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Global Climate Change: The USAID Response

A Report to Congress

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List of Acronyms and Nomenclature

AFOS	Agriculture, Forestry and Other Human Activities Subgroup of IPCC Working Group III
APAP	USAID's Agricultural Policy Analysis Project
ARS	USDA's Agricultural Research Service
BEST	USAID's Biomass Energy Systems and Technology Project
BIA	DOI's Bureau of Indian Affairs
BIO	NSF's Directorate for Biological Sciences
BLM	DOI's Bureau of Land Management
BOM	DOI's Bureau of Mines
BOR	DOI's Bureau of Reclamation
BSP	USAID's Biodiversity Support Program
°C	Degrees Celsius
C	Carbon
CDE	Corporación Dominicana de Electricidad
CEES	Committee on Earth and Environmental Sciences
CGIAR	Consultative Group on International Agricultural Research
CFCs	chlorofluorocarbons
CIFOR	USAID's Center for International Forestry Research
CILSS	USAID's Permanent Inter-State Committee for the Campaign Against the Drought in the Sahel
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
COP	Conference of the Parties
CP	centrally planned
CRREL	DOD's Cold Regions Research and Engineering Laboratory
CRSP	USAID's Trop Soils Collaborative Research Support Program
CSI	U.S. Country Studies Initiative
CSRS	USDA's Cooperative State Research Service
DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
EC	European Commission
EEC	European Economic Commission
EEP	USAID's Energy Efficiency Project
E/GCC	USAID's Environment/Global Climate Change Project
EIS	Energy and Industry Subgroup of IPCC Working Group III
EJ	exajoule
EMCAT	USAID's Energy Management Consultation and Training Project
ENERCON	Pakistan's National Energy Conservation Centre

EOS	NASA's Earth Observing System
EPA	U.S. Environmental Protection Agency
EPAT	USAID's Environmental and Natural Resources Policy and Training
EPDAC	USAID's Energy Policy Development and Conservation Project
ERS	USDA's Economic Research Service
ESTs	environmentally sound technologies
ETIP	USAID's Energy Technology Innovation Project
ETP	USAID's Energy Training Project
EXIM	Export-Import Bank of the United States
FA-G	Forestry Advisors Group
FAO	Food and Agiculture Organization
FCCC	Framework Convention on Climate Change
FCCSET	Federal Coordinating Council for Science, Engineering, and Technology
F/FRED	USAID's Forestry/Fuelwood Research and Development Project
FONAMA	Bolivia's National Fund for the Environment
FRM	USAID's Forest Resources Management Project
FS	USDA's Forest Service
FSP	USAID's Forestry Support Program
FUNEA	Fundación Mexicana para la Educación Ambiental
FWS	DOI's Fish and Wildlife Service
FY	fiscal year
GCCS	USAID's Global Climate Change Strategy
GCDIS	global change data and information system
GCMs	general circulation models
GDP	gross domestic product
GEEI	USAID's Global Energy Efficiency Initiative
GEF	Global Environment Facility
GEO	NSF's Directorate for Geosciences
GFA	FAO's Global Forest Assessment
GOI	Government of India
GOP	Government of Pakistan
GT	gigatonne
GtC	gigatonnes carbon
GWI	USAID's Global Warming Initiative
GWP	global warming potential
HC	hydro-carbon
HCFCs	hydrochlorofluorocarbons
HFCs	hydrofluorocarbons
HHS	U.S. Department of Health and Human Services
IBPGR	International Board for Plant Genetic Resources
IC	SI's International Center
ICLARM	International Center for Living Aquatic Resources Management
ICRAF	International Center for Research on Agroforestry

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICSU	International Council of Scientific Unions
IDB	Inter-American Development Bank
IGBP	International Geosphere-Biosphere Programme
IGCC	integrated gasification combined cycle
ILCA	International Livestock Center for Africa
IMF	International Monetary Fund
INC	Intergovernmental Negotiating Committee
INFORUM	International Forum for the Development of Sustainable Land Use Systems
IPCC	Intergovernmental Panel on Climate Change
IPPI	USAID's India Private Power Initiative
IRRI	International Rice Research Institute
IS-92a	IPCC Scenario 1992, alternative "a"
IS-92b	IPCC Scenario 1992, alternative "b"
IS-92c	IPCC Scenario 1992, alternative "c"
IS-92d	IPCC Scenario 1992, alternative "d"
IUCN	International Union for Conservation of Nature and Natural Resources
IWGDMGC	Interagency Working Group on Data Management for Global Change
kg	kilogram
kJ	kilojoule
kt	kilotonne
kWh	kilowatt-hour
MDBs	mutilateral development banks
MDS	Multi-donor Secretariat of the World Bank
MMT	million metric tonnes
MTPE	NASA's Mission to Planet Earth
N	nitrogen
N_2O	nitrous oxide
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NASM	SI's National Air and Space Museum
NEAP	National Environmental Action Plan
NGOs	non-governmental organizations
NIEHS	HHS's National Institute of Environmental Health Sciences
NIS	New Independent States
NMNH	SI's Natural Museum of Natural History
NO	nitric oxide
NO_2	nitrogen dioxide
NOAA	DOC's National Oceanagraphic and Atmospheric Administration
NOx	nitrogen oxides
NPS	DOI's National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRM	natural resource management

NSF	National Science Foundation
NZP	SI's National Zoological Park
O_3	ozone
OECD	Organization for Economic Cooperation and Development
OEP	Egyptian Office for Energy Planning
OH	hydroxyl radical
OHER	DOE's Office of Health and Environmental Research
ONR	DOD's Office of Naval Research
OPIC	U.S. Overseas Private Investment Corporation
OPPE	EPA's Office of Policy and Program Evaluation
ORD	EPA's Office of Research and Development
ORNL	Oak Ridge National Laboratory
OS	DOI's Office of the Secretary
OSTP	Office of Science and Technology Policy
PACER	USAID's Program for the Acceleration of Commercial Energy Research
PACT	USAID's Program to Accelerate Commercial Technology
PARTS	USAID's Policy, Analysis, Research and Technical Support Project
PC	conventional pulverized coal
ppbv	parts per billion by volume
ppmv	parts per million by volume
PRINCE	Program for Measuring Incremental Costs to the Environment
PSED	USAID's Private Sector Energy Development Project
PVOs	Private Voluntary Organizations
RBO	TVA's River Basin Operations
REAT	USAID's Renewable Energy Applications and Training
REPSOs	Renewable Energy Project Support Offices
S	sulfur
SANREM	USAID's Sustainable Agriculture and Natural Resources Management
SAO	Smithsonian Astrophysical Observatory
SAVEM	USAID's Substainable Approaches via Environmental Management Project
SBE	NSF's Directorate for Social, Behavioral, and Economic Sciences
SCI	USAID's Sustainable Cities Initiative
SCS	USDA's Soil Conservation Service
SEB	India's State Electricity Board
SERC	Smithsonian Environmental Research Center
SI	Smithsonian Institution
SO_2	sulfur dioxide
SOx	sulfur oxides
STAP	GEF's Scientific and Technical Advisory Panel
STRI	Smithsonian Tropical Research Institute
TDA	U.S. Trade and Development Agency
TFAP	Tropical Forestry Action Plan
Tg	teragrams

TgN	teragrams nitrogen
TOGA	NSF's Tropical Oceans/Global Atmosphere
TVA	Tennessee Valley Authority
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
USGCRP	U.S. Global Change Research Program
USGS	DOI's U.S. Geological Survey
USIJI	U.S. Initiative on Joint Implementation
WDC	World Data Centers
WEATS	Wind Energy Applications and Training Symposium
W/m^2	watts per meter squared
WMO	World Meteorological Organization
WRI	World Resources Institute
WWF	World Wildlife Fund

Glossary Of Terms*

Climate System

The interactive components of our planet that determine the climate. This includes the atmosphere, oceans, land surface, sea ice, snow, glaciers, clouds and the biosphere. Climate change can be measured in terms of any part of the system, but it is most convenient to use surface air temperature.

General Circulation Model (GCM)

A computer model of the Earth's climate based on equations that describe the conservation of energy, momentum, and mass, and which explicitly calculate the distribution of wind, temperature, precipitation, and other climatic variables.

Global Warming Potential (GWP)

A concept originally utilized by the Intergovernmental Panel Climate Change to put the relative ability of different greenhouse gas emissions to affect climate on a common basis. The GWP accounts for differences in molecular structure and atmospheric lifetime of the various greenhouse gases, and expresses their radiative forcing relative to that of CO_2. Being replaced with better models.

Greenhouse Gases

Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and certain man-made chemicals that absorb and re-radiate some of the heat radiated from the earth's surface. In a rough sense, these gases trap some of the heat that would normally escape as radiant energy into space; hence, the analogy to a greenhouse.

Radiative Forcing (also called "external forcing")

A change imposed on the climate system, as opposed to generated by the internal dynamics of the climate system, that modifies the radiative balance of the climate system. Examples include: changes in the output of the sun or the orbit of the Earth about the sun, and increased concentrations of particles in the atmosphere due to volcanoes or human activity. Radiative forcing of the surface-troposphere system has been adopted as a simple and convenient way to estimate the potential climatic effects of various greenhouse gas species. It is often specified as the net change in energy flux at the troposphere (W/m^2) or the equilibrium change in surface temperature (°C) in the absence of feedbacks.

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* Adapted from *Policy Options for Stabilizing Global Climate*, Draft Report to Congress, U.S. EPA, Office of Policy, Planning, and Evaluation, Washington, D.C., 1989 (EPA, 1989).

We must take the lead in addressing the challenge of global warming that could make our planet and its climate less hospitable and more hostile to human life. Today, I reaffirm my personal, and announce our nation's commitment to reducing our emissions of greenhouse gases to their 1990 levels by the year 2000. I am instructing my administration to produce a cost-effective plan...that can continue the trend of reduced emissions. This must be a clarion call, not for more bureacracy or regulation or unnecessary costs, but instead for American ingenuity and creativity, to produce the best and most energy-efficient technology.

President Clinton
April 21, 1993

The following are excerpts from President Clinton's Global Climate Change Action Plan (Clinton, 1993).

International Policy:

"Global climate change is a long-term problem that will require years of sustained effort. The time for action is now."

"At the Earth Summit in June 1992, the United States joined other countries in signing the Framework Convention on Climate Change, an international agreement to address the danger of global climate change. The Convention has been signed by 161 countries and has been ratified by 31 of those countries. The objective of the Convention was stated to:

> ...achieve...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.'"

Domestic Policy:

"The Framework Convention on Climate Change challenges the industrial countries of the world to begin a long journey with the proverbial first step -- to return greenhouse gases to 1990 levels by the year 2000. We should strive to do no less; ultimately we will have to do more."

Executive Summary

BACKGROUND AND PURPOSE

The Senate Appropriations Committee has requested the U.S. Agency for International Development (USAID) to describe its planned activities and future strategic approaches to combat global climate change. This report is a response to that request, emphasizing developments since the 1990 Report to Congress entitled *Greenhouse Gas Emissions and the Developing Countries: Strategic Options and the USAID Response (USAID, 1990)*. With the end of the cold war that has dominated the second half of the twentieth century, and the signing of the Framework Convention on Climate Change and other agreements by over 100 Heads of State in Rio in 1992, USAID and the international community can now chart fundamental new directions to face the challenges of the twenty-first century.

USAID's approach to combating environmental threats associated with global climate change is anchored in its post-cold war mandate for sustainable development. Such development is characterized by *economic and social growth that does not exhaust the resources of a host country; that does not damage the economic, cultural, or natural environment; that creates many incomes and chains of enterprises; and that builds indigenous institutions that involve and empower the citizenry*. Equity-among and between generations is at the heart of sustainable development. The Brundtland Commission (Brundtland, 1987) adopted the concept of intergenerational equity when it defined sustainable development as *meeting the needs of the present generation without compromising the needs of future generations*.

This report draws its inspiration from the current initiative to reinvigorate the Agency, and builds upon strategies in four areas that are critical to sustainable development: Population and Health, Economic Growth, Environment, and Democracy (USAID, 1994). These strategies create a new role for USAID that greatly reinforces U.S. foreign and domestic policy, complements the work of other U.S. Government agencies, collaborates closely with international organizations, national governments, universities and non-governmental organizations, and leverages the financial resources of multilateral banks and the private sector.

USAID will pursue two strategic goals in its new approach to protecting the environment:

- Reducing long-term threats to the global environment, particularly loss of biodiversity and climate change; and

- Promoting sustainable economic growth locally, nationally, and regionally by addressing environmental, economic, and sociopolitical practices that impede development and are unsustainable.

Rapid climate change induced by increasing concentrations of carbon dioxide and other greenhouse gases arising from human activities presents a long-term threat to the global environment despite uncertainties surrounding the timing, magnitude and impacts of such change. Scientific advisory committees to the United Nations and the National Academy of Sciences (NAS) have estimated that by the end of the next century, assuming the continuation of current trends, the global mean temperature could rise by 1.5 to 4.5 °C. In comparison, the earth's mean temperature has risen only 0.3 to 0.6 °C in the last century, and probably has not varied by more than 1-2 degrees over the past ten thousand years.

USAID will reduce long-term threats to the global environment and will promote sustainable economic growth by adopting an approach whereby energy efficiency, sustainable land-use management, and a less carbon intensive path to modernization can accelerate economic growth while reducing local, regional and global environmental risks. All nations would find such a path in their economic self-interest, even in the absence of any risk of climate change. To reduce the risk of rapid climate change, developing countries can focus on indigenous capacity strengthening, policy and regulatory innovation, and technological leapfrogging, as central elements of sustainable development.

In signing the United Nations Framework Convention on Climate Change, the international community has embraced the notion of the developed countries assisting developing countries in meeting the terms of the convention. In contributing to the Global Environment Facility (GEF) through parallel activities, USAID has also endorsed the approach of the Climate Convention.

An ambitious long-term goal for the global community is to stabilize the concentration of greenhouse gases by the middle of the twenty-first century. Such stabilization can only occur if the major greenhouse gas emitting nations of the world convert to a predominantly non-fossil energy infrastructure over the next fifty years. Successful conversion to a non-fossil fuel based industrial civilization will require massive innovation on all fronts-technological, policy, financing and institutional.

No single innovative approach or technology can adequately control the growth of greenhouse gas emissions, but by implementing an integrated strategy over the next few decades, significant

reductions in emissions can accompany accelerated economic growth in all nations. However, nothing short of bold and innovative efforts on a global scale can simultaneously reconcile vigorous economic growth with stabilization of the global climate system.

LESSONS LEARNED

The most important lesson learned by USAID is that broad access by people to their country's economy and participation in their society's decisionmaking processes, are fundamental to sustained development. Successful and unsuccessful experiences of USAID, other bilateral donors, private foundations and multilateral banks have demonstrated that development assistance works best when it fully takes into account and responds to the priorities and values of the recipient society, whether at the local sector, or national levels. The policy and regulatory changes necessary to open up economies to innovation and investment must be supported by broad elements of the society, or such changes will not be sustained after donor assistance is withdrawn.

To expand the impact and maximize the effectiveness of its programs, USAID must leverage its limited grant resources by creating favorable conditions for development in the host countries, especially in the private sector and in local community organizations. USAID has also learned the importance of collaborating with other bilateral donors, multilateral development banks and indigenous institutions, from project conceptualization through implementation, and from local to international levels of interaction.

STRATEGIC APPROACHES

USAID has identified approximately twenty developing and former communist countries that are, or will become, significant contributors to total global greenhouse gas emissions. Using clearly established selection criteria, USAID will collaborate with a subgroup of these countries to develop and implement plans that reduce sources and increase sinks of greenhouse gases. Through the adoption and enchancement of local and national economic and environmental goals. This subgroup includes, but is not necessarily limited to, Brazil, Central Africa (as a region), India, Indonesia, Kazakhstan, Mexico, Poland, the Philippines, Russia, and the Ukraine. Though China is a pivotal country from a global climate perspective, USAID is not authorized to conduct projects there. Additional countries where USAID will work to address global climate change are identified in Chapter 3. USAID will also help countries that are particularly vulnerable to the effects of climate change to adapt to the effects of such change. Such adaptation measures will form a vital component of sustainable development at the country level, and will be integrated into sound natural resource management strategies and economic growth.

The objectives of future USAID projects and programs are to : 1) promote the implementation of energy efficient technologies, renewable energy facilities and low carbon-emitting energy systems

through the private sector and effective public/private partnerships; 2) foster sound forestry and natural resources management practices by limiting deforestation and other carbon-emitting land-use changes; and 3) implement advanced information technologies, including global information and communication networks. To implement these objectives, this report proposes strategic approaches that are anchored in current Agency activities in the area of global climate change. A representative list of current Agency climate change activities is described in Appendix 1.

PROMOTING ENERGY EFFICIENCY, LOW CARBON-EMITTING ENERGY SYSTEMS, AND RENEWABLE ENERGY WHILE EXPANDING PRIVATE AND PUBLIC ENERGY SERVICES.

Most countries are caught in an excruciating "triple-bind" in the energy sectors, characterized by inadequate investment capital, an inhibiting policy environment and lack of institutional capacity, and both local and global environmental constraints. To sever this bind, the report proposes three interconnected global approaches to lower the rate of growth of greenhouse gas emissions while enhancing and expanding energy services. These approaches will be implemented primarily on a country-by-country basis.

These approaches stress:

- Institutional reform and private sector involvement to improve the efficiency of delivered energy services;
- Environmental technology cooperation; and
- Leveraging multilateral and private sources of capital to promote energy efficiency.

These are described below:

Institutional Reform and the Private Sector: USAID's approach to institutional reform will focus on policy and regulatory reform to implement efficiency measures, environmental standards and private capital investment, integrated resource planning and demand-side management, and innovative training and capacity building involving collaborative programs among U.S. and host country institutions.

Environmental Technology Cooperation: There is a major opportunity for developed and developing countries to accelerate technology transfer and cooperation involving environmentally sound technologies (ESTs). For technologies that are close to commercialization, USAID will build on the successes of its Program to Accelerate Commercial Technology (PACT) and the Program for

Acceleration of Commercial Energy Research (PACER). These model programs support the accelerated movement of environmental technology into the global marketplace by providing "conditional grants" to private sector joint ventures of U.S. and developing country firms. The grant converts to a soft loan and is paid back if the venture is successful. USAID will also catalyze industrial and utility partnerships through study tours of the U.S. by foreign institutions, and will foster long-term relationships among industries, utilities, cities and universities.

Investing in a Sustainable and Efficient Power Sector: USAID will help to create the conditions for economically sustainable development, and will provide grants to meet international commitments, including commitments to the pilot phase of the Global Environment Facility (GEF). USAID will complement the work of other U.S. Government agencies, such as EXIM Bank, the Overseas Private Investment Corporation (OPIC), and the Trade and Development Agency (TDA) and will act to leverage multilateral and private sources of equity and loan capital.

PROMOTING SOUND FORESTRY AND NATURAL RESOURCES MANAGEMENT

This objective is promoted through three country-based approaches stressing sustainable land-use, citizen empowerment through participation, and resource and technology assessment and development.

Sustainable Land-Use: Assistance will be provided to host countries to identify the impact of development policies on land use. USAID will promote policies that provide economic incentives for sustainable forest management and will discourage policies that lead to deforestation and unsustainable resource use. Policies that facilitate the sustainable production of goods and services for a rapidly increasing population will be encouraged. Opportunities will be sought to promote cooperation among donors and host countries in evaluating natural resource management policies and avoiding policy inconsistencies.

Empowerment through Participatory Institutions: Activities designed to enhance institutional capacity will include development of incentives that empower women and disadvantaged minorities, and that involve non-governmental organizations and the private sector in natural resource management decisions, and that encourages the transfer of management technologies to those who work on the land. Participatory planning processes that begin with indigenously performed local needs assessments, and that link the knowledge base to the users, will be promoted.

Resource and Technology Assessment and Development: To provide a baseline level of knowledge about the geophysical, climatic and biological production potential of forest, range and agricultural ecosystems, assistance will be provided for countries to determine current land-use practices and assess the current stock of natural resources. Also needed is an understanding of the

ecological relationships among species within natural ecosystems. To complement this knowledge, assessments will be made of traditional uses of forest and trees in agricultural production systems.

IMPROVING INFORMATION COLLECTION AND DISSEMINATION AND GLOBAL ELECTRONIC COMMUNICATIONS

Global Energy and Environment Information Exchange: USAID is currently transforming its internal communications to incorporate linkage to the Internet. The Internet, a rapidly-expanding network of numerous individual data networks worldwide that conform to U.S.-developed standards, is a widespread and cost-effective means for worldwide information delivery. It also is being pursued rapidly by USAID's counterpart organizations, such as the World Bank and the United Nations Development Program (UNDP). Expansion of affordable Internet access will be a high priority throughout USAID's programs, including those addressing global change.

MEASURING RESULTS

The report identifies illustrative quantitative and qualitative indicators for measuring the results of projects in energy, forestry and agriculture. Project evaluations will utilize these indicators to verify whether USAID's sustainable development goals are being met.

In the energy and industry sector, key illustrative targets will be the enactment of policy, regulatory or price reforms, and reductions of energy-related environmental emissions (such as CO_2, NO_x, SO_x, CO, HC, and particulates per kWh, mile traveled, pound of product, or unit of GDP). In the forestry, natural resources and agriculture sectors, the targets could include net reductions in greenhouse gas emissions from deforestation. In the information technology arena, as countries adapt advanced information technology and improve communications with each other, international organizations, NGOs, PVOs, and other U.S. businesses, targets will include the development of capacity to electronically access a wide range of international information.

Chapter 1

Introduction

In 1990, USAID began its Global Warming Initiative (GWI) to combat global warming and the long-term threat that emissions of greenhouse gases pose. Legislation directed USAID to focus its global warming activities in "specific key countries which stand to contribute significantly to global greenhouse gas emissions, and in which actions to promote energy efficiency, reliance on renewable energy resources, and conservation of forest resources, could significantly reduce emissions of greenhouse gases" (P.L. 101-167, section 534).

The exact amount of funding allocated to global climate change activities is difficult to determine. Although accounting records associated with the individual projects are available, it is not clear what fraction of the funding for each project was spent on climate change activities. The coding system currently used to track projects is not designed to provide an accurate and comprehensive accounting of the funding levels associated with major categories such as global climate change, and quite likely provides an overestimate of the actual obligations.

A listing of projects related to climate change issues and the total funding obligation amounts for each project is provided in Appendix 1. Also listed is an estimate of the percentage of the total project funding allocated to climate change activities. This is the value that is uncertain. Subject to this caveat, the cumulative obligation since 1990 totals over $240 million. Only projects directly intended to address climate change issues are included in the list, although other agricultural and forestry projects may also have an indirect impact on the net emissions of greenhouse gases.

Budget amounts for fiscal year 1994 were not available when this report was prepared. New climate change projects may be designed, and existing projects may be modified if necessary, as Agency restructuring is completed and more detailed planning activities continue.

In December, 1992 the U.S. Senate ratified the Framework Convention on Climate Change (FCCC) that had been signed in June at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, that same year. The FCCC will structure the international policy debate on the climate issue for the next decade. It establishes several new institutional mechanisms for international cooperation and binds the issues of environmental protection and economic development. The prudent policy response of the international community is contained in the FCCC. USAID will support the implementation of the FCCC, and will continue to assess its

strategy in the light of new scientific evidence. This path-breaking international treaty has now been signed by 154 countries, and the treaty entered into force in March 1994.

There are several key elements in the FCCC. The first is Article II, which defines the objective of the Convention to be achieving "*stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.*" It is important to note that the objective is stated in terms of stabilizing *concentrations*, not emissions of greenhouse gases. The timeframe in which this process can occur and the absolute level at which stabilization occurs will depend on many factors including population growth, economic growth rates, power sector fuel mix, deforestation and reforestation rates, and agricultural practices.

Other key elements are found in Article III which states the fundamental principles of the Convention. Several are: "*developed country Parties should take the lead in combating climate change and the adverse effects thereof,*" and "*the Parties have a right to and should promote sustainable development.*"

GLOBAL CLIMATE CHANGE STRATEGY

USAID's new Global Climate Change Strategy (GCCS) is designed to support the fundamental objectives of the FCCC as stated above. The goal of the GCCS is: ***To contribute to global efforts to stabilize greenhouse gas concentrations and to assist countries to adapt to the adverse effects of climate change, while maintaining economic growth in developing and post-communist countries.*** As clearly stated in this goal, USAID is committed to addressing both mitigation and adaptation aspects of the climate change dilemma.

This report will concentrate on USAID's global greenhouse gas assessment and mitigation program. Mitigation methods, particularly in the energy sector, are generally applicable throughout the world, and therefore it is possible to address this dimension of the climate change problem on a global basis. Vulnerability and adaptation are also significant aspects of the global climate change problem. Because the effects of climate change are manifested on a regional level, they will be addressed in more detail in individual country programs, and will only be cvered in general here. Therefore, the key objectives of the GCCS will be to:

- promote efficient energy use and renewable energy implementation while expanding public and private energy services;
- promote sound forest and natural resources management practices; and

- improve information collection and dissemination and global electronic communications.

For USAID's efforts to be effective, these global issues must be approached strategically and collaboratively. This report outlines strategic approaches that have proven effective in on-going projects, and proposes to strengthen collaborative efforts with other bilateral and multilateral development partners. Because of limited human and financial resources, the Agency must focus its efforts on key countries and pivotal issues. USAID will work with key countries to develop appropriate action plans that reflect: the scope of the problems faced in that country; the country's commitment to real change; and the probable impact this effort will have on reducing global greenhouse gas concentrations.

