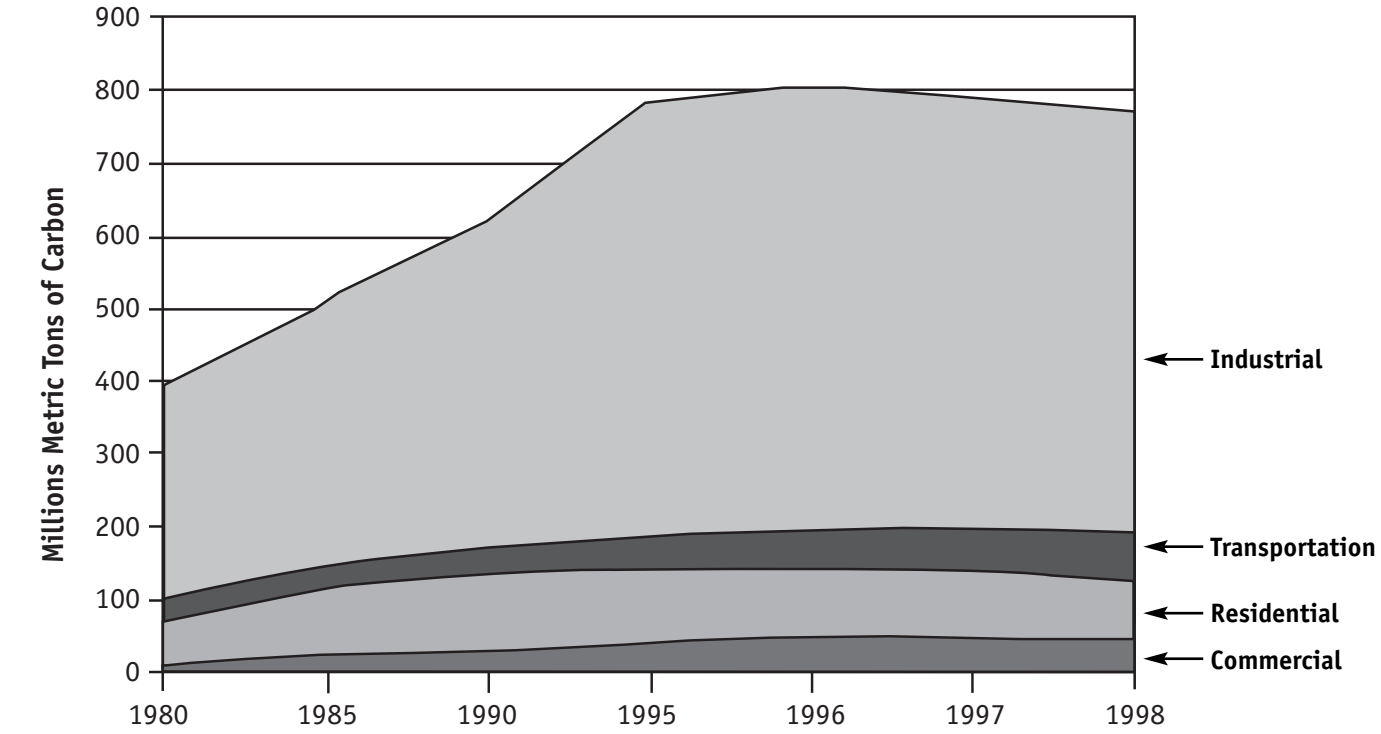
Figure 2 shows the distribution of carbon emissions in China by sector over time. The industrial sector, the largest source of China's carbon emissions, emits 75% of the total.[39] While possibilities exist to achieve decreases in this area, due to the growth of populations in urban centers, emissions from the transportation and commercial sectors will likely show an

III. Emissions Estimates for China, *continued*

increase in the future. The Energy Information Administration estimates that Chinese transportation sector energy consumption will increase by nearly 7% per year as the government pledges major investments in the country's transportation infrastructure.[40] The EIA projects significant carbon emissions from the transportation sector if this growth is not accompanied by improvements in vehicular fuel-efficiency standards and improvements in technology.

Figure 2. Carbon Emissions by Sector in China

Source: Energy Information Administration. China. Environmental Issues. April 2001.[41]



III. Emissions Estimates for China, *continued*

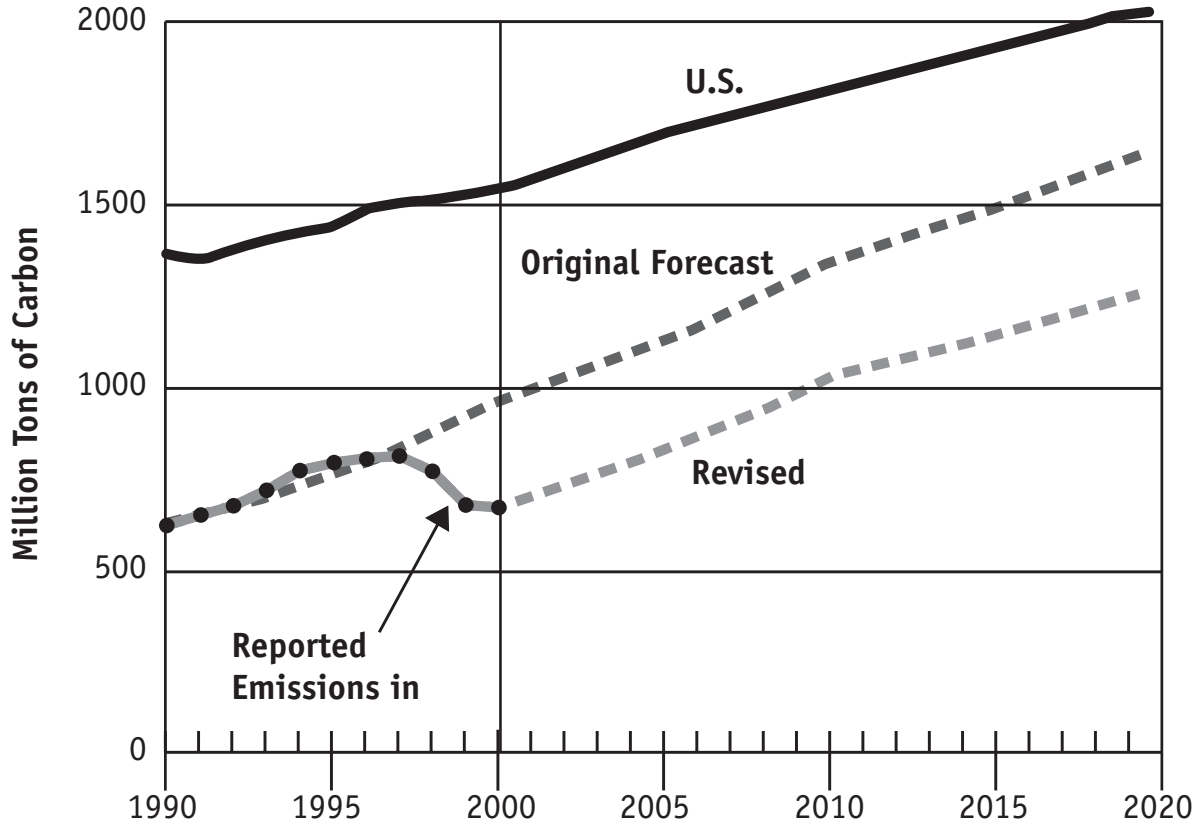
China's historical emissions of CO_2 show enormous growth in industrial sector emissions from 1950, when China was tenth among nations based on annual fossil fuel CO_2 emissions. Since 1970, China's fossil fuel CO_2 emissions have grown at an annual rate of 5.1%.[42] During the period from 1990 to 1996, emissions from fossil fuel consumption and cement production rose 39%.[43]

However, since the early 1980s, energy conservation has become one of China's priorities.[44] Measures encouraging efficient energy use included efficient production technologies and the reduction in subsidies for energy consumption. Coal subsidy rates were decreased from 61% in 1984 to 29% in 1995, and those for petroleum from 55% in 1990 to 2% in 1995.[45] Moreover, the services sector, a less energy-intensive economic sector, was promoted by the government. Additionally, national energy conservation programs introduced low interest rates for state loans for energy efficient projects. A shift to the construction of large-size coal-fired power plants led to large coal savings and an increase in the average generation efficiency of thermal power from 28.5% in 1984 to 29.7% in 1994.[46] All of these efforts resulted in a cumulative energy consumption increase in this sector between 1991 and 1996 of only 807.23 Mtce, despite the incredible growth of the industrial sector and projected increase of consumption by 1615.95 Mtce.[47] The machinery sector contributed the most (25.8%) to the total reduction in industrial energy consumption. This fall is explained by the share that this subsector has in industry and reduced real energy intensity in the sector.[48] The reduction of China's CO_2 emissions in 1997 was equal to 432.32 MtC,[49] an amount almost 50% lower than its emissions without policies and programs implemented to increase energy conservation.

This achievement in the mid-1990s indicated the beginning of a decrease in CO_2 emissions in China during a period of rapid economic growth. The Natural Resources Defense Council (NRDC), in analyzing the reduction of CO_2 emissions during that time, discovered that China, by applying energy efficient strategies, decreased CO_2 emissions from 6% to 14% between 1996 and 1999 (Figure 3) as economic growth achieved 27%.[50] The NRDC also states that China achieved better results addressing climate change issues than did the U.S.[51] According to estimates of the Carbon Dioxide Information Analysis Center, emissions in China fell from a high of 909 million metric tons of carbon in 1996 to 848 million metric tons of carbon in 1998, or about 7%, while continuing to be below the global average.[52] Jonathan Sinton with colleagues at the Lawrence Berkeley National Laboratory are even more optimistic with their estimates. They state that China's emissions of carbon dioxide have diminished by 17% since the mid-1990s as energy use has fallen.[53] Over the same period, China's GDP grew by 36%.[54] European Union representatives in China who stated that energy efficiency rose by 50% supported these estimates. Coal consumption fell by 30% for the period from 1996 to 2000.

Figure 3. Forecast CO_2 Emissions: China and the United States

Source: Natural Resources Defense Council. "Second Analysis Confirms Greenhouse Gas Reductions in China."[55]



III. Emissions Estimates for China, *continued*

Estimates of future trends also vary considerably and depend on sources. All projections predict an increase in emissions as a result of economic and energy growth. Figure 4 demonstrates U.S. and China CO_2 emissions distribution and projections of different studies. The "provisional revised baseline" indicates the findings of the Environmental Energy Technologies Division of Lawrence Berkeley National Laboratory working with Chinese researchers on the *China Energy and Carbon Scenarios Project.* Researchers from this laboratory state that although amounts of carbon emitted in the future will rise, they will not achieve the U.S. rates in 1990 (Figure 4).[56] By 2020, China's carbon dioxide emissions will be just over 1,100 MtC, about twice its 1990 levels, and still significantly below U.S. emissions in 1990 of 1,300 Mt.[57] The rate of emissions growth varies from 2% to 5% per year between 2000 and 2020.[58]

Despite a decrease in coal use and CO_2 emissions in the late 1990s, the Energy Information Administration predicts a rise in China's future emissions because coal,

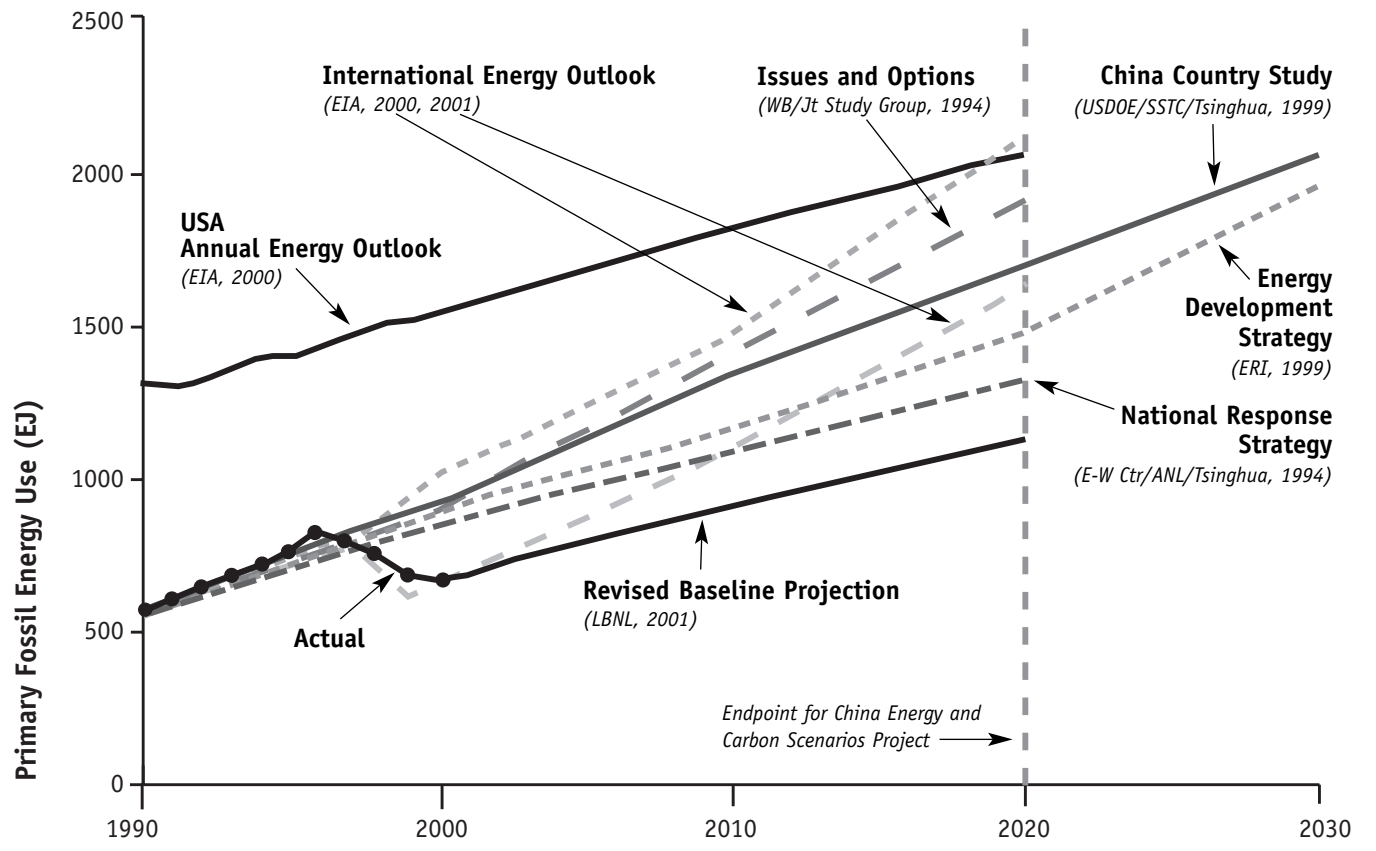
III. Emissions Estimates for China, *continued*

being the cheapest and most available source of energy, continues to be "the main fuel in a rapidly growing industrial sector, reflecting the country's abundant coal reserves and limited access to other sources of energy."[59] According to the EIA, China is still the largest consumer and producer of coal (73.9% in 1998), as well as the second largest energy consumer and third largest energy producer in the world.[60] Therefore, China's coal-dominated energy structure is not likely to change in the short term, and greenhouse gas emissions resulting from energy consumption will continue to rise.[61]

Some of the latest studies question the significant drop in GHG emissions in China. John Pomfret, in his article "Research Casts Doubt on China's Pollution Claims" in *The Washington Post,* provides the conclusions of a Japanese scientist who found that coal mines considered by Chinese statistics as closed and not accounted for in reports are in fact still active and producing coal, even as local authorities in the provinces cover up this fact. The Japanese researcher also does not believe there has been such rapid progress in energy efficiency. He is convinced that it is not possible to achieve the reported improvement in such a short period.[62] The author also provides information from the U.S. Embassy stating that coal is still the main fuel, and it is preferred over gas. Furthermore, U.S. representatives in China assert that the number of vehicles increased twofold over the last five years, which in turn led to an increase in petroleum consumption.[63] These data are confirmed by some new investment projects proposed today in China. For example, in Shanghai investments are being made to improve the public transport system in response to the projected increase in the numbers of cars in the city by 2020.[64] At present transportation accounts for only 6% of total GHG emissions in Shanghai, but in the case of the "high pollution scenario" they are expected to increase sevenfold.[65] The extent of any future increase will depend on the implementation of policies to promote energy efficient systems and infrastructure use and a highly efficient public transportation system.[66]

Figure 4. Actual and Projected Carbon Emissions, USA and China

Source: Sinton, Jonathan and Fridley, David.[67]



IV. Emissions Reduction Initiatives

IV. Emissions Reduction Initiatives

The information given above illustrates China's actual and projected development. There also is a great deal of evidence to show that China is committed to reducing its GHG emissions and to making rapid progress as it moves along its development path. It is obvious that China cannot avoid increases in energy consumption during continued economic growth. At the same time, old technologies continue to be used, and utilization efficiency remains lower than that in the developed countries.[68] China has to maintain its economic growth and its low energy use, which is approximately only one-tenth of U.S. per capita energy consumption.[69]

The Government of China places a strong priority on implementation of its obligations under the UNFCCC, has adopted extensive programs to slow growth in energy consumption, and has made some progress over the last decade in controlling that growth. These programs included an increase in fuel prices, closed subsidies on coal production, and control measures such as coal burning controls

IV. Emissions Reduction Initiatives, *continued*

and energy codes for new buildings. The result was the visible drop in emissions during the period from 1996 to 1999.[70]

Establishing a legal base for controlling air quality, China proclaimed the Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution in 1995.[71] The system of permitting air pollution was adopted in big cities. China joined the global atmosphere data observation network by creation of the World Atmosphere Background Data Observatory in 1994. The initiative belonged to the World Meteorological Organization (WMO) and the Global Environment Fund. The following year the National Climate Center was opened for the purpose of research and service work such as the forecasting of floods.[72] Clean coal and clean combustion technologies such as the use of coal washers were encouraged to reduce sulfur dioxide emissions.[73] Research in cooperation with international organizations undertaken since establishment of the National Climate Center include *China's Greenhouse Gas Resources and Reducing Strategy* and *Climate Change Caused by the Greenhouse Effect and Its Influence on China.* During the Ninth Five-Year Plan, China emphasized research on the *Assessment of Influence of Climate Change on China's Regional Environment* and *The Influence of Greenhouse Gas Exhaustion on Climate Change and its Counter-Measures.*[74]

In November 1997 China took a major step forward regarding energy efficiency work with the passage of the Energy Conservation Law. National energy efficiency planning in China was supported by the Packard Foundation's and Energy Foundation's *China Sustainable Energy Program* and the Shell Foundation's *Sustainable Energy Initiative.*[75]

An additional significant step has been taken in China to show its efforts in GHG reduction through the clear emphasis on environmental protection in the Tenth Five-Year Plan, where an overall environmental objective was established to reduce the emissions of major pollutants 10% below the 2000 level by 2005.[76] At the beginning of 2002 a $7.85 billion plan to clean up and set strict control targets was approved by the State Council.[77]

Since forests are important sinks for greenhouse gas emissions, as trees and other green plants take up carbon dioxide from the atmosphere for growth, China has undertaken extensive afforestation activities for the past several decades, which have led to almost 30 million hectares of afforested land. Currently, China's forests are estimated to be net sinks on the order of 50-90 million tons of carbon annually.[78]

Financial assistance from international organizations helped initiate a number of projects with the main goal of reducing greenhouse gas emissions. Current projects include the adaptation of high efficiency foreign technologies.[79] For example, the project called *Efficient Industrial Boilers,* approved in 1996, provided tools to strengthen China's coal-fired industrial boiler engineering in its operations, production, management and marketing capabilities, and improvement of boiler technology exchange domestically.[80] Also, the utilization of energy efficient technologies in the brick, cement, metal casting, and coking sectors are supported by another UNDP project, *Energy Conservation and GHG Emission Reduction in Chinese*

IV. Emissions Reduction Initiatives, *continued*

Township and Village Enterprises (TVE).[81] Other projects try to achieve GHG emissions reduction by replacing fossil fuels with the use of renewable energy sources. One such project, *Capacity Building for the Rapid Commercialization of Renewable Energy,* was initiated by the UNDP as implementing agency in 1998, and continues today. China also participates in regional/global initiatives that promote alternative energy sources in national and regional energy planning and sector restructuring, as well as in related policy making and improved energy management practices.[82]

In response to the surge in the number of cars, the World Bank initiated a range of projects to invest in the development and implementation of "a motor vehicle emissions control strategy" (*China Liaoning Urban Transport Project,* 1991), which includes the promotion of non-motorized transport by constructing overpasses and bicycle paths and creating pedestrian and restricted traffic zones. For example, the ongoing *Second Shanghai Metro Transport Project* includes the "establishment of an exclusive 19.4 kilometers of routes for non-motorized vehicles in and around the central business district" at a cost of U.S.$657 million.[83] Some World Bank projects initiate the prohibition of polluting vehicles, but they do not usually address fuel quality because it is under the control of the national energy policy.[84]

In analyzing the energy sector in China, the Pew Center on Global Climate Change recommends some possible strategies on how to meet energy demand, which is projected to grow at three times the 1995 rate by 2015, without harming the environment at a "relatively low incremental cost."[85] The policies to cut sulfur emissions proposed by the Center include controls to set fees that would force the use of clean technologies.[86] Measures that would reduce carbon emissions by 10% by 2015 are very high carbon taxes and construction of new, less carbon-intensive power plants. But the least expensive way is to use alternative sources of fuel. The use of cheap natural gas plus turbine efficiency and fees on sulfur dioxide emissions would decrease emissions of carbon and sulfur dioxide by 14% and 35% respectively, and reduced costs of advanced coal technologies together with sulfur dioxide emissions fees would cut these emissions by 9% and 75%.[87]

Studies conducted by the World Bank Development Research Group demonstrate that economic reforms are an important measure in air pollution control, increasing productive efficiency and reducing "the costs of abating pollution."[88] Researchers propose increasing the air pollution levy for large polluters as the most cost-effective way to deal with air pollution. Also, they emphasize a need to involve Township-Village Industrial Enterprises in the regulation system, since previously they were outside of its focus.[89] The research group states that rapid social and economic development is one of the key factors in addressing air quality problems. Even if regulations are not strengthened, market reforms will be able to slow air pollution growth. They conclude that regulations and economic changes should be combined to improve air quality.[90]

V. Future Directions

V. Future Directions

The decline in carbon dioxide emissions in the late 1990s demonstrates that China, without undertaking legally binding commitments under the international agreement to reduce carbon dioxide emissions, has contributed to global emissions reduction. This decline was achieved by efforts that include energy efficiency programs, energy price and market reforms, household fuel switching, and structural change in the economy that closed inefficient factories and shifted production to more efficient ones.[91] These forces, as well as the increasing availability of natural gas and efficient and clean technologies, and the strengthening of environmental protection efforts, may neutralize growth in the future demand for energy that is being driven by China's economic growth.

The difference in emissions estimates confirms the need for national communication preparation activities, since conducting such inventories will provide measurements of the actual amount of emissions and real projections. In any case, forecasts, even the most optimistic ones, show that China's energy use will grow. And even though growth in carbon emissions will be slower than expected, further reductions are necessary, and "could be achieved with net gains to China's economy."[92] Sinton and colleagues claim that policies increasing the availability and application of natural gas, renewable energy sources, and efficient technologies will change energy consumption and, as a result, contribute to GHG emissions reduction without affecting productivity and increasing environmental costs.[93]

The main question is how can China meet the demands of its growing population without dramatically increasing its greenhouse gas emissions? Researcher ZhangXiang Zhang believes that "future carbon limits" is not the right way to go. For the country to reduce its emissions it will have to have a very high carbon tax, which will generate significant GNP losses. He states that China's GNP losses "under less restrictive carbon limits are in the same range as the often reported estimates for industrialized countries under very restrictive carbon limits."[94] Instead he proposes that China continue to focus on strategies such as the Clean Development Mechanism that will limit GHG emissions and at the same time help achieve sustainable development.[95] Given the prominent role China plays in the global community, such actions not only benefit its own future but that of the community of nations as well.

Endnotes

[1] **The World Fact Book 2001.** U.S. Central Intelligence Agency (CIA), 2001. <http://www.cia.gov/cia/publications/factbook/index.html>

[2] Ibid.

[3] **World Population Data Sheet**. Population Reference Bureau. 2001 <http://www.prb.org/>

[4] **China.** World Bank Group. <http://www.worldbank.org.cn/English/home.asp>

[5] Ibid.

[6] Ibid.

[7] Ibid.

[8] **SIMA Quick Query Database.** 2001. World Bank <http://sima-ext.worldbank.org/query/>

[9] International Energy Agency. **Key World Energy Statistics from IEA. 2001.** Paris: International Energy Agency (IEA), 2001. <http://www.iea.org/statist/key2001/keyworld2001.pdf>

[10] **Social Indicators.** United Nations Statistics Division. <http://www.un.org/Depts/unsd/social/index.htm>

[11] **Convention Parties and Observers.** United Nations Framework Convention on Climate Change. <http://unfccc.int/resource/country/country.html?46>

[12] **Kyoto Protocol Status of Ratification.** 20 December 2002. United Nations Framework Convention on Climate Change. Retrieved 30 December 2002. <http://unfccc.int/resource/kpstats.pdf>

[13] **Project Proposal. Enabling China to Prepare Initial National Communication to the UNFCCC.** Global Environment Facility. 2001. <http://www.gefweb.org/Documents/Project_Proposals_for_Endorsem/China_EA_CC.pdf>

[14] Ibid.

[15] Ibid.

[16] Ibid.

[17] Ibid.

[18] **GEF Projects.** Global Environmental Facility (GEF). <http://www.gefonline.org/projectList.cfm>

[19] Ibid.

[20] Ibid.

[21] Op. cit., United Nations Statistics Division.

[22] Op. cit., Project Proposal.

[23] Op. cit., IEA (2001).

[24] **China's Worldwide Quest for Energy Security.** 2000. International Energy Agency (IEA). <http://www.iea.org/books/studies/2000/china2000.pdf>

[25] **Urban Air Quality Management - Coordinating Transport, Environment, and Energy Policies in Developing Countries.** World Bank. Clean Air Initiatives. Publications. 30 Sep. 2001. <http://www.wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2001/10/12//000094946_01100204051788/Rendered/PDF/multi0page.pdf>

[26] **Country Analysis. China.** Energy Information Administration (EIA). U.S. Department of Energy (U.S. DOE). June 2002. <http://www.eia.doe.gov/emeu/cabs/china.html>

[27] **China. Key Energy Indicators.** International Energy Agency (IEA). <http://www.iea.org/stats/files/selstats/keyindic/nmc/china.htm>

[28] Op. cit., EIA/U.S. DOE (June 2002).

[29] Op. cit., IEA. China. Key Energy Indicators.

[30] Op. cit., World Bank (2001).

Endnotes, *continued*

[31] **International Energy Outlook 2002.** Energy Information Administration (EIA). U.S. Department of Energy (U.S. DOE). April 2002. <http://www.eia.doe.gov/oiaf/ieo/tbla9_a16.html>, <http://www.eia.doe.gov/oiaf/ieo/tbl_a6.html>

[32] Op. cit., IEA. China. Key Energy Indicators.

[33] Ibid.

[34] Op. cit., Project Proposal.

[35] Ibid.

[36] Ibid.

[37] Ibid.

[38] Op. cit., World Bank (2001).

[39] **China: Environmental Issues.** Energy Information Administration (EIA). U.S. Department of Energy (U.S.DOE). April 2001. <http://www.eia.doe.gov/emeu/cabs/chinaenv.html >

[40] Ibid.

[41] Ibid.

[42] **Global, Regional, and National CO_2 Emissions.** People's Republic of China. Carbon Dioxide Information Analysis Center (CDIAC). <http://cdiac.esd.ornl.gov/trends/emis/prc.htm>

[43] Ibid.

[44] Zhang, ZhongXiang. *Can China Afford to commit itself an emission cap? An Economic and Political Analysis*. **Energy Economics.** Vol.22. No.6. October 2000.

[45] Ibid.

[46] Ibid.

[47] Zhang, ZhongXiang. *Why Had the Energy Intensity Fallen in China's Industrial Sector in 1990s? The Relative Importance of Structural Change and Intensity Change.* CCSO Centre for Economic Research. CCSO Working Paper #2001/5, Vol. 3, No. 2, June 2001.

[48] Ibid.

[49] Op. cit., Zhang (2000).

[50] **Second Analysis Confirms Greenhouse Gas Reductions in China.** Natural Resource Defense Council (NRDC). October 2001. As presented by Jeffrey Logan in *China's Air Pollution Down Dramatically, But Can It Last?* **Havard Asia Pacific Review,** Summer 2001. <http://nrdc.org/globalWarming/achinagg.asp>

[51] Ibid.

[52] Op. cit., CDIAC.

[53] Sinton, Jonathan and David Fridley. *Growth in China's Carbon Dioxide Emissions is Slower than Expected.* **Sinosphere.** Volume 4, Issue 1, Winter 2001. <http://china.lbl.gov/pubs/sinospherewin2001ex.pdf>

[54] Ibid.

[55] Op.cit., NRDC.

[56] Op. cit., Sinton and Fridley.

[57] Ibid.

[58] Ibid.

[59] Op. cit., EIA/U.S. DOE (June 2002).

[60] Ibid.

[61] Ibid.

[62] Pomfret, John. *Research Casts Doubt on China's Pollution Claims.* **Washington Post Foreign Service.** 15 Aug. 2001.

[63] Ibid.

Endnotes, *continued*

[64] Zhou, Hongchang, Daniel Sperling, Mark Delucchi, Deborah Salon. **Transportation in Developing Countries: Greenhouse Gas Scenarios for Shanghai, China.** Pew Center on Global Climate Change, July 2001. <http://www.pewclimate.org/projects/transportation_shanghai.pdf>

[65] Ibid.

[66] Ibid.

[67] Op. cit., Sinton and Fridley.

[68] Ibid.

[69] Eckholm, Erik. *China Said to Sharply Reduce Carbon Dioxide Emissions.* **N.Y. Times.** 15 June 2001.

[70] Op. cit., Sinton and Fridley.

[71] **United Nations Sustainable Development.** National Implementation of Agenda 21. 2002. Country Profile. China. <http://www.un.org/esa/agenda21/natlinfo/wssd/china.pdf>

[72] Ibid.

[73] Ibid.

[74] Ibid.

[75] **Energy and Energy Efficiency Policy Analysis.** China Energy Group. <http://eetd.lbl.gov/EA/partnership/China/policy.html>

[76] Ramsay, William C. *Energy Technology and the Environment: Policy Framework for Action.* Keynote Speech by Ambassador William C. Ramsay, Deputy Executive Director of International Energy Agency. Conference and Exhibition on Clean Energy Technologies. 29-31 August 2001 Beijing, China. <http://www.iea.org/about/files/bijing.pdf >

[77] **China says Kyoto Benefits Both Rich and Poor.** CNN.com. 17 Jan. 2002. <http://www.cnn.com/2002/TECH/science/01/17/china.reut/index.html>

[78] Op. cit., Project Proposal.

[79] Op. cit., GEF.

[80] Ibid.

[81] Ibid.

[82] Ibid.

[83] Op. cit., World Bank (2001).

[84] Ibid.

[85] Dadi, Zhou, Guo Yuan, Shi Yingyi, William Chandler, and Jeffrey Logan. **Developing Countries & Global Climate Change. Electric Power Options in China.** Pew Center on Global Climate Change, May 2000. <http://www.pewclimate.org/projects/pol_china.pdf>

[86] Ibid.

[87] Ibid.

[88] Dasgupta, Susmita, Hua Wang, and David Wheeler. **Surviving Success: Policy Reform and the Future of Industrial Pollution in China.** The World Bank Development Research Group, Policy Research Working Paper 1856, November 1997. <http://www.wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1997/11/01/000009265_3971229181112/Rendered/PDF/multi_page.pdf>

[89] Ibid.

[90] Ibid.

[91] Op. cit., Sinton and Fridley.

[92] Ibid.

[93] Ibid.

[94] Op. cit., Zhang (2000).

[95] Ibid.

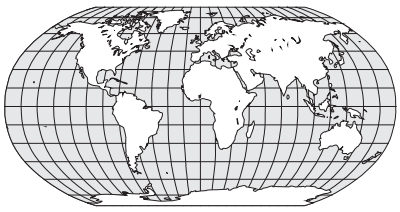
Country Case Study: India

I. Introduction

As the second most populous and seventh largest country in the world, the Republic of India holds status as a leader among developing nations.[1] The country spans numerous geographical zones, including deserts and jungles, farms, and sprawling cities. Its boundaries extend north to the Himalayas and south to the Peninsula that juts into the Indian Ocean. The world's largest democracy, India is divided into twenty-eight states with 476 districts, one national capital territory, and six union territories. The country is home to over one billion people.[2]

The emergence of a middle class during the 1980s and 1990s is a remarkable social development. This group, composed of prosperous farming families and urban-based professional, administrative, and business elites, has driven the movement toward modernization by demanding a loosening of economic controls, better education for children, and an improved standard of living.[3] However, various statistics of development still illustrate the need for improvement in the living conditions for the rest of

I. Introduction, *continued*



India's populace. Health expenditure per capita is startlingly low, averaging between U.S.$16 and $20 per person per year in the 1990s—well under the average for OECD countries or low and middle-income countries.[4] Infant mortality, along with diseases such as malaria, filariasis, leprosy, cholera, pneumonic plague, tuberculosis, trachoma, goiter, and diarrheal illnesses occur in significant numbers. Drop out rates, even in compulsory grade levels, is high, exemplified by the high rate of illiteracy among adults (43%).[5,6] Housing, sanitation, and access to clean water and nutrition are also among those things in meager condition in many parts of the country. Topping one billion people in the year 2000, India's rapidly growing population has strained living conditions all over the country. Population density was recorded at an average of 342 people per square kilometer in the year 2000, with over 440 people per square kilometer in rural areas.[7]

The Indian economy is growing at a significant rate. The majority of the GDP is derived in services, including the country's large system of transport. In the fourth most heavily used rail network in the world in both freight and passengers, track routes exceed more than 60,000 kilometers in length, one-sixth of which is electrified. Roads, maritime transport, and aviation also add significantly to the large transport sector. Agriculture, although in decline, holds another significant portion of the economy and the largest percentage of the country's work force. Advancements in technology during the Green Revolution in the 1970s and 1980s have increased the use of fertilizers and irrigation techniques. Important crops include sugar, rice, wheat, pulses, and oilseeds. Industries including textiles, steel, aluminum, fertilizers, electronics, motor vehicles, and petrochemicals, make up the remainder of the economy. India's energy needs are met with imported petroleum and natural gas, as well as abundant domestic coal and hydroelectric power. Nuclear power is also growing.

India holds a unique position as a nation that rushes toward development but still copes with many of the struggles of a developing country. With significant portions of the population lacking access to nutrition, clean water, sanitation, basic health care, and educational benefits, India continues to strive toward improved quality of life for its citizens. The United Nations Development Programme ranks India at a level of "medium human development," number 115 on the list of 162 countries. The table on the following page lists several summary statistics which illustrate the current state of development in India.

India emits less than 5% of the world's greenhouse gas emissions.[10] Per capita CO_2 emissions averaged one-twelfth that of high-income countries in the 1990s. In fact, per capita emissions in India were approximately half those of low and middle-income countries for the same period.[11] Despite these revealing facts, India still ranks fifth in the world in carbon dioxide emissions, after the U.S., China, Russia, and Japan.[12] A country that both contributes a growing proportion of greenhouse gas emissions and anticipates the climatological impacts of global warming, India joined global mitigation efforts by signing the United Nations Framework Convention on

I. Introduction, *continued*

Table 1. India Summary Statistics*

Sources: World Bank, 2000[8] and International Energy Agency, 2001.[9]

External Debt, Total (DOD, current USD)	100,367,302,656
IBRD Loans and IDA Credits (PPG DOD, current USD)	27,866,300,416
Commercial Energy Use (kg oil equivalent per capita)	482 (1999 value)
GDP (billion 95 USD)	449.12
GDP-PPP (billion 95 USD)	2165.90
GDP Per Capita (95 USD)	459
GDP Growth (annual %)	4
GDP Per Capita Growth (annual %)	2
Agriculture (% of GDP)	25
Industry (% of GDP)	27
Services, etc. (% of GDP)	48
Population (millions)	997.52
Population Growth (annual %)	2
Urban Population (% of total)	28
Fertility Rate, Total (births per woman)	3
Life Expectancy at Birth (years)	63
Adult Illiteracy Rate	43
Sanitation (% of population with access)	31
Improved Water Source (% of population with access)	88
Internet Users	5,000,000
Surface Area (km^2)	3,287,260
Land Use - Permanent Cropland (% of land area)	3 (1999 value)
Forest Area (% of land area)	22
CO_2 Emissions (Mt of CO_2)	903.82
CO_2 Emissions Per Capita (t CO_2/population)	0.91
CO_2 Emissions Per GDP (kg CO_2/95 USD)	2.01
CO_2 Emissions Per GDP (kg CO_2/95 USD PPP)	0.42

** All figures are from the year 2000, unless otherwise indicated.*

Climate Change (UNFCCC) on June 10, 1992, during the UN Conference on Environment and Development in Rio de Janeiro. The accord was ratified the following year, and entered into force in India on March 21, 1994.[13]

India hosted the eighth session of the Conference of the Parties (COP8) to the UNFCCC in October 2002 and acceded to the Kyoto Protocol a few weeks earlier on August 26, 2002.[14] Prior to India's accession, U.S. President George W. Bush asserted his intentions not to proceed with the United States' Kyoto Protocol commitments early last year, stating "I oppose the Kyoto Protocol because it exempts ... major population centers, such as China and India, from compliance, and would cause serious harm to the U.S. economy."

I. Introduction, *continued*

However, these "population centers" contribute only a fraction of global greenhouse gas emissions, especially when compared to the U.S., which emits approximately 25% of the world's greenhouse gases alone. Carbon dioxide emissions from a single American are more than nineteen times that of one Indian, based on 1996 estimates. At a time when India is struggling to provide mere basic services to the entirety of its population, demanding an extreme reduction of greenhouse gas emissions could serve to deepen its global inequity, since carbon dioxide emissions are closely linked to GDP growth.[15] *It is well understood that energy is the key driving force in the process of development. However, India recognizes its status as a rapidly developing country and one of the fastest growing contributors of greenhouse gases worldwide and was among the first signatories of the UNFCCC in 1992.*

II. India's Participation in the UNFCCC

II. India's Participation in the UNFCCC

India is classified as a non-Annex I Party to the UNFCCC, without obligation to set greenhouse gas emissions reduction targets in light of the country's need for continued economic development. Their commitments under the accord include the submission of a national communication, a report that accounts a national greenhouse gas emissions inventory and a catalog of steps the country is taking toward reducing emissions.[16]

Preparing a National Communication Report

India faces obstacles in preparing a national communication report. A significant amount of funding, coordination, public awareness, training, and capacity building are necessary in order to comply with this UNFCCC requirement. Numerous workshops and meetings, including eight last year, have been held over the years to discuss these issues and familiarize participating organizations with procedures and guidelines of inventory development. More than 300 participants from various research groups, government institutions, universities and nongovernmental organizations have attended these meetings across the country.[17]

Appropriately, as a non-Annex I country, India is entitled to receive assistance in these tasks. In July 2001, a project entitled *Enabling Activities for the Preparation of India's Initial National Communication to the UNFCCC* was initiated under the United Nations Development Programme - Global Environment Facility (UNDP-GEF) for this purpose.[18] With a grant of U.S.$2 million from the GEF, the project is scheduled for completion in 2003. The primary goal is to assist India in completing an initial national communication, but building capacity for continual compliance with the UNFCCC is also a focus.[19] Specific objectives include:

- The construction of a national greenhouse gas inventory using methodology outlined by the Intergovernmental Panel on Climate Change (IPCC) in the *Revised 1996 Guidelines* and the *Good Practices Report 2000*
- The reduction of uncertainty and estimation errors and improved reliability of sector emissions estimates and emissions factors from core activities
- An assessment of the potential impacts of climate change on food security, water resources, coastal zone management, and other areas of national concern

II. India's Participation in the UNFCCC, *continued*

- An assessment of potential adaptation and mitigation strategies
- A broad-based coordination of research institutions, government agencies, industry, and nongovernmental organizations in the compilation of a national communication, as well as general climate change mitigation and adaptation efforts
- The preparation of a climate change action plan for India
- A strengthened domestic and international exchange of information and technology
- An increased general awareness of climate change issues among the Indian public and the different sectors contributing greenhouse gases
- The establishment of an "Enabling Activity Data Center" which will maintain databases established in constructing the greenhouse gas inventory
- The completion of the first national communication to be submitted according to UNFCCC requirements[20]

The project is being executed under the Ministry of Environment and Forests (MoEF), the government agency that oversees climate change related issues in India.[21] MoEF has appointed Winrock International India as the facilitating agency, within which the National Communication Center (NATCOM) works.[22] Additionally, a National Steering Committee oversees project implementation, and a Technical Advisory Committee advises on the scientific and technical aspects of the program.[23] The initial national communication is scheduled for release in 2003.[24]

III. Emissions Estimates for India

III. Emissions Estimates for India

Current Greenhouse Gas Inventory

In the absence of a completed national communication, the *Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS)* provides us with a greenhouse gas inventory for India. This report, prepared in 1998, was a project co-sponsored by the Asian Development Bank and the United Nations Development Programme - Global Environment Facility. The first inventory of greenhouse gas emissions from India was prepared in 1991, and updated in 1992. The latest ALGAS inventory, presented on the following page in Table 2, is the most comprehensive version currently available, incorporating emissions sources that had not been included in the earlier inventories.[25]

Methodologies follow those of the IPCC Greenhouse Gas Inventory Program.[26]

Five greenhouse gases have been included in the ALGAS inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), oxides of nitrogen (NO_X), and carbon monoxide (CO). Carbon dioxide equivalents have also been computed. Aerosols and non-methane volatile organic compounds (NMVOCs) are notable omissions from the study.

Table 2. Greenhouse Gas Emissions and Removals, 1990 (Unit: Gg)

Source: Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS), 1998.[27]

Greenhouse Gas Sources and Sinks	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	CO_2-Equivalent[c]
1. Energy	**508,600**	**-**	**2,535**	**11**	**3,084**	**14,965**	**565,245**
A. Fuel Combustion	508,600						
1. Energy and Transformation Industries					2,684[d]	3,493[d]	508,600
2. Biomass Burning	300,460[a]		1,579	11	400	11,472	36,569
B. Fugitive Emissions from Fuels							
1. Solid Fuels			330				6,930
2. Oil and Natural Gas			626				13,146
2. Industrial Processes	**24,200**	**-**	**-**	**1**	**-**	**-**	**24,510**
3. Agriculture	**-**	**-**	**12,654**	**243**	**109**	**3,038**	**341,064**
A. Enteric Fermentation			7,563				158,823
B. Manure Management			905				19,005
C. Rice Cultivation			4,070[b]				85,470
D. Agricultural Soils				240			74,400
E. Prescribed Burning of Savannas							
F. Field Burning of Agricultural Residues			116	3	109	3,038	3,366
4. Land-Use Change and Forestry	**52,385**	**-50,900**					**1,485**
A. Change in Forests & Woody Biomass Stock		-6,171					-6,171
B. Forests and Grassland Conversion	52,385						52,385
C. Abandonment of Managed Lands		-44,729					-44,729
5. Waste			**3,288**				**69,048**
A. Solid Waste Disposal on Land			334				7,014
B. Domestic and Commercial Wastewater			49				1,029
C. Industrial Wastewater			2,905				61,005
D. Other Waste							
6. Total	**585,185**	**-50,900**	**18,477**	**255**	**3,193**	**18,003**	**1,001,352**

[a] *CO_2 emissions from biomass burning are not included in the national totals.*

[b] *CH_4 emissions according to IPCC 1996 methodology.*

[c] *CO_2-equivalents (CO_2 +CH_4 + N_2O) are based on global warming potentials (GWPs) of 21 for CH_4 and 310 for N_2O. NO_x and CO are not included since GWPs have not been developed for these gases. Bunker fuel emissions are not included in the national total.*

[d] *NO_x and CO emissions are computed for the transport sector.*

III. Emissions Estimates for India, *continued*

The greatest emissions sources for all reported gases, except methane, are by far energy-related, with carbon dioxide resulting from fossil fuel combustion as the largest. India relies substantially upon traditional fuels (animal wastes, fuel wood, crop residues) for energy consumption, due to its largely agrarian economy.[28] The country also relies heavily on imported oil and gas.[29] Coal remains the mainstay of power generation, providing more than 60% of the country's power. Hydroelectric dams account for 25%, while gas-fired power and nuclear power provide most of the remaining 15%. Although renewable energy contributes only about 1% of power generation in India, this sector is growing rapidly due to multiple renewable energy programs that have been installed in recent years.[30] The next fifteen years could see as much as a seven-fold increase in renewable energy supplies, and a tripling of renewable energy's share in the country's total power generation capacity.[31]

Methane is the second largest source of greenhouse gas emissions by weight, and is

III. Emissions Estimates for India, *continued*

primarily emitted from agricultural activities such as enteric fermentation in domestic animals, manure management, rice production, burning of agricultural crop residue, and agricultural soils. Another significant source of methane comes from the waste sector. Carbon monoxide also comprises a substantial portion of total emissions, again, largely from fossil fuel combustion. Industrial processes, most notably cement production, emitted a CO_2-equivalent of 24,510 Gg.[32]

Net emissions (Net Emissions = Total Emissions - Removals) for the year 1990 are given by the inventory to be: 534,285 Gg CO_2, 18,477 Gg CH_4, 255 Gg N_2O, 3,193 Gg NO_X, 18,003 Gg CO. Net CO_2-equivalent emissions are 1,001,352, or about 3% of total global greenhouse gas emissions. [33]

Projected Greenhouse Gas Emissions

ALGAS also provides numerous emissions projections in its report, developed by various independent groups. A carbon dioxide emissions projection, prepared by the Tata Energy Research Institute (TERI), is given in the table below. TERI used the MARKAL model in the production of these estimates, along with earlier studies which account for the growth of the Indian economy.[34]

Table 3. CO_2 Emissions Projections in the Baseline Scenario (Unit: Tg)

Source: Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS), 1998.[35]

	1990	2000	2010	2020	Total 1990 - 2020
Baseline	532	973	1,555	2,308	46,352

The focus of abatement strategies is carbon dioxide in the energy and forestry sectors, and methane in the agricultural sector.[36] The National Physical Laboratory (NPL) and TERI in Table 4 below provide these emissions projections, which extend to the year 2020.