Chapter 2 of this report outlines USAID's global climate change activities since 1990, while Chapter 3 addresses future activities under the GCCS. Global climate change activities of USAID are focused in the energy and industrial, forestry, and agricultural domains. In energy and industrial areas, emissions of carbon dioxide, carbon monoxide, and methane are the primary foci of attention. In the forestry and agriculture sectors, carbon dioxide may be both emitted and sequestered, and nitrous oxide and methane are major emissions. Climate change activities in each of these major sectors can be broadly classified under the headings of policy reform and capacity building, environmental technology cooperation, and investment leveraging. Numerous examples that show the breadth of current Agency programs in the global climate change area are presented in Appendix 1. An overview of the international and U.S. global climate change program is presented in Appendix 2, and the U.S. Global Climate Change Research Program is outlined in Appendix 3. Appendix 4 addresses key country selection criteria for greenhouse gas emissions in the energy and industrial sectors.

Chapter 2

USAID's Operational Approach in Global Climate Change

This chapter presents USAID's guiding principles and operational strategy in the GWI from 1991 through 1993 and summarizes the salient aspects of both greenhouse gas emission reduction and climate change adaptation projects. A representative list of current GWI projects can be found in Appendix 1.

The major principle underlying the present U.S. response to the global climate change[1] issue is an approach whereby energy efficiency, afforestation and a less carbon intensive path toward modernization accelerates economic growth while reducing local, regional and global environmental risks. Even though the scientific community is developing a better understanding of the physical phenomenon occurring in the atmosphere, the amount of uncertainty inherent in predictions of future climate patterns dictates that emphasis be placed on those policies and actions that can be justified independently of the timing and magnitude of potential climate changes. USAID's climate change activities over the past several years meet this principle.

The Agency's global climate change activities are mainly focussed on energy and industry, forestry and natural resources, and sustainable agriculture. Within each sector, the strategic approach involves leveraging of financial and intellectual resources, policy reform, institutional and private sector capacity building, and technology cooperation. Experience has demonstrated that all of these major elements must be addressed if sustainable development is to be achieved.

USAID's experience has shown that market reform and sector restructuring require a strategic framework that addresses both the complexity of economic transformation as well as the multi-dimensional character of the problems. USAID has found that assistance efforts such as leveraging, policy reform, capacity building, and technology cooperation can logically be addressed at different levels of interaction - international, national, state, and commercial transaction. Depending on the

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1 Over the past three years, much has been learned regarding the global climate change issue. Most importantly, if temperatures rise as expected under current practices, other climatic variables will also change adversely, affecting developing countries in both the long- and short-term. Therefore, the term "global climate change" is more descriptive than "global warming". However, for purposes of discussing all past activities from FY 1991-1993, the acronym GWI will often be used as this refers specifically to the Congressional mandate of 1990.

levels of interaction - international, national, state, and commercial transaction. Depending on the strategic element being addressed and the specific country and project being considered, interaction may occur at only a single transaction level, or at all levels. For instance, leveraging of financial resources can be effective at either the international level (i.e., with the multilateral development banks (MDBs)), or at the state level (i.e., local banks). Empowerment, or capacity building, can occur at all levels of interaction.

The USAID 1990 Report to Congress indicated that the Agency would try to commit up to $248 million by 1991 in support of global climate change activities. In the interim the Agency has had to change the level of funds obligated, the key countries, and the types of activities associated with global climate change in light of other major global events. A major change has taken place in the political arena, namely the emergence of the New Independent States (NIS). This event has caused USAID to respond quickly to new U.S. policy and financial commitments. The NIS is a significant greenhouse gas contributor, accounting for 17 percent of the world's total CO_2 output (IPCC, 1991a). USAID has begun a comprehensive program in the NIS under the GWI designed to improve the efficiency of industries and utilities, and to reduce pollution per unit of output from plants. Over the past three years, new activities such as those in the NIS have stretched both human and financial resources to their limits. Specialists who might otherwise have spent their time on those key countries identified in the 1990 report, were reassigned to assist with new activities in the NIS. Of the total FY 1992 funds initially obligated for global climate change, over $33 million were re-designated for projects in the NIS. In FY 1993, over $65 million in global climate change funding was obligated to support activities in the NIS.

Global Climate Change Activities Associated with Emissions Stabilization

As discussed in the 1990 Report to Congress, the GWI focuses on specific areas of USAID activity where the Agency can be effective in reducing greenhouse gas emissions and augmenting naturally occurring greenhouse gas sinks. A significant number of new activities launched over the past few years in the energy, forestry, and agricultural sectors were specifically aimed at the development of the political and institutional frameworks necessary to allow greenhouse gas reduction projects to be implemented. In addition, support was provided to U.S. industry to foster technology cooperation between U.S. developers and manufacturers and developing country counterparts.

2.A. Energy and Industry

A paucity of energy services dominates the lives of most people in developing countries. The vast majority of the 2.5 billion people living in villages have no energy services other than their own

countries is less than one-tenth that of the Organization for Economic Cooperation and Development (OECD) countries; the average American uses 33 times more energy than the average Indian and 295 times more than the average Tanzanian (WRI, 1992).

The rapid expansion of energy services will be essential for the continued economic development of developing and post-communist nations. However, energy services do not equate directly with energy used, and it is possible for services and economies to expand without increasing the supply of energy proportionately.

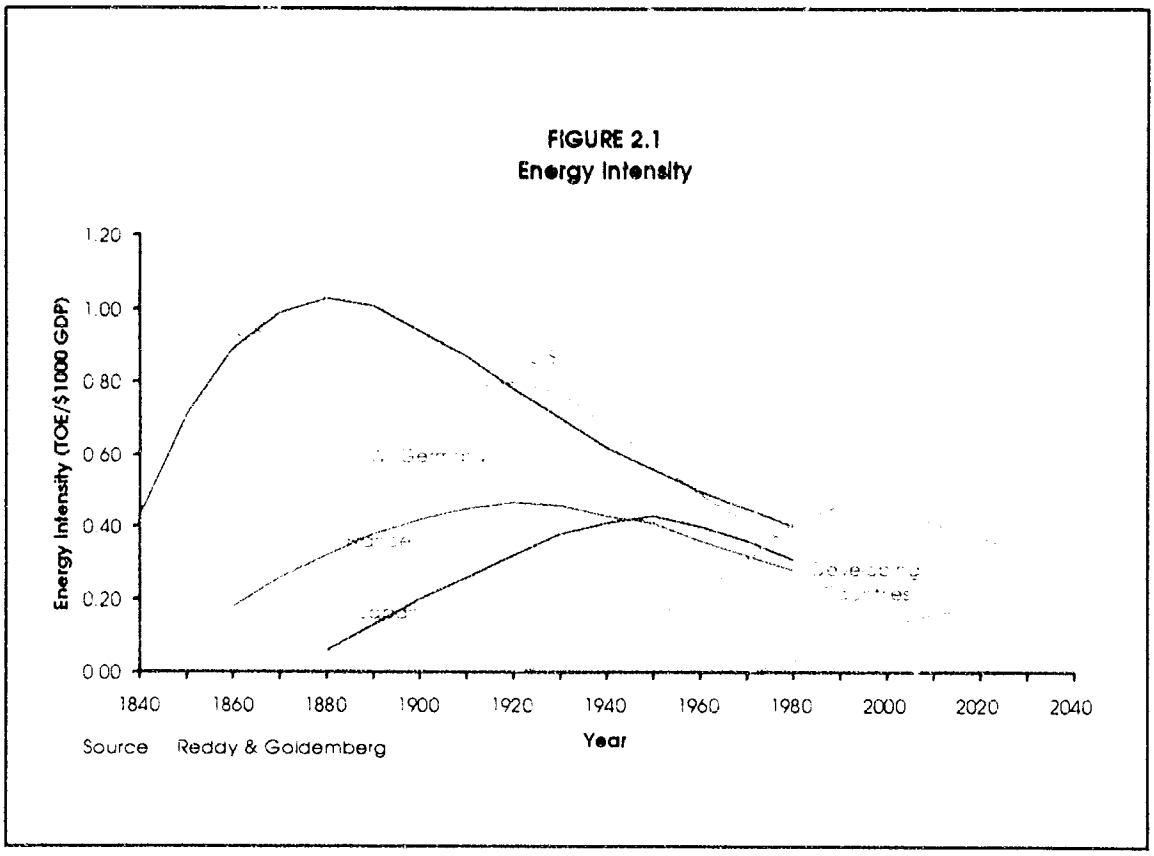
Developing and post-communist countries do not need to completely repeat the historic experience of most industrialized countries. For many industrialized countries, energy consumption grew faster than the gross domestic product (GDP) initially while the countries built infrastructure and saturated various energy use markets. Then as experience was gained the countries discovered more efficient means of producing goods and materials. Each country participating in the industrial revolution learned from those that had preceded them in the industrialization process. These trends are clearly shown in Figure 2.1 (Reddy, 1990).

In principle, by accessing state-of-the-art technology, developing and post-communist countries can "leapfrog" over the long and resource-intensive development process experienced by most industrialized nations, and achieve high rates of economic growth with lower levels of energy use. USAID has estimated the potential for energy efficiency improvement in developing countries at 25 percent over the next 30 years (Levine, 1991).

Reduction of greenhouse gas emissions has also been achieved through projects which substitute a lower carbon fuel such as natural gas for coal. Combustion of natural gas instead of coal considerably reduces the amount of carbon dioxide produced per unit of electricity delivered. Various renewable energy technologies which produce little or no carbon dioxide are becoming cost effective in a number of applications, particularly when used in remote locations. USAID has an active renewable energy program as a component of its overall global climate change strategy.

2.A.1. Leveraging Investments and Donor Coordination

USAID has learned that leveraging works best if it increases the number of public and private donors and financial backers involved in projects. There have been enormous shifts in wealth during the last twenty years among nations, communities, and individuals. Any successful strategy for development must seek to expand the donor and investment community beyond the traditional sources and particularly in the private sector.



Many of USAID's activities under the GWI involve the leveraging of financing from the MDBs and international finance institutions. By providing pre-investment study and initial design support funds, USAID has assisted lending institutions and developing countries in the preparation of viable innovative projects prior to the loan appraisal stage. The GWI also serves as a focal point for developing and implementing USAID's projects for the GEF, and will continue to assist the World Bank in developing and assessing GEF projects that address global climate change.

USAID must leverage its scarce resources to secure multilateral and private bank funding in order to have an impact in the multibillion dollar energy sector. In India, for example, the Energy Management Consultation and Training (EMCAT) project is a $20 million USAID project, which is leveraging $1.5 billion in World Bank, Asian Development Bank, Government of India, and private sector funding for power project development and energy efficiency improvements.

USAID promotes private sector solutions to the energy problems of the developing countries and market economies by providing technical assistance, disseminating market information, and co-funding feasibility studies. Through its private sector program, USAID seeks to increase the supply of reliable, affordable, and environmentally-sound energy from the private sector. Indigenous non-governmental organizations (NGOs) and private voluntary organizations (PVOs) play an important role in this process. Successful development requires more than money, however. It also requires the skills and talents of individuals trained to handle such situations. USAID believes that every project should "leverage" its personnel, and include a major role for local participants in the planning and execution of the program. By making this kind of leveraging an operational goal, USAID believes it can make empowerment an integral part of the development process.

In Poland, Lithuania, and the Czech Republic, USAID is carrying out demand-side management programs with electricity distribution companies that are helping to create an industrial market for private energy service companies. Through the USAID's Utility Partnership Program with the U.S. Energy Association, leading U.S. utilities are donating the time of their executives and experts to work with sister utilities and help them in their efforts to privatize and adapt to a market economy.

2.A.2. Policy Reform

Energy sector policy has been inadequate in many developing and centrally planned countries. In the power sector, for instance, many government operated utilities are unable to meet the rapidly growing energy needs as the economies expand. Poor financial management and subsidized tariffs have resulted in deteriorating rates of return on power investments and an inability to finance additional facilities. Operating efficiencies are frequently very poor, and even normal maintenance activities are inadequate because of lack of funds or poor training.

To combat the deficiencies in power sector policy, USAID has made energy efficiency, renewable energy, and integrated resource planning key elements of its GWI. Many of the management deficiencies can be addressed through integrated resource planning techniques, and technology and financial management issues can also be incorporated into this planning process.

Much of USAID's energy sector activities have been concentrated in the power sector, both in the supply and demand side. This sector has been selected because there is a reasonably well defined infrastructure and hierarchy of organizations, and the relatively limited resources available to USAID can be used effectively. However, the Agency also recognizes that inadequate planning in the transportation sector is a universal problem, and has begun to address transportation issues in several of its GWI projects.

A component of the policy reform strategy has been the encouragement of private sector participation, particularly in the power sector. Policy guidelines and regulations, and financial incentive mechanisms are required prior to private sector investment. The Agency has found that it is more effective in promoting the adoption of environmentally-sound technologies by assisting in the reform of markets and restructuring of economic sectors, than through the more traditional approach of unsustainable isolated demonstration projects.

As an example of a broad policy driven project, the Agency is supporting an innovative program in Costa Rica to make use of agricultural residues in the sugar industry to fuel on-site private power generation. Part of an 11-year, $12 million USAID project, this activity focused on the development of a government policy permitting private power hookups, pricing reform, and power sales to the national grid. The project also concentrates on the development of new, privately-owned, biomass-fired power generation units.

2.A.3. Capacity Building

In countries dominated by the public sector, a thriving market economy and private sector cannot be created overnight. New institutions must be created such as those necessary to encourage private sector producers, and old institutions dismantled. A critical aspect of USAID's strategy must be to strengthen private sector capabilities, particularly in the construction and management of efficiently run plants and businesses, and to build the capacity within the public sector to manage market-based decision-making mechanisms.

To support these efforts, increased resources are being devoted to the training of host country officials and experts on energy planning, renewable energy systems, environmental management in the energy sector, energy efficiency, private power participation, and financing. Training opportunities include formal course work, internships with U.S. energy organizations, and visits to U.S. energy facilities, including utilities, manufacturers, architect-engineers and private developers.

In 1990, for example, USAID launched the Global Energy Efficiency Initiative (GEEI) to encourage the incorporation of energy efficiency into the development strategies of developing countries and countries in Eastern and Central Europe. GEEI is a coalition of U.S. government agencies, universities, national laboratories, private companies, environmental and energy organizations, and other nongovernmental groups, and whose primary aim is to build a partnership among such institutions in industrialized and developing countries.

2.A.4. Environmental Technology Cooperation

As part of the GWI, USAID is promoting innovative, market-driven technology cooperation between U.S. and developing country organizations. The U.S. manufactures and exports some of the world's most energy efficient and environmentally-sound energy and information technologies. These technologies include combined cycle power plants, renewable energy technologies, computer-based control systems, heat exchangers, lighting equipment, windows, electric motors, refrigeration and air-conditioning equipment, automotive emissions controls, and expertise from energy services companies. U.S. manufacturers and developers can work with developing country counterparts to develop new environmentally-sound, global information technologies suitable for developing country markets. In addition, through its work on projects with private power developers, USAID can also effect a more immediate transfer of efficient and environmentally-sound energy technologies through the development and construction of projects using these technologies in those countries.

The growing demand for new, efficient power plants and the realization of energy efficiency needs in developing countries create increased export opportunities for U.S. technologies. Imports by developing countries of energy efficiency technology totaled $4.2 billion in 1990, and are expected to grow by 2 to 3 percent annually. The U.S. market share of these imports was only 10 percent in 1990, however, and is now declining. Close collaboration between developing countries and U.S. industry has helped to improve the competitive advantage of U.S. firms and helped increase U.S. market share in power generation, energy efficiency, and environmental technologies and services.

Coal is a major source of energy for millions of people around the world, accounting for a quarter of total primary energy use worldwide (Holdren, 1992; IPCC, 1991b). Coal is also responsible for about 42 percent of all CO_2 emissions from the energy sector, and approximately 36 percent of CO_2 emissions from all anthropogenic sources (IPCC, 1991c). Coal use for electricity generation is expected to grow substantially in countries such as Indonesia, India, and China over the next several decades, providing a major opportunity for technology cooperation in coal-gasification and other environmentally-sound technologies.

2.B. Sustainable Agriculture

With some 3.2 billion hectares of arable land on the Earth's surface, agriculture is a major sector of human interaction with the environment. The sector is extremely complex, interacting at all levels of human endeavor (production, marketing and consumption) and environmental consequence (air, soil, water, climate, biodiversity, and natural resource base). Priority is now placed on agricultural activities which build on a country's comparative advantage and optimize present and future uses of natural resources in an environmentally-sound manner.

Improvement of the well-being of the world's less advantaged people is based on addressing long-range concerns about food security and the "health" of natural resources. To do this, agricultural programs are now devoting greater attention to developing integrated production systems - systems that enhance the structure and function of the broader agroecosystems. The lack of understanding of the interrelatedness of system components has undermined agricultural sustainability in the past, and failure to consider any one of them fully will inevitably undermine it in the future. A systems approach to agricultural development is necessary if these shortcomings are to be overcome.

The impact of agriculture on global climate change comes in two general forms: 1) global warming through disruption of the carbon cycle and emission of other greenhouse gases such as methane and nitrogenous gases, and 2) disruption of micro and macroclimates (rainfall, temperature, and season length) through human intervention caused by agricultural production, agroforestry, and silvopastoral practices.

The agricultural sector has responded to the challenge of global climate change in two ways: development of an awareness of the causes and implications of climate change; and mitigation of processes and activities considered to be the causes of global climate change. Mitigation has been by far the most important focus area of USAID intervention. For instance, the development of productive economic and sustainable systems of food production in tropical regions is key to reduction of deforestation. Developing an awareness of the causes and implications is an important part of the USAID portfolio. Awareness takes many forms; training, public (and governmental) awareness, and basic research, and usually is integrated as elements of on-going programs.

2.B.1. Leveraging Investments and Donor Coordination

The thrust of USAID's donor coordination has been to find potential collaborators with shared program and technical objectives, and to design and implement programs collaboratively. Multilateral cooperation has had its greatest impact and success in small countries or regions. The problem to be addressed is limited to a manageable size either geographically, socially, or politically. Recently there has been a trend for greater multilateral coordination at the program planning stage. A general acknowledgement by donors is that, in an atmosphere of diminishing resources, better coordination and cooperation is required. Globally, USAID, the Food and Agriculture Organization (FAO), the Rockefeller Foundation, and the World Bank are supporting the International Forum for the Development of Sustainable Land Use Systems (INFORUM) which serves as a communication network among researchers and policy-makers on topics related to sustainable agriculture and global climate change issues.

2.B.2. Policy Reform and Capacity Building

USAID recognizes that the policy environment in many developing countries is responsible for market distortions, discouraging food and agriculture production, and negatively affecting the natural resource base. Before governments can implement agricultural reforms, focused policy analysis is required to help policy decision-makers better understand policy alternatives and impacts. Greenhouse gas emissions by agricultural systems has only recently been added to the list of potential impacts of policy decisions.

The Agricultural Policy Analysis Project (APAP) and the Environmental and Natural Resources Policy and Training Project (EPAT) are programs that provide policy analysis support to USAID Missions. These programs are global in design, and have slightly different policy focus targets. APAP deals only with natural resource issues affected by agricultural systems, while EPAT covers general natural resource and environmental policy issues. Both are relatively new programs which are active in all regions of the world, and both address issues of global climate change.

2.B.3. Environmental Technology Cooperation

USAID's strength in reducing the impact on global climate change has been through its global network of technical cooperation. The relationship of the forest with agriculture, especially in tropical regions that provide productive, economic and sustainable food production systems, is a major key to reducing deforestation.

USAID is the lead donor to the Consultative Group on International Agricultural Research (CGIAR) that sponsors two international centers dedicated to reducing deforestation. The International Rice Research Institute (IRRI) is also undertaking research on methane emissions from rice production.

2.C. Conservation of Forests and Biological Diversity

Forests and other natural terrestrial ecosystems are significant to global climate change for two principal reasons. First, a significant amount of carbon is stored in the biomass of trees, shrubs, and other organisms and the organic matter in the litter and soil. When forests are converted to other land uses, much of the carbon stored in the biomass, litter, and soil is converted to CO_2 and released into the atmosphere, either quickly as the felled biomass is burned to prepare the site for planting, or more gradually as leaves, branches, roots, trunks or processed lumber decay. Secondly, ecosystems will be adversely affected by climate change, because some species within natural communities will be less adapted to survive under an altered climate, thus leading to changes in species composition of communities and ecosystems.

USAID is implementing activities specifically designed to counter CO_2 emissions from tropical deforestation in Latin America and the Caribbean. In Africa, USAID is improving the capacity of institutions to address global climate change by funding resource, policy, and institutional analyses and training. Most of USAID's sustainable forestry and natural resources management activities help to lessen either the rate or the impact of climate change, although they were not designed specifically for either purpose. Presently, the impacts of these activities on the global carbon budget are not being monitored. Conserving tropical forests avoids the net release of CO_2 which would occur otherwise because the carbon sequestered in biomass and soil would be oxidized by burning and decomposition processes. The same policies and institutional capacity that countries require to sustainably manage their forests will also equip them to assess their vulnerability and to adapt to climate change.

In fiscal year 1992, 133 projects in 56 countries were being carried out by USAID to conserve tropical forests and biological diversity. Through these projects, complemented by financial and technical support to other international agencies, NGOs, and scientific research centers, USAID is addressing the root causes of tropical forest and biodiversity loss (ENRIC, 1993).

To attack the root causes of tropical deforestation, USAID assists countries to rationalize policies in all sectors affecting forests, promotes effective government and private sector institutions for policy analysis and technology application through technical assistance and training, develops and adapts sustainable resource management technologies, and coordinates donor assistance in forestry.

2.C.1. Leveraging Investments and Donor Coordination

Many of the investments and institutional reforms required before developing countries are in a position to manage their forests sustainably are beyond the budget capabilities of USAID. However, well-timed and designed interventions by USAID can frequently catalyze or leverage much larger investments by other donors.

In several countries, USAID has used relatively modest sums of money to catalyze cross-sectoral collaboration among the government, national NGOs, the private sector, USAID, and other donors to analyze the interaction of forestry and natural resources management with other environmental issues and to integrate environmental and economic policies through the National Environmental Action Plan (NEAP) process. The success of the NEAP for engaging the participation of a broad cross-section of society in integrating environmental and economic issues has prompted the World Bank to require that countries prepare NEAPs prior to receiving development loans (Ford, 1992).

The Tropical Forestry Action Plan (TFAP) was launched in 1985 by the World Bank, the United Nations Development Programme (UNDP), FAO, and the World Resources Institute (WRI) to counter tropical deforestation by improving coordination among donors and raising increased overseas development assistance for forestry. Soon after the initiation of the TFAP, forestry advisors representing the major donors formed an *ad hoc* consultative group on TFAP called the TFAP Forestry Advisors Group (FA-G). While providing liaison work with FA-G, USAID has participated in the FA-G's evaluation of the effectiveness of the TFAP and helped to develop recommendations for its reform.

2.C.2. Policy Reform

Unsound economic and natural resource policies and inconsistent environmental laws and regulations are among the major causes of environmental degradation in developing countries (USAID, 1992). Forest product prices that do not reflect the full environmental costs of resource use, depletion and degradation, inconsistent tax policies, and insecure and inequitable resource tenure all reduce the value of forested land and promote its conversion to other uses. USAID helps countries analyze and improve their environmental polices both through project-level technical assistance and through non-project assistance policy dialogue. One of the most important policy interventions toward the achievement of sustainable economic growth is democratizing natural resource management by involving local people in management decisions for public lands. USAID achieves this goal through government adoption of incentives such as secure resource tenure, technical assistance, cost-sharing, and favorable tax policies. Governments are also assisted in the identification and reform of regulations for private forest lands that stifle sustainable and productive enterprises. The revised regulations result in the transfer of enforcement to the community level, and regulations that concentrate on activities that affect other landowners and public resources. In East, Central and Southern Africa, the capacity for local staff to effectively manage protected areas is being increased through training by the Protected Area Conservation Strategy project. Protected area managers will be trained to promote the development of local communities, ecotourism enterprises, and local vigilance of protected areas. Regional training needs assessments are being carried out, and pilot training programs will test training methodologies for protected area staff.

2.C.3. Capacity Building

For countries to sustainably manage their forests, government and non-government institutions must exist that possess the capacity to determine and implement appropriate policies in the forest sector (and other sectors that affect forests). They must be able to assess the natural resource stock, evaluate land use capabilities, and allocate land to sustainable uses through a participatory process. These institutions must also develop or adapt appropriate resource management technologies and make the technologies available to those people managing the land. One of the

most common elements of USAID projects is technical assistance designed to develop these capacities in host-country governmental and non-governmental institutions. In the Philippines, the 5-year, $125 million, Natural Resources Management Program enhances the ecological and economic sustainability of lands managed as primary or secondary forests. The three major components are performance-based sectoral policy reforms, resource protection through a debt-for-nature swap, and support services for technical assistance. NGOs are being funded to assist 20 communities in organizing low-input, labor-based forest management. The government is being assisted to work with the private sector to develop a planning methodology to shift concessions from primary to secondary forests.

2.C.4. Environmental Technology Cooperation

USAID works in partnership with developing countries to fund research, development, and adaptation of sustainable forest management policies and technologies. Frequently, additional funds are leveraged through cooperation with other donors. Assisting the public and private sector in developing countries to access new forest management and forest products technologies, and helping entrepreneurs and producer organizations to adapt these technologies in profit-making enterprises, are important elements of USAID's technology cooperation activities. In Asia and Africa, USAID has been supporting the Forestry/Fuelwood Research and Development Project (F/FRED), ending this year, to increase the capacity of national institutions to carry out and apply research on multi-purpose tree species in woodlots and agroforestry associations that are used for fuelwood and other community needs. Networks of national researchers and institutions have been developed. By developing management systems for rehabilitating degraded forest land, the project will reduce pressure on natural forests, while meeting the needs of indigenous people living in and around these forests. Technologies developed by the project also have the potential for use in establishing forest stands as sinks of atmospheric CO_2.