Table 4. Emissions Projections by Sector (Unit: Tg)

Source: Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS), 1998.[37]

Sector	GHG	1990	Year 2000	Year 2010	Year 2020
1. Energy		**508.6**	**948.1**	**1,646.4**	**2,862.0**
A. Coal	**CO_2**	328	628.0	1,125.0	2,014.0
B. Petroleum		162.7	270.0	439.8	715.0
C. Natural Gas		17.5	50.1	81.6	133.0
2. Agriculture		**12,538**	**13,834**	**14,968**	**16,204**
A. Enteric Fermentation	**CH_4**	7,563	8,297	9,102	9,985
B. Manure Management		905	977	1,036	1,099
C. Rice					
NPL		4,070	4,560	4,830	5,120
TERI		3,090 ± 1,460	3,260 ± 1,550	3,630 ± 1,730	4,050 ± 1,930
3. Forestry/Land Use	**CO_2**	**1.5**	**29.3**	**-**	**77.3**

III. Emissions Estimates for India, *continued*

Energy-related carbon dioxide emissions are expected to multiply by more than five times the 1990 emissions levels by the year 2020, while methane levels increase by approximately 30%. Carbon dioxide emissions resulting from forestry and land-use change will grow to more than fifty times the 1990 emissions levels over the next two decades. However, it should be noted that carbon intensity is projected to decrease over the same period, at an average annual change of -2.3%.[38]

IV. Emissions Reduction Initiatives

IV. Emissions Reduction Initiatives

With wide ranging geographical zones, sections of India's population will be severely affected by climate variations. TERI reports some effects that are already being observed, including rises in average surface temperature and sea level.[39]

At current consumption rates, India contributes less than 5% of the world's greenhouse gases, despite containing approximately 20% of the world's population. However, with a strengthening economy (average of 6% GDP growth per year since 1990), emissions can be expected to increase dramatically in the next century, as is evidenced by the emissions projections in Tables 3 and 4.[40] A developing country, India has opted out of the reductions obligations present in the UNFCCC. The need for economic growth and the pursuit of higher standards of living for Indian citizens currently warrant a higher priority, as may be construed by examining the development statistics in Table 1 above.

However, India recognizes its growing contributions to global greenhouse gas emissions, as well as the fact that the lives of many of its citizens will deteriorate as the effects of climate change become more apparent. The country has worked diligently to achieve its commitments to the UNFCCC on the basis of "common but differentiated responsibilities and respective capabilities" of member countries.[41] At a recent meeting of Indian and American representatives in New Delhi, India announced a renewed effort to enhance ongoing collaborative projects in clean and renewable sources of energy, energy efficiency, energy conservation, climate modeling, weather early warning systems, and the development of advanced energy technology. Intentions to continue dialogue and cooperation with the U.S. under the UNFCCC were also expressed.[42] The study, *Enabling Activities for the Preparation of India's Initial National Communication to the UNFCCC,* exemplifies the strength of this ongoing commitment to complete the national communication according to UNFCCC guidelines.

Since India's signing of the UNFCCC ten years ago, several projects have been initiated for the purpose of climate change mitigation or adaptation. For example, a *National Action Plan* was developed as the country's chief greenhouse gas mitigation policy plan in the energy sector. The *Plan* uses two criteria to adopt reductions options: first, the share of subsector or end-use in total energy consumption and, second, the potential for greenhouse gas reduction.[43] Under these premises, numerous programs have been implemented, including the following:

- Carbon emissions reductions through photovoltaic power generation in urban areas and stand alone decentralized power sources for small villages
- Fuel cells for the transport sector
- Installation of compact fluorescent lamps in the commercial sector

IV. Emissions Reduction Initiatives, *continued*

- Promotion of compressed natural gas as a fuel for cars
- Wind power generation projects
- Biomass gasification for power generation
- Construction of small hydropower systems to reduce the cost of off-grid rural electrification
- Coal washing projects
- Promotion of large hydroelectric projects
- Renovation and modernization of old coal-fired thermal power plants[44]

With only 28% of the population living in urban areas, India is predominantly a rural population.[45] Unsurprisingly, agriculture is the largest source of methane in India. Within the agricultural sector, which makes up over one quarter of the annual gross domestic product, enteric fermentation and rice cultivation are the largest sources of methane. Four main projects have been implemented to reduce methane emissions: strategic supplementation of animal feed to increase digestibility, implementation of small-scale digesters to check release of methane and meet domestic energy requirements with the biogas produced, employment of appropriate agronomic practices such as frequent draining and increased paddy variety, and increased efficiency of nitrogen fertilizer application.[46]

Energy is essential in the development of any country's economy. In India, emissions from energy use account for 57% of total greenhouse gas emissions and 97% of carbon dioxide emissions. Total energy-related emissions more than doubled from 1980 to 1994 and will continue to grow given the development priorities of the country. However, the Indian government has initiated substantial measures in energy efficiency and renewable alternatives in an effort to slow increases in emissions intensity (emissions per GDP). Some of these projects include a centrally sponsored program for the renovation and modernization of thermal power stations, consumer labeling for energy efficiency, and a restructuring in the government pricing regime for coal, hydrocarbons, liquefied petroleum gas, and other emissions sources.[47,48]

The Indian government has been at the forefront of renewable energy use, maintaining an independent Ministry of Non-Conventional Energy Sources and the Indian Renewable Energy Development Agency, a separate financial institution set up to promote, finance and develop renewable energy technology.[49] In fact, a progressive policy proposed in India would require that 10% of new capacity additions through the year 2012 come from renewable energy. Much of the focus in renewable energy development has been in rural areas in order to increase levels of electrification sustainably for these more remote populations. Wind power generation has grown immensely in India, and improved biomass cooking has been installed in numerous households. Rural entrepreneurs are selling small solar home systems in increasing amounts. A regulatory framework for grid-based renewable power producers is present, offering investment tax credits for grid-based renewable power and subsidies for rural solar projects.[50]

These and many other programs are being implemented in all sectors, demonstrating India's commitment toward global climate change mitigation and adaptation efforts.

In working toward its UNFCCC commitments, India has benefited greatly by being the subject of numerous country studies, conducted both by nongovernmental and intergovernmental organizations, as well as

IV. Emissions Reduction Initiatives, *continued*

by foreign and domestic government agencies. These studies have contributed to the development of a greenhouse gas inventory, as well as the creation of numerous climate change policies. For example, the Tata Energy Research Institute has contributed in many diverse ways, including analysis of climate negotiations, capacity building to fulfill UNFCCC commitments, assistance in preparation of greenhouse gas inventories and abatement and adaptation policies, assessment of impacts, examination of financing options for climate-related projects, technical assistance in implementation, information dissemination and exchange, creation of public awareness, and input into the IPCC reports and methodologies.[51] Table 5 below lists some other major studies of which India has been a part.

These studies have supplemented India's mitigation and adaptation efforts by providing research and innovation, as well as links with outside groups that offer support, knowledge, and technology exchange.

Table 5. Indian Country Studies

Source: Confronting Climate Change, 2000.[52]

Name of Study	Year	Agency
GHG Abatement Costing Study	1991	UNEP
Impact of Sea Level Rise	1993	MoEF
Climate Change In Asia	1994	ADB
Environmentally Sound Energy Development Strategies	1997	UNEP/Risø National Laboratory
Asia Least-cost Greenhouse Gas Abatement Study	1998	UNEP-GEF/ADB
GHG Pollution Prevention Project	1998	U.S. AID

V. Future Directions

V. Future Directions

With many Indian citizens lacking basic necessities such as food, education, housing, health care, and clean water, development is a primary concern for the government. Indeed, by adapting technologies to local circumstances, strengthening education, and coordinating the goals of government and industry, the country can "leapfrog" past the model industrialized countries have followed, and into a sustainably developed economy.[53] India recognizes, however, that it has a growing contribution to global greenhouse gas emissions and that its inhabitants are very likely to experience the negative impacts of climate change.[54] For these reasons, India has been cooperative in its obligations under the UNFCCC. The country's first national communication is nearing completion, and numerous mitigation and adaptation policies have been implemented.

Joint projects with various nongovernmental and intergovernmental organizations, as well as foreign government agencies, have aided Indian efforts in this area. The exchange of knowledge and technology, as well as support for research initiatives, has served to increase capacity for compliance with UNFCCC obligations. Workshops have been essential in raising planners' awareness, identifying the best strategies, achieving consensus on project activities, publicizing findings, and designing programs.[55] The government is committed to the goals of the UNFCCC, as has been demonstrated by the many initiatives taken with respect to climate change. Continuing support for these efforts can only advance the already marked progress India has made.

Endnotes

[1] Chatterjee, Kalipada. *India.* **Confronting Climate Change: Economic Priorities and Climate Protection in Developing Nations.** Ed. B. Biagini. Washington, DC: National Environmental Trust, 2000, pp. 31-62.

[2] **The World Factbook 2002.** U.S. Central Intelligence Agency (CIA), 2002. <http://www.cia.gov/cia/publications/Factbook/geos/in.html>

[3] Ibid.

[4] **SIMA Quick Query Database.** 2001. World Bank. Retrieved 10 June 2002. <http://sima-ext.worldbank.org/query/>

[5] Op. cit., Library of Congress.

[6] Op. cit., World Bank.

[7] Ibid.

[8] Op. cit., World Bank.

[9] International Energy Agency (IEA). **Key World Energy Statistics from the IEA: 2001 Edition.** Paris: International Energy Agency (IEA), 2001. p. 48-57.

[10] **Top 20 (1998 total CO_2 Emissions).** 1998. Carbon Dioxide Information Analysis Center (CDIAC). Retrieved 19 July 2002. <http://cdiac.esd.ornl.gov/trends/emis/graphics/top20_1998.gif>

[11] Op. cit., World Bank.

[12] Op. cit., CDIAC.

[13] **United Nations Framework Convention on Climate Change: Status of Ratification.** 11 December 2001. United Nations Framework Convention on Climate Change. Retrieved 3 June 2002. <http://unfccc.int/resource/conv/ratlist.pdf>

[14] **Kyoto Protocol Status of Ratification.** 20 December 2002. United Nations Framework Convention on Climate Change. Retrieved 30 December 2002. <http://unfccc.int/resource/kpstats.pdf>

[15] **Press Release of March 16th 2001.** 16 March 2001. Center for Science and Environment. Retrieved 3 June 2002. <http://www.cseindia.org/html/au/au4_20010317.htm>

[16] **National Communications from Parties Not Included in Annex I to the Convention: Third Compilation and Synthesis of Initial National Communications from Parties Not Included in Annex I to the Convention.** 5 October 2001. United Nations Framework Convention on Climate Change. FCCC/SBI/2001/14/Add.1. Retrieved 10 July 2001. <http://unfccc.int/resource/docs/2001/sbi/14a01.pdf>

[17] **Annual Report 2001-2002: International Cooperation.** 2002. Ministry of Environment and Forests-Government of India (MoEF-GoI). Retrieved 22 July 2002. <http://sdnp.delhi.nic.in/resources/annual-report/moefreport.html>

[18] **India's Initial National Communication to the UNFCCC.** October 2001. Cane Cogen India. Retrieved 4 June 2002. <http://www.renewingindia.org/newsletters/canecogen/current/news_cci_011.htm#ncc1a>

[19] **India - Enabling Activity for the Preparation of India's Initial Communication to the UNFCCC.** Global Environment Facility (GEF) Project Tracking System. Retrieved 9 May 2002. <http://www.gefonline.org/projectDetails.cfm?projID=11>

[20] Op. cit., Cane Cogen India.

[21] Op. cit., GEF.

[22] Op. cit., Cane Cogen India.

[23] Op. cit., MoEF-GoI.

[24] Op. cit., GEF.

[25] Asian Development Bank (ADB), Global Environment Facility (GEF), United Nations Development Programme (UNDP). **Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS): India.** Manila: Asian Development Bank, 1998.

[26] **The IPCC Inventory Methods and their Application and Limitations in Asia.** July 1995. ALGAS. Retrieved 5 June 2002. <http://ntweb03.asiandevbank.org/oes0019p.nsf/pages/102ATP1>

Endnotes, *continued*

[27] Op. cit., ADB/GEF/UNDP, 5.

[28] Op. cit., Chatterjee, 31.

[29] **World Energy Outlook 1999 Insights, Looking at Energy Subsidies: Getting the Prices Right.** 1999. International Energy Agency. Retrieved 26 April 2002. <http://www.worldenergyoutlook.org/weo/pubs/insights99/insights99.asp>

[30] Shukla, P.R., William Chandler, Debyani Ghosh and Jeffrey Logan. **Developing Countries & Global Climate Change: Electric Power Options in India.** October 1999. Pew Center on Global Climate Change. Retrieved 22 July 2002. <http://www.pewclimate.org/projects/pol_india_execsumm.cfm>

[31] World Bank. **Meeting India's Future Power Needs: Planning for Environmentally Sustainable Development.** Washington, DC: World Bank, 1999.

[32] Op. cit., Chaterjee, 31.

[33] Ibid., 4.

[34] Ibid.

[35] Ibid., 6.

[36] Ibid., 7.

[37] Ibid., 6.

[38] Energy Information Administration. **International Energy Outlook: 2002.** Washington, DC: U.S. Department of Energy, 2002.

[39] **India: Country Profile.** 30 September 2000. Climate Change in Asia - Tata Energy Research Institute. Retrieved 23 July 2002. <http://www.ccasia.teri.res.in/country/india/india.htm>

[40] Op. cit., World Bank (SIMA Quick Query Database).

[41] **U.S.-India Joint Statement on Climate Change: Statement on the Visit of Mr. Harlan Watson, U.S. Climate Change Negotiator and Special Representative.** 6 May 2002. U.S. State Department. Retrieved 10 May 2002. <http://www.gcrio.org/OnLnDoc/pdf/us_india020506.pdf>

[42] Ibid.

[43] Op. cit., Chatterjee, 45.

[44] Ibid.

[45] Op. cit., World Bank (SIMA Quick Query Database).

[46] Op. cit. Chatterjee, 49.

[47] Pachauri, Rajendra K. and Sudhir Sharma. *India's Achievements in Energy Efficiency and Reducing CO_2 Emissions.* **Promoting Development While Limiting Greenhouse Gas Emissions: Trends and Baselines.** Eds. José Goldemberg and Walter Reid. New York, NY: United Nations Publications, 1999, pp. 59-74.

[48] Goldemberg, J., E. Martinot and A. Miller. **Energy Since Rio: Achievements and Promising Strategies.** Washington, DC: Global Environment Facility, 2002.

[49] Op. cit., Pachauri and Sharma, 70-71.

[50] Op. cit., Goldemberg, Martinot, and Miller, 11.

[51] **Centre for Global Environment Research: Scope.** 2002. Tata Energy Research Institute. Retrieved 23 July 2002. <http://www.teriin.org/division/padiv/cger/cger.htm>

[52] Op. cit., Chaterjee, 50.

[53] Goldemberg, José. *What is the Role of Science in Developing Countries?* **Science.** 20 February 1998, pp. 1140-1141.

[54] Op. cit., Chaterjee, 31.

[55] Op. cit., World Bank (Meeting India's Future Power Needs).

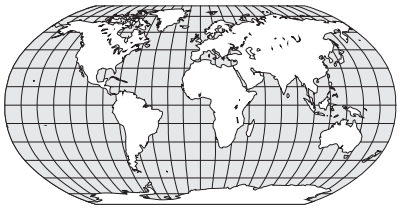
Country Case Study: Korea

I. Introduction

The Republic of Korea, or South Korea, is located on the lower half of the Korean Peninsula. The Sea of Japan to the east, the Yellow Sea to the west, and the Korean Strait to the south border the country. The northern border is defined by the Demarcation Line, which divides North and South Korea.[1] Topographically, the country is characterized by mountains, rolling hills and uplands, with wide coastal plains in the west and south.[2] There are three major rivers that flow throughout the country, and the irregular coastline is dotted with over three thousand islands.[3,4]

Geographically poised between the powerful nations of Japan and China, South Korea has strived to develop its own unique social and cultural patterns throughout history, along with a strong international reputation. South Korea has maintained a close relationship with the United States since the end of World War II, which has further enhanced the country's development.[5] Today the nation is often considered one of the most progressive developing countries in the

I. Introduction, *continued*



world, and its citizens generally realize a higher standard of living than most developing country populations. The United Nations Development Programme ranks South Korea as a country of "high human development," higher than 80% of the 162 listed ountries.[6]

Economic growth of the South Korean economy has been extremely rapid, recording between 5% and 11% annual increase in GDP since 1980 (with the exception of the 1997 financial crisis), and a doubling of GDP between 1985 and 1995.[7] *South Korea joined the Organisation for Economic Co-operation and Development in 1996, and currently ranks tenth in GDP among the thirty member countries.*[8] *Moreover, South Korea has the highest GDP per capita (U.S.$13,062) and GDP per capita growth (9%) of all seven countries discussed in this text.*[9]

The South Korean economy is almost entirely dependent upon the service and industry sectors. Over the last fifty years agriculture has played a steadily decreasing role in the nation's economy and culture.[10] *Today, the rural population composes less than one-fifth of the total population, and agriculture accounts for only 5% of the annual GDP.*[11] *Much of the economic growth seen in the last century can be attributed to the sizeable export-oriented manufacturing sector. However, as the population has become more educated and other developing countries have begun to offer cheaper production costs and less strict labor laws, other industries and services, such as real estate, entertainment, hotels and supply services, have grown. Manufacturing sectors that remain strong in South Korea involve high-level technologies and knowledge-intensive fields, including materials science, biotechnology, electronics, and aerospace.*[12]

Along with a solid economy, other indicators of development prove the remarkable insight of South Korean planners over the last century. The rate of literacy was 98% in 2000, and education rates are admirably high at secondary as well as university levels.[13] *In fact, a movement to dramatically increase university enrollments in the 1980s gave South Korea one of the highest percentages of students in the world.*[14] *Health issues have also changed with development. Priorities have shifted away from acute and communicable diseases as medical care, sanitation, and water quality have improved. Furthermore, during the 1990s, policies to promote health education, disease prevention, nutrition improvement, and the practice of healthy lifestyles were installed. Infant and maternal mortality rates have decreased dramatically, and average life expectancy has increased by more than twenty years since 1950.*[15] *Another indicator of industrialization is a drop in population growth. In fact, population policies and family planning campaigns have been so successful that many Asian countries have sent officials to Seoul for training.*[16] *Table 1 on the following page provides a few summary statistics that further illustrate the current state of development in South Korea.*

I. Introduction, *continued*

Table 1. Korea Summary Statistics*

Sources: World Bank, 2000[17] and International Energy Agency, 2001.[18]

External Debt, Total (DOD, current USD)	134,416,900,096
IBRD Loans and IDA Credits (PPG DOD, current USD)	8,096,999,936
Commercial Energy Use (kg oil equivalent per capita)	3,871 (1999 value)
GDP (billion 95 USD)	566.33
GDP-PPP (billion 95 USD)	710.01
GDP Per Capita (95 USD)	13,062
GDP Growth (annual %)	9
GDP Per Capita Growth (annual %)	8
Agriculture (% of GDP)	5
Industry (% of GDP)	43
Services, etc. (% of GDP)	53
Population (millions)	46.86
Population Growth (annual %)	1
Urban Population (% of total)	82
Fertility Rate, Total (births per woman)	1
Life Expectancy at Birth (years)	73
Adult Illiteracy Rate	2
Sanitation (% of population with access)	63
Improved Water Source (% of population with access)	92
Internet Users	19,040,000
Surface Area (km^2)	99,260
Land Use - Permanent Cropland (% of land area)	2 (1999 value)
Forest Area (% of land area)	63
CO_2 Emissions (Mt of CO_2)	410.41
CO_2 Emissions Per Capita (t CO_2/population)	8.76
CO_2 Emissions Per GDP (kg CO_2/95 USD)	0.72
CO_2 Emissions Per GDP (kg CO_2/95 USD PPP)	0.58

** All figures are from the year 2000, unless otherwise indicated.*

This venerable movement toward modernization and development has been accompanied by some lesser-appreciated characteristics of the industrial world. Greenhouse gas emissions, while below the average for high-income countries, are significantly greater in South Korea than the averages for middle and low-income countries.[19] In this rapidly developing country, greenhouse gas emissions and climate change have become important issues of national discussion. South Korea is a country vulnerable to the anticipated changes in climate. Predicted impacts include a general rise in surface temperature, changes in seasonal temperature variation and rainfall patterns, variations in soil moisture and water resources, alteration of agricultural climate zones and crop growth periods, and increases in the incidence of severe weather events such as floods and droughts.

I. Introduction, *continued*

Additionally, crop productivity, growth distribution of vegetation, forestry growth patterns, sea levels, and marine production operations are also expected to be negatively impacted.[20] Some effects have already become apparent. The year 1998 brought South Korea's hottest spring in history, along with severe floods, and an autumn hotter than the preceding summer. Changes in flower blossoms and fish species were also noted by both public and private sources. The Han River, which runs through the capital city Seoul, used to be frozen during the winter season. However, since the 1970s, the river has not frozen, even partially. In fact, a recent survey in Korea showed that 77% of the respondents were "seriously worried about climate changes."[21]

Thus, Korea plays a significant role in the issue of global climate change, both as a developing nation with substantial greenhouse gas emissions and as a country likely to experience the negative impacts of climate change. For these reasons, South Korea has exhibited a notable commitment to the United Nations climate change agreements. The government signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 and ratified the agreement in December 1993, the 47th country to do so.[22] South Korea signed the Kyoto Protocol on September 25, 1998, and ratified it on November 8, 2002.[23]

II. South Korea's Participation in the UNFCCC

II. South Korea's Participation in the UNFCCC

South Korea adopted the UNFCCC as a non-Annex I Party, without obligation to set greenhouse gas (GHG) emissions reduction targets, in light of the country's more pressing concerns for continued development. However, South Korea does maintain certain responsibilities in global greenhouse gas reduction efforts under the UNFCCC. Among these is the assemblage of a national communication, a report that inventories the country's current and projected greenhouse gas emissions and climate change policy initiatives.[24]

Preparing a National Communication Report

Many South Korean organizations are involved in climate change research and action. Within the government, the Ministry of Commerce, Industry, and Energy (MOCIE) is the agency that oversees energy and climate change issues, among other matters. The Korean Energy Management Corporation (KEMCO) implements conservation and energy efficiency policies designed by MOCIE.[25] Numerous additional government agencies and government-affiliated groups, such as the Korea Energy Economics Institute (KEEI), have participated in climate change related research and implementation projects.[26] The Inter-Ministerial Committee on Climate Change Convention, a group incorporating related government agencies, academia, and industry and led by the Prime Minister, was created in April 1998 to coordinate these various working bodies in an effort to improve implementation of the UNFCCC and compilation of a national communication.[27] Finally, the Industrial Committee on Measures for the UNFCCC was established in 2001 with two guiding principles: first, that Korean industry should support global efforts

II. South Korea's Participation in the UNFCCC, *continued*

toward climate change, and second, that Korean industry continues to be competitive while maintaining this support.[28]

Remarkably, much of the financial support for projects designed to facilitate the completion of a national communication came from domestic government sources. Media surrounding the 1992 United Nations Conference on Environment and Development served to increase public awareness in South Korea, and subsequently, interest among research institutions, including those funded by government agencies. Funding for climate change related research became more accessible as environmental issues were increasingly broadcast as national priorities. Numerous research projects were conducted to investigate the role of South Korea in climate change issues, including both emissions and possible reduction strategies for the country. By 1998, three separate predominantly government-funded studies had been initiated in this area: the *Studies on the National Communications and Response Strategy to the Climate Change Convention, the Study of Planning National Actions for the UNFCCC,* and the *Asia Least-cost GHG Abatement Strategy Project (ALGAS),* which was done in cooperation with the Asian Development Bank and the United Nations Development Programme - Global Environment Facility (UNDP-GEF). These research programs contributed significantly to South Korea's completion and submission of its *National Communication.*[29]

In addition to predominantly government-led efforts, industry also contributed to South Korea's progress in completing the *National Communication.* Public utilities and energy intensive industries established a greenhouse gas database. Specific companies, such as Korea Electric Power Corporation, Ssang Yong Cement Corporation and Pohang Steel Corporation, offered research funding and technical assistance that were directly involved in the establishment of the national greenhouse gas inventory.[30]

The preparation of South Korea's national communication report required multiple resources that were not readily available at the time of UNFCCC ratification. Technical knowledge of greenhouse gas accounting and the creation of a greenhouse gas inventory, coordination among multiple private, academic and government institutions, technological resources and support, and a significant amount of public awareness were all essential ingredients in South Korea's UNFCCC compliance. In order to overcome initial obstacles and adequately meet the requirements for national communications, South Korea initiated multiple research and capacity-building programs. By 1998, the aforementioned research projects measuring greenhouse gas emissions and removals had been initiated. Various groups were created to fortify administrative capacity. Numerous workshops and seminars were conducted to increase awareness and training among researchers and government employees. For example, much of the data on greenhouse gas emissions and removals had already been collected by various government research institutes but was not formatted according to the guidelines of the Intergovernmental Panel on Climate Change (IPCC), as required by the UNFCCC. Training and workshops allowed government workers to acquire the knowledge necessary to construct a greenhouse gas inventory following

II. South Korea's Participation in the UNFCCC, *continued*

UNFCCC and IPCC protocols. Ultimately, South Korea completed and submitted its *National Communication* in 1998, one of the few non-Annex I countries to do so.[31]

Contributions from foreign governments, intergovernmental organizations, and nongovernmental organizations also enabled completion of South Korea's *National Communication.* South Korea received more than $5 million from the Global Environment Facility for environmental activities.[32] International workshops and seminars provided education and training of researchers on issues specific to national communications, exchange of advanced inventory information and technology, and establishment of an international network of associated researchers. Additionally, South Korea benefited greatly by participating in the U.S. Department of Energy's *Country Studies,* the Asia-Pacific Network's *Policy Design of Climate Change Collaboration in Northern Asia study,* and the *Program for Asian Cooperation on Energy and the Environment,* which was conducted jointly by the United Nations Development Programme and the Economic and Social Commission for Asia and the Pacific. Efforts such as these were essential in contributing to South Korea's submission of its *National Communication.*[33,34]

III. Emissions Estimates for South Korea

III. Emissions Estimates for South Korea

Current Greenhouse Gas Inventory

The South Korean greenhouse gas inventory submitted as part of the *National Communication* was compiled using procedures outlined in the IPCC's 1995 *Guidelines for National Greenhouse Gas Inventories,* with few exceptions. National emissions for six types of greenhouse gases are reported: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), oxides of nitrogen (NO_X), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOCs).[35] These are cataloged in Table 2 on the following page.

Table 2. Greenhouse Gas Emissions and Removals in South Korea, 1990 (Unit: Gg)

Source: National Communication of the Republic of Korea, 1998.[36]

Category	CO_2	CH_4	N_2O	NO_X	CO	NMVOCs
Net Emissions	**230,278**	**1,362**	**12**	**851**	**1,056**	**152**
1. Energy-Related Emissions	**238,990**	**264**	**11**	**851**	**1,056**	**152**
A. Fuel Combustion	238,990	17	11	851	1,056	152
1. Energy Transformation	37,934	0.3	2	193	7	NA
2. Industry	87,282	1	2	135	25	NA
3. Transport	42,198	6	2	401	600	152
4. Residential & Commercial*	64,592	7	3	105	364	NA
5. Public & Other**	6,985	0.5	4	16	39	NA
6. Biomass Burning	-	2	0.02	0.6	20	NA
B. Fugitive Fuel Emissions	-	246	-	-	-	-
1. Coal Mining	-	230	-	-	-	-
2. Oil and Gas Systems	-	16	-	-	-	-
2. Industrial Processes	**17,512**	**5**	**-**	**-**	**-**	**-**
A. Cement Industry	14,841	-	-	-	-	-
B. Limestone & Dolomite Use	2,459	-	-	-	-	-
C. Soda Ash Use	212	-	-	-	-	-
D. Chemical Industry	-	5	-	-	-	-
3. Agriculture	**-**	**599**	**1**	**-**	**-**	**-**
A. Rice Fields	-	414	-	-	-	-
B. Enteric Fermentation	-	144	-	-	-	-
C. Animal Excrement	-	41	-	-	-	-
D. Nitrogen Fertilizers	-	-	1	-	-	-
4. Waste Management	**11**	**495**	**-**	**-**	**-**	**-**
A. Waste Incineration	11	-	-	-	-	-
B. Landfills	-	200	-	-	-	-
C. Household Wastewater	-	21	-	-	-	-
D. Industry Wastewater	-	274	-	-	-	-
5. Total	**256,513**	**1,362**	**12**	**851**	**1,056**	**152**
6. Removals (Managed Forest)	**-26,235**	**-**	**-**	**-**	**-**	**-**
7. International Bunkering	**7,140**	**-**	**-**	**-**	**-**	**-**

** non-CO emissions are those from residential and commercial sectors in 1989*

*** non-CO_2 emissions are those from public and other sectors in 1989*

III. Emissions Estimates for South Korea, *continued*

Net emissions (Net Emissions = Total Emissions - Removals) for the year 1990 are given by the inventory to be: 230,278 Gg CO_2, 1,362 Gg CH_4, 12 Gg N_2O, 851 Gg NO_X, 1,056 Gg CO, 152 Gg NMVOCs. The greatest source for all six types of gases, except methane, is by far energy-related emissions, mostly the result of fossil fuel combustion.[37] In fact, 80% of all greenhouse gas emissions originates from energy consumption.[38] The energy sector includes the industry, transport, residential and commercial, public, and energy transformation subsectors. Of those subsectors, industry emits the largest share, accounting for 37% of CO_2 emissions. Data for all sects of industry are not available, but cement production is known to comprise the main source of industrial CO_2 emissions.[39]

III. Emissions Estimates for South Korea, *continued*

Energy consumption in Korea has surged over the last two decades, nearly quadrupling between 1981 and 2000. Currently, Korea ranks as the tenth largest energy-consuming country in the world.[40] One of the most promising options for abatement of energy-related greenhouse gas emissions is improvement of efficiency and conservation among the various sectors. Promotion of technology development and the replacement of highly intensive fuels are some examples. Price adjustment, voluntary agreements, incentive programs, institutional and regulatory improvement, and public awareness campaigns can serve to facilitate such measures.[41] In fact, the Korean environment industry is projected to have great potential for growth under these circumstances.[42] As recently as June of 2002, Korea's Ministry of Planning and Budget announced a budget allocation specifically for environment technology, recognizing that these industries are some of the most promising and fastest growing industries today.[43] However, the energy-intensive industrial structure of the Korean economy will likely still prove difficult to manage even with these facilitative actions.[44]

Methane, the second largest source of greenhouse gas emissions by weight, is primarily emitted from agricultural activities such as livestock and rice production.[45] Abatement strategies include careful water management, improvement of application methods of organic materials to soils, increase of direct seeding over transplanting, and the breeding of rice cultivars. Another substantial source of methane comes from the waste management sector, a result of solid waste and waste-water treatment. Because the reduction of waste at the source would be the most cost-effective option, waste minimization and recycling campaigns have been explored as desirable policy options.[46] In fact, in 2002 the government announced its reinforced efforts to continue the *Volume-Based Waste Charging Program,* which has resulted in large reductions in waste in concert with increased recycling.[47] Incineration has also been examined as a major option.[48]

Projected Greenhouse Gas Emissions

Carbon dioxide emissions compose over 95% of South Korea's greenhouse gas emissions by weight. Thus, examining projected CO_2 emissions can provide us with a satisfactory proxy of future greenhouse gas emissions. Projected CO_2 emissions, as reported in the *National Communication,* are listed in the following table:

Table 3. Projected CO_2 Emissions (Unit: million TC, per capita TC, TC/90 million Won)

Source: National Communication of the Republic of Korea, 1998.[49]

	1985	1990	1995	2000	2005	2010	AAGR(%)	
							86-95	96-10
CO_2 Emissions	44.0	65.2	101.1	148.5	187.4	217.0	8.7	5.2
Per Capita CO_2 Emissions	1.1	1.5	2.3	3.2	3.9	4.4	7.7	4.5
CO_2/GDP	0.39	0.36	0.39	0.42	0.40	0.36	-0.1	-0.7

III. Emissions Estimates for South Korea, *continued*

These estimates forecast general increases in CO_2 emissions and CO_2 emissions per capita. A 32% increase in CO_2 emissions and a more than doubling of CO_2 emissions per capita have been projected between the years of 1990 and 2010. Average annual growth rate (AAGR) is estimated at 5.2% for CO_2 emissions and 4.5% for per capita CO_2 emissions through 2010. However, the estimates for CO_2 intensity (CO_2/GDP) show a decrease of about 0.7% through 2010.[50]

A Comparison of Numbers

In order to test the strength of the numbers outlined in the *National Communication,* a comparison of emissions estimates may be conducted with those of other independent sources. For instance, in comparing CO_2 emissions from fossil fuel combustion to those figures of the International Energy Agency (IEA), slight differences are noted. These are illustrated in Table 4 below.

Table 4. Comparison of CO_2 Emissions Estimates (Unit: million T CO_2)

Sources: National Communication of the Republic of Korea, 1998[51] and IEA Statistics, 1997.[52]

Source	1990	1991	1992	1993	1994	1995
National Communication	238.940	262.559	285.793	313.986	342.764	374.104
IEA	231.63	254.75	276.67	303.81	324.25	353.10
% Difference*	3.15	3.07	3.30	3.35	5.71	5.95

** % Difference = (NC-IEA)/IEA*

The figures published by the IEA differ by a small amount, about 3% to 5% for the numbers in this sample. Reasons for these slight differences center around the fact that the IEA estimates are calculated using IEA energy data and default methods and emissions factors from the IPCC's *Revised 1996 Guidelines.* South Korean experts used 1995 guidelines, and in many cases have access to more detailed figures than the defaults and estimates used by the IEA.[53] Discrepancies of this nature are small enough that in this case we may accept the estimates that have been submitted in the South Korean *National Communication*.

IV. Emissions Reduction Initiatives

IV. Emissions Reduction Initiatives

South Korea considers itself a developing country with a need for economic growth, and increasing energy consumption to support that development. At the fifth Conference of the Parties (COP5)to the UNFCCC in Bonn, Germany, in November 1999, South Korea opted out of the reduction obligation based on non-binding and voluntary regulations.[54] However, the South Korean government has enacted numerous policies dedicated to the reduction of greenhouse gas emissions.

The 1998 *National Communication* lists several policy initiatives undertaken following the adoption of the UNFCCC. With respect to energy conservation, in 1992 the *Five-Year Conservation Plan for Energy Intensive Industry* was released, followed by the *Second Five-Year Energy Conservation Plan* in 1996. In 1997 the *Rational Energy Utilization Act* was revised to increase residential energy conservation, and in the following year, the government imposed the *Minimum Efficiency Performance Standards* on the production and sale of appliances and equipment.[55] Other energy-related initiatives include the expansion of liquefied natural gas, nuclear power plants, and other new and renewable energy resources. The *Ten Year National Plan for Energy Technology Development* was established in 1997 with the goal of reducing 10% of the total national energy consumption and replacing 2% of the total with clean energy by 2006.[56]

Another notable event was the establishment of the Centre for Climate Change Mitigation Projects (CCCMP) in the beginning of 1999 with the specific purpose of expanding greenhouse gas mitigation efforts. Thus far, the CCCMP has developed energy consumption and CO_2 emissions inventories, and advocated climate change policies that rely on demand-side management and raise public awareness.[57] In January 1999, South Korea joined the *Technology Cooperation Agreement Pilot Project* (TCAPP), an agreement which helps developing countries design and implement actions to attract investment in clean energy technologies that will meet their economic development goals, while mitigating greenhouse gas emissions.[58] Through this agreement, CCCMP has been able to establish a bilateral partnership with the U.S. government for technology transfer under the UNFCCC.[59] Three priority technologies have been selected thus far: energy management, methane recovery from organic waste, and waste energy recovery using heat pumps. The South Korean TCAPP team is currently developing specific actions to increase private investment in these technologies.[60]

An additional progressive policy initiative took the form of the *2000 Blueprint,* which stresses that "the nation needs to improve energy efficiency while securing a safe supply of energy resources." One of the main objectives of the *2000 Blueprint* is the transition to a low energy consumption structure, which includes:

- the positive promotion of energy conservation policy
- encouragement of an energy conservation movement by maintaining prices at an advantageous level
- promotion of energy technology development
- continued progress under the UNFCCC
- establishment of a National Energy Strategy to cope with economic, social, and other changes in the 21st century[61]

IV. Emissions Reduction Initiatives, *continued*

These and numerous other policy refinements in the residential, commercial, industrial, public, and transportation sectors illustrate the continuing progress of the South Korean government in the area of climate change mitigation and adaptation. One example within the transportation sector entails subsidies provided by the Ministry of Environment to build a fleet of buses operating on compressed natural gas (CNG). Today, over 2,000 CNG buses (10% of total intra-city buses) have been supplied by the Ministry, with plans to provide 1,000 more by the end of this year. Efforts to provide fuel and refueling stations, and raise public awareness, have been essential to this development.[62]

Additional groups, both private and public, are involved with emissions reductions initiatives. For example, the Korea Energy Economics Institute has been extremely active in the climate change arena. Recently, the group released a study advocating the development of a climate change policy portfolio, which could include a carbon tax and a domestic emissions trading program, among other measures.[63] The *Green Energy Family (GEF),* created in 1995, works to enhance energy efficiency through the diffusion of energy efficient facilities. Through the GEF, citizens, companies, nongovernmental organizations, and media all work together to participate in programs such as the *Green Lighting, Green Motor, Green Energy Design,* and *Green Cooling Programs.* The Korean Industrial Committee has stated its dedication to voluntary agreements in greenhouse gas emissions reduction, emissions trading, the Clean Development Mechanism, application of carbon sinks, and the careful implementation of a carbon tax.[64] These and other examples represent Korea's continued, countrywide commitment to climate change mitigation efforts.

V. Future Directions

V. Future Directions

While South Korea has managed to make considerable progress with respect to its UNFCCC commitments, both in the submission of its *National Communication* and in its continuing efforts at greenhouse gas emissions reduction, improvement is still an essential task. Many of the figures submitted in the *National Communication* are incomplete, as can be noted by examining Table 2 above. Considerable improvement can be made to data quality, and inventory and projection methodologies.[65]

Nonetheless, the Republic of Korea provides a rousing example of the capability developing countries have to contribute to global climate change mitigation and adaptation. Although classified as a non-Annex I country, South Korea is the tenth highest emitter of greenhouse gases in the world, thus playing a significant role in the global climate change arena. Furthermore, the country widely recognizes that extreme weather events, sea level rise, and other manifestations of the changing climate will likely have drastic effects on its population. For these reasons, South Korea has made advances toward changing its basic economic structure to reduce greenhouse gas emissions. Low energy-intensive industries, such as environmental technology and bioengineering, are advancing

V. Future Directions, *continued*

rapidly in South Korea. Furthermore, the government has focused industrial development policies in such a way that these sectors may grow.[66]

South Korea's contributions, both within and beyond its borders, signify the commitment this country has to climate change mitigation. It should be noted, however, that South Korea is among the more stable, wealthier countries of the world. Strong economic development and a relatively stable economy, in addition to assistance from international organizations and governments, have helped South Korea to achieve such marked progress with respect to climate change mitigation efforts.[67] The transfer of knowledge, training, and technology to South Korean government researchers and scientists played a considerable role in the completion of the *National Communication,* as did participation in various country studies, such as the *U.S. Country Studies* and *ALGAS.* Continued assistance from industrialized governments, nongovernmental organizations, and intergovernmental organizations would only serve to improve South Korean cooperation and participation in global efforts toward climate change and in the production of their next national communication report.

Endnotes

[1] **South Korea - A Country Study.** June 1990. Library of Congress. Retrieved 23 July 2002. <http://lcweb2.loc.gov/frd/cs/krtoc.html#kr0000>

[2] **Geography: Korea, South.** 2002. About, Inc. Retrieved 24 July 2002. <http://geography.about.com/library/cia/blcsouthkorea.htm>

[3] Op. cit., Library of Congress.

[4] **Country Health Information Profile: Korea, Republic of.** World Health Organization. Retrieved 24 July 2002. <http://www.who.org.ph/chip/ctry.cfm?ctrycode=kor&body=kor.htm&flag=kor.gif&ctry=KOREA,%20REPUBLIC%20OF>

[5] Op. cit., Library of Congress.

[6] **Human Development Indicators.** 2001. United Nations Development Programme (UNDP). Retrieved 23 May 2002. <http://www.undp.org/hdr2001/back.pdf>

[7] **SIMA Quick Query Database.** 2001. World Bank. Retrieved 24 May 2002. <http://sima-ext.worldbank.org/query/>

[8] Witherell, William. **Korea in the OECD: Realising the Promise.** Second Korea-OECD Conference, *Korea's Five Years in the OECD: Finding a New Path.* 13-14 December 2001. Seoul, Korea. Retrieved 24 May 2002. <http://www.oecd.org/pdf/M00022000/M00022937.pdf>

[9] Op. cit., World Bank.

[10] Op. cit., Library of Congress.

[11] Op. cit., World Bank.

[12] Op. cit., Library of Congress.

[13] Op. cit., World Bank.

[14] Op. cit., Library of Congress.

[15] Op. cit., World Health Organization.

[16] Op. cit., Library of Congress.

[17] Op. cit., World Bank.

[18] International Energy Agency (IEA). **Key World Energy Statistics from the IEA: 2001 Edition.** Paris: International Energy Agency (IEA), 2001. p. 48-57.

[19] Op. cit., World Bank.

[20] The Government of the Republic of Korea. Ministry of Trade, Industry and Energy (MOTIE). **National Communication of the Republic of Korea.** 1998.

[21] **Climate Change and Korea: Perspectives on Korean Environmental Movement.** 23 September 1998. Korean Federation for Environmental Movement. Retrieved 29 July 2002. <http://english.kfem.or.kr/international/symposium/KFEM.doc>

[22] **United Nations Framework Convention on Climate Change: Status of Ratification.** 11 December 2001. United Nations Framework Convention on Climate Change. Retrieved 20 June 2002. <http://unfccc.int/resource/conv/ratlist.pdf>

[23] **Kyoto Protocol Status of Ratification.** 20 December 2002. United Nations Framework Convention on Climate Change. Retrieved 30 December 2002. <http://unfccc.int/resource/kpstats.pdf>

[24] **National Communications from Parties Not Included in Annex I to the Convention: Third Compilation and Synthesis of Initial National Communications from Parties Not Included in Annex I to the Convention.** 5 October 2001. United Nations Framework Convention on Climate Change. FCCC/SBI/2001/14/Add.1. Retrieved 10 July 2002. <http://unfccc.int/resource/docs/2001/sbi/14a01.pdf>

[25] **Energy Efficiency Policies 2000, 2001, and 2002.** October 2001. International Energy Agency (IEA). Retrieved 10 May 2002. <http://www.iea.org/pubs/newslett/eneeff/Table.htm>

[26] **About KEEI.** 2001. Korea Energy Economics Institute (KEEI). Retrieved 26 July 2002. <http://www.keei.re.kr/keei/main_eng.html>

Endnotes, *continued*

[27] Op. cit., IEA. Energy Efficiency Policies.

[28] Sung, Joon Yong. **Climate Change Policies and Measures in Korea.** 17 December 2001. LG Institute of E.S. & H., Korea. Retrieved 17 July 2002. <http://host-4.iges.or.jp/cc/cp/papers/asia/data/pdf2/211P.pdf>

[29] Jung, Yonghun. *Lessons Learned from Preparing a UNFCCC National Communication: A Case of the Republic of Korea.* **Asia: Looking Ahead - Initial Stages of National Communications Reporting.** Eds. Kilaparti Ramakrishna, Barbara Bamberger, and Linda Jacobsen. Woods Hole, MA: The Woods Hole Research Center, 2000, pp. 1-12.

[30] Ibid., 7.

[31] Ibid.