2.D. Lessons Learned

USAID has learned many valuable lessons regarding the sustainability of development projects. ***The most important lesson learned is that for on-the-ground, lasting results, projects must include training components so that host country nationals will be able to manage and maintain the project.*** For this to occur, there must be incentives to the would-be host country practitioner of the project to become its manager. These incentives should be in the form of monetary increases or benefits from the host government.

Other lessons learned include the following:

There are four levels of project interaction necessary for successful projects. These levels include international, national, state and commercial transactions.

International - USAID has been working collaboratively with international partners to create a policy environment that will encourage multilateral lenders, private lenders, and other groups to increase the availability of capital for investments.

National - Much of the market reform and sector restructuring that will be necessary must take place at this level. This may involve rewriting of national laws and regulations, institutional reorganization and strengthening, privatization of public enterprises including industry and the power sector, price reform, and other measures that clear the way for private sector initiative and create a level playing field in the marketplace. The purpose is to identify and accelerate sustainable social and economic development by promoting private sector solutions in developing countries and emerging market economies. Private sector participation helps governments to utilize their own resources more effectively, to access new sources of capital, and to capitalize on the technical and managerial expertise of private companies.

State - In spite of sweeping national reforms, the institutional capability to implement new policies and programs is often lacking at the state or regional level. Certainly this is true in the NIS, where authority is rapidly moving to the regional level and is ahead of the local institutional capability to handle the new responsibilities. Power and other infrastructure regulation often rests at the state or local level in many countries, and significant efforts are necessary at this level to create the understanding and capability to promote and manage private sector options.

Commercial Transactions - This is where the private marketplace operates. Strong capabilities must be developed at the transaction level that accommodate the needs of both the host-country government and the private sector. These transaction capabilities often exist at only a rudimentary level in many developing countries. Actions at the international, national, and state levels will be ineffective unless sufficient transaction incentives and capabilities exist.

Leveraging works best when all donor partners are present at all stages of a project from its definition and design through its implementation. There is a need to build institutional partnerships in developing countries between donor partners, country officials, and the private sector.

Replicating model projects has proven to be a cost-effective and time-effective means of bringing the successes and lessons learned from one country to another. Care must be taken to tailor the projects to the specific needs of the country.

Projects that are developed jointly by several organizations must be housed within one specific organization. This approach will give one group the ultimate responsibility to supervise the successful implementation of the project.

It is preferable that policies needed for project implementation be in place before the projects are implemented. However, project development and policy/regulation formulation activities can be concurrently implemented. It is important to note, though, that without the appropriate policy environment, projects will not be sustainable.

USAID has learned these and other valuable lessons in developing and implementing projects to combat global climate change. These lessons are an integral part of USAID's suggested GCCS strategy. With a strong foundation in global climate change activities, as seen through the examples in Appendix 1, USAID is ready to lead the U.S. in designing, developing, implementing, and evaluating global climate change activities in developing and post-communist countries.

Chapter 3

USAID's Global Climate Change Strategy

USAID will concentrate on the development of national policies and institutions that will lead to the reduction in the rate of growth of greenhouse gas emissions from key developing and former communist countries. As the lead U.S. international development agency, USAID will collaborate closely with other international donors and lending institutions, and with other U.S. agencies who will be instrumental in the implementation of development projects and the promotion of U.S. technologies.

Strategic approaches which have proven successful in past USAID and other international development projects can be used as guidelines for the development and implementation of country specific or more general global programs designed to mitigate the net emission of greenhouse gases. The strategic approaches address three major topical areas - the energy sector, forestry and natural resource management, and information technology and dissemination. The agricultural sector has been included in the forestry and natural resource management sector as a land-use issue.

The strategic elements are policy reform, capacity building, technology cooperation, and financial leveraging. All four elements must be addressed successfully if sustainable development is to be achieved. These strategic elements may be addressed at the international, national, state, and transaction levels. Interactions may occur at a single level, or at all levels depending upon the specific issue or project being addressed and the country involved.

The first two strategic elements involve interaction with national and state agencies within the host countries. Policy reform establishes the foundation for the creation of standards, codes, and regulations, and the formulation of market structure within the economic sector. Capacity building is vital in both the government and private sector if development is to occur and be sustainable. Capacity building may also involve interaction at the international level (e.g., MDBs) and at the transaction level which could involve either public or private sector entities.

Technology cooperation is more than simply technology transfer. The technology cooperation process involves the development and enhancement of institutions and human resources capable of implementing and sustaining new technology. Successful technology cooperation requires an institutional and regulatory framework to foster cost effective infusion of new technologies into an economy. And, it also requires access to financial markets. Successful technology cooperation will typically involve interactions at all four levels.

The remaining strategic element, financial leveraging, is required to provide the linkage between policy development, capacity building, and technology commercialization. Financial leveraging may occur internationally with donor and multilateral development bank partners, or more locally with private sector lending institutions.

USAID will concentrate on the first two strategic elements described above - policy reform and capacity building - which historically have been key foci of Agency attention. One of the major goals of USAID will be to create a favorable political and market climate for the successful adoption and implementation of state-of-the-art, environmentally-sound technologies. The Agency will also collaborate with other donors and MDBs to ensure that the developing countries are provided access to development grants and concessional funding to foster the successful commercialization of new technologies. With its decades of successful experience in these areas, and with a continuing in-country presence, USAID is positioned to lead the U.S. interagency effort in the development of institutional and regulatory frameworks in developing countries which will open the path to widespread utilization of environmentally-sound technologies and methodologies and the creation of economically and environmentally-sustainable economies.

USAID will focus its main attention on the development of country-level greenhouse gas (GHG) mitigation programs. The basis of these activities may be national level efforts to inventory sources and sinks of greenhouse gases, and to develop national action plans and response strategies to reduce greenhouse gas emissions. Currently USAID, along with ten other U.S. agencies, is participating in the U.S. Country Studies Initiative (CSI) which is providing assistance to developing countries and the NIS in these areas. Close coordination with the host governments will assure that additional USAID efforts in the mitigation area will be complementary in nature. USAID will also coordinate with the appropriate host government agencies to encourage the integration of emission reduction goals in relevant national development policies and goals.

Because of limited availability of funding for climate change activities, USAID must concentrate on a set of key countries. The criteria used to select key countries for mitigation programs include the type and quantity of emissions and the ability to absorb GHGs in natural sinks. Consistent with findings of the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Programme (UNEP), and other international global climate change organizations, these should be the most important criteria for selecting a key country. Another important factor to consider includes the ability and willingness of a country to adopt greenhouse gas emission mitigation policies (i.e., its "tractability"). A country that receives high ratings of tractability would be one in which our investments would likely make a positive difference. It is also in the interest of the U.S. to recognize those developing countries that have joined us in signing such international agreements as the FCCC. Other secondary criteria that should be considered are the natural and financial resources available within a particular country.

Evaluating the effectiveness of new sustainable development projects will be a primary goal of USAID as it restructures its foreign assistance program. This will be a major challenge, particularly for projects that concentrate on human development as opposed to implementation of specific technologies. It may be possible, for example, to quantify the amount of carbon dioxide emitted per unit of electricity generated or the amount of methane produced per ton of rice harvested. It will be difficult, however, to attribute a specific reduction to specific measures such as policy reform, capacity building, institutional development, or technology cooperation.

A secondary USAID objective in the climate change arena - and one that is mandated under the terms of the FCCC - is to assist developing countries assess their vulnerability to changes in climate caused by the accumulation of greenhouse gases in the atmosphere, and to assist in the formulation of plans to adapt to climate change if requested by the affected countries. Although USAID will also assist developing countries in the vulnerability assessment and adaptation area, those activities will be conducted on a country-by-country basis, but not as part of a broader global program.

The key objectives of the GCCS will be to: promote efficient energy production, transmission and end usage and renewable energy technologies while simultaneously expanding public and private energy services in developing countries; promote sound forest and natural resources management practices in key countries; and improve information collection and dissemination and global electronic communications. These objectives must also contain achievable targets and criteria for selecting key countries.

The final section of this chapter focuses on measuring results. Illustrative targets are presented for discussion purposes only. The key indicators for success should be selected to indicate whether programs are effective in establishing long range trends that lead to the eventual stabilization of greenhouse gas concentrations in the atmosphere at a level that will not result in unacceptable global climate changes. In the energy and industrial sector the initial goals should be the reduction of greenhouse gas emissions per unit of useful output (e.g., kWh of electricity, passenger mile, ton of steel) through implementation of energy efficiency measures and improved technologies, and the substitution of low carbon emitting fuels such as natural gas for coal or oil. The long range goal should strive toward: the expanded use of renewable energy technologies; commercialization of power sector equipment such as biomass and coal gasifiers; use of fuel cells and high specific energy intensity and storage capacity batteries; restructuring of the transportation sector; utilization of more efficient and creative engineering and architectural designs in the built environment and the industrial sector; and more effective use of information technologies. These short and long term goals acknowledge both the need for developing countries to increase per capita services over the next half century, and the obligation to participate in the global effort to reduce greenhouse gas emissions and stabilize GHG concentrations. In the forestry and natural resource management sectors, including agriculture, global climate change efforts must concentrate on the net reduction

of carbon dioxide emissions through appropriate forestry and land use practices, and on the reduction of methane and nitrous oxide in the agricultural sector.

3.A. PROMOTING EFFICIENT ENERGY USE AND RENEWABLE ENERGY WHILE EXPANDING PUBLIC AND PRIVATE ENERGY SERVICES

The energy sector will play a pivotal role in USAID's GCCS since this sector accounts for one half of the potential global warming problem. Because of the importance of the energy sector to economic development, and because of the significant potential for managerial and technological improvements in this sector, USAID has a major opportunity to foster economic growth while simultaneously addressing the greenhouse gas emission problem. In particular, USAID can assist in restructuring the energy sector, promoting the adoption of low and non-carbon emitting technologies and energy efficiency improvements, and fostering conditions that are favorable for investment, particularly from the private sector.

Declining institutional and financial performance has been a major problem in many developing countries. Financial rates of return have been declining since the 1970s, from around 10 percent to as little as 2.8 percent in 1989 (Schramm, 1991). Compounding the problem are artificially low tariffs, now approximately half those in the OECD countries. Inappropriate investment policies have emphasized the construction of new facilities while simultaneously de-emphasizing good operating practices and periodic maintenance procedures. These policies have resulted in nominal capacity margins of 40-59 percent versus a more desirable 15-30 percent in OECD countries. Transmission and distribution losses are up to 20-30 percent versus 7-8 percent in OECD countries. The result has been peak demands which outstrip peak supply by between 10-25 percent in many countries. Rolling blackouts or brownouts are the only immediately available means of coping with the shortfalls.

At the heart of many of these problems are fundamental institutional and management issues (Jhirad, 1992; Schramm, 1991). Most electric utilities are government-owned. They are regulated by a ministry with a politically appointed head and a regulatory body that is not independent. International studies coordinated by the United Nations and the World Bank, such as the *Report on the Stockholm Initiative on Energy, Environment and Sustainable Development (SEED): Strategies for Implementing Power Sector Efficiency* (SEED, 1991) and the *Core Report of the Electric Power Utility Efficiency Improvement Study* (World Bank, 1991), found that many of the utilities suffer from management problems caused by a lack of autonomy from government, and that there was a growing tendency to view public utilities as political patronage machines or as a vehicle for local employment generation.

In the past, power expansion has been financed through internal resources and major loans from multilateral and bilateral development institutions. However, inefficient financial management, combined with the inability of a country to meet the financial commitments necessary to address the growing demand of power expansion, have made investment in power expansion increasingly unattractive to potential investors. With the demand for electricity growing at between 5 and 15 percent per year in most developing countries, the traditional sources of capital are insufficient (Cartselos, et al., 1993). Over the next decade, it is estimated that aggregate capital requirement for the projected 384 gigawatt (GW) sector expansion program will amount to $1 trillion in current dollars (Moore, et al., 1990). Of the $100 billion annual requirement, about $40 billion is required in foreign exchange, and only about $10 billion per year is projected to be available for developing country expansion projects from all multilateral and bilateral development institutions and external private lenders and investors (Jhirad, 1990).

Developing countries have begun to adopt economic and investment policies that attract private sector investment and capital. Private sector participation helps governments to utilize their own resources more efficiently, to access new sources of capital, and to capitalize on the technical and managerial expertise of private energy companies. Involvement of the private sector in the development of the power sector can accelerate sustainable economic growth and social development in USAID-assisted countries by helping to alleviate these countries' energy shortages. Private sector participation, besides providing needed capital infusion, also helps to strengthen the sector through competitiveness, efficient management techniques, promotion of efficient use of fuel-mix, and timely on-budget completion of environmentally-sound power plants.

Efforts aimed at institutional and policy reforms and at providing capital flows within developing countries should result in increased access to environmentally-sound technologies that are essential for sustainable development. At the present time, however, the "gap between the least technologically developed countries and the rest of the world is accelerating, requiring special attention to their problems" (Gray, 1992). Past efforts to transfer environmentally-sound technologies have often failed because the transfer was viewed as a single event, was overly focused on hardware, and did not involve a symmetrical relationship between the parties involved. The adaptation and diffusion of energy efficient and renewable, environmentally-sound, energy technologies is best viewed as an on-going process where there are mutual interests in sharing information, know-how and technology, and where technologies are viewed as total systems, including procedures, processes, products and services as well as equipment (U.S. Delegation of Technology Cooperation, 1991). Indeed, the process is more productively and accurately understood as technology "cooperation" as opposed to technology "transfer", with the emphasis on collaboration and accommodation of mutual interests rather than on the simple transfer of equipment.

The problems described above are interconnected in a complex web referred to here as the "triple-bind": insufficient capital; outmoded institutions and policies; and severe environmental constraints. (Jhirad, 1991). The formula necessary to address the triple-bind is a combination of improved investment capabilities, enhanced institutional and individual performance, and increased technology cooperation. The building of indigenous capability to produce and use energy efficient and renewable energy technologies on a significant scale should be the objective of such technology cooperation. A necessary ingredient is increased involvement of the private sector.

3.A.1. Institutional Reform and the Private Sector

USAID's approach toward reforming and enhancing energy and industrial institutions should focus on three areas: 1) institutional restructuring, 2) industrial modernization, and 3) capacity building in both the public and private sectors.

Commercially-autonomous entities governed by politically independent regulatory bodies have proven to be most effective in reforming and retrofitting inefficient and environmentally-unsound power sources and industrial facilities. Pricing reforms should: introduce full-cost pricing for electricity and other energy forms; remove inefficient and ineffective subsidies (except those safety-nets for low-income households); and identify, quantify and include environmental externalities in the price of energy.

The industrial sector accounts for approximately half of commercial energy use in most developing countries. This sector is often characterized by a predominance of a few large, publicly-owned plants, such as steel mills and cement plants, with a large number of smaller, usually privately owned plants. The large public plants are often considered as "employers of last resort", and thus are overstaffed and inefficiently operated. In addition, the prices of both raw materials and components, as well as the end produ prices, are often regulated thus removing market incentives to improve efficiency.

Major reforms of the industrial sector include: the introduction of efficiency and emissions standards for common energy consuming equipment such as motors, lighting and boilers; the creation of comprehensive programs aimed at improving the energy efficiency of buildings, including a global effort to promote the adoption of building energy codes and appliance efficiency standards; a broad-based effort to redirect present trends in the transport sectors of key countries, including the introduction of electric vehicles and greater investment in mass transit; and, technology cooperation programs to infuse modern information-intensive manufacturing, quality control, and distribution methodologies and technologies, adapted to local conditions and oriented to address indigenous problems, into developing country industrial sectors.

Revitalization of developing country institutions and the private sector will not succeed unless the capacity exists to take advantage of and properly manage the new market-oriented approaches. Within governments, capacity must be strengthened to regulate the power sector based on true cost (including environmental externalities) considerations. In many cases, basic cost information is not available, not to mention the tools and expertise to use this information for cost-based tariff setting or integrated resources planning. Within the private sector or newly privatized enterprises, management must be retrained regarding everything from identifying products demanded by the market to managing power production facilities for maximum efficiency. Experience has shown that this training is needed at both the state and federal levels to provide in-country officials with appropriate skill to efficiently evaluate, negotiate and interact with private sector investors on proposed projects. Key components of a capacity building program, in response to these needs, should include training, exchange and technical assistance programs directed at:

- **the power sector**, including utility regulation, tariff design, integrated resources planning, demand-side management, competitive bidding and issues related to independent power development and privatization, energy and emissions monitoring, data collection and analysis to facilitate power sector planning, and emissions control; and

- **the industrial sector,** including pollution prevention and control, efficient plant operation and management, transportation planning, use of modern information technology, land use planning, and energy efficient building design.

USAID will also continue its support of the CSI which is primarily engaged in capacity building activities. One of the major objectives of this program is to foster the development of indigenous institutional capabilities for addressing the climate change issue. Through its active participation in the CSI, USAID will seek to ensure coordination of U.S. Government efforts in developing countries.

3.A.2. Environmental Technology Cooperation

There now exists over a decade of experience in technology transfer and cooperation, and several effective programmatic models have emerged. USAID/India's PACER has yielded commercially viable joint ventures to produce innovative technological solutions to local energy and environmental problems. USAID/Thailand's U.S.-Thai Development Partnership Project is also rapidly stimulating the formation partnerships that benefit the energy, and other, sectors. These programs, and other USAID experience confirm the six essential building blocks for successful technology cooperation: 1) sound economic conditions, 2) national capacity, 3) an assessment of the country's technology situation, 4) a sound decision-making process, 5) access to information,

and 6) an introduction to and encouragement of private sector participation (U.S. Delegation of Technology Cooperation, 1991).

The development, commercialization and widespread diffusion of environmentally-sound technology will be an essential element in the industrial modernization and economic growth strategies of all nations. This common goal provides a major opportunity for global partnerships between developed and developing nations stressing technology cooperation that is both economically productive and environmentally sustainable.

USAID's strategy for broad-based economic growth recognizes the need for productive technology, along with other important factors, such as good governance, adequate investment and savings, and access to education and health care. USAID will emphasize the need for sectoral reforms, and will assist host nations in building indigenous institutions and policies that promote openness to trade and investment.

Information-intensive technologies, based on globally-competitive technological elements but adapted to local conditions and incorporating local skills, offer a special opportunity for technology cooperation having a strong positive environmental impact. In addition, because the United States is a world leader in these technologies, this emphasis offers numerous mutually-beneficial trade and investment opportunities.

In this process, USAID will support the development of an institutional and policy capacity within recipient countries to develop, transfer and adopt technologies that will enhance environmentally-sound growth. This will also entail the strengthening of local markets for environmental technology services and equipment through capacity building, local environmental management, training and information dissemination. Sectorally, this will require the reduction and eventual elimination of environmentally harmful industrial and energy practices. USAID therefore has a unique role in the U.S. Government in creating the conditions for effective technology cooperation and adoption, and will cooperate with other U.S. Government agencies such as TDA, the Department of Commerce (DOC), and the U.S. EXIM Bank and OPIC.

One method whereby USAID may improve its role in environmental technology cooperation is by fostering industrial and utility partnerships. These partnerships will be catalyzed and established through a "Marshall Plan" approach that supports institutional representatives from developing countries and the former communist nations in developing long-term industrial, commercial and private sector educational and cultural links with counterpart organizations in the United States. The plan will support study tours and fellowships in the United States, and will foster sister relationships among universities, industries, utilities and cities focusing on environmental technology in infrastructural investment. It is anticipated that the element will build on existing programs

supported by the U.S. Energy Association and the Sustainable Cities Initiative (SCI). SCI brings together private sector companies involved in environmental technology to focus on creating and implementing models for sustainable development in select cities in the world. USAID will work in partnership with the private sector to ensure that environmentally-sound investments in energy, transportation and buildings are leveraged and implemented. For example, USAID will participate actively in the U.S. Initiative on Joint Implementation announced in the President's Climate Change Action Plan.

In a wide spectrum of developmental situations, the needs for appropriate technology and for accurate and relevant information conjoin to create a demand for information technology. Information and information technology also play crucial direct roles in mitigating the adverse environmental effects of economic activity (see box), and hence constitute a key cross-cutting element of USAID's global environment and climate change strategy. This application of information and information technology is addressed here.

Information Technology in Environmentally Sustainable Economic Development

Information and knowledge are well recognized as powerful forces for economic growth and efficiency. Information also can be a powerful force for mitigating the adverse environmental consequences of economic activity, such as natural resource depletion and climate change. The key tool for using information effectively on an economically significant scale is information technology. Because of the stunning rate of global technological advance, information technology is becoming rapidly more powerful, accessible, and cost-effective. Consequently, it is becoming an essential element of numerous other technologies and processes important for sustainable economic development. Together with pure information technology, these constitute the powerful group of *information-intensive technologies.*

Win-win solutions that employ information-intensive technologies to increase resource consumption efficiency, reduce greenhouse gas emissions, and at the same time create economic value, are arising rapidly throughout such diverse economic sectors as agriculture and food systems, energy production, energy consumption, manufacturing, transport, and recycling.

These developments reflect the underlying scientific principles that energy and matter may be transformed, but not lost, so that consumption or loss of a material resource means conversion to a less useful form, technically speaking a less ordered or higher entropy form. The conversion of electrical energy into waste heat, or petroleum reserves into atmospheric greenhouse gases and more waste heat, are examples. The capacity of information to mitigate the growth of disorder by increasing process efficiency reflects the underlying scientific fact that information and entropy are opposites.

USAID has already begun to take advantage of these dramatic developments in such initiatives as improving electric power plant and district heating efficiencies through sophisticated electronic control systems; many more opportunities exist.

3.A.3. Investing in a Sustainable and Efficient Power Sector

Lenders are only willing to take on commercial risks in developing countries if the political risk is covered by a combination of government guarantees, political risk insurance, multilateral bank participation, and export credit agency guarantees. The Institute for International Finance, which represents over 175 of the world's largest banks, is pressing the World Bank and the IMF to adopt procedures that will cover the political risks of lending to developing countries (Bacon, 1993). Developing country governments clearly want to limit their exposure by restricting the use of government guarantees.

A key factor in a successful investment program is political vision and commitment from the developing country governments, and in particular, from progressive leaders who are willing to serve as champions for the concept. Expanding power sector investments in developing countries will involve a multi-pronged effort that entails close cooperation between country governments, development institutions, and private developers, investors and lenders (Buresch, et al, 1993).

A sustainable development investment strategy in the energy sector will complement its sister strategies in institution building and technology cooperation by providing the necessary financial resources required to make development projects viable. Specific components of effective institutional reform and technology cooperation strategies were outlined in the preceding two sections. Key aspects of the investment strategy are summarized below.

Agency collaboration with MDBs is necessary to promote additional lending in the areas of energy efficiency, renewable energy systems, and low carbon emitting technologies, and to ensure that climate change objectives are adequately incorporated into lending programs. USAID should also cooperate closely with multilateral and bilateral development institutions to implement policies that more effectively leverage private capital for large environmentally sound infrastructure projects.

USAID should encourage efforts by developing countries to develop investment policies that favor private power generation, and in special cases, wholesale privatization of the electric utility. This includes promoting local currency investments through market reforms and domestic capital market development.

Successful Mission-funded programs should be replicated in other countries. Examples of several successful programs in India include: PACER, that leverages private sector commercialization of new environmentally superior energy technologies; EMCAT, that promotes enhanced capital productivity through financing, technology, and management innovations; and, a project in the Philippines focusing on demand-side management and energy sector restructuring, thereby encouraging the increased use of sustainable, efficient energy technologies in the generation and use

of electrical power. A key element in several of these programs is the use of host-country lending institutions as key partners in the program implementation process.

3.A.4. Criteria for Selection of Key GCCS Countries and Major Contributors to Energy Sector Emissions

The principal criteria used in the selection of key countries in the energy sector are the fraction of total greenhouse gas emissions contributed by a particular country, and the type of greenhouse gas emitted. This set of criteria is consistent with the findings of the IPCC, UNEP, and other international global climate change organizations. Both current and potential future contributions to GHG emissions should be considered. The major type of GHGs include carbon dioxide, methane, nitrous oxide, and chloroflourocarbons (CFCs[1]).

Other criteria include the ability and willingness of a country to address global climate change mitigation and adaptation issues. This is termed a country's "tractability." A country that receives high ratings of tractability will be one in which USAID investments will provide tangible results. In addition, it is in the U.S. interest to recognize those developing countries that have signed the FCCC. Other secondary criteria that should be considered are the natural and financial resources available within a particular country. These criteria were used to screen a number of USAID assisted countries to determine potential candidates for assistance in the global climate change area. Details are presented in Appendix 4.

Based on the above criteria, USAID has identified the countries shown in the box and maps below as major contributors to their energy sector GHG emissions. The first map below in Figure 3.1a shows priority countries excluding those in the NIS. The second map shows the priority countries in the NIS.

Major Contributors to Energy Sector Emissions:

Brazil, India, Indonesia, Kazakhstan, Mexico, Philippines, Poland, Russia, Ukraine

1 CFCs are covered under the Montreal Protocol, and are not addressed further in this report.

Figure 3.1a - Major Contributors to Energy Sector Emissions - Global

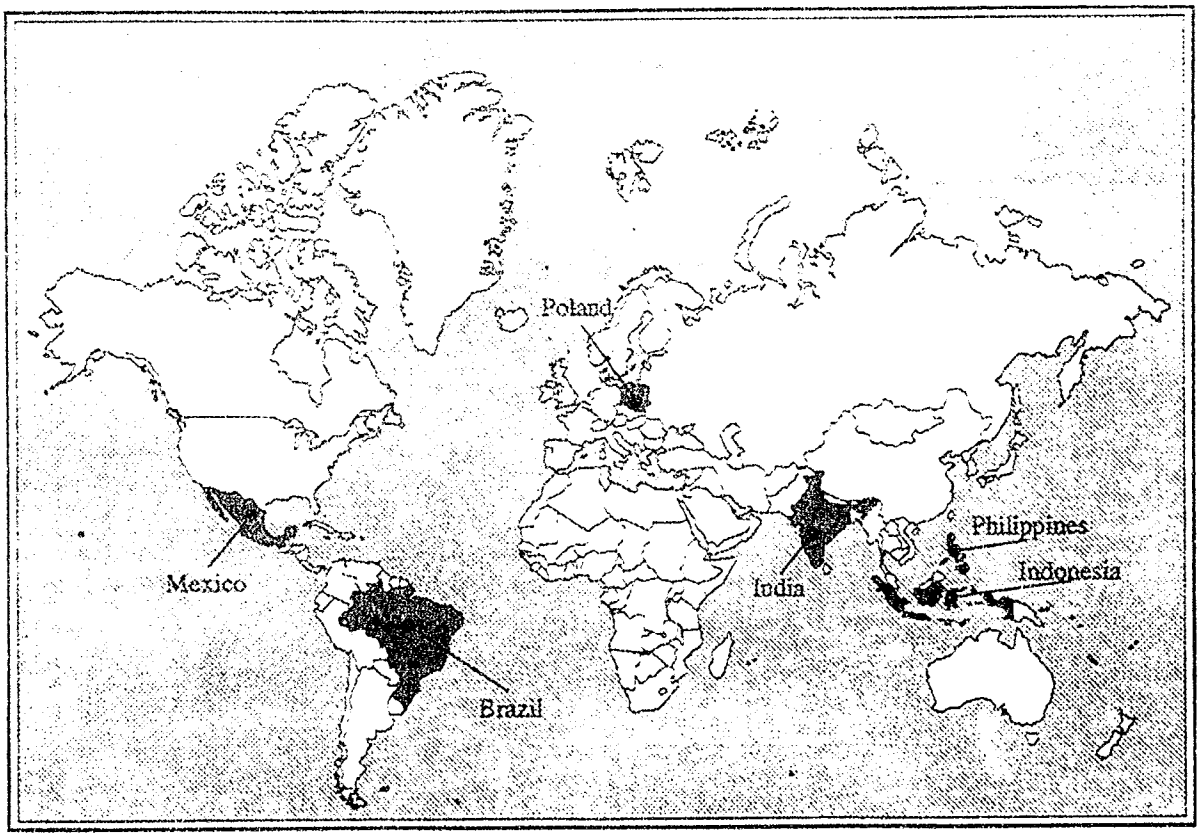
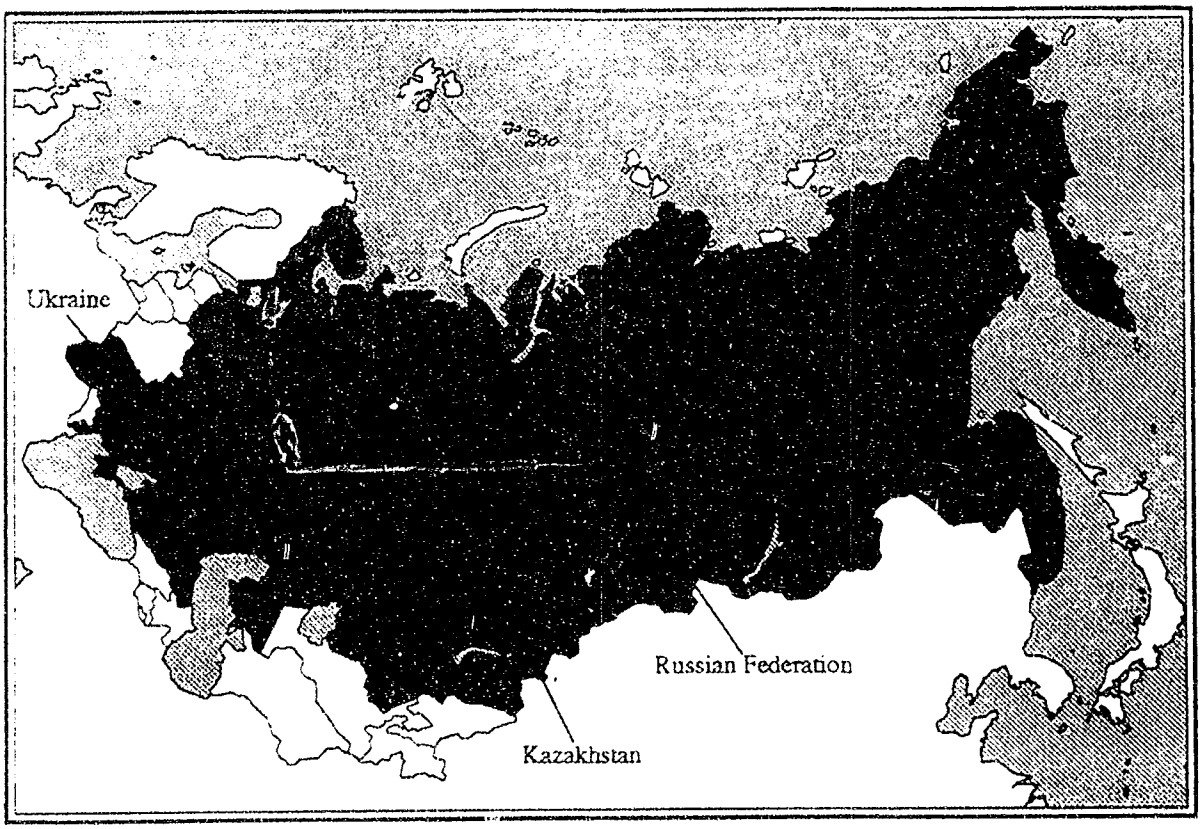


Figure 3.1b - Major Contributors to Energy Sector Emissions - NIS



3.B. REDUCING GREENHOUSE GAS EMISSIONS BY PROMOTING SUSTAINABLE LAND USE IN KEY COUNTRIES

Between 1 and 3 billion tons of carbon per year enter the atmosphere as the biomass present in tropical forests cleared for agriculture is oxidized, either quickly in fires set to prepare planting sites or gradually through the decay of leaves, branches, roots, and trunks (Sundquist, 1993). This is equivalent to between 1/5 and 1/2 of all carbon released from combustion of fossil fuels, and thus represents a major source of greenhouse gases. Forests cover about 3.6 billion hectares, or 28 percent of the earth's land area, and other wooded land such as forest fallows and shrubland total 1.7 billion hectares (World Resources Institute, 1992). The biomass of these forest and woodland ecosystems represents a tremendous sink of carbon.

As a central element of our climate change strategy, USAID will undertake activities to favorably influence the balance between organic and atmospheric carbon through two complementary approaches. The first approach will maintain current carbon sinks by promoting activities to reduce the high rate of tropical deforestation. The second approach will increase carbon sinks by increasing the carbon stored in existing forests and establishing new forests.

Deforestation can be countered by establishing protected areas such as parks and by sustainably managing forests to produce goods to the benefit of rural people. USAID will promote the replacing of policies and economic incentives that motivate rural people to convert forests to other land uses such as farming and grazing with policies and economic conditions that will motivate and empower these people to sustainably manage forest resources for their economic benefit. Such management will not only avoid emissions of greenhouse gases, but will also provide long-term income generation to alleviate poverty among forest-dependant people, in support of USAID's economic growth strategy. Reducing deforestation will also counter the accompanying loss of biological diversity, which limits the present and future ability of many countries to sustainably produce equitable economic benefits from their natural resource base. This component of the Global Climate Change Strategy complements USAID's Biological Diversity Strategy.

New carbon sinks will be established through ecologically, socially, and economically sustainable tree planting. USAID will provide support for the development of tenure policies, reliable accounting procedures, and appropriate technologies to create a favorable environment needed for such reforestation to occur.

USAID efforts in support of sustainable agriculture under the Economic Growth Strategy will also help to avoid deforestation by maintaining and increasing agricultural yields in areas already cleared. Under the Global Climate Change Strategy, USAID will also assist the international regional agricultural research centers and host-country partners to cooperate with U.S. Department

of Agriculture (USDA) scientists to develop and apply technologies to reduce per capita methane production from paddy rice and livestock production.

USAID will support efforts to establish a policy environment that will motivate local people to conserve tropical forests and biological diversity and to plant trees. Donor coordination on policies will be an important element of the objective. USAID will support the creation of strong, lean, representative, accountable government and non-government institutions that will empower rural people to sustainably manage forests by promoting their increased participation in natural resources decision-making. USAID will also assist rural people to access, adapt, and/or develop appropriate technical, cultural, and socio-economic information and technologies for sustainable forest resource management.

Appropriate policies, capable institutions, and knowledge are all necessary, but none alone is sufficient, to achieve reduced greenhouse gas emissions by bringing about the sustainable management of forest, range, and agricultural ecosystems. Therefore, USAID must support interventions in all three areas to achieve the objective of sound sustainable land use in key countries.

3.B.1. Sustainable Land Use Policies

USAID will provide assistance to host countries to identify the impacts of development policies on forest use. Sustainable land use policies that provide economic incentives for sustainable resource management and discourage policies that lead to unsustainable resource use, are critical. Policies that facilitate the sustainable production of goods and services for a rapidly increasing population will be encouraged in future activities. In this manner, the GCCS will contribute to and build on activities under the economic growth focal area of USAID. Policies that lead to sustainable agriculture adjacent to forests, and buffer zone management that protects ecosystem processes, will be encouraged. Tenure policies that provide rural inhabitants with secure access and traditional user rights to resources will also be promoted by this strategic approach. Local people's participation in natural resource management decisions will contribute to and build on USAID's democratization focal area.

USAID will promote market incentives for sustainable resource management, including the accurate valuation of non-timber and timber forest resources. Current impediments to full valuation include low prices paid to private and government producers, and concession policies that favor resource mining. National policies, especially in the agricultural sector, that motivate rural inhabitants to convert forests to other uses will be discouraged. Trade barriers, such as tariffs and restrictions on imports and exports, will be modified and policies which encourage value-added forest and agricultural product processing and open markets will be promoted. Using the strengths of markets

to promote sustainable natural resources management is consistent with, and will build on, USAID's economic growth focal area.

Conditions outside of the forest sector also influence natural resources policy. Population growth, another focal area for USAID, will be a central part of the policy dialogue. Foreign currency shortages are frequently offset by increased commodity exports produced through unsustainable resource use. This strategic approach will provide technical assistance and promote policy dialogue to improve natural resources legislation and government administrative procedures. Policy reform will promote sustainable natural resource management through a legal and regulatory framework of market incentives and strengthened enforcement. A policy-making process that bases land use priorities on resource information and available technologies will be encouraged.

3.B.2. Empowerment Through Participatory Institutions

Activities designed to enhance institutional capacity will include incentives that empower women and involve non-governmental organizations and the private sector in natural resources management decisions and provide management technologies to those on the land. Specific institutional skill development areas will include science and technology generation and adaptation, resource and policy monitoring and analysis, and budgeting, accounting, and personnel management. Emphasis will be given to advocacy and access to information. Participatory planning processes that begin with local needs assessments and indigenous knowledge and that link the knowledge base to the users will be promoted.

An effective capacity-building component must include cross-sectoral activities that link sustainable natural resource and protected area management with policy, population, economic growth, and the education of, and participation by, women and disadvantaged minorities.

This strategic approach will complement activities undertaken to meet USAID's democracy focal area by promoting the development of democratic institutions that are empowered to make and implement sound natural resource management decisions.

A strategic approach that emphasizes empowerment through participatory institutions will provide technical assistance and training to local institutions through specific Mission projects, assistance from global bureau projects, and partnerships with other donors and multilateral development banks and technical agencies. USAID technical assistance will complement and leverage investments in host-country infrastructure and commodities by other donors.

3.B.3. Resource and Technology Assessment and Development

USAID will assist host countries to assess the ecological, socio-cultural, and economic trends of current land management practices that affect forests. Our combined efforts will seek to increase public awareness of the causes and effects of the loss of forests and biological diversity. Host countries will be assisted in developing natural resource management systems that maintain biological diversity and ecological processes while allowing people to benefit economically from the resource. Assistance could include the compilation of current information on culturally derived land use systems, indigenous knowledge, and the resource base. Information gaps will be identified, and priorities will be established and funding provided for additional cost-effective assessments of management systems and inventories for biological, water, and soil resources. Identifying indigenous technologies that sustainably manage natural resources will be a central part of this analysis. An assessment of current resource uses is essential to accurately project future needs.

To provide a baseline level of knowledge about the geophysical, climatic, and biological production potential of forest, range, and agricultural ecosystems, assistance will be provided for countries to determine current land use and assess the current stock of natural resources. Assessments will need to be made of traditional uses of forests and of trees in agricultural production systems.

3.B.4 Criteria for Selection of Key GCCS Countries and Major Contributors to Forest and Agricultural Sources and Sinks of GHGs

Countries in which USAID may focus activities to promote sound forest and natural resources management practices for reducing emissions of greenhouse gases are identified based on their current or potential levels of greenhouse gas emissions from deforestation and agricultural practices. USAID may also focus on these countries because of their potential to sequester carbon through reforestation or afforestation. As discussed in Section 3.A.4, additional criteria includes the tractability of USAID working effectively in a country and the signatory status of the country with regard to the FCCC.

Bolivia, Brazil, Ecuador, and Peru are identified because they encompass the Amazon Basin, the largest extent of tropical forest remaining on earth. The forests of central Africa are the second largest extent of tropical forest. This area, called into the Central African Region, includes Cameroon, the Central African Republic, Equitorial Guinea, Gabon, Zaire, and the Congo. Indonesia and Papua New Guinea are identified countries because they are the home of the third largest area of tropical forest. The Mayan forests of southern Mexico and adjacent Belize and Guatemala represent another significant extent of tropical forest. Finally, Russia has the largest extension of remaining temperate and boreal forest.

The countries of Central America and the Philippines are identified as good candidates for the establishment of sinks of carbon through tree planting. India, Indonesia, and the Philippines are also included because of the importance of their extensive rice paddies.

Major contributors to forest and agricultural sources and sinks of GHGs for forestry and agricultural emissions are listed in the box below and are also shown on the following two maps, Figures 3.2a and 3.2b.

Major Contributors to Forest and Agricultural Sources and Sinks of GHGs

Priority Countries: Bolivia, Brazil, Central African Region (Cameroon, Central African Republic, the Congo, Equatorial Guinea, Gabon, and Zaire), Central America, Ecuador, India, Indonesia, Mexico, Papua New Guinea, Peru, the Philippines, and Russia.

3.C. IMPROVING INFORMATION COLLECTION AND DISSEMINATION AND GLOBAL ELECTRONIC COMMUNICATIONS

Agenda 21 addresses the issue of better information flow to and from developing countries. The need for information arises at all levels, from that of senior decision makers at the national and international levels to the grass-roots and individual levels. There is a lack of capacity, particularly in developing countries, and in many areas at the international level, for the collection and assessment of data, for their transformation into useful information, and for their dissemination.

Sustainable development cannot occur in a vacuum, however. It is not enough to reform out-of-date environmental policies and regulations or to leverage the necessary funds to bring plans or projects to fruition. USAID must also help people locate sources of technology, share lessons learned about projects with neighboring countries, and contribute to current databases of global climate change and remote sensing information about their countries. A major part of capacity building is assisting people to be self-reliant. To contribute, and to have ready access to, environmental information will empower developing countries to sustain and build their own capacity.

Figure 3.2a - Major Contributors to Forest and Agricultural Sources and Sinks of GHGs

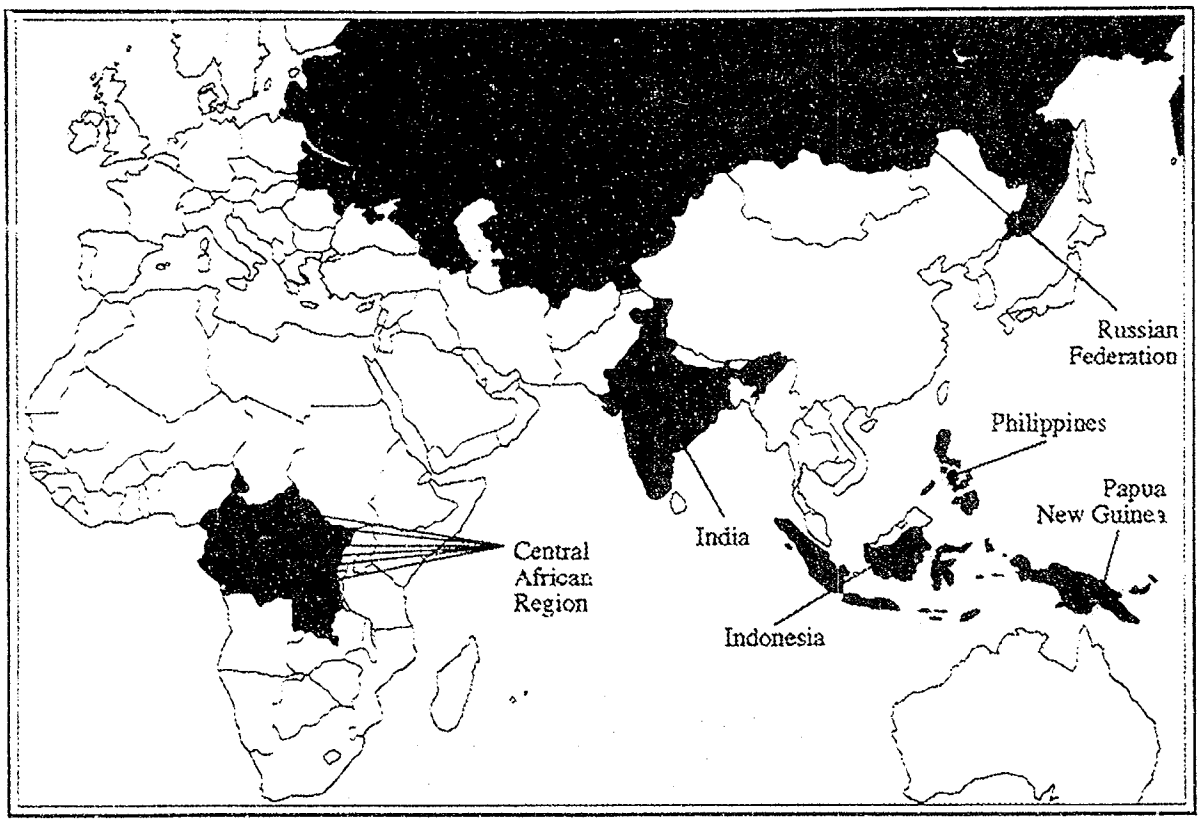
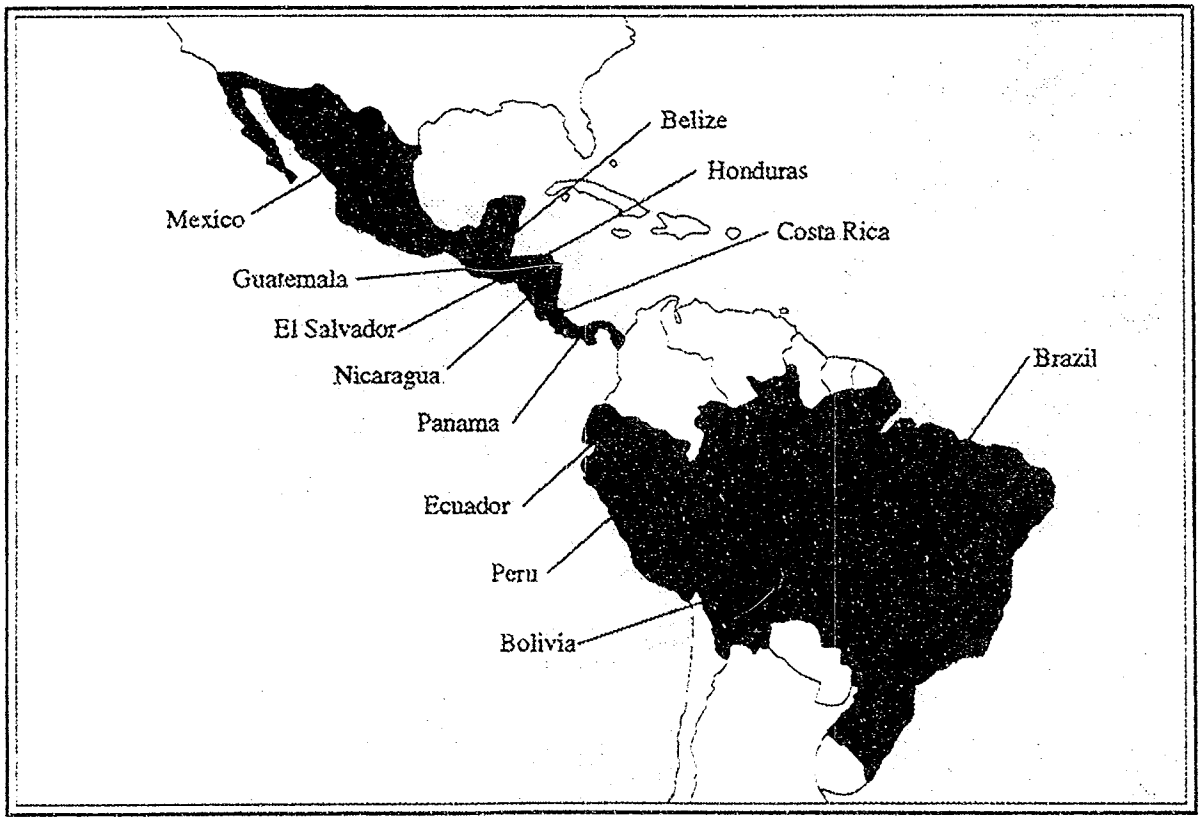


Figure 3.2b - Major Contributors to Forest and Agricultural Sources and Sinks of GHGs



Technology, capital and institutional reforms are necessary if developing countries are to improve their efficiency and management practices, but these alone are not sufficient. Information regarding new technologies and market reforms is a missing critical ingredient. Increased access by developing countries to information is critical because:

- Information is essential for the efficient functioning of free markets; as market reforms take place and industry, power, and forest sectors are privatized, easy access to information will be vital;

- Information can move more quickly than technologies, capital or institutions; accelerating the rate of information flows to developing countries is the fastest means of promoting the use of environmentally sound technology, and is an essential preparatory task to the transfer of technology and capital; and,

- The U.S. is the world leader in information technologies; it can build on this leadership to the benefit of both the developing world and U.S. businesses by building information highways to the developing world to carry critical energy and environmental information.

3.C.1. Global Energy and Environment Information Exchange

The massive costs of both global environmental monitoring initiatives and the information processing required to produce policy-relevant assessments of the data, together with substantial unresolved scientific uncertainties, preclude more than a marginal role for USAID in either data collection, data interpretation, or development of policy advice. Nevertheless, instances will exist in which USAID can employ available information effectively to advance developmental goals. Developmentally-sound USAID initiatives will exist in the following areas:

- Facilitating developing country access to global monitoring data, especially via the global Internet;

- Providing limited support for data assessments critically needed for developmental or assistance delivery policy decisions;

- Providing limited support for monitoring activities where critically-needed data do not already exist, such as essential local information on certain globally-significant greenhouse gas emission sources; and,

- Building indigenous data assessment capacity to inform local decision-making.

USAID is currently transforming its internal communications to incorporate linkage to the Internet. The Internet, a rapidly-expanding network of more than 5,000 individual data networks worldwide that conform to U.S.-developed standards, is the most widespread and most cost-effective means for worldwide information delivery. It is being pursued rapidly by USAID's counterpart organizations, such as the UNDP and the World Bank. Expansion of affordable Internet access will be a high priority throughout USAID's programs, including those addressing global climate change.

3.D. ASSISTING DEVELOPING AND EMERGING COUNTRIES IN DEVELOPMENT OF ACTION PLANS FOR ADAPTATION TO GLOBAL CLIMATE CHANGE

Although vulnerability and adaptation issues are discussed in this report, a "global" adaptation strategic approach is not proposed. Instead, USAID will address adaptation responses on a country-by-country basis. In general, adaptation involves responding and adapting to the adverse impacts of climate change.

As a signatory to the FCCC, the United States Government has made a commitment to assist particularly vulnerable developing countries in adapting to the adverse impacts of climate change pursuant to Article 4, paragraph 4. Even though the U.S. has such a commitment, the principal financial mechanism of the convention, the GEF, is not available as a source of assistance for adaptation measures. Under the terms of the GEF, only projects designed to combat *global* climate change will be eligible for financial support. Because adaptation measures generally confer national and local benefits, but not significant global benefits, projects aimed at adapting to climate change will probably not be eligible for funding under the GEF.

One mechanism for assistance is the CSI. USAID is currently working collaboratively with other U.S. Government agencies in the interagency CSI program. The individual country studies are initiated at the request of host country governments. The Missions are working closely with the host country to assure consistency of USAID programs and the CSI activities.