[32] **Country Profiles of Environmental Performance: Republic of Korea.** Yearbook of International Co-operation on Environment and Development. Retrieved 30 July 2002. <http://www.greenyearbook.org/profiles/korea.htm>

[33] **Project # 2001-15.** 2002. Asia-Pacific Network. Retrieved 17 July 2002. <http://www.apn.gr.jp/p-rep0115.htm>

[34] Op. cit., Jung, 8.

[35] Op. cit., Government of the Republic of Korea.

[36] Ibid., 29.

[37] Ibid., 32-36.

[38] Op. cit., Sung,.

[39] Op. cit., Government of the Republic of Korea, 32-36.

[40] Op. cit., Sung, 1.

[41] Asian Development Bank (ADB), Global Environment Facility (GEF), United Nations Development Programme (UNDP). **Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS): Republic of Korea.** Manila: Asian Development Bank, 1998.

[42] Tae-kyung, Byun. *Korea Strives to Develop Environment Technology.* **The Korea Herald.** 5 June 2002. Retrieved 16 July 2002. <http://koreaherald.com/SITE/data/html_dir/2002/06/05/200206050011.asp>

[43] **Environmental News: Budget for Environmental Technology To Be Expanded.** 18 June 2002. Ministry of Environment-Republic of Korea. Retrieved 16 July 2002. <http://www.me.go.kr:8080/me/front/env/bbs_read.jsp?tablename=me_envs&bbs=bbs1&pg=1&seq=40>

[44] Op. cit., Sung, 3.

[45] Op. cit., Government of the Republic of Korea, 32-36.

[46] Op. cit., ADB/GEF/UNDP, 13.

[47] **Environmental News: Korea's Experience of Reafforestation As A Step Towards Global Sustainability.** 21 June 2002. Ministry of Environment-Republic of Korea. Retrieved 16 July 2002. <http://www.me.go.kr:8080/me/front/env/bbs_read.jsp?tablename=me_envs&bbs=bbs1&pg=0&seq44>

[48] Op. cit., ADB/GEF/UNDP, 13.

[49] Op. cit., Government of the Republic of Korea, 41.

[50] Ibid.

[51] Ibid., 32.

[52] International Energy Agency (IEA). **CO_2 Emission from Fuel Combustion: A New Major Basis for Comparing Emissions of a Major Greenhouse Gas.** Paris: OECD/IEA, 1997.

[53] Ibid., 27.

[54] Op. cit., IEA. Energy Efficiency Policies.

[55] Op. cit., Government of the Republic of Korea, 45.

[56] Op. cit., Sung, 4.

[57] Op. cit., IEA. Energy Efficiency Policies.

[58] **Technology Cooperation Agreement Pilot Project (TCAPP).** National Renewable Energy Laboratory. Retrieved 30 May 2002. <http://www.nrel.gov/tcapp/index.html>

Endnotes, continued

[59] Op. cit., IEA. Energy Efficiency Policies.

[60] **Technology Cooperation Agreement Pilot Project: Republic of Korea.** National Renewable Energy Laboratory. Retrieved 30 May 2002. <http://www.nrel.gov/tcapp/republic_of_korea.html>

[61] Op. cit., IEA. Energy Efficiency Policies.

[62] **Environmental News: The Number of CNG Buses In Operation Reached 2000 on June 5th.** 4 June 2002. Ministry of Environment-Republic of Korea. Retrieved 16 July 2002. <http://www.me.go.kr:8080/me/front/env/bbs_read.jsp?tablename=me_envs&bbs=bbs1&pg=2&seq=31>

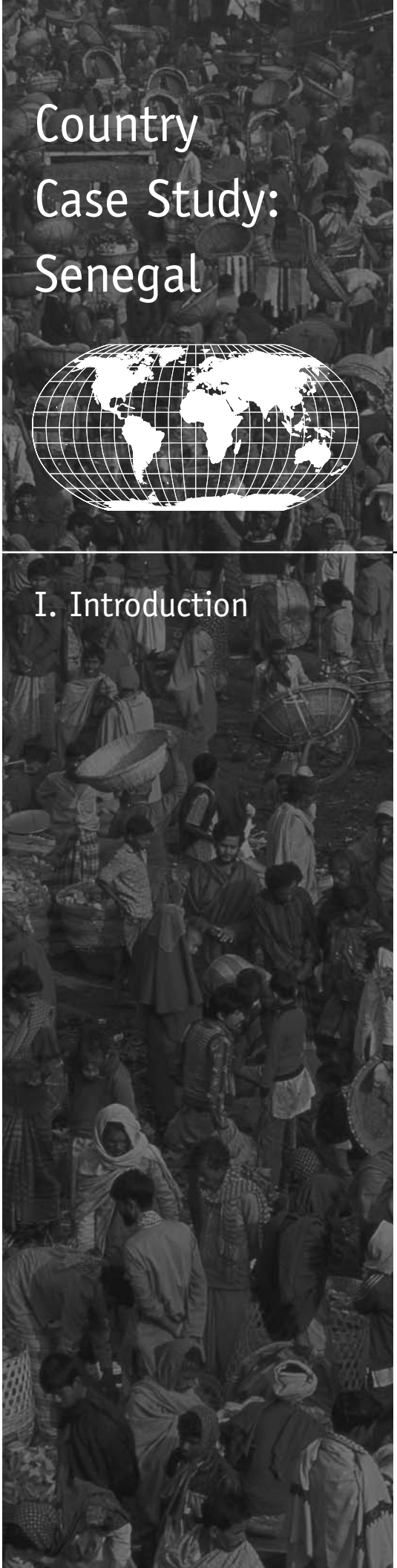
[63] **A Study on Portfolio of Domestic Policies and Measures for GHG Emissions Abatement.** 14 March 2002. Korea Energy Economics Institute. Retrieved 29 July 2002. <http://www.keei.re.kr/keei/main_eng.html>

[64] Op. cit., Sung, 6-9.

[65] Op. cit., Jung, 8.

[66] Myung-ja, Kim. *Now Is The Time To Act.* **The Korea Times.** 7 November 2001. Retrieved 17 July 2002. <http://www.hankooki.com/kt_nation/200111071659334111O.htm>

[67] Op. cit., Jung, 11.



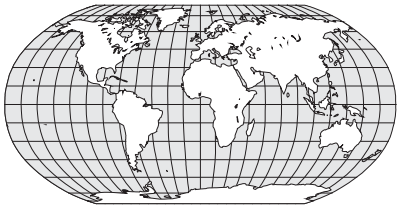
Country Case Study: Senegal

I. Introduction

Senegal became an independent nation in 1960 and has been a pioneer in writing a rulebook on how an independent country in Africa might thrive. It has experienced economic development with an annual GDP growth of more than 5% since 1994.[1] This includes a growth of 2.5% per capita with a population increase of 2.5% over the period 1994-2000.[2]

Although agriculture, a dominant economic sector, has been declining over the last decade, it still contributed 1.8 of the 5.5% GDP growth in 2000. Since the majority of Senegalese land is not fertile, only 19% of the country (37,377 km^2) can be farmed, and almost 30,000 square kilometers of this land is already being actively used. A secondary sector, commerce, contributed the most to GDP in 2000. By implementing structural and fiscal reforms, Senegal reduced inflation to 0.8% in 1999. The Organisation for Economic Co-operation and Development (OECD) predicts a slower growth in 2002 of 3.5% because "a more energetic growth policy would destabilize public finance."[3] Because of the country's more or less supportive investment environment,

I. Introduction, *continued*



its political and economic stability and privatization policy, plus its quite developed infrastructure and banking system, there is an increase in investments and aid to "projects from bilateral and multilateral sources." However, there is no equitable distribution between rural and urban areas, and the rural poverty level is much higher than that of the urban population. Despite achieving economic growth of this magnitude, Senegal is classified by the World Bank as a low-income economy with insufficient growth to combat poverty.[4]

Along with other African countries, the Senegalese government gives priority to sustainable development, poverty alleviation, adaptation to climate change, and capacity building in its national strategy. However, the very low social indicators such as life expectancy and illiteracy rate, plus the slow economic growth of African countries, show the difference in the state of development between African countries and those of Latin America and South Asia.[5] *Africa's energy consumption is less than 2-3% of the global energy resources. This low energy consumption results in only a 4% African contribution to global greenhouse gas (GHG) emissions.*[6] *However, African countries are considered the most vulnerable countries to climate change effects. This vulnerability is a result of many factors. The lack of institutional, economic, and financial capacity makes African countries sensitive to climatic changes. Climate change consequences such as desertification or floods may lead to falls in agricultural production, decreases in the food supply, and progressive poverty.*[7]

Low contributions to global emissions also decrease the opportunity for African countries to benefit from the Clean Development Mechanism (CDM). The CDM was introduced in the Kyoto Protocol to the UNFCCC with the following aim: "promoting the implementation of projects in developing countries which should achieve sustainable development, contribute to the ultimate objective of the UNFCCC and assist developed countries in complying with their quantified emission reduction and limitation commitments."[8] *African countries may not be able to take part in CDM investments for a number of reasons. For example, developing countries with high emissions such as China and India have large numbers of "lower cost abatement opportunities."*[9] *Because of the small size of potential projects, Africa cannot compete with these countries for CDM projects without some special considerations. Moreover, the small and undeveloped market and private sector, the instability of the African economy, and the overall socio-political conditions, coupled with the lack of domestic capacity to process and implement these projects, are additional obstacles that make Africa unattractive for investments. Also, without strong, well-linked structures at the national level, and the necessary institutional capacity and administrative infrastructure, it is difficult to develop and implement climate change policy. Key ministerial departments such as finance, energy, transport, agriculture, and others are not yet involved in the climate change debate. Africa's weak infrastructure in terms of transport, telecommunications, energy supply, and institutions means that the transaction costs of project negotiation, development, and implementation will be particularly high on this continent.*[10]

I. Introduction, *continued*

In addition to this lack of institutional, personnel, and monitoring capacities, African countries do not have historical investment relationships. Only 3% of global Foreign Direct Investment (FDI) in 1997 went to Africa, and this inflow was devoted to the extraction of natural and mineral resources and was concentrated in only a few countries.[11] *And African countries have so far been unable to fully benefit from the financial opportunities offered by the Global Environment Facility (GEF), nor are they able to exploit the opportunities presented by participating fully in a feature advanced in implementing the United Nations Framework Convention on Climate Change (UNFCCC) called AIJ (Activities Implemented Jointly). Indeed, African countries proposed very few projects.*[12]

Table 1. Senegal Summary Statistics*

Source: World Bank, 2000[13] *and International Energy Agency, 2001.*[14]

External Debt (% of GDP at nominal value)	78.3
Aid Per Capita (current USD)	44
Energy Production (million tons oil equivalent)	1.68 (1999 value)
Total Primary Energy Supply (million tons of oil equivalent)	2.96 (1999 value)
GDP (billion constant 1995 USD)	5.81
GDP (billion current USD)	4.37
GDP, PPP billions (constant 1995 USD)	12.93
GDP Per Capita (constant 1995 USD)	609
GDP Growth (annual %)	6
GDP Per Capita Growth (annual %)	3
Agriculture (% of GDP)	18
Industry (% of GDP)	27
Services, etc. (% of GDP)	55
Population (millions)	9.53
Population Growth (annual %)	3
Urban Population (% of total)	47
Poverty Incidence (% of population)	57
Rural (% of rural population)	76
Fertility Rate, Total (births per woman)	5
Life Expectancy at Birth, Total (years)	52
Illiteracy Rate, adult female (% of female ages 15 and above)	72
Illiteracy Rate, adult male (% of male ages 15 and above)	53
Sanitation (% of population with access)	94
Improved Water Source (% of population with access)	78
Internet Users	40,000
Surface Area (km^2)	196,722
Forest Area (% of land area)	32
CO_2 Emissions (Mt)	3.28 (1999 value)
CO_2 Emissions (metric tons per capita)	0.35 (1999 value)
CO_2 Emissions (kg per 1995 USD of GDP)	0.60 (1999 value)
CO_2 Emissions (kg per PPP $ of GDP)	0.25 (1999 value)

** All figures are from the year 2000, unless otherwise indicated.*

II. Senegal's Participation in the UNFCCC

II. Senegal's Participation in the UNFCCC

Senegal signed the Convention on June 13, 1992, and ratified it on October 17, 1994. Senegal acceded to the Kyoto Protocol on July 20, 2001.[15]

Senegal has been one of the most active countries in Africa in carrying out a series of workshops and training programs to build capacity at various levels of society in both francophone and anglophone countries of Africa. Senegal also played a vital role in the Convention process by bringing the concerns of Africa to the table. Recently, it established a National Climate Change Committee (NCCC) and was elected as an alternate member of the CDM Executive Board. In addition to these activities, Senegal joined others in ensuring that the African Ministerial Conference on Environment included climate change as one of the priority areas in the New Partnerships for Africa's Development (NEPAD).

The *Initial National Communication of Senegal* has been prepared according to the guidelines adopted by the Intergovernmental Panel on Climate Change (IPCC) and was submitted on December 1, 1997.[16] The Ministry of Environment and Nature Protection of Senegal executed the preparation of the *National Communication* in cooperation with the Regional Bureau of UNDP and GEF. The *National Communication* inventory was completed on the basis of 1994 data, including data from the previous inventory of 1991. There is a useful comparison of energy consumption between these years and a projection of trends to come.[17]

In attempting to use the IPCC guidelines in the preparation of the emissions inventory, several difficulties were encountered in using materials already available because of the differences in methodologies and the units used. Also, difficulties during inventory preparation are associated with the general weakness of the science and technology infrastructure—in particular, the relatively small numbers of technically trained professionals. This low capacity of the country limited implementation of the research. There are also gaps in the inventory presented in the *National Communication* resulting from the absence of carbon stock data.[18] Improved forest inventory, agricultural systems, and energy sector data are needed to refine the inventory. Some assumptions, especially the default data used, should be adjusted for the socioeconomic conditions of Senegal.

III. Emissions Estimates for Senegal

III. Emissions Estimates for Senegal

The inventory provides us with GHG emissions numbers for 1994. The energy sector of the national economy emitted the largest amount of GHGs at 3.8 million metric tons ECO_2, which is 40% of the country's total emissions. The second biggest emitter (32%) is agriculture, the sector employing 70% of the working population.[19] Table 2 demonstrates the summary of GHG emissions by sector in 1994.

Table 2. Synthesis of the GHG Emissions in Senegal in 1994

Source: Initial National Communication of Senegal.[20]

Sectors	Emissions in Gg					Gg equivalent	
	CO_2	CH_4	CO	N_2O	NO_X	ECO_2	%
Energy							
Source of energy	3,660	5.38	41.25	0.032	1.17		Except
Oil production/gas		0.27					forest
Total	3,660	5.65	41.25	0.032	1.17	3,788.6	40.6
Industry	345.5						
Total	345.5					345.5	3.7
Agriculture							
Livestock		137.98					
Savanna burning		0.99	26	0.012	0.44		
Other agricultural activities		1.19	25	0.034	1.25		
Total		140.16	51.00	0.046	1.69	2,957.6	31.7
Forests							
Deforestation	19,244.5						
Gas traces		25.04	219.15	0.17	6.21		
CO_2 annual abatement by exploited forests	-25,820.0						
Total	-6,575.5	25.04	219.15	0.17	6.21	-5,997	
Waste							
Public		86.80					
Industrial		19.21					
Total		106.01				2,226.2	24
Cumulative emissions	-2,570	276.86	311.4	0.248	9.07	3,321	100
Potential for global warming for 100 years	1	21		310			
Equivalent CO_2	-2,570	5,814		77		3,321	100

III. Emissions Estimates for Senegal, *continued*

The previous study of greenhouse gas emissions in 1991 also states that the energy sector emitted the largest percentage of GHGs (45%).[21] Moreover, the burning of biomass fuels produced 33% of total GHG emissions and 23% of CO_2 emissions. GHG emissions from fossil fuels accounted for 12% of the total, and 10% of total CO_2 emissions came from burning fossil fuel.[22] After the energy sector the agricultural sector had the second largest GHG emissions percentage (24%). Livestock, savanna burning, and rice cultivation are the main sources of emissions of CO, CH_4, NO_X and N_2O. A significant part of GHG emissions (18%) resulted from land-use changes that contributed 66% of CO_2.[23] There is no information about industrial emissions, with the exception of the cement industry, which contributed 1% of CO_2, because it was the only industry for which data were available. There was also no information on energy consumption. Varying sources and estimations were used to make the inventory.[24] The inventory of 1991, providing a balance of sources and sinks of CO_2, stated that sinks sequestered less CO_2 (11.6 million metric tons) than was emitted (22.4 million metric tons). As a result, 10.8 million metric tons of CO_2 from 17.6 million metric tons ECO_2 of all GHG emissions were produced in 1991.[25] Percentages of CO_2 and CH_4 and N_2O emissions equal 61%, 35%, and 4% respectively.[26]

III. Emissions Estimates for Senegal, *continued*

In contrast to this analysis, the inventory prepared under the *National Communication,* using 1994 data, reports that the capacity of sequestration of the exploited forests (25.8 million metric tons of CO_2) compensates for emissions from other sectors, and results in total GHG emissions of 3.3 million metric tons ECO_2 in 1994 (Table 2).[27] Thus, GHG emissions were equal to 408.3 kg ECO_2 per capita (population was 8,133,000 people) or 1.12 kg ECO_2 per day.[28]

Of the emissions of 1994 related to energy sources, 44% are associated with industrial activities, 32% with transport, and 24% with the residential and other sectors (Table 3).[29]

Table 3. Emissions from energy sources

Source: Initial National Communication of Senegal.[30]

Sectors	Emissions of GHGs (Gg)					Total (ECO_2)		
	CO_2	CH_4	CO	N_2O	NO_X	Gg	MMt	%
Industries	1623	1.30	21.7	0.025	0.92	1658.1	1.658	44
Transport	1233					1233	1.233	32
Residential	804	4.35	19.5	0.007	0.24	897.5	0.898	24
Total	3660	5.65	41.2	0.032	1.16	3788.6	3.789	100

Analyzing the energy balances of 1991 and 1994, the *National Communication* indicates the slight rise in energy production of 0.17% from 489,870 Mtoe to 490,733 and the rise of the import of petroleum products from 844,901 Mtoe to 1,097,743 Mtoe, which equals almost 30% for the period from 1991 to 1994. Also, there was a significant decrease of almost 21% in charcoal consumption.[31] The final energy consumption in 1994 was 701,328 Mtoe with the following sectoral distribution: industry - 34%, transport - 41%, households and others - 25%.[32]

The data provided by the Energy Information Administration (EIA) of the U.S. Department of Energy (U.S. DOE) for 1998 and 1999 show the changes in the sectoral distribution of carbon emissions. In contrast to 1994, transportation, in 1998, was 43.1% of total carbon emissions, but the industrial share accounted for 36.3%. The residential and commercial sectors tallied 16.0% and 4.6% respectively. Oil shared more than 98% of carbon emissions, with the residual percentage due to natural gas.[33] The constant increase in carbon dioxide emissions from petroleum consumption for the last decade is presented in Table 4 and confirms the continuing growth indicated by the *National Communication* inventory. Also shown are CO_2 emissions numbers from the consumption and flaring of natural gas, which have grown since 1993.[34]

Table 4. Carbon Emissions from the Consumption of Petroleum and Natural Gas 1991-2000

Source: Energy Information Administration. International Energy Annual 2000.[35]

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Carbon Dioxide Emissions from the Consumption of Petroleum, (MMTCE)	0.64	0.79	0.80	0.95	1.02	1.03	0.95	1.00	1.11	1.20
Carbon Dioxide Emissions from the Consumption and Flaring of Natural Gas, (MMTCE)	0.00	0.00	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.02

III. Emissions Estimates for Senegal, *continued*

According to the Energy Information Administration, energy related carbon emissions of 1999 were equal to 1.06 million metric tons of carbon, which is less than 0.1% of world total carbon emissions.

The value of carbon emissions per capita in 1999 was 0.1 metric tons of carbon, which is less than 2% of the U.S. value (5.5 metric tons of carbon).[36]

IV. Emissions Reduction Initiatives

IV. Emissions Reduction Initiatives

The strategies of reduction and/or stabilization of the emissions of GHGs include improving energy efficiency and working on increasing activities that sequester carbon through afforestation. An example of a project combining these strategies is the *Sustainable and Participatory Energy Management* project initiated by the World Bank and the Senegalese ministries of Environment and Protection of Nature and of Industry and Energy in 1996.[37] The goals of the project are carbon sequestration, local income enhancement, and fuel substitution in the Niokolo-Koba National Park and surrounding area. Another project, entitled *Energy Sector Investment*, will complement the government strategy for energy sector reform and liberalization described in the Letter of Sector Development Policy issued in 1997.[38] This project, while increasing access to electricity in rural areas, promotes renewable energy sources. The project was approved by the GEF in February 2001. Also, the UNDP implemented the project *Climate Change Enabling Activity (Additional Financing for Capacity Building in Priority Areas)* in August 2000.[39]

Senegal also participates in regional and global initiatives. The project *Control of Greenhouse Gas Emissions through Energy Efficient Building Technology in West Africa* is already in its final stage.[40] The main goal of this project is to introduce energy efficient building technologies "to retrofit the existing buildings and to design, build and operate more efficient new buildings." Another project, whose first phase is close to the end, is *Economics of GHG Limitation,* which involves studies of climate change mitigation options in the various sectors of the national economy.[41] Studies under this project estimated the possible amount of avoided CO_2 emissions of 1.1 million tons by using new energy sources instead of fossil fuel burning during a fifteen-year period.[42] The project *Country Case Studies on Sources and Sinks of Greenhouse Gases* provided direct operational and financial support for development of methodologies that Senegal as well as some other developing countries might use to develop national GHG inventories. The project was completed in 1997.[43]

The African Forum on Climate Change (AFCC) project was created to help

IV. Emissions Reduction Initiatives, *continued*

UNFCCC Parties from Africa to mobilize the major "stakeholders" such as government, NGOs, and the private sector to participate in the UNFCCC. The *Clean Development Mechanism and Technology Transfer* project provides assistance to deal with problems listed above to promote CDM coverage in African countries.[44]

Senegalese authorities actively promote the use of renewable energy by initiating such projects as the *Solar Equipment Program 1995-2000* to raise electrification of rural areas and provide wind power and solar indices for water pumping and community and administrative infrastructures. An example of government's initiative is the "eco-city"—a model town built of sand-filled tubes that uses solar and wind energy. The eco-city, if implemented, aims to help solve the housing problem in Senegal.[45]

Senegalese authorities have made a conscious decision to promote energy efficiency and to this end have modified their most inefficient power plants, transport, and distribution network. They have also helped restore to effectiveness the transportation infrastructure. With the incentives offered by the government of Senegal in providing energy efficient equipment to industry, industrial enterprises have avoided high capital investment costs and have succeeded in reducing their annual consumption by as much as 30%.[46] There are also programs to promote the improvement of commercial and household lighting efficiency and the development of cleaner alternatives to wood fuels, including local manufacture of improved cook stoves.[47]

V. Future Directions

V. Future Directions

The authors of "Confronting Climate Change," a report that was prepared under the auspices of the *Climate of Trust* project of the National Environmental Trust and its partners in developing countries, while discussing the capabilities of implementation of the UNFCCC of developed and developing countries and the conflict between national interests and international responsibilities, acknowledge the important role of civil society. NGOs, as representatives of civil society can make international negotiations truly effective by contributing their global environmental perspective to the debate.[48]

Given the prominent role that agriculture plays in the Senegalese GDP, and given its contributions to GHG emissions and the purported plan of the government to work on mitigating these emissions, there is an urgent need for the development of a sustainable agricultural system.

Achieving sustainable development, the priority of all African countries, that will decrease their vulnerability to climate change, requires the attraction of investments. These efforts should consider the country's national strategies and be adaptable to the needs and objectives of the country, and also involve all interest groups. Cooperation between developing nations will help support their position in the achievement of development needs.[49]

Endnotes

[1] **Data and statistics. Country classification.** World Bank. <http://www.worldbank.org./data/countryclass/countryclass.html>

[2] Organisation for Economic Co-operation and Development (OECD)/African Development Bank (AfDB). **African Economic Outlook.** Senegal. January 2002. <http://www.oecd.org/pdf/M00025000/M00025431.pdf>

[3] Ibid.

[4] Op. cit., World Bank. Data and Statistics.

[5] Sokona, Youba and Fatma Denton. **Climate Change Impacts: Can Africa Cope the Challenges?** Dakar, Senegal: ENDA Tiers Monde, January 2001. <http://www.enda.sn/energie/cc/ccimpacts.htm>

[6] Sokona, Youba and Djimingué Nanasta. *The Clean Development Mechanism: An African Delusion?* **Change,** No. 54, October-November 2000, pp. 8-11. <http://www.enda.sn/energie/cc/cdm-afric.htm>

[7] Op. cit., Sokona and Denton.

[8] Op. cit., Sokona and Nanasta.

[9] Ibid.

[10] Ibid.

[11] Ibid.

[12] Ibid.

[13] **SIMA Quick Query Database.** The World Bank. <http://sima-ext.worldbank.org/query/>

[14] International Energy Agency. **Key World Energy Statistics from the IEA.** 2001. Paris: International Energy Agency (IEA), 2001. <http://www.iea.org/statist/key2001/keyworld2001.pdf>

[15] **Convention Parties and Observers.** United Nations Framework Convention on Climate Change. <http://unfccc.int/resource/country/country.html?46>

[16] **Initial National Communication of Senegal.** UN Framework Convention on Climate Change. November 1997. <http://unfccc.int/resource/docs/natc/sennc1.pdf>

[17] Ibid.

[18] Ibid.

[19] Ibid.

[20] Ibid.

[21] Sokona, Youba. *Greenhouse Gas Emission Inventory for Senegal, 1991.* In J.F. Fitzgerald, et. al., eds., **African Greenhouse Gas Emission Inventories and Mitigation Options: Forestry, Land-Use Change, and Agriculture.** London; Boston; Dordrecht: Kluwer, 1996.

[22] Ibid.

[23] Ibid.

[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] Op. cit., Initial National Communication of Senegal.

[28] Ibid.

[29] Ibid.

[30] Ibid.

[31] Op. cit., UNFCCC. Convention Parties and Observers.

[32] Op. cit., Initial National Communication of Senegal.

[33] **Country Analysis.** Energy Information Administration (EIA). U.S. Department of Energy (U.S. DOE). <http://www.eia.doe.gov/emeu/cabs/senegal.html>

[34] Op. cit., IEA.

Endnotes, *continued*

[35] **International Energy Annual 2000.** Tables H2 and H3. Energy Information Administration (EIA). U.S. Department of Energy (U.S. DOE), 2000. <http://www.eia.doe.gov/emeu/iea/carbon.html>

[36] Op. cit., EIA/U.S. DOE. Country Analysis.

[37] **GEF Projects.** Global Environmental Facility (GEF). <http://www.gefonline.org/projectList.cfm>

[38] Ibid.

[39] Ibid.

[40] Ibid.

[41] Ibid.

[42] **Economics of Greenhouse Gas Limitations.** UNEP Collaborating Center on Energy and Environment. 2001. <http://www.uccee.org/EconomicsGHG/Senegal.pdf>

[43] Op. cit., GEF.

[44] **Climate Change Program.** African Centre for Technology Studies. <http://www.acts.or.ke/>

[45] **Model Eco-City Could Soon Rise in Senegal.** Planet Ark World Environmental News. March 2002. <http://www.planet.ark.org/dailynewsstory.cfm?newsid=15008&newsdate=14-Mar-2002>

[46] Biagini, B. (Ed.) **Confronting Climate Change: Economic Priorities and Climate Protection in Developing Nations.** A Climate of Trust Report. Washington, D.C.: National Environmental Trust, 2000.

[47] Ibid.

[48] Ibid.

[49] Thomas, Jean Philippe and Sokona, Youba. *The Future Is Now.* **Development First.** Vol.3. May 2002.

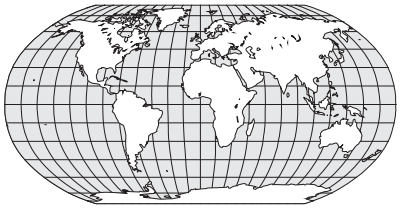
Country Case Study: South Africa

I. Introduction

The Republic of South Africa is the seventh largest country in Africa, with varying climate throughout its many regions. Subtropics in the northeast and the desert in the northwest, with Mediterranean-like conditions in the south of the country, characterize the land. Topographically, the interior highlands are a continuation of the African Plateau, which stretches north to the Sahara Desert, and rises to the Drakensburg Mountains in the south and east. The Great Escarpment descends into coastal lowlands, where many natural harbors dot the 3,000-kilometer long South African coast.[1]

South Africa's emergence from global isolation in the 1990s brought with it great political and economic upheaval, and the country continues to work toward eliminating the vestiges of apartheid. That system deprived South African society of much of its human potential, and coping with its legacies has complicated the process of establishing a new societal system

I. Introduction, *continued*



based on nonracial norms. Many of the difficulties the South African government and people face are directly affected by race and class differences that continue to hang heavily over the population, beyond the abolition of apartheid.[2]

For example, a superior education system served only the racial minority until the 1990s; today, the system is overwhelmed by a shortage of teachers, classrooms and equipment. These shortages, once confined to poor black communities but more widespread since integration, are exemplified in the rate of illiteracy, which was as high as 40% in the 1980s. Consequently, a largely unskilled and uneducated population has been left with few employment options, resulting in high rates of unemployment and, simultaneously, high rates of crime. Access to health care for South African citizens is also clearly divided along class lines, as superior care is available to wealthy, urban residents (1 physician per 1,200 people), most of whom are white, while inferior services are available to the rural poor (1 physician per 10,000 people), most of whom are black. Indeed, tuberculosis, HIV/AIDS, and malaria continue to plague large sectors of the population.[3] *However, more recent figures collected by the United Nations Development Programme (UNDP) show a dramatic increase in adult literacy to about 85%.*[4]

The South African economy appears to be service-oriented, but in fact is largely comprised of highly energy-intensive industry, with manufacturing comprising the largest sector at approximately one-fifth of the total GDP.[5] *Strong growth is occurring in the area of export-oriented manufacturing. Mining holds about 10% of the GDP, with operations that extract the famous South African diamonds, as well as gold, platinum, manganese and vanadium. Coal mining operations are also fairly strong, as South Africa has extensive coal reserves that are projected to last throughout the 21st century. Trade, finance, general government operations and agriculture complete the current structure of the economy.*[6]

Despite various promising signs of improvement, much of the population lacks access to the basic securities of employment, safety, health care and educational benefits, and South Africa is still deep in the struggle for development and improved quality of life for its citizens. Furthermore, the disparities between the wealthy and the poor are startlingly vast. The Gini index,[7] *a figure that measures "the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution," was estimated as high as 60 in the 1990s (a Gini index of zero represents perfect equality, while an index of 100 implies perfect inequality).*[8] *The UNDP Human Development Index marks South Africa a country of "medium human development," ranked above approximately 40% of the 162 listed countries.*[9] *This ranking is lower than one might expect due to the country's low life expectancy, an impact of the HIV/AIDS crisis. The table that follows lists several summary statistics that illustrate the current state of development in South Africa.*

I. Introduction, *continued*

Table 1. South Africa Summary Statistics*

Sources: World Bank, 2000[10] and International Energy Agency, 2001.[11]

External Debt, Total (DOD, current USD)	24,861,399,040
IBRD Loans and IDA Credits (PPG DOD, current USD)	3,400,000
Commercial Energy Use (kg oil equivalent per capita)	2,597 (1999 value)
GDP (billion 95 USD)	164.37
GDP-PPP (billion 95 USD)	360.65
GDP Per Capita (95 USD)	3,985
GDP Growth (annual %)	3
GDP Per Capita Growth (annual %)	1
Agriculture (% of GDP)	3
Industry (% of GDP)	31
Services, etc. (% of GDP)	66
Population (millions)	42.11
Population Growth (annual %)	2
Urban Population (% of total)	55
Fertility Rate, Total (births per woman)	3
Life Expectancy at Birth (years)	48
Adult Illiteracy Rate	15
Sanitation (% of population with access)	86
Improved Water Source (% of population with access)	86
Internet Users	2,400,000
Surface Area (km^2)	1,221,040
Land Use - Permanent Cropland (% of land area)	1 (1999 value)
Forest Area (% of land area)	7
CO_2 Emissions (Mt of CO_2)	346.31
CO_2 Emissions Per Capita (t CO_2/population)	8.22
CO_2 Emissions Per GDP (kg CO_2/95 USD)	2.11
CO_2 Emissions Per GDP (kg CO_2/95 USD PPP)	0.96

** All figures are from the year 2000, unless otherwise indicated.*

As a country particularly vulnerable to changes in climate, South Africa has recognized the importance of international agreements on climate change. Government reports claim that climate variability and the potential impacts of global warming are taken seriously at a national level.[12] Furthermore, as the 14th highest emitter of greenhouse gases worldwide, South Africa acknowledges its role as a developing country with rapidly increasing greenhouse gas emissions.[13] South Africa signed the United Nations Framework Convention on Climate Change (UNFCCC) on June 15, 1993, and ratified it on August 29, 1997.[14] In addition, South Africa acceded to the Kyoto Protocol on July 31, 2002, due to mounting pressure by nongovernmental representatives and concerted efforts by governmental representatives, just in time to be able to announce it at the World Summit on Sustainable Development (WSSD).[15,16]

II. South Africa's Participation in the UNFCCC

II. South Africa's Participation in the UNFCCC

A developing nation, South Africa adopted the UNFCCC as a non-Annex I country, without obligation to make reductions in greenhouse gas emissions. However, a major requirement under the Convention is the production and submission of the national communication, a report that includes a national greenhouse gas emissions inventory, as well as a discussion of the various policy initiatives taken with respect to greenhouse gas emissions reductions.[17]

Preparing a National Communication Report

The Department of Environmental Affairs and Tourism (DEAT) is the government body that oversees climate change issues in South Africa. Additionally, in order to cope with the task of managing climate change policy development and compiling a national communication, South Africa established the National Committee on Climate Change, a multi-stakeholder forum with representatives from government, industry, labor, NGOs, civic organizations, and the research community.[18] The Committee advises DEAT and oversees capacity-building studies on greenhouse gas emissions accounting, mitigation and adaptation strategies, policy development, public communication, and the impacts of climate change on agriculture, water resources, biodiversity, human health, and other areas of national concern.[19]

As a non-Annex I country, South Africa is granted support from the United Nations Environment Programme - Global Environment Facility (UNDP-GEF). In June 1998, a project entitled *Enabling Activities for the Preparation of Initial National Communication Related to the UNFCCC* was approved with a budget of U.S.$321,000, specifically for the purpose of assisting the DEAT in compiling a national communication, and bringing South Africa into compliance with the UNFCCC. According to GEF reports of the project, a national greenhouse gas inventory has been completed, along with the First National Mitigation Strategy and a vulnerability assessment. Furthermore, the first draft of the initial national communication was also reported to be finished. Previous project reports anticipated the submission of the finalized version of the communication in April 2001, but to date it has not been released.[20]

Reasons for the delay in submission of the national communication were made clear at the Workshop of the Consultative Group of Experts on National Communications from Non-Annex I Parties, which took place on April 10 and 11, 2002. At the Workshop, Laurraine Lotter, Executive Director of Chemical & Allied Industries South Africa, enumerated a long list of difficulties the country had encountered while attempting to prepare its first national communication. The constraints included slow funding approval from the GEF, poor accessibility of relevant information, lack of prioritization of climate change issues, inadequate coordination among government departments, lack of specific climate change expertise, and reluctance among individuals to submit poor quality data. Other impediments revolved around voluntary reporting. Lotter disclosed that because reporting on abatement options is voluntary, such reporting had been limited for reasons including a lack of funding and technical expertise, inadequate institutions, and the absence of public and political support. These obstacles were overcome with varied political and economic strategies, also described by Lotter, such as increased political commitment to climate change,

II. South Africa's Participation in the UNFCCC, *continued*

improved government coordination, a linking of sustainable development goals with those of climate change, and an authorization for all government departments to review the national communication draft.[21]

Some motivation to complete and submit the first national communication was derived from the fact that South Africa was host to the WSSD in Johannesburg, and was striving for UNFCCC compliance before the conference began in August. It was not, however, submitted in time. The report is said to be in the final stages of review, and its release is expected shortly.[22]

III. Emissions Estimates for South Africa

III. Emissions Estimates for South Africa

Current Greenhouse Gas Inventory

Until the release of South Africa's first national communication, a comprehensive greenhouse gas emissions inventory is unavailable. However, a rough inventory has been compiled since the signing of the UNFCCC nearly ten years ago. Table 2, given by the DEAT from an unpublished country study report, accounts greenhouse gas emissions and removals from the baseline year 1990.

Table 2. Greenhouse Gas Emissions and Removals in South Africa, 1990 (Unit: Gg)

Source: South Africa Department of Environmental Affairs and Tourism, 1999.[23]

Source	CO_2	CH_4	N_2O	CO	NO_X	NMVOC	SO_2
Energy *(electricity, industrial, domestic, mining and refineries)*	238,554	751	7	1,660	1,221	88	1,695
Transport	31,390	39	5	2,707	995	569	37
Industrial Processes	23,461	4	2	28	13	194	28
Agriculture, Land-Use Change and Forestry	-20,614	1,064	61	1,286	39		
Waste *(landfills and treatment of effluent and sewage)*	380	3					

** Empty blocks in the table mean that these greenhouse gases were not emitted from the listed sources, according to current knowledge.*

** The methodologies and sources used to obtain these numbers are not reported with the data.*

Energy-related carbon emissions compose the largest share of South Africa's greenhouse gas emissions. Per capita energy emissions in 2000 were estimated by the International Energy Agency (IEA) at 6.91 tons while African per capita emissions (including South Africa) were 0.86 tons.[24] Coal is the primary fuel produced and consumed in South Africa, and contributes to increasing concentrations of greenhouse gases in the atmosphere.[25] In fact, in the last 50 years, South Africa has experienced an almost six-fold increase in fossil fuel-derived carbon dioxide emissions, 80-90% of which come from coal. In 1998, 80% of South Africa's fossil-fuel CO_2 emissions were from coal, another 18% were from oil consumption, and the remainder was from cement manufacture and natural gas and coke-oven gas consumption.[26]

The post-apartheid government of South Africa places equitable access to affordable

III. Emissions Estimates for South Africa, *continued*

energy among its top priorities for management. Indeed, increased access to electricity and a decreased burden of energy investment on the public sector have been high priorities in the *South African Reconstruction and Development Program.* Since 1991, more than four million homes have been put on an electricity grid. While doing much to improve the standards of living for many South Africans, indicators such as carbon emissions per capita and energy intensity are not currently at sustainable levels, due in part to the high dependence on coal as a primary energy source. Other contributors include low energy prices, high-energy intensity of synthetic petrol made from coal, and poor end-use energy efficiency in different sectors. Indeed, the call for decreased greenhouse gas emissions in the UN climate change agreements has raised concerns about how the coal industry will be affected.[27]

The second largest source of greenhouse gas emissions is emitted from the transport sector, at about 10% of total emissions.[28] While above those of most other African countries, emissions from this sector are still very low when compared to wealthier, more industrialized countries with a greater number of automobiles per capita.[29] However, long distances and high altitudes are contributing a growing amount of carbon dioxide, hydrocarbons, carbon monoxide, and nitric oxide in South Africa.[30]

Largely the institution of apartheid, which ended little more than a decade ago, has molded the transportation structure. For example, because land-use policies were based on race, black residential areas grew mostly on the outskirts of urban areas, leading to long work commutes for those inhabitants that compose the majority of the population. Public transport and shipping systems that served those populations were poor, leading to the growth of informal, privatized services that used inefficient vehicles. Also, energy investments in coal-based synthetic fuel processes, import substitution economic policies for automobiles, and subsidized vehicle schemes were promoted during the decades of international sanctions, when reliance on domestic production was strong.[31]

In truth, the transport sector is exhibiting the most rapid rise in greenhouse gas emissions on a global level, due mainly to increased motorization in developing countries. While the increase in access to transportation indicates positive signs of economic development (more efficient movement of goods, improved access to jobs, health services, and education), it also leads to a worsening in air quality and, of course, increases in greenhouse gas emissions. As a developing country making choices as to how to expand a national system of transport right now, South Africa does have an opportunity to capitalize on the knowledge collected by industrialized countries during the growth of their own transportation sectors. Indeed, it may be possible for developing countries such as South Africa to use "leapfrog" technology and expertise to build more efficient systems of transport at the outset.[32]

And, although the motivation to improve the efficiency of the transport sector may be derived in a movement to improve mobility, accessibility, road safety, and reduce traffic congestion, these goals may serve to decrease greenhouse gas emissions as well.[33] Options that have been considered for emissions reductions in South Africa include development and wider use of the public transport system, increased use of rail transport for shipping, and measures to

III. Emissions Estimates for South Africa, *continued*

increase energy efficiency.[34]

Projected Greenhouse Gas Emissions

In the absence of a completed national communication, emissions projections are not available for all greenhouse gases. The Energy Information Administration (EIA) of the U.S. Department of Energy (U.S. DOE) has estimated energy-related carbon emissions, which comprise the bulk of South African greenhouse gas emissions, to grow at a rate of approximately 1.5% per year.[35] Per capita energy consumption and per capita energy-related carbon emissions have remained fairly constant over the last 25 years.[36]

Expected increases in demand in the commercial and transportation sectors, as well as more coal-fired electricity generation, account for the rise in emissions. Nuclear generation does offset projected increases somewhat.[37] In fact, the South African government is currently exploring pebble bed nuclear reactors as a way to increase access to energy services for disadvantaged households, small businesses, community services and rural areas. The environmental impacts have not yet been assessed, and the likelihood of this technology being used in rural areas with no technical support available is very low. But the proponents of this scheme point out that there will be a decrease in the growth of greenhouse gas emissions.[38] However, carbon dioxide emissions are still expected to increase at a faster rate than total energy consumption. In addition, slight declines in nuclear generation in the future, as well as a slow growth in renewable energy are also predicted by the U.S. DOE.[39]

IV. Emissions Reduction Initiatives

IV. Emissions Reduction Initiatives

Despite no legal obligation to reduce greenhouse gas emissions under the UNFCCC, South Africa has initiated various reduction strategies. For example, as a relatively energy-intensive economy, much interest has grown in the field of renewable energy. In the past, renewable energy has not been an economical option, as the low price and abundance of coal gave little incentive for public or private organizations to explore alternative options.[40] In 1998, over three quarters of the total energy consumption in South Africa came from coal.[41] However, in addition to climate change awareness, pushes to increase the availability of electricity to the widely dispersed national population have induced a change in vision.[42] In the nascent stages of development, "clean energy" is far from sustainable levels, but there has been a marked commitment to increase investment in renewable energy and energy efficiency, both by the public and private sector.[43]

In the public sector, South Africa's Department of Minerals and Energy (DEM) released the *White Paper on the Promotion of Renewable Energy and Clean Energy Development: Part One - Promotion of Renewable Energy*[44] in August 2002. This paper, a supplement to the *White Paper on Energy Policy of the Republic of South Africa* of 1998, presents "Government's vision, policy principles, strategic goals and objectives for promoting and implementing renewable energy in South Africa."[45] A ten-year renewable energy target was also established, aiming for "an additional 10,000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2012, to be produced mainly from biomass, wind, solar, and small-scale hydro."[46] Some renewable energy initiatives are listed in Table 3.

Table 3. Renewable Energy Projects in South Africa

Source: EIA/U.S. DOE,[47] GEF Project Tracking System[48] and SECCP.[49]

Groups	Projects Initiated
Eskom Shell International Renewables	*Installation of a solar panel, charge-controlled battery and metering unit into 50,000 individual homes, without large upfront or monthly costs associated with such systems.*
South African Government Governments of Other African Countries U.S. Government	*Renewable Energy for African Development Program (READ). Promotes cooperation between African countries and U.S. industry, government, and academia on renewable energy issues. Endorses sustainable rural development through appropriate use of renewable technologies.*
South African Government Lesotho Government	*Lesotho Highlands Water Project. Will provide needed water and hydropower to South Africa and Lesotho.*
UNDP South Africa Department of Minerals and Energy	*South Africa Wind Energy Program. Project will identify and address the barriers to large-scale commercialization of wind power.*
UNDP South Africa Department of Minerals and Energy	*Solar Water Heaters for Low-Income Housing in Peri-Urban Areas. Project will provide support to a solar water heater business plan in South Africa, in order to overcome market barriers for widespread use of solar water heaters. The plan was designed and negotiated as part of the application of the FINESSE strategy in South Africa where 9,000 solar water heaters are to be installed over 5 years in a low-income housing peri-urban upgrade.*
IBRD - World Bank Eskom	*Concentrating Solar Power for Africa. Project will evaluate the possibility of introducing solar thermal electric technologies as electricity generation options into Southern Africa.*
UNDP South Africa Department of Minerals and Energy	*Pilot Production and Commercial Dissemination of Solar Cookers. Project aims to remove barriers that currently hamper the local manufacturing, retailing and provision of after sales services for different solar cookers, remove awareness and information barriers existing with end-users in the target areas as well as with other stakeholders involved in the further development of solar cooking and baking.*
Oelsner Group	*Darling Sustainable Energy and Employment Scheme. Plan to develop a large scheme in the field of renewable energy applications. Includes the Darling National Wind Farm Demonstration project.*
South African Government Danish Government	*DME-DANCED. Project aimed at building capacity within the Dept of Minerals and Energy (DME) in renewable energy and energy efficiency.*
Sustainable Energy Society of South Africa Eskom	*Initiative to test lighting products currently available on the South African market, with an aim to provide user information with regard to life expectancy and performance of product as well as the energy efficiency of the various products.*
AGAMA Energy Green Energy Initiative at WSSD South Africa Dept of Environment and Tourism	*Development of a mechanism for trading green electricity through 'green power certificates.'*

IV. Emissions Reduction Initiatives, *continued*

These "clean energy" initiatives, and others such as increased energy efficiency, influence of energy supply and demand, and decreased reliance upon fuel wood, have scarce data to support an indication of progress. Furthermore, reports of capital investment by the South African energy industry are scarce. Randall Spalding-Fecher reports that less than half of one percent of clean energy investment will come from the energy sector, although this may have increased with recent instigation of various solar projects in conjunction with rural energy development.[50,51] However, it is widely held that renewable energy markets are poised to increase rapidly if supported by a strong and diverse energy policy framework.[52]

A deeply imbedded impediment to progress on climate change related work, not only in South Africa but in Africa as a whole, is the fact the governments are, not surprisingly, more committed to economic development than climate change mitigation. A plan that has acquired more devotion by South Africa and other African nations is the New Partnership for Africa's Development (NEPAD). This plan, developed by African leaders throughout 2001, seeks to "promote accelerated growth and sustainable development, eradicate widespread and severe poverty, and halt the marginalization of Africa in the globalization process."[53] Due to the engagement of the African Ministers Conference on Environment, NEPAD as part of its "Environment Initiative" focuses on issues such as desertification and climate change.