3.D.1 Climate Change Impact Assessment Issues

In developing countries, a changing climate will exert increasing impacts on an environment already stressed by rising population levels. Marked decreases and increases in precipitation could result in drought and flooding, causing drastic reductions in the productivity of traditional agriculture and in water supply for domestic and industrial consumption. Shifting coastlines and rivers could displace homes, industries, and farmland. Increased storm frequency and intensity could affect people and infrastructure along rivers and coastlines and on small islands. Altered natural terrestrial and marine ecosystems could result in loss of biological diversity and impacts on communities

dependent on forests and fishing. The people of developing countries are most vulnerable to these changes.

The primary impacts of increased atmospheric concentrations of anthropogenic greenhouse gases, especially carbon dioxide (CO_2) and methane (CH_4), are predicted to be a warming of the atmosphere, changes in the annual amount and timing of precipitation, increased severity and frequency of extreme climate events, and sea level rise. Global circulation models predict a greater warming at the poles than at the equator, decreases in precipitation in some areas, increases in other areas, and no change in yet other areas. A warmer atmosphere will have an increased capacity to store water, and evaporation and transpiration rates should increase as a consequence.

3.D.2 Criteria for Country Selection

Although countries are not being suggested here, USAID will apply the following criteria in considering assistance in adapting to climate change: the severity of impact on agricultural production systems; the degree to which natural ecosystems and biodiversity are threatened; the susceptibility of low-lying coastal areas and islands from sea-level rise and storms; and the lack of water resource development. Consistent with the findings of the IPCC and other international global climate change organizations, these will be the most important criteria for selecting key countries with respect to vulnerability and adaptation to climate change. Other important factors could include a country's "tractability" -- the extent to which a country is ready for long-term change, both from a political and institutional standpoint. Availability of both indigenous and financial resources will be a consideration. And, finally, countries which have joined the international community in ratifying the FCCC will be eligible for priority treatment.

3.E. MEASURING RESULTS AND ILLUSTRATIVE TARGETS

USAID will measure the results of the GCCS by examining both progress in reducing net GHG emissions and improvements in the quality of life for host country peoples. Any targets set must be consistent with the interests and values of the American people and international agreements of which the U.S. is a signatory. For sustainable reform to occur, the targets and results will be based on a number of factors ranging from market price reforms to assisting key countries with the establishment of policy and the implementation of regulatory and institutional reforms. A key performance factor will be the success (or failure) of local capacity building programs.

The following illustrative targets are examples of the type of commitments the Agency will make to address climate change. While these targets are only for illustration, they represent the breadth and depth of the type of targets necessary if a lasting impact in developing countries is to be made. It should be noted that targets, when set, will be part of an Agency-wide goal, and not necessarily

goals for individual projects. In addition, a project could encompass several of the targets simultaneously.

Energy and Industry

Target 1: By the year 2005, USAID would have worked with at least 10 key countries to establish and implement pricing policies and regulatory reforms that set efficiency and environmental standards. Policy and regulatory reform are a necessary component of any environmentally sustainable project. To determine if this target has been reached, USAID would look specifically at three factors:

a) Comparisons of domestic energy prices with "world" or "border" prices, and estimates of the effects of implicit and explicit subsidies, taxes, and other distortions;

b) Demand-side management utility investment shares of 10-15%; and,

c) Market shares of energy efficiency and renewable energy technologies.

Target 2: By the year 2005, USAID would have successfully completed 20 pilot projects in key countries using energy efficiency and renewable energy technologies that demonstrate between 15 and 50 percent reductions in greenhouse gas emissions per unit of service delivered. Such projects would include information technologies and information intensive methodologies. Pilot projects have proven to be an effective means of implementing and evaluating development projects for continuation or replication with fewer human and financial resources at stake. Three areas to look at in evaluating pilot projects include:

a) Specific energy consumption (or energy intensity), by sector and nationally. This is a measure of the energy used per unit of use or output such as kWh, GDP, product, passenger-mile, square mile, or other meaningful measure of output (e.g., kJ/kg of steel output). This can be modified, especially in the power and industrial sectors, to include direct measures of efficiency such as overall generation efficiency or line losses;

b) Specific energy-related environmental emissions, by sector and nationally. Examples include the emissions of CO_2, CO, NO_x, SO_x, HC, and particulates per kWh, mile-traveled, pound of product, unit of GDP, or other important use or output measure; and,

c) Market shares of energy efficiency and renewable energy technologies.

Target 3: By the year 2005, USAID would have leveraged economically and environmentally sustainable public and private sector investments in at least 10 key countries. Investment leveraging is needed to concentrate the plethora of international funds into well-defined projects in developing countries. Focusing financial resources into well-defined projects would encourage donor coordination and participation while meeting the needs of developing countries. To measure the results of this target, USAID needs to quantify the amount of public and private investment in the energy sector (especially electric power, oil products, and gas).

Target 4: By the year 2005, USAID would have taken action to encourage sound industrial pollution prevention practices which reduce greenhouse gases in specific enterprises in key countries by 15-25 percent per unit of output in at least 10 key countries. Strong pollution prevention practices are necessary for any sustainable environmental program. This target would be evaluated using specific energy-related environmental indicators such as emissions of CO_2, CO, NO_x, SO_x, HC, and particulates per kWh, mile traveled, pound of project, unit of GDP, or other important use of output measure.

Forest and Natural Resources Management Practices

Target 1: By the year 2005, USAID would have assisted 10 key countries from among those with the world's highest current or potential deforestation rates to establish and implement policy, regulatory, and institutional reforms that promote full valuation of both commodity and non-commodity forest resources, resulting, if successfully implemented throughout the country, in a 15 percent net reduction in the 1990 levels of CO_2 emissions from deforestation. A concerted effort to promote sustainable forest management in key countries would complement USAID funding through leveraging and donor coordination, improve policies, increase local capacity for management, and make appropriate technologies available and assist with their adaptation to meet local needs. To determine if the target has been reached, USAID would:

a) Assist local governmental and non-governmental institutions to establish a baseline inventory of existing land use, and monitor changes as part of their national environmental planning process. These activities can be accomplished in cooperation with the United Nations Global Forest Assessment coordinated by FAO. In this manner, enhanced national capacity to monitor resource stocks and their drawdown would assist USAID in measuring how well targets are met; and,

b) Assist to key countries evaluate their current policies, institutional capacity, and technology as part of their national environmental planning process. Increased national capacity to analyze policies and develop and adapt technologies through USAID assistance

would allow national governmental and non-governmental institutions to evaluate improvements in policies, institutional capacity, and technologies made by the year 2005.

Target 2: By the year 2005, USAID would have assisted key countries in: acquisition of analyzed images from remote sensing; ground verification; and assessment of forest cover data. Among the countries assisted would be the countries identified under Target 1. To measure whether this target has been reached, USAID would:

a) Evaluate the Global Forest Assessment budget to determine the relative contribution of USAID; and

b) Assemble information from missions and regional bureaus about support to countries for acquisition of analyzed images from remote sensing data, ground verification, and assessment of forest cover data.

Target 3: By the year 2005, USAID would have assisted with the development of rice and livestock production systems and products that produce 10 percent less methane per capita from rice and livestock in key countries. USAID would support research in partnership with host country institutions to develop paddy rice production systems that produce less methane. Other possible interventions would contain methane in manure through biogas generation and use for on-farm energy production. Once technologies have been developed, USAID would assist host country government and non-government institutions with the adaptation of technologies by farmers. To evaluate whether the target has been reached, USAID would:

a) Determine baseline per capita methane production levels for different rice and livestock production systems through consultation with international experts or through monitoring programs;

b) Support funding for research programs in rice and livestock production systems that produce less methane at international agricultural research center in partnership with host country institutions;

c) Assist with the adaptation of reduced-methane rice and livestock production systems by farmers; and,

d) Monitor per capita methane production levels for different rice and livestock production systems in the year 2005.

Information Dissemination and Electronic Communications

Target 1: By the year 1996, USAID would have established information dissemination plans for all global climate change key countries. As stated in the documents from the Earth Summit, developing countries and, upon request, international organizations should carry out inventories of environmental, resource and developmental data, based on national and global priorities for the management of sustainable development. The first step in this endeavor is to develop a plan of action that takes into account current information dissemination activities and builds new ones depending on the resources available within the developing countries.

Target 2: By the year 2005, USAID would have assisted in electronically linking members of key developing countries with each other and with USAID. As USAID and other international organizations, as well as some developing countries, become electronically linked to energy and environmental information and electronic mail systems, the time to answer questions and respond to emergencies would decrease substantially. Without electronic communication, there would be no gains in the information collection and dissemination realm.

Target 3: By the year 2005, USAID would have trained select personnel in the above key countries to operate and maintain these electronic systems. As countries learn more about the capabilities and advantages to being linked electronically with neighboring countries, international organizations, NGOs, PVOs, and other U.S. businesses, adequate training programs would be established to allow the host country nationals to use and maintain these systems.

Target 4: By the year 2005, USAID would have trained host country personnel in at least 10 key developing countries to assist in "ground-truthing" remote sensing satellite data of deforestation and agricultural areas. Ground-truthing, the process of physically verifying satellite-based data, is a necessary step in remote sensing. Agenda 21 (UNCED, 1992) calls for all countries to set up continuous and accurate information systems and make use of geographic information systems, expert systems, models and a variety of other techniques for the assessment and analysis of data. These steps would be particularly relevant, as large quantities of data from satellite sources would need to be processed in the future.

Technical criteria are not the only criteria by which to measure the results of the GCCS. To address sustainable development in particular, USAID's projects must also have criteria that focus on: creating jobs and increasing incomes; improving air and water purity; slowing loss of soil and soil fertility; increasing adaptability of a country to climate change; utilizing both men and women in identifying problems and solutions; involving host country people, NGOs, PVOs, and the donor community in defining, designing, implementing and evaluating projects; sharing information and lessons learned concerning projects; and transferring ownership and operation of projects to the host

countries. These criteria cross all sectors and borders and are critical components to all USAID projects.

Appendix 1

Examples of USAID's Current Global Climate Change Activities in Energy, Sustainable Agriculture, and Forestry and Natural Resources

Examples of USAID's Current Global Climate Change Activities in Energy, Sustainable Agriculture, and Forestry and Natural Resources

The following information outlines examples of USAID's global climate change activities associated with GHG emissions stabilization by sector.

A1.A. Energy and Industry

As discussed in the 1990 Report to Congress, the GWI focuses on specific areas of USAID activity where the Agency can be effective in solving the energy crisis while reducing greenhouse emissions per unit of service delivered. These areas are energy efficiency and conservation, energy policy and planning, renewable energy and alternative resources, private sector participation in the development and operation of efficient power facilities, low carbon-emitting technologies, information dissemination, training, institution building, leveraging multilateral and private bank funding, price reform, and technology cooperation.

A1.A.1. Leveraging Investments

A1.A.1.a. Multilateral Banks

Many of USAID's activities under the GWI involve the leveraging financing from the MDBs and international finance institutions. By providing pre-investment study and initial design support funds, USAID has assisted the lending institutions and developing countries in the preparation of viable projects. The GWI also serves as a focal point for developing and implementing USAID's projects for the GEF, and will continue to assist the World Bank in developing and assessing GEF projects that address global climate change. There is a list of current and planned USAID-GEF parallel-financed projects at the end of this appendix.

Examples:

- In the NIS, USAID has conducted a pre-loan assessment to secure final approval by the European Bank for Reconstruction and Development of a $60 million loan to improve the efficiency and reduce pollution from a 300 MW Armenian power plant. Once completed, the plant will burn natural gas and be the cleanest power plant in Armenia.

- In India, USAID must leverage its scarce resources to secure multilateral and private bank funding in order to have an impact in the multibillion dollar energy sector. The EMCAT project is a $20 million USAID project, which has leveraged over $1.2 billion in World Bank and Asian Development Bank funding for power project development and energy efficiency improvements.

- In Indonesia, USAID has also been supporting World Bank activities in the development of new power sector loans that will likely include renewable energy components totaling close to $90 million.

- In the Philippines, USAID is funding technical assistance to the national government to administer a government loan program targeted at renewable energy projects, and seeding an independent private-sector financing mechanism, also for renewable energy project financing.

- In the Dominican Republic, USAID is closely coordinating its technical assistance efforts with the World Bank and the Inter-American Development Bank (IDB). These efforts focus on the privatization of Corporación Dominicana de Electricidad (CDE), the national electric utility. USAID is assisting the Government of the Dominican Republic in the development of an international solicited bidding process for the selection of private sector combined-cycle power facilities that meet the country's least-cost expansion plan. The successful bidder will also be eligible to apply for funding from a joint World Bank/IDB fund.

- In Costa Rica, the Agency is cooperating with the U.S. wind technology industry, the Costa Rican electric utility, the GEF, and the IDB in the development of a 20 MW grid-connected wind electric power plant.

- In Pakistan, USAID has coordinated its program of institutional capacity building to assist the Government of Pakistan in the evaluation and negotiation of private power project proposals which meet World Bank environmental guidelines. USAID also cooperated with the World Bank and other multi- and bi-lateral donors in establishing a private sector fund to assist in the funding of the projects.

- In Russia, USAID is working with the World Bank to structure a $600 million World Bank loan. The proposed loan would enable Russia to increase energy production and exports by capturing and utilizing natural gas and gas liquid products. USAID assistance will focus on the recovery of gas and gas condensates presently being flared at the Tyumen oil fields in Siberia. This project would help generate hard currency for the Russian economy, and simultaneously reduce the environmental impact caused by gases burned in the field.

- In Mexico, USAID funded a feasibility study for a pilot project under consideration by the GEF and World Bank to promote energy efficient lighting for the residential sector of Mexico. The study found that the pilot project could achieve 100,000 tons of carbon dioxide emission reduction annually with a very high internal rate of return. Because of the success of the feasibility study, the Government of Norway has agreed to contribute $3 million to the pilot project and the World Bank is scheduled to finalize approval of the project funding in late 1993.

A1.A.1.b. Private Sector

Lack of adequate capital and poor performance by public utilities continue to be major problems in many developing countries. These conditions contribute to unnecessarily high emissions of greenhouse gases. Successful development requires more than money, however, it also requires the skills and talents of individuals trained to handle such situations. Private sector participation in the electric utility sector of these countries could provide infusion of new capital and management efficiency to make them sustainable on their own. In the past, USAID has promoted private sector solutions to the energy problems of the developing countries and market economies by providing technical assistance, disseminating market information, and co-funding feasibility studies. Through its current private sector program, USAID seeks to increase the supply of reliable, affordable, and environmentally sound energy from the private sector. Indigenous NGOs and PVOs play an important role here. USAID believes that every project should "leverage" its personnel, and include as many local participants in the planning and execution of the program as practicable. By making this kind of leveraging an operational goal, USAID believes it can make empowerment an integral part of the development process, and not just an end result.

Examples:

- In India, USAID is providing assistance through the IPPI project to respond to proposals from foreign interests to invest in the electric power sector. The $5.3 million project involves establishing a coherent policy and regulatory framework to encourage private power development and assists the Government of India (GOI) and State Electricity Boards (SEB) in working through their backlog of proposals. IPPI also helps establish the capability of the GOI and SEBs, through ongoing training efforts, to manage private power development in an integrated and transparent manner.

- In the Philippines, USAID sponsored a study of cost structure and transfer pricing in the petroleum industry with the objective of helping the Philippine government to organize policy and regulatory reforms that will open the petroleum sector to private sector participation.

- In Poland, Lithuania, and the Czech Republic, USAID is carying out demand-side management programs with electricity distribution companies that are helping to create an industrial market for private energy service companies. Through USAID's Utility Partnership Program with the U.S. Energy Association, leading U.S. utilities are donating the time of their executives and experts to work with sister utilities and help them in their efforts to improve their management and electricity systems, and adapt to a market economy.

- In Egypt, USAID is providing assistance to study and analyze the effects of policy reform in the electric power sector. Consideration is given to the operational issues of splitting the national electrical grid into separate operating entities in order to maximize the ability to attract increased investment for new environmentally sound power generation facilities.

- In Mexico and the southern cone of Latin America, USAID has provided assistance to private entities in the development of wind power farms to generate electricity for captive use and for sale to the national grid.

- In the Philippines, Indonesia, and Costa Rica, USAID has established Renewable Energy Support Offices (REPSOs). REPSOs offer selected programs to promote private sector investments in renewable energy technologies, the principal component being a program to share the costs of pre-investment studies. Another REPSO is planned for Guatemala to serve all of Central America.

- In many USAID-assisted countries, the Agency has been aggressively promoting the participation of the private sector in the construction and operation of efficient, privately-owned power facilities. It also has expanded its activities to promote the competitive, efficient development of least-cost generation opportunities through its Private Sector Energy Development project.

- In the Ukraine, USAID is supporting the state oil and gas corporation to privatize key activities in the petroleum sector. A technical review of refineries, oil storage, distribution facilities (including ports) is being prepared to facilitate investment by U.S. firms.

A1.A.2. Policy Reform

The promotion of energy efficiency through conservation, private sector participation, and least-cost utility planning are key elements in USAID's GWI. Several examples are provided below.

Examples:

- In Hungary, USAID had helped achieve liberalization of petroleum prices and elimination of federal energy subsidies through a $10 million grant to the Hungarian Government. This effort was part of a World Bank structural adjustment package.

- In Pakistan, USAID helped establish ENERCON in collaboration with the Government of Pakistan (GOP). ENERCON was created to improve the efficiency of energy use in all sectors of the economy (e.g., agriculture, industry, transportation, power generation, buildings) and to alleviate some of the serious threats that energy shortages posed to Pakistan's continued economic development. ENERCON is now self sustaining, receiving support from the GOP, and has assisted in preparing conservation laws, regulations, and codes, and has sponsored energy audits, workshops and training courses for Pakistani industry.

- In Costa Rica, the Agency is supporting an innovative program to make use of agricultural residues in the sugar industry to fuel on-site private power generation. Part of an 11-year, $12 million USAID project, this activity focuses on power generation from biomass, pricing reform, the development of an interim government decree permitting private power hookups, and power sales to the national grid. The project also concentrates on the development of new, privately-owned, biomass-fired power generation units.

- In the NIS, as part of the Gore-Chernomyrdin process, USAID is working with the U.S. Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), and the Russian Ministry of Energy and Fuel on a joint energy alternatives strategy to reduce risks associated with nuclear power, reduce the environmental impacts of the electric sector (including greenhouse gas emissions), increase efficiency of energy use, and assist in the sector's transition to a market structure.

- In Egypt, USAID has performed a Policy Reform and Institutional Development Assessment of the Egyptian Power Sector under the direction of the Private Sector Energy Development project. The guidelines developed under this project establishes the building blocks essential to successful private power development. Tangible recommendations were made for operation on a commercial basis through increased operational and financial independence, increased operational efficiency, and improved profitability and return on investments.

A1.A.3. Capacity Building

Increased resources are being devoted to the training of host country officials and experts on energy planning, renewable energy systems, environmental management in the energy sector, energy efficiency, private power participation, and financing. Training opportunities include formal course work, internships with U.S. energy organizations, and visits to U.S. energy facilities, including utilities, manufacturers, architect-engineers and private developers.

Examples:

- In Pakistan, USAID has implemented an extensive training program to assist the government in the development of in-country institutional capacity in energy and least-cost capacity planning, electricity pricing reform, and in the assessment and negotiation of environmentally sound private power projects.

- In the NIS, in cooperation with the U.S. Environmental Protection Agency (EPA), USAID is integrating resource planning concepts into Russian utility enterprises. Introducing such least cost planning concepts into the electric and gas utilities will improve the efficiency of energy services, reduce capital costs, and prevent environmental damage.

- In Uruguay, USAID provided assistance to the Government of Uruguay and Administración Nacional de Usinas y Transmisiones Eléctricas (the national utility) by sponsoring a study to investigate the level of public and private support for a proposed Uruguay-Argentina gas pipeline project to fuel an environmentally-clean power station. The investigation focused on private sector participation in all aspects of the project, including ownership and operation of the pipeline, the power plant, and transmission facilities.

- In Russia, a study of natural gas distribution systems in four Russian cities is being undertaken as part of USAID's technical support of the World Bank's efforts to structure a $200 million loan to Russia. The Agency also is preparing a technical, economic, and financial assessment of gas distribution systems in Volgograd, Saratov, Ryazan, and Voronezh. By identifying high priority investments in the gas distribution industry, the study will form the basis for developing strategies for reconstruction of that industry over the next five years. Potential investments could total $50 million in each city.

- In the Dominican Republic, USAID is providing technical assistance in the privatization of the national utility (CDE) into its generation, transmission, and distribution components. A focus of its activities will be to assist both the government and CDE in the establishment of

a supporting policy, regulatory, and institutional capacity through which future additions of environmentally sound capacity additions can be sought by CDE.

- USAID hosted a private power development workshop for a high level delegation of GOI officials, as well as representatives from India's largest electric utilities. The workshop provided an excellent forum for interaction between the Indian delegation and the U.S. private power developers and investors. The U.S. developers and utility experts were able to share their private power experience with the delegation and exchange information on the private power opportunities in India.

- In Pakistan, USAID has implemented the Energy Planning and Development project to improve coal exploration, processing and use. The project established coal analysis groups in the Energy Ministry, conduct energy audits in major industries, established a data-gathering and analysis system, and performed an energy needs survey.

- In Poland, the Czech Republic, and Bulgaria, USAID has assisted NGO energy efficiency centers in the development of local networks for the dissemination of information on energy efficiency measures and technologies. In Romania, Bulgaria and Hungary, local private energy services companies have been trained in energy auditing and business development.

- In Asia, USAID sponsored a private power conference with the World Bank which brought together high-level energy officials from eight Asian countries. The participants discussed the favorable policy, regulatory, statutory, and financial conditions that would needed in their countries to attract U.S. and international private power investors. Representatives of the U.S. private power industry were also invited to inform them of power market opportunities in these countries and to convey their needs to the attending country officials.

- In Egypt, USAID has been assisting the Egyptian Office for Energy Planning (OEP) with a major energy policy and planning project that includes two rounds of in-depth energy audits in the agricultural, chemical, cement, and petroleum industries. The purposes of these audits were to identify the energy conservation opportunities at the plants, calculate the economic cost/benefits for the conservation measures, identify energy conservation-related policies that OEP should pursue, and train OEP staff in energy auditing. The reports have been presented to each plant management team, and the recommendations of the reports are now under consideration or are being implemented.

- In Poland and the Czech Republic, USAID, in collaboration with the U.S. Department of Energy, has supported pilot projects which have developed cost-effective measures for improving efficiency and reducing local environmental pollution.

- In Asia, Africa, Latin America, and the Caribbean, USAID has been involved in over 200 renewable energy programs. These projects have lead to a reduction in oil imports, augmented domestic fuelwood resources, and increased energy self-reliance in developing countries, including 1990 USAID-designated key countries such as India, Indonesia, Pakistan, the Philippines, Zaire, and the Central American region. These projects have involved the development and testing of solar, wind, biomass, biogas, and small hydro systems for meeting rural and village energy needs.

- USAID has been sponsoring the annual Wind Energy Applications and Training Symposium (WEATS). The symposium has provided training for over 80 individuals from 37 countries in resource assessment, project finance, technological development, and other subjects. WEATS also provided opportunities to visit both large and small wind projects in the U.S.

- USAID sponsored a number of individuals from the South African Developing Countries, Indonesia, and the Philippines to attend the 1993 SOLTECH conference. SOLTECH participants were exposed to the latest technologies in photovoltaics (solar cells), solar thermal, and biomass. USAID has also been sponsoring annual training on photovoltaics design and use.

- In the NIS, in cooperation with the U.S. Energy Association and the Russian Ministry of Fuel and Energy, USAID has put together a strategy for restructuring the electric utility sector. Five jointly-managed working groups will increase institutional capacity through legislative and regulatory reform, private sector investment promotion, and training.

A1.A.4. Environmental Technology Cooperation

As part of the GWI, USAID is promoting innovative, market-driven technology cooperation between U.S. and developing country organizations. The U.S. manufactures and exports some of the world's most energy efficient and environmentally benign energy technologies. These technologies include combined cycle power plants, computer-based control systems, heat exchangers, lighting equipment, windows, electric motors, refrigeration and air-conditioning equipment, automotive emissions controls, and expertise from energy services companies. U.S. manufacturers and developers can work with developing country counterparts to develop new environmentally-sound technologies designed for new markets. In addition, through its work on projects with private power developers, USAID can also effect a more immediate transfer of efficient and environmentally-benign energy

technologies through the development and construction of projects using these technologies in those countries.

Examples:

- In Nepal, USAID is offering technical assistance in developing a policy and regulatory framework for private sector generation of electricity, and then following up with cost-shared (with the private sector) pilot programs in small hydro-electric facilities for rural electrification.

- In India, USAID is assisting the Government to assess the technical and economic feasibility of Integrated Gasification Combined Cycle (IGCC) technology as an alternative to conventional pulverized coal (PC) power generation technology. IGCC has the dual advantages of much higher energy efficiency (about 10-15% greater than PC) and virtually no emissions of particulates or sulfur dioxide. Efforts are underway to strengthen Indian technological capabilities in addressing problems of high-ash Indian coals through innovative systems such as Atmospheric Fluidized Bed Combustion and slagging combustors. USAID is also promoting additional projects that include coal-cleaning technologies.

- In the NIS, in cooperation with the EPA, USAID is investigating the utilization of coal bed methane, usually vented during mining, to produce energy in Russia and the Ukraine. If economic and successful, this effort would improve mine safety, reduce greenhouse gas emissions, and increase gas exports.

- In India, USAID provides assistance through PACER, a $20 million collaborative initiative launched by the Government of India. PACER provides funding for innovative research, development, and commercialization for energy efficiency technologies adapted to Indian needs. Both PACER and PACT projects promote joint Indo-American R&D projects for the development of innovative products and processes, including environmental technologies that reduce greenhouse gas emissions.