Because the continent does not have extraordinarily high greenhouse gas emissions, most of Africa is not in the best position to benefit economically from the policy mechanisms of the UNFCCC and Kyoto Protocol. For example, the Clean Development Mechanism, a policy option where Annex I Parties to the Protocol may earn credit for lowering emissions in non-Annex I countries, does not give equal advantage to those African countries with negligible emissions as compared to their Asian and South/Central American counterparts. However, it must be noted that, as one of the more industrialized non-Annex I countries, not only in Africa but world-wide, South Africa's emissions per capita and carbon intensity are higher than most developing countries. This should make South Africa one of the more sought-after candidates for CDM-related initiatives, thus helping the government to simultaneously pursue both development and climate change mitigation goals.[54]

V. Future Directions

V. Future Directions

With 50% of all new global power generation capacity expected in developing countries over the next 20 years, we find ourselves at a decision point of sorts. A "business as usual" approach can result in only the unchecked rise of global greenhouse gas emissions. Researchers at the Pew Center on Global Climate Change predict a tripling of emissions from developing countries before 2020 under this scenario. However, research and technology, policy, and planning may be able to change this unsettling future.[55]

South Africa has grand intentions, envisioning many initiatives concerning climate change mitigation and adaptation. Particular motivation has arisen from its role as the host of this past year's World Summit on Sustainable Development in Johannesburg. As an example, eight South African cities embarked on a campaign to reduce greenhouse gas emissions and improve energy efficiency before the commencement of the WSSD in August 2002.[56] However, with resources stretched dangerously thin among the many pressing national concerns, climate change related projects are not well supported, and progress has been slow. Furthermore, the "development first" approach that Africa has demonstrated continues to put climate change concerns below other national priorities — even though climate vulnerability could severely impact certain development priorities such as food security, health, and others.

Increased training for researchers and policy makers is essential, along with a greater exchange of information and technology from foreign governments, nongovernmental organizations, and intergovernmental organizations. Like many other countries in similar positions, South Africa could serve to benefit greatly from the types of country studies that have provided others with research and expertise in areas of low domestic capacity. This kind of support would supplement the varied efforts made by South Africa. Indeed, a shift from the "business as usual" approach to planning would result in the installation of innovative policies and technologies, serving to reduce growth in greenhouse gas emissions without depriving these countries of their sovereign rights to development.

Endnotes

[1] **South Africa - A Country Study.** May 1996. Library of Congress. Retrieved 18 June 2002. <http://lcweb2.loc.gov/frd/cs/zatoc.html>

[2] Ibid.

[3] Ibid.

[4] **Human Development Indicators.** 2001. United Nations Development Programme (UNDP). Retrieved 23 May 2002. <http://www.undp.org/hdr2001/back.pdf>

[5] **SIMA Quick Query Database.** 2001. World Bank. Retrieved 16 May 2002. <http://sima-ext.worldbank.org/query/>

[6] Op. cit., Library of Congress.

[7] More detailed information about the Gini index can be found at <http://www.panix.com/~dhenwood/Ginisupplement.html>

[8] Op. cit., World Bank.

[9] Op. cit., UNDP.

[10] Op. cit., World Bank.

[11] International Energy Agency (IEA). **Key World Energy Statistics from the IEA: 2001 Edition.** Paris: International Energy Agency, 2001. pp. 48-57.

[12] **Climatic and Atmospheric Change.** October 1999. South Africa Department of Environmental Affairs and Tourism (DEAT). Retrieved 13 June 2002. <http://www.environment.gov.za/soer/nsoer/issues/climate/index.htm>

[13] **National Fossil Fuel CO_2 Emissions.** 1998. Carbon Dioxide Information Analysis Center (CDIAC). Retrieved 11 July 2002. <http://cdiac.esd.ornl.gov/trends/emis/graphics/top20_1998.gif>

[14] **United Nations Framework Convention on Climate Change: Status of Ratification.** 11 December 2001. United Nations Framework Convention on Climate Change. Retrieved 13 June 2002. <http://unfccc.int/resource/conv/ratlist.pdf>

[15] **Kyoto Protocol: Ratification Before the WSSD.** 2001. World Wildlife Fund South Africa. Retrieved 13 June 2002. <http://www.panda.org.za/article.php?id=71>

[16] **Wildnet Africa News Archive.** 16 November 2001. WildNet Africa, Ltd. Retrieved 13 June 2002. <http://wildnetafrica.co.za/wildlifenews/2001/11/1948.html>

[17] **National Communications from Parties Not Included in Annex I to the Convention: Third Compilation and Synthesis of Initial National Communications from Parties Not Included in Annex I to the Convention.** 5 October 2001. United Nations Framework Convention on Climate Change. FCCC/SBI/2001/14/Add.1. Retrieved 10 July 2001. <http://unfccc.int/resource/docs/2001/sbi/14a01.pdf>

[18] **Summary of the Workshop of the Consultative Group of Experts on National Communications from Non-Annex I Parties: 10-11 April 2002. 15 April 2002.** International Institute for Sustainable Development (IISD). Retrieved 13 June 2002. <http://www.iisd.ca/linkages/vol12/enb12190e.html>

[19] Op., cit., DEAT.

[20] **South Africa - Enabling Activities for the Preparation of Initial National Communication related to UNFCCC.** Global Environment Facility. Retrieved 14 June 2002. <http://www.gefonline.org/projectDetails.cfm?projID=487>

[21] Op. cit., IISD.

[22] Ibid.

[23] Op. cit., DEAT.

[24] Spalding-Fecher, Randall. *African experiences with the UNFCCC.* Presentation given during WHRC side event entitled *Developing Countries and the UNFCCC: Retrospect and Prospect,* UNFCCC COP8, October 25, 2002, New Delhi, India.

[25] **South Africa: Environmental Issues.** January 2002. Energy Information Administration (EIA). U.S. Department of Energy (U.S. DOE). Retrieved 14 June 2002. <http://www.eia.doe.gov/emeu/cabs/safrenv.html>

Endnotes, *continued*

[26] **South Africa: Trends.** 2001. Carbon Dioxide Information Analysis Center (CDIAC). Retrieved 11 July 2002. <http://cdiac.esd.ornl.gov/trends/emis/tre_saf.htm>

[27] Spalding-Fecher, Randall. **Energy Sustainability Indicators for South Africa.** Cape Town: University of Cape Town Energy & Development Research Center, 2002.

[28] **Discussion Document on Climate Change.** July 1998. National Committee on Climate Change (NCCC). Retrieved 15 May 2002. <http://www.environment.gov.za/soer/nsoer/resource/climate/climate.htm>

[29] Op. cit., DEAT.

[30] Op. cit., NCCC.

[31] Prozzi, Jolanda Pretorius, Clifford Naudé, Daniel Sperling and Mark Delucchi. **Transportation in Developing Countries: Greenhouse Gas Scenarios for South Africa.** February 2002. Pew Center on Global Climate Change. Retrieved 16 July 2002. <http://www.pewclimate.org/projects/trans_sa_execsumm.cfm>

[32] Sperling, Daniel and Deborah Salon. **Transportation in Developing Countries: An Overview of Greenhouse Gas Reduction Strategies.** May 2002. Pew Center on Global Climate Change. Retrieved 16 July 2002. <http://www.pewclimate.org/projects/transportation_overview.cfm>

[33] Op. cit., Pew Center on Global Climate Change (Prozzi, Naudé, Sperling and Delucchi).

[34] Op. cit., NCCC.

[35] **Annual Energy Outlook 2002 with Projections to 2020: Overview.** 10 June 2002. Energy Information Administration (EIA). U.S. Department of Energy (U.S.DOE). Retrieved 16 June 2002. <http://www.eia.doe.gov/oiaf/aeo/index.html>

[36] Op. cit., EIA/U.S. DOE. South Africa: Environmental Issues.

[37] Op. cit., EIA/U.S. DOE. Annual Energy Outlook 2002.

[38] Pressly, Donwald. *Nuclear Power May Be Used in Rural Areas.* **Business Day.** 2002. Retrieved 17 July 2002. <http://www.businessday.co.za/bday/content/direct/1,3523,1078387-6078-0,00.html>

[39] Op. cit., EIA/U.S. DOE. Annual Energy Outlook 2002.

[40] Op. cit., EIA/U.S. DOE. South Africa: Environmental Issues.

[41] **South Africa.** 8 December 2000. United States Department of Energy. Retrieved 13 June 2002. <http://www.eia.doe.gov/emeu/cabs/safrica.html>

[42] Op. cit., EIA/U.S. DOE. South Africa: Environmental Issues.

[43] Op. cit., Spalding-Fecher (2002), ii.

[44] DME. **White Paper on the Promotion of Renewable Energy and Clean Energy Development: Part One — Promotion of Renewable Energy.** Department of Minerals and Energy (DME) of the Republic of South Africa, Pretoria, August 2002.

[45] Ibid, p. vi.

[46] Ibid, p.3.

[47] Op. cit., EIA/U.S. DOE. South Africa: Environmental Issues.

[48] **GEF Project Tracking System.** Global Environment Facility (GEF). Retrieved 18 June 2002. <http://www.gefonline.org/projectList.cfm>

[49] Schutze, Erika and Mette Nedergaard, Eds. *SA's Renewable Energy Progress* and *Preparing for the WSSD.* **Sustainable Energy News on Email.** Retrieved 14 June 2002.

[50] Spalding-Fecher, Randall. **Sustainable Energy Watch Report on South Africa.** 2001. Helio International. Retrieved 15 July 2002. <http://www.i-kan.net/Helio/Reports/2001/SouthAfrica/index.html>

[51] Goldemberg, J., E. Martinot and A. Miller. **Energy Since Rio: Achievements and Promising Strategies.** Washington, DC: Global Environment Facility, 2002.

[52] Op. cit., Spalding-Fecher (2001).

Endnotes, *continued*

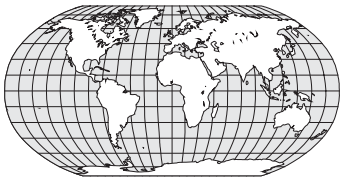
[53] **What is NEPAD - The New Partnership for Africa's Development?** 18 January 2002. New Partnership for Africa's Development. Retrieved 11 July 2002. <http://www.nepad.org/AA0010102.pdf>

[54] Op. cit., Spalding-Fecher (2002), i.

[55] Bernstein, Mark, Pam Bromley, Jeff Hagen, Scott Hassell, Robert Lempert, Jorge Munoz, and David Robalino. **Developing Countries and Global Climate Change.** June 1999. Pew Center on Global Climate Change. Retrieved 16 July 2002. <http://www.pewclimate.org/projects/pol_countries_execsumm.cfm>

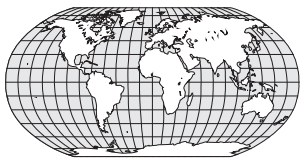
[56] **Cities Embark on Environmental Plan Before World Summit.** 6 March 2002. Business Day. Retrieved 15 May 2002. <www.environment.gov.za/NewsMedia/Articles/2002march6/Cities_Summit_06032002.htm>

Glossary



ADB	Asian Development Bank
ALGAS	Asia Least-cost Greenhouse Gas Abatement Strategy
CDM	Clean Development Mechanism
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DOD	Debt Outstanding and Disbursed
ECO_2	Carbon Dioxide Equivalent
EIA	Energy Information Administration of the U.S. Department of Energy
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Gigagram (10^9 grams)
GHG	Greenhouse Gas
GNP	Gross National Product
GWh	Gigawatt Hour
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
MMTCE	Million Metric Tons of Carbon Equivalent
MtC	Million Tons of Carbon
Mtce	Million Tons of Carbon Equivalent
Mtoe	Million Tons of Oil Equivalent
N_2O	Nitrous Oxide
NGO	Nongovernmental Organization
NMVOCs	Non-Methane Volatile Organic Compounds
NO_x	Nitrogen Oxides
OECD	Organisation for Economic Co-operation and Development
PPG	Public and Publicly Guaranteed
PPP	Purchasing Power Parity
TC	Tons Carbon
Tg	Teragram (10^{12} grams)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
U.S. AID	United States Agency for International Development
USD	United States Dollars
U.S. DOE	United States Department of Energy
WSSD	World Summit on Sustainable Development

APPENDIX



National Communications from Parties Not Included in Annex I to the Convention

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Consideration of the Fourth Complilation and Synthesis of Initial National Communications

Executive Summary

Executive summary of information contained in initial national communications from Parties not included in Annex I to the Convention

Note by the secretariat[1]

Summary

This executive summary presents the main issues arising from the four reports of the compilation and synthesis of 83 initial national communications from Parties not included in Annex I to the Convention (non-Annex I Parties). The information is organized according to the UNFCCC guidelines for the preparation of national communications from non-Annex I Parties. Many new initial communications have been submitted to the secretariat since the last report, but the issues of relevance for non-Annex I Parties have remained the same for all reporting Parties. Climate change education, training and public awareness, and the needs for financial resources and technical support, have been recognized as having considerable importance in the preparation of national communications and the implementation of the Convention over the long term.

At the seventeenth session of the Subsidiary Body for Implementation (SBI), Parties may wish to take note of this executive summary with a view to recommending a draft decision for further compilation and synthesis of initial national communications from non-Annex I Parties, for adoption by the Conference of the Parties at its eighth session.

I. Introduction

1. The fourth compilation and synthesis of initial communications from Parties not included in Annex I to the Convention (non-Annex I Parties) is based on 31 communications received by the UNFCCC secretariat between 2 June 2001 and 1 June 2002. The executive summary, as presented here, is based on the third compilation and synthesis of 52 national communications and the fourth compilation and synthesis of 31 national communications submitted to the secretariat as at 1 June 2002.[2] These 83 communications are from: Algeria, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, Barbados, Bhutan, Bolivia, Botswana, Burkina Faso, Burundi, Cape Verde, Chad, Chile, Colombia, Congo, Cook Islands, Costa Rica, Côte

d'Ivoire, Cuba, Democratic Republic of the Congo, Dominica, Ecuador, Egypt, El Salvador, Ethiopia, the Federated States of Micronesia, Georgia, Ghana, Grenada, Guatemala, Guyana, Haiti, Honduras, Indonesia, Israel, Jamaica, Jordan, Kazakhstan, Kiribati, Lao People's Democratic Republic, Lebanon, Lesotho, Malaysia, Maldives, Mali, Marshall Islands, Mauritius, Mexico, Mongolia, Morocco, Nauru, Nicaragua, Niger, Niue, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Republic of Korea, Republic of Moldova, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Senegal, Seychelles, Singapore, Sri Lanka, Swaziland, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkmenistan, Tuvalu, Uruguay, Uzbekistan, Vanuatu, Yemen and Zimbabwe.

II. National Circumstances

2. Parties provided information, with various levels of detail, on their national circumstances within the national communications, either as a separate chapter or as part of other chapters. Parties also provided information on the size and location of their territories, climate and other physical and geographical characteristics, development status and socio-economic conditions. The population of reporting Parties ranged from less than 3,000 to more than 209 million. In terms of development status, 14 reporting Parties are rated as having low human development and 44 as having medium human development, and nine are in the high human development group, according to the human development report of 2001 by the United Nations Development Programme. Sixteen Parties were not classified in the human development context. Twenty-one reporting Parties are also classified in the current United Nations Conference on Trade and Development list as least developed countries.

3. Parties described the importance of different economic sectors with respect to their development priorities and many Parties stressed the particular importance they attach to agriculture and water resources. Some Parties stressed the important contribution of the service sector in their economies. Many Parties, including small island developing States, stressed the primary importance of economic activities associated with coastal zones and fisheries. Most Parties provided detailed information on the energy sector, which indicated very wide disparities in Parties' circumstances and in the trends relating to current and future energy supply and demand.

III. Sustainable Development and the Integration of Climate Change Concerns Into Medium- and Long-term Planning

4. Parties provided information on sustainable development plans and the integration of climate change concerns into medium- and long-term planning. In general, information provided on this topic was limited and was not detailed enough to identify concrete activities relating to their plans. Only a few Parties dedicated a separate section of their communication to sustainable development concerns, and some other reporting Parties included a separate section on their national plans.

5. Many Parties provided information on sustainable development and planning activities when describing national development and environmental plans, institutional arrangements and legislation on the environment and/or development. Several Parties emphasized the need to ensure that an integrated approach is followed in dealing with environmental issues. Many Parties described activities that national development and environmental plans should incorporate in order to achieve sustainable development. Only a few Parties reported on activities relating to

the implementation of Agenda 21 of the United Nations Conference on Environment and Development. Many Parties also underlined the importance of effective participation of stakeholders, including non-governmental organizations, the private sector, and academic and community-based organizations, in the development of climate change policies.

6. Most reporting Parties indicated that they intend to include climate change planning in future social, economic and environmental considerations. Several Parties indicated that they either had already developed or were in the process of formulating comprehensive national climate change action plans and/or policy frameworks to meet their obligations under the Convention. Most of the Parties stressed the need for improved capacity to develop institutional frameworks dedicated specifically to climate change activities.

7. Many Parties provided information on their efforts to coordinate climate change activities and others highlighted the importance of the UNFCCC focal points in the coordination of these activities. The need to strengthen coordination at the local, national and/or regional levels was emphasized by several Parties. Many Parties expressed the need to maintain the activities already initiated during the preparation of the initial national communication. Many Parties provided information on existing and planned environmental legislation and strategies.

IV. Inventories of Anthropogenic Emissions and Removals of Greenhouse Gases

8. Parties provided national inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases (GHGs). The level of information provided varied among Parties and very often small island developing States did not include emissions in some source categories because they did not have the necessary data. However, the reporting by other Parties was generally comparable to that of Annex I Parties.

9. Most Parties followed the advice of the Subsidiary Body on Scientific and Technological Advice (FCCC/SBSTA/1996/20, para. 30) and used the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. Most of them adopted the reference approach, except for a very few Parties which used the possibility offered by the IPCC Guidelines to develop methodologies and/or emission factors for some selected subcategories of sectors, such as agriculture, land-use change and forestry (LUCF) and waste, to better suit their national circumstances. The majority of Parties reported on difficulties relating to activity data, but some of them faced problems with emission factors and others reported difficulties in applying the IPCC Guidelines. About half of the reporting Parties indicated that they estimated carbon dioxide (CO_2) emissions from fuel combustion using both the IPCC reference approach and the sectoral approach. In most cases reported differences between the two approaches were of the same order of magnitude for both Annex I and non-Annex I Parties.

10. All Parties compiled data on emissions for CO_2, methane (CH_4) and nitrous oxide (N_2O), with the exception of Maldives, which did not include N_2O emissions. Many Parties (57) also provided estimates of aggregate GHG emissions in terms of CO_2 equivalent. CO_2 generally appeared to be the most important GHG emitted. Most Parties provided data on their largest GHG emission source and sink categories, such as CO_2 emissions from fuel combustion and industrial processes, CO_2 removals

from LUCF, CH_4 emissions from agriculture and waste, and N_2O emissions from agricultural soils and fuel combustion. Most reporting Parties provided emissions data for all or some ozone precursors (carbon monoxide (CO), nitrogen oxides (NO_X) and non-methane volatile organic compounds (NMVOC)). Few Parties provided emissions data on hydrofluorocarbons (HFCs), perflurocarbons (PFCs) or sulphur hexafluoride (SF_6), but more than half of the reporting Parties provided data on sulphur dioxide (SO_2) emissions. Nearly two thirds of the reporting Parties provided information on emissions from bunker fuels. Some Parties also provided information on the level of uncertainty of their estimates of GHGs.

11. For a majority of Parties, the energy sector was the largest source of GHG emissions, followed by the agricultural sector, but for more than one third of the Parties, the latter was the largest emitter. In two thirds of the cases, the emissions from these source categories were more than offset by removals by sinks within the LUCF sector as a whole.

12. The source of activity data for estimating emissions was referenced by most Parties even though this type of information was not requested by the UNFCCC guidelines. Sources of data varied widely among the Parties and frequently included national statistics. The two primary factors reported to have affected the quality of national GHG inventories were lack of activity data and unsuitability of default emission factors. Unavailability, inaccessibility and poor quality of activity data were frequently reported, particularly in the energy, agriculture and LUCF sectors.

13. Most Parties used the IPCC summary table, or a similar format, to report the inventory results. One third of the reporting Parties provided all or some of the relevant worksheets of the IPCC Greenhouse Gas Inventory Workbook, which facilitated ease of replication and transparency of data.

14. Most Parties described existing institutional arrangements for the preparation of national inventories and identified possible areas for their improvement. In a few cases, where national GHG inventories were prepared and reported for other year(s) in addition to the originally submitted inventory for the base year, the completeness, transparency and quality of the data were improved. This would suggest that there is some scope for encouraging the preparation of inventories on a continuous basis. Many Parties expressed the need to improve and update their inventories, and would require additional financial and technical assistance. Almost all Parties received external support in preparing their GHG inventories.

V. Measures Contributing to Addressing Climate Change

15. Almost all Parties included in their national communication information on programmes containing measures that could contribute to addressing climate change by limiting the increase of GHG emissions and/or enhancing removals by sinks. The majority of Parties identified the relevant sectors in terms of their importance in present and/or future GHG emissions and analysed measures or projects that could contribute to GHG emissions abatement. Some Parties described sectoral policies and measures that would affect future emissions. The sectors covered in the reports included energy, agriculture, land-use change and forestry, and waste.