- In Poland, 80% of the country's energy comes from coal. Uncontrolled sulfur emissions from power plants, boiler houses, and small furnaces have made Poland one of Europe's most polluted countries. Under the 1990 SEED Act, USAID and DOE have recently completed the installation of Poland's first high-efficiency Flue Gas Desulphurization units on a Krakow power plant. USAID is also working with Polish officials to reduce pollution from the 3,000 small boilers and 200,000 home furnaces located in Krakow through commercial projects in energy efficiency and district heating system improvement, modernization of boilers, upgrading and switching fuels.

- In Belarus, USAID assisted the Ministry of Energy in developing a private power project suitable for multilateral financing. This assistance included assessing the investment required for the rehabilitation of the power and thermal energy subsectors. The project resulted in the identification of a highly efficient, environmentally-acceptable and economically-sound combined cycle power plant project. The loan document for this power facility was prepared and submitted to a prospective lender.

- In Eastern and Central Europe, USAID has demonstrated the potential for low-cost energy savings in industries in nine countries and has leveraged a $1 million investment into a $16 million savings in annual energy costs. This is clearly a least-cost approach compared with the construction of new power plants, and has important implications for the World Bank and other international lending institutions that have focused on adding new capacity in the past.

- In Russia, Belarus, the Ukraine and Armenia, USAID has installed $150,000 worth of equipment and instrumentation in district heating systems. These efficiency improvements have resulted in annual energy savings of $4.5 million at world energy prices.

A1.B. Sustainable Agriculture

With some 3.2 billion hectares of arable land on the earth's surface, agriculture, by definition, is a major sector of human interaction with the environment. The sector is extremely complex, interacting at all levels of human endeavor (production, marketing and consumption) and environmental consequence (air, soil, water, climate, biodiversity, and natural resource base). Priority is now placed on agricultural activities which build on a country's comparative advantage and optimize present and future uses of natural resources in an environmentally-sound manner.

The agricultural sector has responded to the challenge of global climate change in two ways: mitigation of processes and activities considered to be the causes of global climate change; and, development of an awareness of the causes and implications of climate change. Mitigation has been by far the most important focus area of USAID's intervention. The development of productive, economic and sustainable systems of food production in tropical regions is key to reduction of deforestation. Deforestation, as explained earlier, is a key element in the destruction of the carbon cycle, and micro and macroclimates.

A1.B.1. Leveraging and Donor Coordination

The thrust of USAID's donor coordination has been through a common theme approach. This approach finds potential collaborators with shared program and technical objectives, negotiates responsibilities and defines programs, and implements the activities on a coordinated basis. Recently

there has been a trend for greater multilateral coordination at the program planning stage. A general acknowledgement by donors is that in an atmosphere of diminishing resources, and a realistic assessment of the magnitude of intervention required by global issues, better coordination and cooperation will be required.

Examples:

- In Francophone Africa, the Permanent Inter-state Committee for the Campaign Against the Drought in the Sahel (CILSS), USAID is one of several collaborating international donors who is coordinating economic and technical support to study the reasons for, and developing alternative solutions to, mitigating the negative environmental impacts for the region.

- Globally, USAID, FAO, the Rockefeller Foundation, and the World Bank are supporting the International Forum for the Development of Sustainable Land Use Systems (INFORUM) which serves as a communication network among researchers and policy-makers on topics related to sustainable agriculture (and global climate change issues).

A1.B.2. Policy Reform and Capacity Building

Before governments can implement agricultural reforms, focused policy analysis is required to help policy decision-makers better understand policy alternatives and impacts. Greenhouse gas emissions by agricultural systems, causing disruption of climate patterns, has only recently been added to the list of potential impacts of policy decisions.

- APAP and EPAT are programs that provide policy analysis support to USAID Missions. These programs are global in design, and have slightly different policy focus targets. APAP deals only with natural resource issues affected by agricultural systems, and EPAT covers general natural resource and environmental policy issues. Both are relatively new programs which are active in all regions of the world, and both are addressing issues of global climate change.

- Regionally, PARTS focuses in Sub-Saharan Africa. The program is designed to increase the utilization and influence of information and analysis for agricultural and natural resource policies and programs in the region. PARTS has twelve resident advisors who provide technical assistance targeted at specific countries with specific problems. Global climate change issues are an integral part of the policy focus.

A1.B.3. Environmental Technical Cooperation

USAID's strength in reducing the impact on global climate change has been through its global network of technical cooperation. The relationship of the forest with agriculture, especially in tropical regions, by providing productive, economic and sustainable food production systems is a major key to reducing deforestation. USAID is the lead donor to CGIAR, which sponsors two international centers dedicated to reducing deforestation.

Examples:

- In Kenya, the International Center for Research on Agroforestry (ICRAF) is working globally to develop alternatives to slash and burn agriculture by incorporating woody plants into tropical farming systems. The goal is to maintain soil fertility while increasing productivity; offering farm families a livelihood without clearing new lands.

- In India, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is working on the incorporation of shrubs and other windbreaks to reduce soil erosion and stabilize fragile environments.

- In Ecuador, Burkina Faso, and the Philippines, the Sustainable Agriculture and Natural Resource Management (SANREM) Trop Soils Collaborative Research Support program (CRSP) is working on developing long-term, sustainable agriculture production systems which preserve the natural resource base. Research highlights participatory methodologies (farmer and end-user involvement in decision-making), but also includes understanding local decision-making processes and training of program collaborators in global environmental issues over which local production practices have an impact. The goal is a long-term mitigation of environmental degradation by present agricultural practices. Additional sites for this project are being considered for Morocco, Cape Verde and Honduras.

- In the Philippines, the International Rice Research Institute (IRRI), in collaboration with the EPA, is studying the effects of increased ultraviolet radiation on rice plant growth and disease. Modeling is being used to estimate the impact of several climate change scenarios. IRRI will then use these models to select genetic materials best suited for climate changes. IRRI is also developing new "ideotype" rice designed to decrease methane production during its growing cycle.

- Globally, CRSP provides critical technical information on soils, in both dry and moist regions of the tropics. These soils are critical "carbon banks" in the global carbon sequestration process which affects climate change.

- Globally, many of the international research centers supported by USAID are trying to anticipate the potential affects of climate change on the areas of their specialization. The International Board for Plant Genetic Resources (IBPGR) in Rome is sponsoring wide-spread testing of plant materials, leading to improved information on plant adaptability to dry and/or hot weather conditions. The International Livestock Center for Africa (ILCA) in Ethiopia is using satellite imagery to monitor climate changes in Africa. The information gathered will be used for adopting program and policy decisions for rangelands and cropping systems to climate changes. In the Philippines, the International Center for Living Aquatic Resources Management (ICLARM) is studying the effects of increased radiation, temperature and potential sea level rise on the "health" and productivity of costal reefs.

A1.C. Conservation of Forests and Biological Diversity

USAID is implementing activities specifically designed to counter CO_2 emissions from tropical deforestation in Latin America and the Caribbean. In Africa, USAID is improving the capacity of institutions to address global climate change by funding resource, policy, and institutional analyses and training. Most of USAID's sustainable forestry and natural resources management activities help to lessen either the rate or the impact of climate change, although they were not designed specifically for either purpose. Presently, the impacts of these activities on the global carbon budget are not being monitored. Conserving tropical forests avoids the net release of CO_2 which would occur otherwise because the carbon sequestered in biomass and soil is oxidized by agricultural burning and decomposition processes. The same policies and institutional capacity that countries require to sustainably manage their forests will also equip them to assess their vulnerability and to adapt to climate change.

Most of the following examples of USAID activities to conserve tropical forests and biological diversity are selected from *Tropical Forests and Biological Diversity: USAID Report to Congress 1991-1992* (ENRIC, 1993).

A1.C.1. Leveraging and Donor Coordination

In several countries, USAID has used relatively modest sums of money to catalyze cross-sectoral collaboration among the government. national NGOs, the private sector, USAID, and other donors to analyze the interaction of forestry and natural resources management with other environmental issues and to integrate environmental and economic policies through the NEAP process. The success of the NEAPs for engaging the participation of a broad cross-section of society in integrating environmental and economic issues has prompted the World Bank to require that countries prepare NEAPs prior to receiving development loans (Ford, et al, 1992).

Examples:

- In Madagascar, USAID supported several Malagasy consultants in the NEAP development process. One valuable outcome was the formation of a working group of donors that can now share information and continue to work with all of the national parties. The technical support for this organization comes from a USAID-funded Secretariat in the World Bank. The broad sectoral approach of the NEAP has allowed various donors to fund activities where they have comparative advantage or special interest. For example, the World Bank is funding agrarian reform and a land survey, USAID is strengthening management of parks and protected areas, and the Swiss are funding agroforestry and rural development.

- In Ghana, the NEAP process was led by the World Bank, and employed eight Ghanian consultants. An Environmental Protection Council was formed to work with the Inter-Ministerial Council to formulate plans that cut across ministries. USAID uses a broad focus on natural resources rather than on the forestry or agricultural sectors. By providing several hundred thousand dollars of local currency support for the NEAP effort, USAID helped to develop a sound environmental policy framework in which to program natural resources activities.

- In Bolivia, USAID took the lead to involve all players, including the government, NGOs, and other donors, in the development of a NEAP, which integrated environmental and economic elements. Additionally, USAID has helped to establish the National Fund for the Environment (FONAMA) with debt-for-nature dollars under the U.S. Enterprise for the Americas initiative. A board with representatives from all sectors establishes the priorities for funding environmental activities from FONAMA.

Building on its success in the Madagascar NEAP process, USAID funds the Multi-donor Secretariat (MDS) in the World Bank. The MDS provides information, participates in donor or NGO evaluation or appraisal missions, reviews plans for project design and technical assistance, coordinates multi-donor and NGO field trips, mobilizes funding and technical assistance, and organizes multi-donor meetings. It also assists national NEAP coordinating agencies provide a liaison among the donor community, provides local coordination of donor and NGO activities, and prepares funding requests and projects proposals for donor support. The MDS has expanded its charter to include the Gambia, Senegal, Rwanda, and Burundi.

A1.C.2. Policy Reform

USAID has made many achievements in forestry policy reform in developing countries from FY 1991 to FY 1993.

Examples:

- In Brazil, USAID's Environment/Global Climate Change (E/GCC) program supports several policy-related activities. The capacity of Amazon basin NGOs to influence policy is being increased by providing training, management assistance, and basic infrastructure needs for working with government research agencies and carrying out demonstration field projects. A small fund will support travel and technical assistance costs so that the upper management of Brazil's national environmental agency, the Special Environment Secretariat, and its implementing arm, the Brazilian Institute for Environment and Renewable Natural Resources, can consult with a wide range of technical experts and interest groups on policy issues. A Policy Analysis and Action Steering Committee based in Blem and made up of key technicians, scientists, researchers, writers, lawyers, and educators involved in environmental issues will analyze current Brazilian natural resources policies. The World Wildlife Fund (WWF) will assist Brazilian counterparts to identify economic policies that inadvertently encourage or permit the inefficient, wasteful, or destructive use of the resource base. Assistance will be provided to design a workshop for Brazilian civil servants responsible for natural resource economic policies in 35 federal agencies. Also supported will be economic and policy studies conducted jointly by Brazilian and leading international environment/natural resource economists.

- In Mexico, USAID's E/GCC program is also addressing natural resource policies. Assistance is being provided to the Mexican environmental NGO, Fundación Mexicana para la Educación Ambiental (FUNEA), to develop an improved policy and legal framework to prevent deforestation and mitigate global climate change. FUNEA will collect and disseminate technical information and hold workshops to strengthen the capacity of municipal and local governments and conservation organizations for environmental planning and management. Technical exchanges and training programs between the United States and Mexico in policy reform, environmental impact assessment and mitigation, and improved environmental planning will be facilitated.

- In Africa, USAID's Policy, Analysis, Research, and Technical Support project has committed $73.8 million to improve policies, institutions, and socio-economic conditions in natural resource management. In addition, land and resource tenure issues are being analyzed and results disseminated by seven collaborating PVOs, universities, and consulting firms.

A1.C.3. Capacity Building

For countries to sustainably manage their forests, government and non-government institutions must exist that possess the capacity to determine and implement appropriate policies in the forest sector (and other sectors that affect forests). They must be able to assess the natural resource stock, evaluate land use capabilities, and allocate land to sustainable uses through a participatory process. These institutions must also develop or adapt appropriate resource management technologies and make the technologies available to those people managing the land. One of the most common elements of USAID projects is technical assistance designed to develop these capacities in host-country governmental and non-governmental institutions.

Examples:

- In Niger, under USAID's Agricultural Sector Development Grant, procedures have been introduced to involve local communities in the management of the Guesselbodi National Forest. Assistance was provided to a local woodcutter's association to develop and implement a sustained management plan that uses vegetative regeneration of native species. Salaries of forest guards are paid out of the revenues from the sale of fuelwood and forage. Low-cost natural forest management techniques are demonstrating that degraded ecosystems can be restored on a sustainable basis to conserve indigenous biodiversity.

- In the Philippines, the 5-year, $125 million, Natural Resources Management Program enhances the ecological and economic sustainability of lands managed as primary or secondary forests. The three major components are performance-based sectoral policy reforms, resource protection through a debt-for-nature swap, and support services for technical assistance. NGOs are funded to assist 20 communities in organizing low-input, labor-based forest management. The government is being assisted to work with the private sector to develop a planning methodology to shift concessions from primary to secondary forests. Nationwide aerial surveys are helping determine the location and extent of the country's remaining primary forests and identify areas of activity that threaten them. Senior officials of the Philippines Department of Environment and Natural Resources were trained to use aircraft for forest surveillance and surveys.

- Globally, USAID's Forestry Support Program (FSP) conducted training in fiscal year 1992 in agroforestry, environmental impact assessment, natural resources extension, integrated pest management, forest resources marketing, forest road maintenance, and women in development for the Peace Corps and other organizations. The 10th Annual Seminar on Forest Administration and Management for senior-level developing country forestry administrators was held in 1993 with funds from the FSP administered by the University of

Michigan. The FSP was established in 1980 in the International Forestry office of the USDA Forest Service (FS) with funding from the Forest Resources Management (FRM) Project to help USAID design, evaluate, and coordinate USAID forestry activities worldwide. Building on experience gained under FRM, the 10-year, $25 million, FRM II Project was begun in fiscal year 1991. Socio-economic research on USAID agroforestry projects by the Forest Service's Southeastern Center for Forest Economics Research in North Carolina will also be funded by FRM II through the FSP.

A1.C.4. Environmental Technology Cooperation

USAID works in partnership with developing countries to fund research, development, and adaptation of sustainable forest management policies and technologies. Frequently, additional funds are leveraged through cooperation with other donors. Assisting the public and private sector in developing countries to access new forest management and forest products technologies, and helping entrepreneurs and producer organizations to adapt these technologies in profit-making enterprises, are important elements of USAID's technology cooperation activities.

Examples:

- On Costa Rica's Osa Peninsula, USAID's Forest Conservation and Management Project is helping to develop and demonstrate natural forest management, ecotourism, and harvesting timber and non-timber forest products by landowners as economic alternatives to deforestation and unsustainable resource exploitation.

- In Papua-New Guinea, USAID's Sustainable Forestry Program works in partnership with the Foundation for the Peoples of the South Pacific to assist communities of forest landowners to adopt small-scale portable sawmill technologies from which they receive economic benefits (Senn, et al, 1993). Some of the lumber produced is being used to upgrade landowners homes, while most is sold locally or exported. Efforts are being made to standardize lumber quality and dimensions and to achieve adequate production levels so that lumber certified to come from sustainable production systems can be marketed in the United States, and the "green premium" passed on back to the landowners as a strong incentive to continue forest management rather than converting forest to agriculture.

- Internationally, USAID's Conservation of Biological Diversity project supports biological diversity research by the Biodiversity Support Program (BSP) (a consortium of WWF, The Nature Conservancy, and World Resource Institute (WRI)) and through a small grants program administered by the National Science Foundation (NSF). An Innovative Research Grants program is funded by BSP under its Biodiversity Analysis for Africa project.

Community-based conservation in Namibia, market-driven forest and biodiversity conservation in Cameroon, public attitudes and human needs around Kasungu National Park in Malawi, and the integrated conservation and development strategy in Madagascar have all been investigated. BSP also funds a Small Research Grants Program for developing country scientists, which received nearly 500 proposals in fiscal year 1992. Research has been funded since 1991 on the natural regeneration of trees species with economic and ecological importance in West Kalimantan, Indonesia. The USAID-NSF Collaborative Program on Biodiversity began in 1990 with almost $1 million to support research activities by U.S. and developing country researchers managed by NSF. To qualify for support, research must further the conservation of biodiversity and strengthen the capacity of USAID host countries to study and manage their own biodiversity.

Table A1.1

U.S. Agency for International Development
Global Warming Initiative

Fiscal Years 1991 - 1993
Budget by Project

Title	USAID Mission or Office	Planned LOP ($000)	Oblig. Yrs.	FY 1991		FY 1992		FY 1993		Project Number	
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Amber Mountain Conservation and Development	Madagascar	912	89-91	6	35	0	0	0	0	687-0103	The project was an integrated conservation program for the Amber Mountain Area forest, a rich source of biodiversity which is also vital to the livelihood of people in the areas. Collaboration between the WWF and the Ministry of Animal Production, Water and Forests.
Sustainable Approaches via Environmental Management (SAVEM)	Madagascar	26700	90-94	8	560	12	480	12	408	687-0110	SAVEM project supports conservation-oriented institutions, grants for protection of priority areas, soil and biodiversity conservation, land surveys, remote sensing, and development of ecologically sensitive economic activities.
Policy Analysis Research and Technical Support	Africa Regional	73800	92-98	0	0	8	442	8	1040	698-0478	This project provides technical assistance and analysis to USAID missions, host-country governments, PVOs, and other development agencies on all aspects of natural resource management and agricultural policies, projects, and programs in sub-Saharan Africa.
Community Natural Resource Management	Guatemala	4200	93-97	0	0	0	0	24	468	520-0404	This project emphasizes activities in sustainable agriculture, watershed management, and policy development for protected areas to promote natural resource management in Guatemala.

Title	USAID Mission or Office	Planned LOP ($000)	Oblig Yrs	FY 1991		FY 1992		FY 1993		Project Number	Description
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Employment and Natural Resources Sustainability	Peru	3600	91-92	7	148	0	0	0	0	527-0341	This project supports the Nature Conservancy to help communities in and around Peru's Pacaya Samiria Nature Reserve to improve their income generating capacities while preserving the reserve's natural resources. Project activities include efforts in sustainable agriculture, watershed management, and policy development for protected areas to promote natural resource management in Guatemala.
Environment/ Global Climate Change	LAC Regional	30000	90-96	100	5962	100	8150	100	12500	598-0784	E/GCC aims to reduce greenhouse gas emissions in the Latin America and the Caribbean region by promoting policy reforms, environmentally-sound technologies, and practices for the sustainable, efficient use of forest and energy resources, especially in Brazil, Mexico, and Central America.
Energy Policy Development and Conservation (EPDAC)	Energy and Infrastructure	36799	82-93	73	4692	80	1786	0	0	936-5728	USAID's longest-running energy project was completed in 1992. EPDAC provided technical assistance to USAID-assisted country institutions in over 30 countries in the areas of energy planning, analysis, and policy development, emphasizing efficient energy use.

Title	USAID Mission or Office	Planned LOP ($000)	Oblig. Yrs.	FY 1991		FY 1992		FY 1993		Project Number	Description
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Renewable Energy Applications and Training (REAT)	Energy and Infrastructure	25000	85-95	100	3694	100	3277	100	5720	936-5730	REAT activities include promoting investments in renewable energy technologies in USAID-assisted countries; conducting country-specific feasibility analyses of alternative energy sources; and disseminating country investment portfolios, energy sector case studies, etc.
Energy Training Project (ETP)	Energy and Infrastructure	29577	87-97	0	0	18	630	18	562	936-5734	ETP provides USAID-assisted country personnel with long- and short-term academic and nonacademic training in environmentally-sound energy planning and management; renewable energy technology applications to public and private sector. ETP also teaches about appropriate U.S. environmentally-sound technologies in its study tour program.
Energy Technology Innovation Project (ETIP)	Energy and Infrastructure	20000	90-98	100	1692	66	2492	66	2479	936-5741	ETIP activities include conducting energy resource and market assessments, pre-feasibility studies, training workshops, etc., to introduce innovative clean energy technology and advanced management techniques for electricity generation, transmission, & distribution.

Title	USAID Mission or Office	Planned LOP ($000)	Oblig Yrs	FY 1991		FY 1992		FY 1993		Project Number	Description
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Energy Efficiency Project (EEP)	Energy and Infrastructure	20000	92-99	0	0	100	3284	100	6900	936-5743	EEP activities center around reducing the demand for energy and greenhouse gas emissions in USAID-assisted countries. Project activities include introducing environmentally-benign, energy-efficient technologies and promoting related policy reforms, investment incentives, and energy management and planning.
Information as a Tool in Development	Center for Development Information & Evaluation		76-C	0	0	2	59	0	0	930-0232	This project has created a centralized information system containing all of USAID's development experience and related research, to expedite the transfer of development and related technical information to USAID-assisted countries, USAID Missions, and others.
Environmental Policy and Technology	Newly Independent States	35000	92-96	0	0	0	0	49	5880	110-0003	The goal of this project is to ensure that economic and social restructuring of the NIS is achieved in an environmentally sound manner.
Energy Efficiency and Market Reform Project	Newly Independent States	272534	92-96	0	0	100	33106	100	59-480	110-0002	Major goals of this project are to: achieve viable economies partially through energy sector investments and foster trade and commercial ties in the energy area.

Title	USAID Mission or Office	Planned LOP ($000)	Oblig. Yrs.	FY 1991		FY 1992		FY 1993		Project Number	Description
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Biomass Energy Systems and Technology (BEST)	Energy and Infrastructure	13131	89-96	10	130	100	1860	100	1800	936-5737	Main objective is to identify and reduce technical, financial,and institutional risks of investment in biomass-fueled power technologies.
Emergency Energy	Europe Bureau	11750	91	100*	11750	0	0	0	0	180-0015	The main objective of this project is to improve industrial energy efficiency, including the use of energy efficient equipment, and improve energy pricing policies.
Regional Energy Efficiency	Europe Bureau	96000	91-93	100*	15500	100*	15750	100*	19050	180-0030	The major goal of this project is the focus on energy efficiency, energy restructuring and nuclear safety.
Krakow Clean Fossil Fuels and Energy Efficiency	Europe Bureau	30000	91-93		3000		5500		7000	180-0031	The main objective of this project is the testing and commercialization of energy efficiency and boiler modernization.

Title	USAID Mission or Office	Planned LOP ($000)	Oblig. Yrs.	FY 1991		FY 1992		FY 1993		Project Number	Description
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Private Sector Energy Development Project (PSED)	Energy and Infrastructure	6042	91-94	0	0	0	750	52	4500	936-5738	Provides technical assistance to governments to help them utilize their resources more effectively, access new sources of capital, mitigate the environmental impact of energy projects, and capitalize on the technical and managerial expertise of the private sector. Also promotes energy efficiency and reduces environmental degradation through the efficient operation of facilities and the use of renewable energy sources.
Energy Management Consultation and Training (EMCAT)	India	20000	91-96	100		100		100		386-0517	Devoted to energy management and energy efficiency improvements in the power sector both on the supply and demand side. Also directed toward private sector invovement on the demand side.
Program for Acceleration of Commercial Energy Research (PACER)	India	20000	87-95	100		100		100		386-0494	Main objective is to promote the commercialization of emerging energy technologies. The project administers a revolving fund for research awards and grants to consortia of manufacturers, researchers, and end users. Projects may be joint ventures between Indian and U.S. parties, or may be solely Indian.

Title	USAID Mission or Office	Planned LOP ($000)	Oblig. Yrs.	FY 1991		FY 1992		FY 1993		Project Number	Description
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Program to Accelerate Commercial Technology (PACT)	India	21225+	85-94	10		10		10		386-0496	Fosters technology development on near commercial technologies between Indian and U.S. private sector entities. Objective is to develop joint ventures between U.S. and Indian entities in areas of environmentally sound technologies.
Energy Conservation and Efficiency/ Science & Technology for Development Project	Egypt	136750	86-98	n/a		n/a		n/a		263-0140.3	This project, a subproject of Science and Technology for Development, promotes the use of energy-efficient industrial and commercial technologies in both the public and private sectors in Egypt. The project has used portable gas analyzers to tune 54 boilers in 18 companies, reducing fuel use by about ten percent and greenhouse gas emissions by 15-30 percent.
Peace & National Recovery	El Salvador	106000	92-96	n/a		n/a		n/a		519-0394	This project aims to promote the economic, social, and political reconstruction in El Salvador's conflict zones (comprising 800,000 persons in 99 municipalities) by restoring infrastructure and access to basic services.

Title	USAID Mission or Office	Planned LOP ($000)	Oblig. Yrs.	FY 1991		FY 1992		FY 1993		Project Number	Description
				Pct.	Oblig	Pct.	Oblig	Pct.	Oblig		
Power Sector Support Program	Egypt	661000	89-96	n/a		n/a		n/a		263-0215	This project aims to rehabilitate electricity generating capacity, increase efficiency, and stimulate energy conservation. The project is achieving greenhouse gas emission reductions through infrastructure investments and technical and policy assistance.
Unallocated Reserve	Special Require-ments Fund		93-93	0	0	0	0	42	10237	999-9991	
	Eastern Europe **			30,250		21,250		26,050			
	NIS**			--		33,106		62,361			
	All Other**			14,843		19,852		31,241			
	Total**			45,093		74,208		123,952			

Notes: Pct. represents the estimated percentage of funding dedicated to global climate change issues.
The current tracking system does not show all of these projects as global climate change activities. All projects that appear to be climate change related, even though they may not have been coded as such in the tracking system, have been included here.
* Athough these projects did not meet the coding guidelines for global climate change, they have been included here because they appear to qualify for consideration as global climate change projects.
** Product of percentage and obligation
\+ Environment Program Report FY 1992-93, Internal Working Document, December, 1993.