16. In the energy sector, Parties reported measures in terms of supply and demand sides. Measures on the supply side included energy conservation and efficiency, cogeneration, modernization of thermoelectric utilities, fuel switching, electricity imports, reduction of losses in transmission and distribution, promotion of rural electrification

and the use of renewable energy sources. On the demand side, Parties outlined measures in the industrial, residential, commercial and/or transport sectors. These measures concerned mainly the enhancement of energy efficiency in lighting, cooling, cooking and air conditioning; the implementation of demand-side management programmes; the promotion of fuel switching and use of renewable energy; the development of road transport master plans; the introduction of electric or compressed natural gas vehicles; discouragement of the use of private vehicles; improvement of the public transport system; legal measures to control vehicle emissions; and limitations on the importation of used and/or reconditioned vehicles.

17. In the agriculture sector, measures outlined related to improvement of farm management practices; reduction of areas under cultivation; rotation, diversification and intensification of crops; plant nutrient management; and substitution of mineral fertilizers. Other measures included adoption of improved irrigation systems, improvement in practices of cattle management, alteration of livestock diet, and improvement of the collection, utilization and storage of organic waste.

18. In the land-use change and forestry sector, measures proposed were, inter alia, preservation of existing forest, afforestation and reforestation programmes; prevention and control of fires and diseases; introduction of tax incentives; development of forestry livestock and agroforestry systems; review of forest and land management policies; and sustainable management of protected areas and fragile ecosystems.

19. In the waste sector, measures related mainly to integrated waste management, waste minimization at the different stages of the production cycle, recovery of methane from landfills and legal instruments.

20. Parties used expert judgement and/or models to assess GHG abatement options. Parties using expert judgement based their assessments on GHG inventories, economic growth patterns and national or sectoral development plans. Parties that used models projected the level of future emissions using business-as-usual and one or two mitigation scenarios. The main variables used to develop scenarios were population growth, urban population, energy demand, gross domestic product, and oil consumption. Emission projections were mainly estimated for the years 2005, 2010, 2020 and 2030.

21. Several Parties reported on the criteria used to assess and select potential abatement options. Criteria used included the possibilities for their integration into national and sectoral development plans and programmes; possible impacts on the economy, enhancing economic growth and development; availability of financial resources and technical assistance; potential environmental impacts; potential emission reductions; and feasibility and cost-effectiveness of implementation.

22. The status of implementation of the abatement options differed among Parties. Many Parties indicated that studies were at an early stage. The development of more detailed recommendations would require consultation with and input from stakeholders in the public and private sectors, as well as the development of appropriate policy and legal measures. Some Parties mentioned specific measures already implemented, relating mainly to policy instruments and forestry laws.

23. Many Parties included in their national communications a number of projects aimed at reducing GHG emissions and enhancing removals by sinks. Information provided on these projects sometimes included associated implementation cost as well as the mitigation potential in

accordance with Article 12, paragraph 4, of the Convention. Some Parties provided project concepts, which included expected outcomes, including environmental and social benefits.

VI. Research and Systematic Observation

24. Most Parties provided information on research and systematic observation either in a dedicated chapter or in a section of their national communication. Some Parties provided information on this issue sporadically in a number of sections of the national communication.

25. Most of the research identified or planned by Parties is on climate change vulnerability and adaptation assessments. The main sectors considered were agriculture, water resources, coastal zones, forestry and energy. Other research focused on improving understanding of the El Niño Southern Oscillation (ENSO) phenomenon, reducing and managing uncertainty relating to climate change and development of appropriate climate change scenarios, and their socio-economic implications. About half of the Parties reported on existing or future institutional arrangements at the national, regional and international levels to facilitate research on climate change.

26. Ongoing or planned research programmes were aimed at further understanding the impacts of climate change, extreme events and climate variability on biodiversity, land use, forests, agriculture, water resources, coastal zones, fisheries, ecosystems, human health and human settlements. Some of the adaptation research programmes included evaluation of a range of coastal adaptation options, plant and animal breeding programmes, integrated pest management, improved soil and crop management, evaluation and costing of adaptation measures in water supply and use, and development of new adaptation technologies and new resistant plant/crop species.

27. When reporting on systematic observation, most Parties included information on their observation records and the types and number of observation networks and stations that are in use. In most cases these systems consist of a network of observation and monitoring stations which collect meteorological, oceanographic and hydrological data. Some Parties mentioned their participation in various global observing systems, such as the global ocean observing system (GOOS) and the global climate observing system (GCOS), and others acknowledged their cooperation and collaboration with international organizations.

28. Most Parties reported on the status of systematic observation and planned activities. The most common ongoing observations focused on climate, hydrology and sea level. Some Parties also described cooperation at the regional and international levels, constraints, and the needs for financial and technical assistance.

29. Research programmes on mitigation were mainly related to analysing options for energy recovery, developing and promoting renewable energy sources, evaluating the applicability of proposed mitigation measures, and the evaluation and costing of mitigation measures. Many Parties also stressed the development of activity data and/or appropriate emission factors for improving the quality of national GHG inventories.

30. The constraints relating to research and systematic observation were broadly identified by many reporting Parties as lack of financial resources and technical support, and lack of human capacities and capabilities. Many Parties provided information on planned research programmes that will be undertaken depending on the availability of financial and technical resources. Needs and priorities for

systematic observation included training and capacity-building in the sciences of meteorology and climatology, database development and management, and the upgrading, rehabilitation and strengthening of existing observation systems, stations and networks. Many Parties also indicated that large gaps exist in observations and therefore require new monitoring stations, improvement of technical capacities and capabilities, upgrading and maintenance of equipment, and coordination and strengthening of the institutions responsible for education, training and research.

VII. Climate Change Impacts, Adaptation and Response Strategies

31. Almost all Parties provided information on their current and future vulnerabilities as well as on adaptation measures and response strategies, including the level of implementation. This included information relating to the use of methods and approaches, limitations of methods and tools, problems and difficulties encountered, sectors studied, methods for analysing and evaluating adaptation needs and priorities, and institutional arrangements and networking. Some Parties also provided information on other technical areas of work relating to vulnerability and adaptation that they would envisage undertaking if they had sufficient financial resources and technical support.

32. Most Parties reported having used the IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations, including the IPCC emission scenarios (IS92 series). Some Parties specifically reported on the use of the United Nations Environment Programme Handbook, expert judgement or their own methods and approaches. Most Parties treated the different sectors in isolation, whereas others performed integrated assessments to account for interactions between two or more related sectors.

33. Most Parties used various global circulation models (GCMs) to generate climate change scenarios, and about half of the Parties used the integrated model system for the assessment of greenhouse gas-induced climate change and the scenario generator (MAGICC-SCENGEN) for generating regional climate change scenarios based on a single or various GCMs. Many Parties also used incremental or analogue scenarios for various time horizons up to the year 2100.

34. The most common methodology adopted for sea-level rise scenarios for different time horizons up to the year 2100 was that of the IPCC. Some Parties also carried out sensitivity analyses by adopting high- and low-emission scenarios in calculating projected sea-level change.

35. Some Parties reported on problems or difficulties encountered in applying the IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations, and on the limitations of the methods and tools used. These were often related to the low resolution of GCMs, the lack of comprehensive data sets required for proper validation of model results, and lack of time, human and financial resources.

Vulnerability

36. A wide range of models as well as expert judgement were used in the analysis of impacts in various sectors. The models were of the process-based or integrated type for sectors such as agriculture (including livestock), water resources, forests, grasslands, coastal zones and human health. Other sectors and areas covered included human settlements, infrastructure, fisheries, biodiversity, tourism and energy, as well as ecosystems such as woodland and coral reefs. Most of the emphasis was placed on specific sectors depending on their socio-economic importance.

37. The majority of Parties assessed the vulnerability of the agriculture sector and indicated that it will be adversely affected by climate change, extreme events such as droughts and hurricanes, a loss of the soil fertility, erosion, leaching of mineral fertilizers, increased incidence of pests and diseases, heat stress on animals and the indirect effects of sea-level rise. The vulnerability assessments also focused on agricultural crops under a range of climate change scenarios. Lower crop and animal productivity were generally expected, except for middle- and high-latitude countries, where it was expected that an increase in crop production will result from the longer growing season, more favourable temperatures and increased CO_2 fertilization. Other effects identified included a lower quality of fodder.

38. Many Parties assessed the vulnerability of coastal zones, some Parties conducting the assessment under different sea-level rise scenarios. The main impacts identified were erosion and setback of coastal areas, an increase of salinity in the estuaries and wetlands with death of mangroves, salt water intrusion into aquifers, beach degradation and losses, a decrease in the productivity of coastal fisheries, enhanced coral bleaching and devastating effects on species of corals. Almost all coastal countries, including the small island developing States, reported that climate change and consequent sea-level rise will have a devastating effect on coastal communities and infrastructure. Some Parties estimated that a sea-level rise of 0.5 to 1.0 m would result in the inundation of coastlines and the destruction of infrastructure such as coastal roads and houses. Most Parties also expressed their concern about the negative impacts of sea-level rise on low-lying agricultural lands and ecosystems, wetlands and estuaries.

39. Most Parties reported on expected impacts of climate change on water resources. Many Parties reported a potential increase in run-off due to more intense rainfall and higher risk of flash flooding, whereas others stressed the decrease in water resources. The latter could result from lower rainfall, increased evaporation, reduction in aquifer recharge and pollution. Reduced water resources will have a negative impact on hydroelectric power generation, food production, especially production of crops under irrigation, and transport. The negative impacts of salt water intrusion on water quality were indicated by many reporting Parties with many Parties also stating that they already face problems of water shortage.

40. Many Parties also provided information, with various levels of detail, on the assessment of climate change impacts on human health. The general view was that the limited observations and studies available make it difficult to understand clearly the relationships between climate characteristics and human health. Most of the Parties reported that the incidence of water- and vector-borne diseases, and those relating to water contamination, is likely to increase. A wide range of diseases have been identified, the most common being malaria, dengue fever and diarrhoea. Many Parties mentioned the additional stress that high temperatures will have on the population, making them more prone to sicknesses. Some Parties indicated a likely increase in the incidence of endemic diseases due to higher population densities and poorer sanitary conditions.

41. Most Parties provided information on the assessment of climate change impacts on terrestrial ecosystems. Most of the Parties indicated a decrease in land cover vegetation as a result of an increase in aridity and the lower productivity of forests and rangelands. Some Parties indicated the change and displacement of ecosystems as well as a general shift in the composition of species. Other Parties stressed that

deforestation is likely to lead to a loss of biodiversity. Some Parties reported on the risk of increased frequency of forest fires in the dry seasons and the consequent increase in soil erosion.

42. Many Parties reported on the expected adverse effects on fisheries resulting from higher temperatures and changes in salinity. Impacts are expected to stem from the destruction of nursery areas and breeding grounds, such as mangroves and coral reefs, and reduced availability of nutrients. In most cases the anticipated impacts remain uncertain as it is still difficult to forecast the rate of change and the ability of species to adapt.

43. Many Parties provided information on the vulnerability of other sectors/resources such as human settlements, tourism and biodiversity. Some Parties indicated the potential negative effects resulting from frequent storms and hurricanes, particularly on infrastructure, energy systems and tourism.

Adaptation

44. Almost all reporting Parties provided information on adaptation options, measures and/or strategies relating to climate change impacts for a wide range of sectors. Information varied widely from one Party to another. Usually no clear indication was given of the methods used in assessing and analysing the adaptation strategies and measures. Some Parties, however, indicated the use of expert judgement based on GCM results or predictions by impact models. Other Parties stressed the need for more detailed in-depth vulnerability studies in order to formulate adaptation measures and identify needs for increased financial and technical support.

45. Many Parties reported on adaptation options and/or strategies in agriculture, including the development of drought-tolerant crops, the improvement of early warning systems, management and crop husbandry practices (alternative cropping schedules, plant densities or crop species), the introduction of irrigation, changing to more efficient systems, enhancement of erosion control, and training and provision of assistance to farmers. Some Parties reported on ongoing breeding programmes that are in line with the adaptation process.

46. Many Parties reported on adaptation options for water resources and indicated various water policy reforms to be introduced, such as those focusing on water conservation, inter-basin water transfer, desalination, flood management, and construction of dams and reservoirs for increased water storage. Some Parties also envisaged recycling of waste water and reducing demand, for instance, by introducing more efficient irrigation systems.

47. About half of the reporting Parties provided information on adaptation measures which could be implemented in the coastal zones through integrated coastal zone management. Other Parties reported on adaptation strategies and measures in the areas of human health, forests, tourism, fisheries, human settlements, biodiversity and wildlife. Measures reported included improving the health care system, enhancing forest management, protecting tourism infrastructure, strengthening legislation and promoting conservation of biodiversity.

48. The needs and priorities for strengthening the institutional arrangements for vulnerability and adaptation work were not clearly spelled out in the information provided by the reporting Parties. However, some Parties mentioned the need for better arrangements to be put in place for data collection and analysis, and others indicated needs for further capacity-building and human resource development.

49. Other Parties identified better coordination and cooperation between relevant institutions and agencies as key factors in facilitating the integration of climate change concerns into policy-making processes, and others suggested possible review and, where necessary, amendment of existing legislation to develop the appropriate institutional framework for dealing with impacts of the climate change. A few Parties indicated the need to improve the abilities of national climate change coordinators and national institutions to manage and coordinate climate change programmes.

50. A few Parties reported on the level of engagement of relevant stakeholders and policy makers in the vulnerability and adaptation assessment process, and on the participation of and collaboration between national experts and institutions in undertaking the vulnerability and adaptation assessment work.

51. Many Parties provided information on their needs and priorities for education, training and research in vulnerability and adaptation assessments, with most of them stressing the importance of training and research. Training aimed primarily at strengthening human and institutional capacities to undertake in-depth work on vulnerability and adaptation assessment in various sectors was deemed essential.

52. Some Parties envisaged tackling technical areas relating to vulnerability and adaptation assessment work, particularly in making better predictions of changes in temperature and precipitation and in reducing the level of uncertainty when undertaking assessments. A few Parties reported on the importance of promoting regional and international cooperation, networking and sharing of information, the pooling of resources, and the transfer of appropriate technologies for vulnerability and adaptation assessment.

VIII. Education, Training and Public Awareness

53. Almost all the reporting Parties provided information on ongoing and/or future programmes on education, training and public awareness, with various levels of detail. A separate chapter was dedicated to these three issues by half of the reporting Parties, and the others either incorporated them as a section of a chapter or covered the issues very broadly within the national communications. In almost all cases, the presentation of the information was such that it was difficult to distinguish clearly between ongoing activities and programmes and those that were to be implemented in the future. Parties generally expressed the need to improve national programmes on education, training and public awareness relating to climate change for practically all sections of the population, including policy makers and the public at large.

54. Most Parties provided information on existing and/or future initiatives to incorporate environmental and climate change issues at all levels of the formal education system. Some Parties have already integrated teaching of climate change issues, mainly within the tertiary education curriculum, and others expressed their intention to do this in the future. One Party indicated its commitment to grant scholarships for studying the science of climate change.

55. Most Parties stressed the importance of training within the context of the preparation of national communications. Several Parties mentioned the lack of enough trained experts in the field of climate change to meet their obligations under the Convention. Some Parties stressed the importance of integrating climate change issues into formal and/or non-formal education programmes and to raise public awareness. Other Parties stressed the inability of existing institutions to undertake research and training to

meet the reporting requirements of the UNFCCC or to develop and implement appropriate public awareness programmes and activities.

56. Many Parties recognized the importance of public awareness programmes and the need to build on and improve existing activities. However, the information provided was often not clear enough to make it possible to assess the focus and scope of such programmes. Information for public awareness was reportedly disseminated using a wide range of materials and means. In addition to the general public being targeted in most cases, some Parties also reported on special awareness programmes for specific groups of the population.

57. Many Parties indicated a need for assistance to enhance research and systematic observation in order to cope better with climate change. Areas emphasized were capacity-building, monitoring and data collection, proper instrumentation and institutional strengthening.

IX. Financial and Technological Needs and Constraints

58. All reporting Parties provided some information on their financial and technological needs and constraints they faced in the preparation of their national communications and the implementation of the Convention. Several Parties provided the information in a separate chapter and/or section, but most Parties raised these issues in chapters of their communication that were dedicated to other areas. Most Parties reported on constraints relating to data availability and quality, available technologies, tools and methodologies, and human, financial and institutional capacities.

59. Most Parties acknowledged having received financial and technical assistance from the Global Environment Facility and its implementing agencies and other bilateral or multilateral programmes for the preparation of the initial national communication. Most Parties stressed the importance of the continuation of such assistance. In accordance with Article 12, paragraph 4, of the Convention and paragraph 17 of the UNFCCC guidelines, many Parties included information on projects to abate GHG emissions proposed for funding, and some Parties included a list of adaptation projects for funding.

60. Almost all Parties reported difficulties they faced in preparing their national GHG inventories and indicated that these stemmed from a lack of technical and institutional capacity as well as good quality data. Many Parties reported that the emission factors were not appropriate or applicable to their situation, and some Parties stressed the need to adapt the methodologies to their own circumstances. They further expressed the need for assistance to ensure continuous collection and maintenance of activity data, to improve the accuracy and reliability of these data, to enhance local technical capacity and expertise, and to develop national emission factors, mainly in the energy, agriculture, LUCF and waste sectors.

61. Parties referred to gaps and difficulties relating either to the assessment or to the possible implementation of abatement options. Among the problems relating to the assessment of abatement options, Parties mentioned inadequate institutional arrangements, lack of information, lack of capacity for mitigation analysis and project development, and lack of financial resources. Constraints on the implementation of abatement measures included inadequate institutional arrangements, lack of financial resources, lack of tax incentives and/or policies to promote the introduction, production and use of more efficient appliances, aversion to the risk of adopting new technologies, higher cost of abatement technologies, and a lack of public and political support for the implementation of abatement measures.

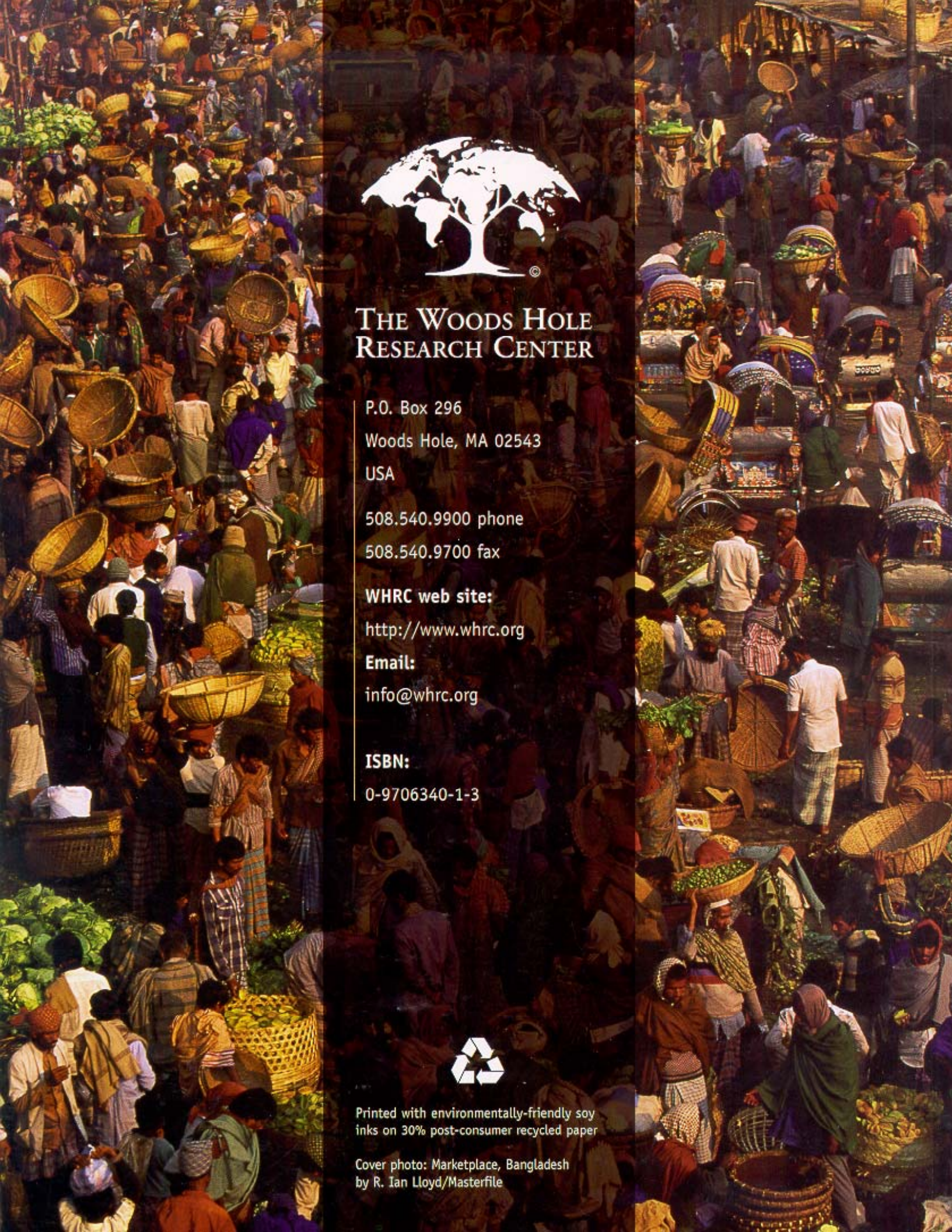
Executive Summary, *continued*

62. With regard to problems and constraints encountered in the area of vulnerability assessments, many Parties indicated that the studies were not sufficiently extensive to cover all vulnerable sectors because of lack of capacity, technology/methodology, good-quality data and adequate financial resources. The needs identified related to upgrading skills and research, improving data collection and analysis pertaining to vulnerability and adaptation measures, and capacity-building to assess and respond to the impacts of climate change. Many Parties emphasized the need to improve on the projections of temperature and precipitation changes as well as on sea-level rise so as to reduce uncertainties about their impacts. The main sectors of concern were water resources, agriculture, coastal zones, human settlements, population, health and ecosystems. Few Parties stated their needs explicitly.

Endnotes

[1] This document is submitted after the due date because of a delay caused by technical problems in communications with an external editor.

[2] See decision 30/CP.7, paragraph 2 (b) (FCCC/CP/2001/13/Add.4).



THE WOODS HOLE RESEARCH CENTER

P.O. Box 296

Woods Hole, MA 02543

USA

508.540.9900 phone

508.540.9700 fax

WHRC web site:

http://www.whrc.org

Email:

info@whrc.org

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