Table A1.2
Summary of Current and Planned USAID Parallel-Financed GEF Pilot Phase Projects

Country or Region	Project	GEF Objective	Funding (U.S. $ million)
India	**Greenhouse Gas Reduction**	**Global Warming**	**19.00**
Philippines	**Demand-Side Management**	**Global Warming**	**4.50**
Mexico	**Environment and Global Climate Change**	**Global Warming**	**4.00**
Philippines	**Philippine Assistance Support Project**	**Global Warming**	**3.75**
Indonesia	**Strengthening Institutional Development**	**Global Warming**	**2.90**
Bolivia	**Alternative Development Electrification**	**Global Warming**	**2.50**
Nepal	**Sustainable Income and Rural Enterprise**	**Global Warming**	**1.00**
Worldwide	**Program on Incremental Costs to the Environment (PRINCE)**	**Global Warming**	**0.40**
Asia-Pacific	Biodiversity Conservation Network	Biodiversity	20.00
Uganda	Action Program for the Environment	Biodiversity	20.00
Mexico	Biodiversity Endowment Fund	Biodiversity	20.00
Indonesia	Indonesia Biodiversity Foundation	Biodiversity	10.00
Eastern Caribbean	Environment and Coastal Resources (ENCORE)	Biodiversity and International Waters	7.00

Jamaica	Development of Environmental Management Organizations	Biodiversity	6.60
El Salvador	Environmental Protection Project (PROMESA)	Biodiversity	5.60
Nicaragua	Natural Resource Management	Biodiversity	5.40
Bulgaria	Development and Implementation of a Nature Conservation Strategy	Biodiversity	4.00
Worldwide	Rapid Biodiversity Assessment	Biodiversity	3.00
South Pacific	Profitable Environmental Protection	Biodiversity	1.70
Poland	World Bank: Forest Biodiversity	Biodiversity	0.10
Czech and Slovak Republics	World Bank: Planning & Mgmt. of Reserves	Biodiversity	0.10
Europe and NIS	Danube Program	International Waters	6.50
Central and Eastern Europe	UNDP/World Bank: Danube Program	International Waters	2.30
Worldwide	UNDP Small Grants Program (Planned Cofinancing)	Cross-cutting	3.00
Total:			$153.35

Appendix 2

International Climate Change - Science, Research, and Policy

International Climate Change - Science, Research, and Policy

International and U.S. Climate Change Programs

The USAID response to global climate change is one part of the U.S. Government's participation in an international effort designed to reduce the scientific uncertainties concerning the mechanisms of climate change, and to develop cooperative international responses that can reduce the damages from those impacts of climate change which can no longer be avoided. In order to develop a systematic and cost-effective response to the risks of rapid climate change, USAID takes account of and seeks to complement the efforts of both international and other U.S. agencies and institutions. The following section outlines the current programs of these institutions and agencies.

A2.A.1 The United Nations Framework Convention on Climate Change

In December 1992, the U.S. Senate ratified the **FCCC** that had been signed in June at the **UNCED** summit held in Rio de Janeiro, Brazil, that same year. The FCCC will structure the international policy debate on the climate issue for the next decade. It establishes several new institutional mechanisms for international cooperation and binds the issues of environmental protection and economic development into one seamless whole.

This path-breaking international treaty has now been signed by 154 countries. It will legally enter into force 90 days after the 50th signatory has ratified the treaty. The fiftieth party to the convention ratified the treaty in December, 1993, and the treaty is expected to enter into force in late March of 1994.

There are several key elements within the Convention relating to greenhouse gas emissions, sustainable development, and the role of both developed and developing country Parties to the Convention.

> **Article II:** defines the objective of the Convention as achieving "*stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.*" It is important to note that the objective is stated in terms of stabilizing *concentrations*, not emissions of greenhouse gases. The timeframe in which this process can occur and the absolute level at which stabilization occurs will depend on many factors including population growth, economic growth rates, power sector fuel mix, deforestation and reforestation rates, and agricultural practices. Most scientists concur with the judgment of the IPCC that stabilizing concentrations *at present day levels* will require a decrease in emissions of long-lived gases by 60-80% from current levels.

Article III: enunciates the fundamental principles of the Convention including the following two statements "*developed country Parties should take the lead in combating climate change and the adverse effects thereof,*" and "*the Parties have a right to and should promote sustainable development.*"

Article IV: includes the following commitments: 1) to develop national inventories of greenhouse gases using agreed methodologies; 2) to implement national programs containing mitigation and adaptation measures; 3) to cooperate in the transfer of technologies to limit or control emissions; 4) to promote sustainable management of biomass, forests, oceans, and other sinks and reservoirs; 5) to cooperate in preparing for adaptation to the impacts of climate change; 6) to take climate change into account in framing social, economic, and environmental policies; 7) to promote and cooperate in exchange of relevant scientific information and development of data archives; and 8) to facilitate education and public awareness programs.

Developed country parties made additional commitments to adopt policies that demonstrate that they "*are taking the lead in modifying longer term trends in anthropogenic emissions...recognizing that the return by the end of the decade to earlier levels of emissions would contribute to such modification.*" They also agreed to take "*all practicable steps to promote, facilitate, and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties...*"

The Parties further agreed to designate the GEF, described below, as the interim financial mechanism of the Convention. Under the Convention, the GEF will be provided new and additional financial resources: 1) to meet the agreed full costs incurred by developing countries in the preparation of inventories and national plans required under the Convention; 2) to meet the agreed full incremental costs of measures taken by developing countries and agreed by the financial mechanism to be appropriate, cost-effective steps toward mitigation of or adaptation to climate change; and 3) to assist in meeting the cost of adaptation to adverse effects of climate change.

The Convention also establishes a **Conference of the Parties (COP)** as its supreme body for reviewing the work of the Secretariat, the GEF, and Subsidiary Bodies for Implementation and for Scientific and Technical Advice.

Until the official entry into force of the Convention, the work related to implementation of the FCCC will be managed by an interim Secretariat and reviewed at regular plenary sessions of the Intergovernmental Negotiating Committee. The interim Secretariat will cooperate closely with the IPCC. A permanent Secretariat will be designated by the Parties at the first session of the COP.

By mandate, the first meeting of the COP will be held within a year of the Convention's legal entry into force. At its first meeting, the COP will review the adequacy of the Convention's provisions

for emissions reductions, evaluate the work to date of the financial mechanism, assess the methodologies established for assembling national inventories of sources and sinks of greenhouse gases, designate the permanent Secretariat, and address other matters which it finds germane to the operation and implementation of the Convention.

All countries will provide information to the Secretariat on the national inventories of greenhouse sources and sinks and their national programs. Developed countries will provide such information within six months of the Convention's entry into force, and developing countries will provide it within three years of entry into force. The least developed countries will provide this information at their discretion.

A2.A.2 International Partnerships for Policy and Scientific Research

The principal forum for discussion of international policy responses to the risks of rapid climate change is the **Intergovernmental Negotiating Committee (INC)**. The INC operates under a charter from the General Assembly of the United Nations. Its original role was to prepare the FCCC for signature at UNCED. With the completion of this role, the INC will address the principal tasks specified in the Convention, supervise the interim Secretariat until the first COP, and provide guidance to the GEF and IPCC.

The **UNEP** has played an active role for many years in the global debate on climate change. UNEP is principally involved in improving the understanding of the global climate system through the **World Climate Program**, which it manages jointly with the **World Meteorological Organization (WMO)**. This multi-disciplinary scientific research program supports cooperative research activities involving scholars from both developed and developing countries. It has a very broad research charter and also maintains extensive programs in monitoring and observation of the Earth's atmosphere.

The UNEP is also helping national governments understand the policy implications of the climate problem. For example, it currently is sponsoring country studies in more than a dozen countries. These country studies include the preparation of inventories of greenhouse gas sources and sinks, and assistance in the evaluation of national policy options.

The principal international vehicle for coordination of scientific research on the risks of rapid climate change is the **IPCC**. The IPCC was commissioned jointly by UNEP and WMO to conduct an objective scientific assessment of the climate problem and to develop a clear consensus of the international scientific community on this problem. The IPCC is a scientific and technical advisory group consisting of approximately 300 of the world's leading scientists, representing over 100 countries. The IPCC is organized into three working groups: WG I -- the scientific working group, WG II -- the socio-economic impacts working group, and WG III -- the cross-cutting issues and policy analysis working group. These three working groups together act as a technical advisory body

to the INC. The IPCC WG III will analyze a wide range of policy options and develop tools to assist national governments in their efforts to formulate cost-effective measures to reduce the risks of rapid climate change.

The first Scientific Assessment Report of the IPCC was presented at the Second World Climate Conference sponsored by UNEP and WMO in November 1990. This report galvanized the scientific community into a leadership role in the climate debate and instigated the participation of many governments in the INC. The IPCC presented an interim update to the 1990 Report in 1992. It is now beginning preparations of the Second Assessment Report and plans to publish a comprehensive analysis of the state of the science in 1995.

The **OECD** has become a principal focal point for collaboration on climate change by the major market economies of the world. The OECD Secretariat has conducted a number of studies on the economic implications of alternative policy responses. The OECD is now working with the IPCC to develop the methodologies that will be used by national governments to prepare inventories of sources and sinks of greenhouse gases, as required under the FCCC.

The **European Commission (EC)** has been an active participant in both the INC and the IPCC. The EC will also support the preparation of a number of country studies in both developing countries and economies in transition. The EC will assist national governments in their efforts to develop local capacity to prepare inventories of sources and sinks as well as national programs of mitigation and adaptation measures.

The **GEF** is a joint program cooperatively managed by the **World Bank**, the UNEP and **UNDP**. The original purpose of the GEF was to provide a mechanism to transfer new and additional funds to developing countries on a concessionary or grant basis to finance activities that were specifically intended to reduce global environmental damages. The four principal areas of activity for the GEF during the $1.5 billion, three year, pilot phase have been global warming, ozone depletion, biodiversity preservation, and protection of international waters. The GEF is scheduled to be reconstituted with a new structure of governance and new operational guidelines during FY93-94. Its budget will also be replenished at that time.

Each of the three partner organizations plays a different and complementary role. The World Bank manages the investment activities of the GEF and houses the GEF Secretariat. The UNEP manages the scientific component of GEF activities, including the operations of the Scientific and Technical Advisory Panel (see below). The UNDP has principal responsibility for capacity-building and institutional-strengthening activities. UNDP also operates a small grants program to facilitate the activities of the NGOs seeking to promote the overall goals of the GEF.

With the signing of the FCCC and Biodiversity Conventions, the GEF was officially designated as the Interim Financial Mechanism for implementing both Conventions. The developed country

signatories are obligated to pay the full costs of measures taken by developing countries to meet the information and communication requirements of the two Conventions, and they are also obligated to pay the "agreed full incremental costs" of measures taken to achieve the overall objectives of the Conventions. The full incremental costs are determined jointly by the GEF and the developing country. USAID is committed to contribute $150 million in parallel financing in support of GEF project activities during the pilot phase of the GEF.

Adaptation measures designed to combat the adverse effects of climate change often provide significant local benefits, but not large global benefits. In these cases, the projects will not qualify for funding under the GEF. In such cases, the developed country Parties to the FCCC will be required to assist the developing countries seeking assistance for adaptation to climate change through other bilateral or multilateral assistance mechanisms.

In order to better understand and develop the requirements for distribution of these new and additional funds, the GEF has undertaken a major, multi-million dollar project, the **Program on Incremental Costs to the Environment (PRINCE)**. The PRINCE Program will develop theoretical and operational tools for determining the full incremental costs of proposed GEF projects. It will also develop taxonomies of countries and project types in order to provide decision-support to the GEF Secretariat in allocating funds among competing projects, regions, technologies, and types of activities.

Although it does not conduct research of its own, the **Scientific and Technical Advisory Panel (STAP)** of the GEF also plays a key role in the global climate debate. STAP develops criteria for project selection, advises the GEF on issues of project evaluation and development, and guides the funding decisions of the GEF.

The climatic problem is also on the research agenda of the **International Geosphere Biosphere Program (IGBP)** organized by the **International Council of Scientific Unions (ICSU)**. The IGBP is a ten-year program of research and analysis on the interactive systems of Spaceship Earth. Its purpose is to improve scientific understanding of the linkages between the coupled non-linear systems of atmosphere, oceans, and biosphere. IGBP coordinates several major research programs on atmospheric phenomena and dynamic processes which affect the rate and extent of climate change. The IGBP also supports a parallel research effort on the Human Dimensions of Global Change. This program seeks to improve current understanding of how the activities of human societies affect the operation and maintenance of Earth's systems.

A broad based geophysical science data collection and dissemination program is coordinated by a network of **World Data Centers (WDC)** under the auspices of the ICSU. The International Geosphere-Biosphere Programme also has extensive data information systems covering climate-related parameters. These organizations, and others, are coordinating efforts to standardize data and

information formats and exchange procedures to allow the international scientific community access to vast amounts of raw data and processed information.

In addition to these major cooperative international efforts, many countries have national climate research programs which cooperate on a bilateral basis with the U.S. Among the largest and most advanced programs are those funded by the governments of Britain, France, Germany, Japan, Russia, Sweden, Canada, Norway, Denmark, Italy, Australia, New Zealand, India, Bangladesh, and China.

A2.A.3 U.S. Government Scientific Research and Policy Analysis Programs

The U.S. government spends more than any other country on global climate research. This research effort is organized under the leadership of the **U.S. Global Change Research Program (USGCRP)** and has an annual budget of nearly $ 1.5 billion. The USGCRP looks at many issues outside the arena of climate change. Its work, and that of other U.S. programs, are briefly summarized below. A listing of the projects and the funding amounts for FY93 and FY94 is presented in Appendix 3 (CEES, 1993). Appendix 3 also provides a table of U.S. Government Agencies, and their respective budgets, that are working in the area of global climate change.

U.S. Global Change Research Program

The **USGCRP** is an important element of President Clinton's strategy to utilize America's investment in science and technology to help stimulate economic growth in an environmentally sustainable manner. It serves as the integrating framework for this country's extensive research program on earth systems science.

In 1988 the USGCRP was established by the **Committee on Earth and Environmental Sciences (CEES)** of the **Federal Coordinating Council for Science, Engineering, and Technology (FCCSET)**. The FCCSET operates under the auspices of the **Office of Science and Technology Policy (OSTP)** in the Executive Office of the President and is responsible for establishing strategic technology-oriented programs.

The USGCRP is jointly funded by eleven U.S. Government Agencies. The proposed budget for FY94 is $ 1.475 billion, up from $ 1.326 billion in FY93. Over two-thirds of the funding comes from the National Aeronautics and Space Administration (NASA) budget, with other significant amounts from NSF, DOE, and DOC/National Oceanographic and Atmospheric Administration (NOAA).

A principal goal of the USGCRP is improved predictive understanding of the Earth system, and the fundamental scientific information gained from this program is used to support national and

international policy formulation relating to climate change. The program has developed four main streams of activities; 1) observations and data/information management, 2) process research, 3) integrative modeling and prediction, and 4) policy relevant assessments. These activities are cross-cutting and address the major areas of priority including climate change, biodiversity, stratospheric ozone depletion, human dimensions and economics, and international cooperation. In the latter area, the USGCRP ensures coordination with other organizations such as the IPCC, WMO, UNEP, and IGBP.

Country Studies Initiative

One of the ways in which the U.S. Government has elected to support its commitment to the principles outlined in the FCCC is through the **CSI**, a $25 million program to be implemented over two years. It will provide financial support and technical assistance, including training, to developing countries and countries in economic transition.

Under provisions of the FCCC, signatories are required to develop and/or update national programs that will include plans to mitigate the impacts of greenhouse gas emissions and to adapt to foreseeable changes in climate. CSI was established to support the formulation of these country plans in selected countries. The program will assist these countries in the development of inventories of sources and sinks of greenhouse gases, the assessment of their vulnerability to climate change, and the evaluation of mitigation and adaptation response strategies.

The initiative is being jointly funded by eleven governmental agencies, with leadership provided by the State Department. The program is being implemented by the Country Studies Management Team consisting of staff personnel drawn from the EPA, DOE, NOAA, and USAID.

Joint Implementation

Under Article 4.2 (a) of the FCCC, developed countries may implement policies and measures to limit greenhouse gas emissions jointly with other parties. In October 1993, President Clinton announced his Climate Change Action Plan for the United States (Clinton, 1993). As part of this plan, the President unfolded a **U.S. Initiative on Joint Implementation (USIJI)** as a pilot program. The purpose of the pilot program will be to:

- encourage the rapid development and implementation of cooperative, mutually voluntary projects between U.S. and foreign partners aimed at reducing net emissions of greenhouse gases, particularly projects promoting technology cooperation with and sustainable development in developing countries and countries with economies in transition to market economies;

- promote a broad range of cooperative, mutually voluntary projects to test and evaluate methodologies for measuring, tracking and verifying costs and benefits;

- establish an empirical basis to contribute to the formulation of international criteria for joint implementation;

- encourage private sector investment and innovation in the development and dissemination of technologies for reducing net emissions of greenhouse gases; and

- encourage participating countries to adopt more complete climate protection programs, including national inventories, baselines, policies and measures, and appropriate specific commitments.

The President established an Evaluation Panel, of which USAID is a member, to review and to approve, domestic and foreign submissions to this pilot program.

Other Elements of the U.S. Climate Research Program

In the U.S., the **Interagency Working Group on Data Management for Global Change (IWGDMGC)** plays a lead role in coordinating data collection, archiving and dissemination activities, and it also coordinates with international data and information organizations. Under the leadership of the IWGDMGC a data and information strategy has been developed for the USGCRP and will be implemented by the **Global Change Data and Information System (GCDIS)**. The GCDIS will be responsible for assembling, documenting, archiving, and disseminating global change data and information. Plans for the U.S. Global Change Data and Information Management Program Plan are outlined in a 1992 report by the Committee on Earth and Environmental Sciences (CEES, 1992).

In addition to the large scientific efforts now underway within the U.S. Global Change Research Program, the U.S. government is managing several other important research efforts addressing the climate problem. The **EPA** is the lead agency in two important areas. Within the EPA's Office of Policy and Program Evaluation (OPPE), the Climate Change Division maintains a broadly diversified portfolio of policy relevant research. This policy research program focuses on issues related to the mitigation of climate impacts and on issues related to the implementation of the Framework Convention.

Also, under the EPA Office of Air and Radiation, the Global Change Division manages important research on sources and sinks of greenhouse gas emissions. This office also evaluates technologies that have the capability of limiting or reducing future emissions of greenhouse gases without limiting economic development.

The **DOE** manages a broad program of technology development and policy research. The principal focus of this research is on measures, technologies, and policies to reduce emissions from the energy sector. In addition, DOE also sponsors basic research on the climate system, potential sinks of greenhouse gases and new technologies to remove carbon dioxide and other gases after they have been emitted from combustion processes.

The **USAID** contributes to the overall global change program principally through its existing GWI, which is described in Chapter 2 and Appendix 1. Brief descriptions of new Agency strategies are presented in Chapter 3.

A2.B Greenhouse Gases and Climate Change

Human activities affect the Earth's climate through the release of "greenhouse gases"[1] to the atmosphere, and through changes in the physical properties of the surface by deforestation, agriculture, and the expansion of human settlements. The atmospheric buildup of greenhouse gases due to human activities appears to be the dominant anthropogenic force affecting global climate change although some evidence suggests that emissions of particulate aerosols (e.g., those formed in the atmosphere from gaseous emissions of sulfur oxides) tends to mask the warming effects of greenhouse gas buildup. In terms of climate impact, the most important gases released through human activities are carbon dioxide, methane, nitrous oxides, halons, and chlorofluorocarbons.

While the emissions of greenhouse gases and their contributions to changes in the thermal properties of the atmosphere are well-documented, scientists are still unable to predict with confidence the regional impacts of the atmospheric buildup of these gases. However, despite the uncertainties about the timing and magnitude of any change, the potential for global warming is increasingly accepted by the international community.

Although there are apparent differences of opinion about the nature, extent, and speed of the changes associated with global warming if current greenhouse gas emission trends continue, the resulting rapid climate change could undermine the stability of national economies and cause major disruptions to the natural ecosystems on which those economies depend. The issue of global climate change has highlighted and dramatized the serious problems that developing countries face in achieving sustained, environmentally-sound, economic and social development. Responding to these growing global concerns without hampering the development process in the world's lower-

[1] "Greenhouse gases" include water vapor, carbon dioxide, methane, nitrous oxide, and certain manmade chemicals that absorb and reradiate some of the heat radiated from the earth's surface. In a rough sense, these gases trap some of the heat that would normally escape as radiant energy into space; hence, the analogy to a greenhouse. This interception of radiant energy contributes to overall heating of the atmosphere.

and middle-income countries is likely to be one of the significant challenges facing national governments and the development assistance community.

The prediction of greenhouse gas concentrations in the atmosphere is a complicated process requiring a knowledge of the rates of emission from natural and anthropogenic sources, the rates of absorption or uptake by naturally occurring sinks (e.g., CO_2 is absorbed by forests and oceans), chemical reactions occurring in the atmosphere, estimates of population and economic growth, policy regarding pollution control and agricultural practices, etc. Climate change prediction models are being developed by the scientific community under the guidance and coordination of the international and national organizations described above. These models will not be addressed here because of their highly complex nature. The reader is referred to the series of excellent publications by the IPCC and others for details (e.g., IPCC, 1992; IPCC, 1990; Mintzer, 1992).

The developed countries are presently the source of most anthropogenic greenhouse gas emissions, particularly carbon dioxide. However, in a number of developing countries, carbon dioxide releases from fossil fuel combustion and deforestation, and methane emissions from rice cultivation, contribute a sizable fraction of the global total. This fraction is expected to grow significantly in the future as described below.

Table A2.1 presents an overview of current greenhouse gas concentrations, their rates of change, and principal sources of these gases. The relative contributions of present greenhouse gas emissions to climate change, by gas, sector, and region are illustrated in Figures A2.1 - A2.3. Also shown in Table A2.2 is a breakdown of greenhouse gas emissions from the energy sector by major global country categories.

The remainder of this section summarizes our understanding of the present levels of greenhouse gas emissions from developed and developing countries.** The prominent gases discussed below include; carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), and halons. Tropospheric ozone, a greenhouse gas that is not emitted directly by human activity, but whose concentration is strongly governed by trace gas emissions resulting from industrial activity and transportation, will not be discussed here because its anthropogenic sources and its contribution to greenhouse warming are not well quantified. Also included is a brief discussion of the principal sources of the gases.

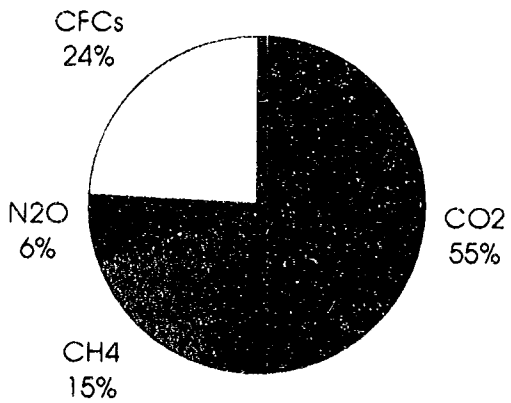
** "Present" in this appendix is defined as the year 1990, except where noted.

Table A2.1
Emissions of the Major Greenhouse Gases

Gas	Concentration	Annual Rate of Increase	Natural and Anthropogenic Sources
Carbon Dioxide	355 ppmv	1.8 ppmv	Fossil fuel combustion, cement production, deforestation and other land-use changes
Methane	1.75 ppmv	0.015 ppmv	Natural sources: wetlands, termites, and oceans; Anthropogenic sources: rice paddies, domestic animals, coal mining, natural gas leakage, biomass burning, landfilling of organic wastes, and fossil fuel combustion
Nitrous Oxide	310 ppbv	0.8 ppbv	Natural sources: soils and the oceans. Anthropogenic sources: land-use modification (biomass burning and increase in cultivated land), nitrogen fertilizers, and fossil fuel use.
CFCs and Halons		See notes	Natural sources: (Halons) - Anthropogenic sources: (CFCs) - refrigerants, foams, insulation, plastics, aerosols. (Halons) - fire extinguishers

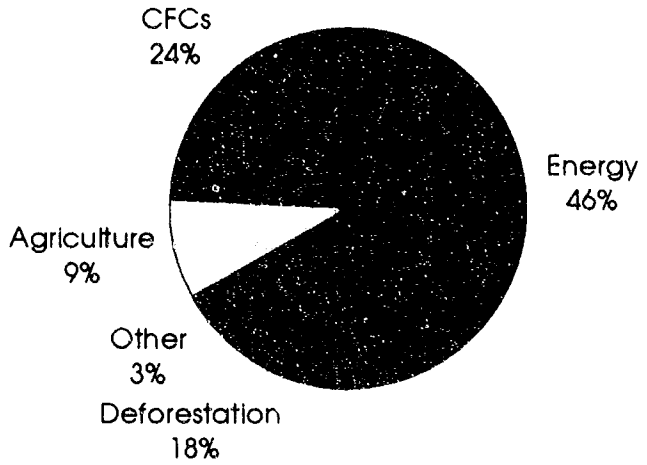
Notes: ppmv=parts per million by volume; ppbv=parts per billion by volume
Under the Montreal Protocol agreements, CFCs and Halons are scheduled to be phased out over the next decade for most uses. Concentration will slowly decline over many decades.

FIGURE A2.1
Contribution to Radiative Forcing in 1980s, By Gas



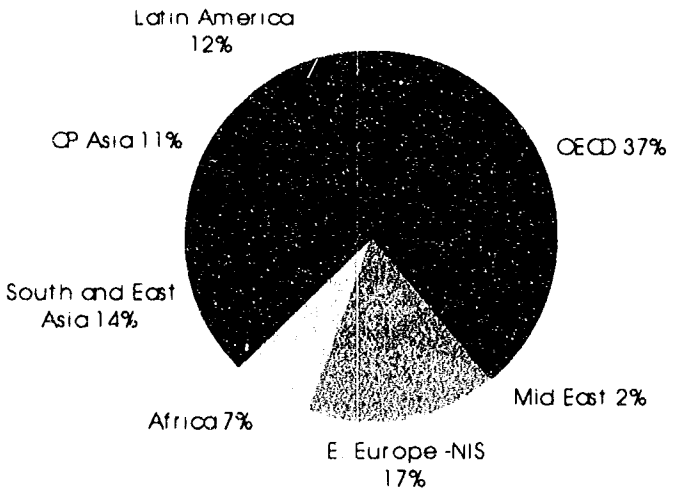
Source: 1990 IPCC Scientific Assessment

FIGURE A2.2
Contribution to Radiative Forcing in 1980s, By Sector



Source: 1990 IPCC Scientific Assessment

FIGURE A2.3
Contribution to Radiative Forcing in 1980s, by Region



Source: 1990 USAID Report to Congress

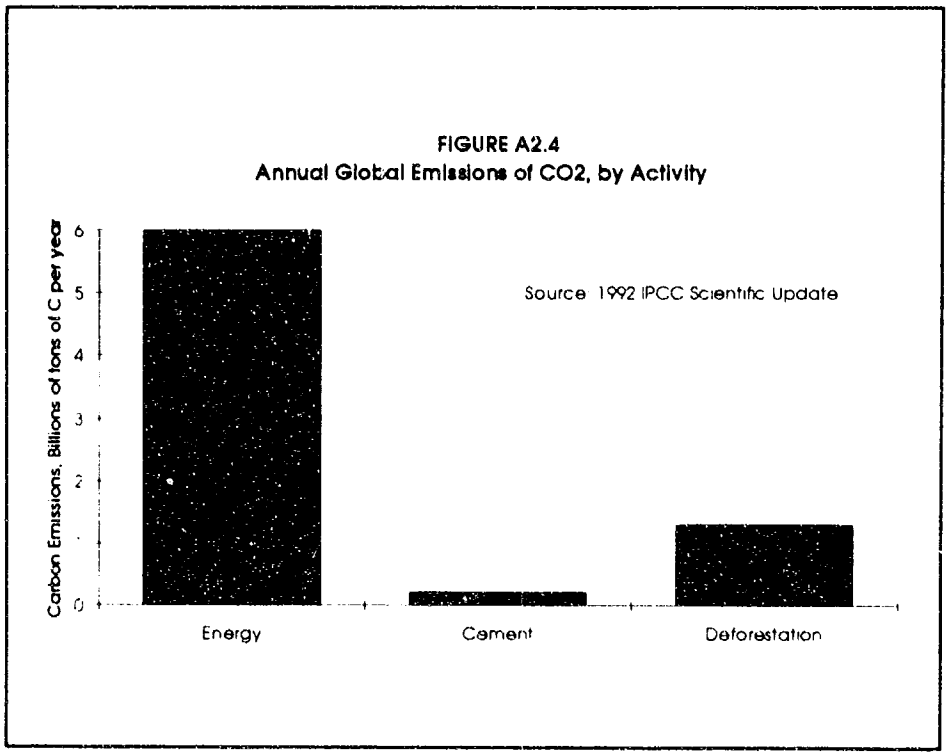
TABLE A2.2
Energy Sector Greenhouse Gas Emissions by Region
Case IS-92a - 1990

Region	CO_2 Bt C	CH_4 Tg CH_4	N_2O Tg N	SO_x Tg S	NO_x Tg N
OECD	2.8	21	0.2	27	12
Eastern Europe/NIS	1.7	46	0.1	17	7
Centrally Planned Asia (Including China)	0.6	9	0.	10	3
Other	0.9	14	0.	12	4
World Total	6.0	90	0.4	65	25

Notes: Bt = billion tonnes; Tg = Terragrams
Because of rounding, sums of regional emissions may not exactly equal totals shown.
Information given for SO_x and NO_x is suggested as an indicator of emissions of ozone precursors.
Source: IPCC 1992 Supplement to the First Scientific Assessment Report

Carbon Dioxide

Carbon dioxide is the most abundant and the single most important greenhouse gas (other than water vapor) in the atmosphere. The current concentration of carbon dioxide in the atmosphere is approximately 355 parts per million by volume (ppmv). The concentration of CO_2 has increased by approximately 25% during the last two centuries and by approximately 10% since 1958. At current rates of emission, the atmospheric concentration of CO_2 is increasing by approximately 0.5%, or 1.8 ppmv per year.



The natural flux of carbon dioxide between the oceanic and atmospheric reservoirs is on the order of 100 billion metric tonnes (or 100 gigatonnes (GT)) of carbon per year. Global anthropogenic emissions of CO_2 in 1990, resulting from fossil fuel combustion, cement production, deforestation and other land-use changes totaled approximately 5.8-8.7 GT (IPCC, 1990; Wisniewski, 1993). The uncertainty in the estimate of total CO_2 emissions is primarily due to large uncertainties in the emissions due to deforestation and land use change. Of the total emissions, fossil fuel combustion was responsible for 70-90%, cement production for 1.5-2%, and deforestation for 7-33% (see Figure A2.4).

Commercial fossil fuel consumption accounts for 65-90% of the total CO_2 emissions from anthropogenic sources. The OECD accounts for almost one-half (see Table A2.2), and the USAID-designated key countries (based on 1990 selected key countries) account for nearly 20% of global CO_2 emissions from commercial energy use.

Deforestation from clearing of lands for agriculture, fuelwood, and other purposes is responsible for approximately 10-29% of the anthropogenic CO_2 emissions. Most of the CO_2 emissions from this source result from deforestation in the tropics. Five countries were responsible for about 45% of the tropical release in 1980: Brazil, Indonesia, Colombia, the Ivory Coast, and Thailand (Ronen 1988). Estimates of CO_2 emissions from deforestation range from about 10% to 40% of CO_2 emissions from fossil fuel combustion. This wide range is due to uncertainties in the annual regional rates of deforestation, the amount of carbon stored in different types of biomass, and the fate of the biomass cleared. Additional satellite mapping and ground measurements will be required to decrease this uncertainty. Forests play a key role as a major reservoir of carbon. While forests can act as a sink for carbon, increased cutting releases carbon that contributes to greenhouse gas emissions. This is precisely why Brazil with its large forest base is listed as an USAID- designated

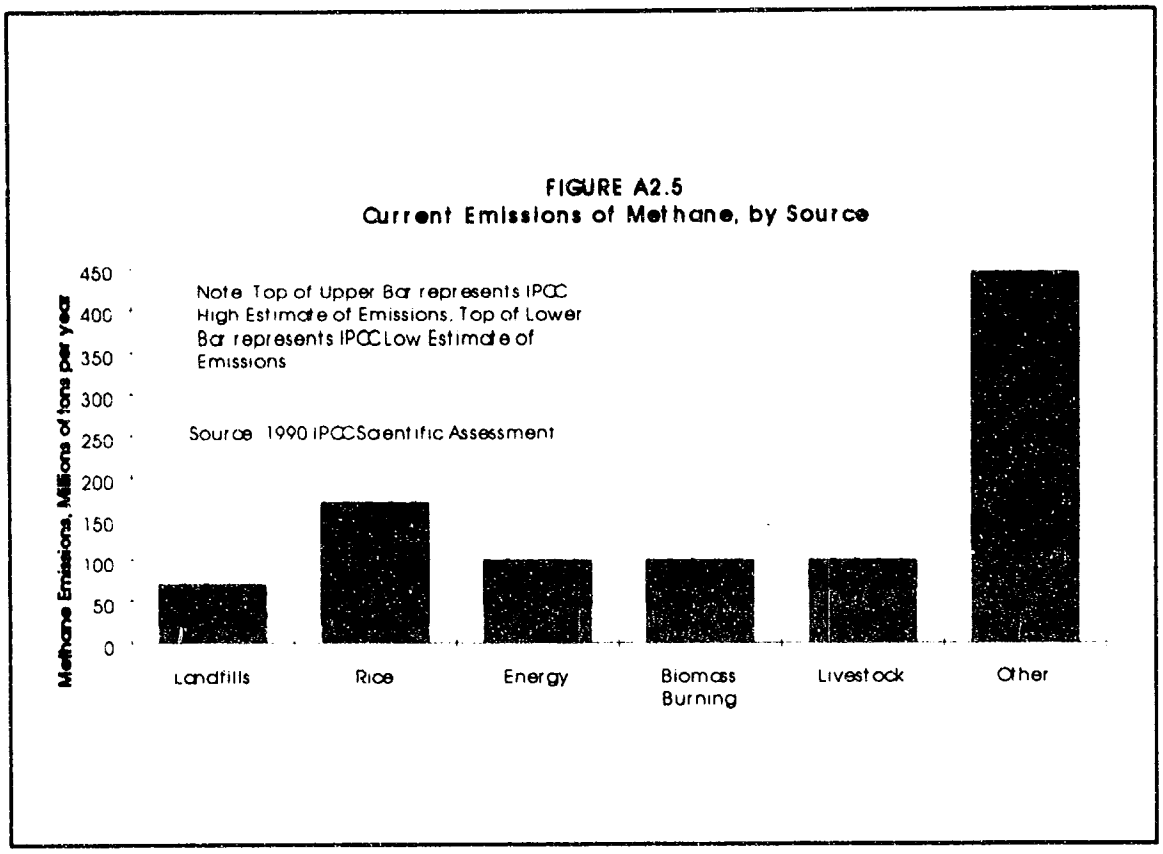
key country, and why the continued protection of Zaire's and Indonesia's forest areas are so important.

Methane

The concentration of methane in the atmosphere is approximately 1.75 ppmv. After remaining constant in the atmosphere for approximately 10,000 years, the concentration of methane has doubled during the last two centuries. In the last decade, the atmospheric concentration has been increasing at an average annual rate of approximately 0.9% or 0.015 ppmv. The observed increase in methane is due to a combination of factors including larger emissions and declining natural sinks. The principal natural sink, the atmospheric OH radicals, is being lost at an unknown rate due to reactions with emissions of carbon monoxide (CO). CO emissions result from biomass burning, automobile exhaust, and other processes of incomplete combustion.

Best estimates of current net emissions of methane are approximately 525 million tonnes, of which 60-70% is anthropogenic (NAS, 1979; Crutzen, 1979). Natural sources include wetlands, termites, oceans, and freshwaters; anthropogenic sources include paddy rice cultivation, enteric fermentation in domestic animals, coal mining, natural gas leakage, biomass burning, landfilling of organic wastes, and a small amount from incomplete combustion of fossil fuels (Figure A2.5). Estimates of emissions from each source are highly uncertain due to lack of data (e.g., measurements of CH_4 emissions from Asian rice paddies, data on the amount of leakage from natural gas distribution systems).

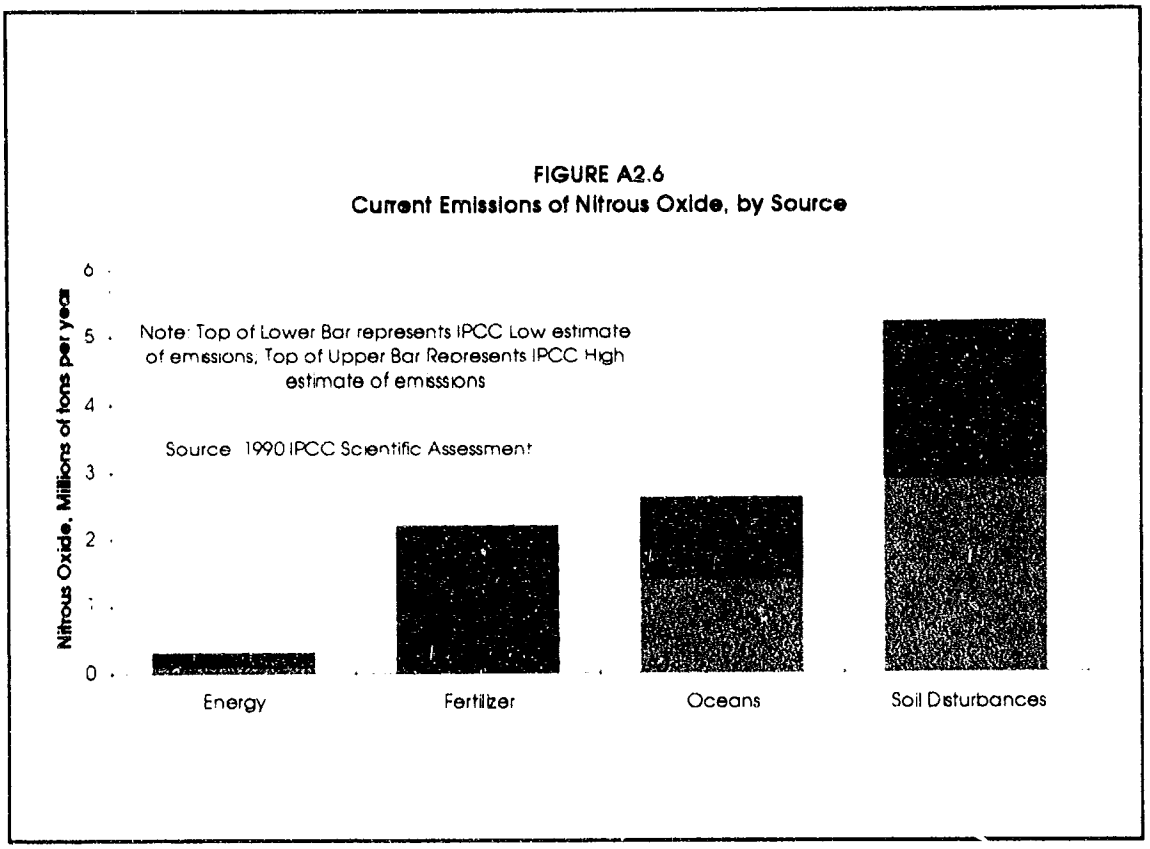
Anaerobic decomposition of organic material in flooded rice fields and enteric fermentation in domestic animals are responsible for 20-50% and 20-35%, respectively, of the total annual anthropogenic CH_4 emissions. Over 90% of the global rice acreage and production occurs in Asia, primarily in the developing countries of this region. In 1984, China, India, Indonesia, Bangladesh, and Thailand together accounted for about 75% of the harvested area and production (NAS, 1983). Domestic animals that produce the bulk of the CH_4 are (in decreasing order, based on amount of CH_4 produced) non-dairy cattle, dairy cows, buffalo, goats, sheep, camels, pigs, and horses. Currently, approximately 57% of CH_4 from domestic animals comes from non-dairy cattle and 19% from dairy cows. Domestic animals in six countries -- India, the NIS, Brazil, the U.S., China, and Argentina -- produce over 50% of the global annual CH_4 emissions from this source (NAS, 1987).



Nitrous Oxide

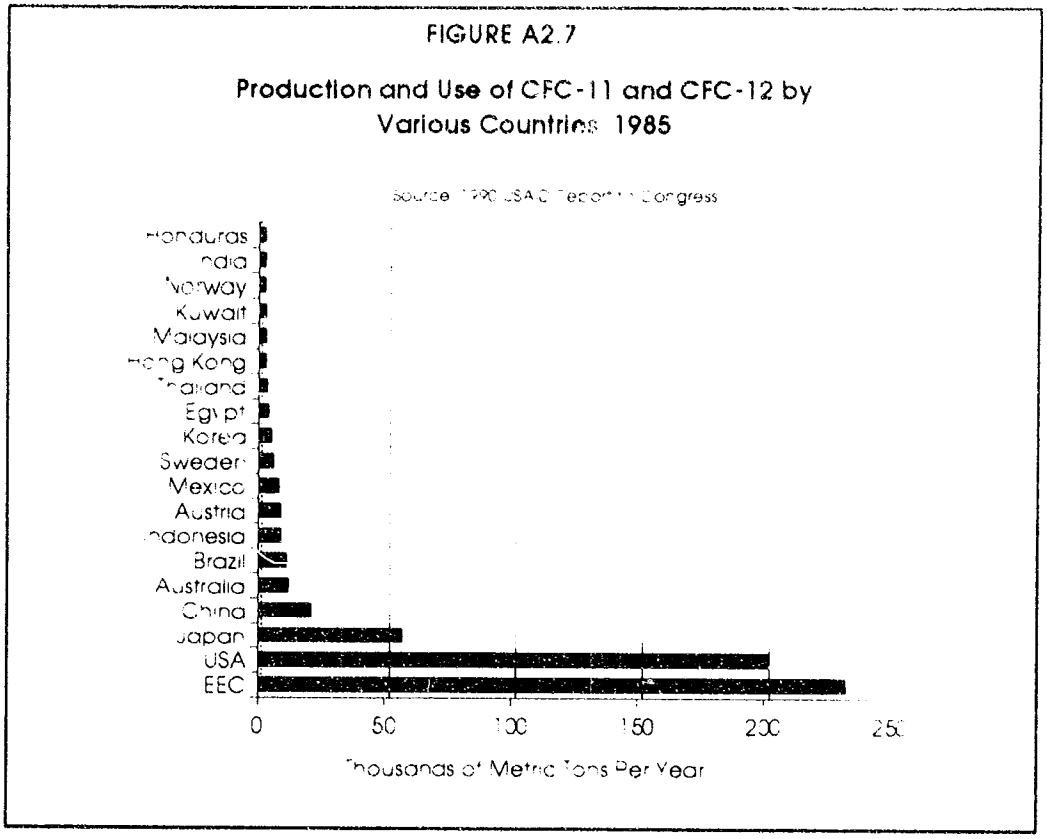
The atmospheric concentration of nitrous oxide was approximately 310 ppbv in 1990. The concentration had been stable for about 2000 years at about 285 ppbv then began to increase during the last 300 years. The current annual rate of increase in atmospheric concentration is approximately 0.2-0.3%. This is equivalent to a growth in the atmospheric reservoir of between 3-4.5 million tonnes of nitrogen per year.

Nitrous oxide (N_2O) emissions levels are uncertain. Natural sources, which release about 60% of the emissions, include soils and the oceans. Anthropogenic emissions result from land-use modification (biomass burning and gain in cultivated land), use of nitrogen fertilizers, and fossil fuel use (see Figure A2.6). Aquifers and surface waters, contaminated from fertilizers and animal and human wastes, may also release significant amounts of N_2O (Ronen, 1988).



Use of nitrogen fertilizers, the most abundant fertilizer nutrient consumed worldwide, contributes 10-30% of the total anthropogenic N_2O emissions. Asia, Western Europe, Eastern Europe, and North America together consumed about 85% of the world's nitrogen fertilizers in 1985/1986. The twelve largest nitrogen fertilizer consumers (in decreasing order) are China, the NIS, the U.S., India, France, the United Kingdom, West Germany, Indonesia, Poland, Mexico, Canada, and Italy. Together, these countries account for almost 75% of the annual nitrogen fertilizer consumption (IRRI, 1986).

CFCs and Halons



CFCs and halons are man-made chemicals that are produced and used almost entirely by the OECD countries (Figure A2.7). CFCs are used to produce plastic foam, as aerosol propellants and refrigerants, in medical sterilization, and as solvents in the manufacture of electronic components. Halons are used principally in fire extinguishers. CFC demand in the developing world is expected to grow in the future as demand for refrigerators and air-conditioners grows.

Because of concern about the effect of these chemicals on stratospheric ozone, an international agreement to reduce their emissions ("The Montreal Protocol on Substances that Deplete the Ozone Layer," or simply, the Montreal Protocol) was signed in 1987. Under this agreement, developing countries with low levels of per capita use are permitted to delay their compliance for up to ten years. The Protocol was recently strengthened in June 1990, when an international agreement was reached to completely phase out production of the major CFCs and halons by 2000, and production of carbon tetrachloride and methyl chloroform by 2000 and 2005, respectively. Under this new agreement, developing countries will be allowed a 10-year grace period for compliance, and an international fund will be set up to assist them in their transition to CFC-free technologies.

A2.C Potential Contributions to Future Greenhouse Gas Emissions

The basis for understanding future contributions to greenhouse gas emissions are the emissions scenarios developed by the IPCC. We use two alternative scenarios developed by IPCC for the 1992 Supplementary Report to the IPCC Scientific Assessment (IPCC, 1992) as the basis for our main discussion. In addition, we also draw upon some detailed information for the Reference Scenario from the original 1990 IPCC report (IPCC, 1991d). The two cases from the 1992 update report reflect very different assumptions concerning future rates of economic growth and population increase. These scenarios are not meant to be predictions of the future, but are used by the science and policy community to evaluate the impact of different assumptions and policy actions.

The first scenario, called IPCC IS-92a, is a "business as usual" scenario, in which no major greenhouse gas emission control policies are implemented and carbon dioxide emissions reach approximately twice the current level by 2050 (i.e., 14.5 GT of C per year in 2050 vs. 7.4 GT of C in 1990). The second scenario, called IPCC IS-92d, leads to a carbon dioxide emissions level approximately one-fifth higher than today's level (i.e., 9.0 GT of C per year) by 2050. This scenario assumes stringent emission control and implementation of strong energy efficiency measures and renewable energy technologies.

The key characteristics of these two IPCC scenarios are given in Tables A2.3 and A2.4. In addition to the characteristics described in the tables, controls on fossil fuel combustion designed to reduce local pollution in IS-92d raise fossil energy costs by 30% as compared to the IS-92a case. Deforestation is halted then reversed, and fugitive emissions of methane are captured from coal mines, natural gas fields, and oil wells. CFCs and HCFCs are phased out worldwide. The global primary energy use for these two scenarios are presented in Figures A2.8 and A2.9.

In these scenarios, future greenhouse gas emissions from Eastern Europe, the NIS, and the developing countries depend on the assumptions about future population growth, economic growth, the amount and types of energy consumed, and the rates and scale of adoption of new policies and technologies. These in turn will be affected by the extent of international financial and technological assistance.

Both scenarios project that the share of greenhouse gas emissions attributable to the developing countries from energy, forestry, agriculture, and industrial activities will approach 50% of global emissions by 2025 (UNEP, 1988). In most of the USAID-designated key developing countries, assuming no policy response to climate change, greenhouse gas emissions could rapidly increase by 2025 with major contributions from energy activities, deforestation, agricultural activities, and CFC usage.

Table A2.3
Socio-Economic Characteristics of Scenarios IS-92a and IS-92d

Scenario	Global Population in 2100	Economic Growth	Solar Energy Costs	Energy Content/Cost per barrel of biofuel
IS-92a	11.3 billion	2.9% from 1990-2025 2.3% from 1990-2100	$0.075/kWh	191EJ/$70
IS-92d	6.4 billion	2.7% from 1990-2025 2.0% from 1990-2100	$0.065/kWh	270EJ/$50

Projected CO_2 emissions and equivalent emissions for all the greenhouse gases are shown in Figures A2.10 and A2.11 for Cases IS-92a and IS-92d. In the second case, the effect of greenhouse gases such as methane, nitrous oxide, and CFCs have been included and the results are presented in terms of an equivalent amount of carbon dioxide, (i.e., the amount of CO_2 that would have the same global warming effect as the original gases). The rate and magnitude of climate change (EPA, 1989) associated with the IS-92a case in which few or no steps are taken to reduce emissions represent a significantly greater climate threat to the global community than would be expected in the IS-92d case where greenhouse gas emission mitigation is emphasized.

To demonstrate the significance of including gases other than CO_2 Figures A2.12 and A2.13 are presented. The data in these figures was taken from the original IPCC 1990 study, and represent a high emissions scenario which is comparable to Case IS-92a from the 1992 update report. The year when the atmospheric concentration of CO_2 alone reaches twice the pre-industrial level for that case is 2050. However, when the other greenhouse gases are included, the equivalent CO_2 concentration reaches twice the pre-industrial level by the year 2025. The factor of two in concentration is an arbitrary level often used by climate experts. Its choice reflects a series of reviews by the National Academy of Sciences (NAS, 1979; NAS, 1983; NAS, 1987) that concluded that the sensitivity of the climate system to a doubling of CO_2 is probably in the range of 1.5 to 4.5°C, with the most likely value being 2.5°C.

Table A2.4
Energy Characteristics of IPCC IS-92a and IS-2d Scenarios

SCENAR-IO	Energy Supply[a]	Energy Demand[b]	Level of Greenhouse Gas Emission Controls[c]	CFC Status[d]	Defores-tation[e]	Agriculture
IPCC IS-92a	Carbon-inten-sive	Business as usual	Modest; business as usual	Montreal Protocol low compliance	Moderate	Current trends
IPCC IS-92d	Major phase-in of renewable sources	Higher degree of energy efficiency	Emissions controls raise cost of fossil fuels by 30%	Total phase-out of CFCs and HCFCs	Halt deforest-ation; Major reforestation	Current Trends

[a] For the IS-92a case, energy supply is dominated by fossil fuel technologies, which contribute approximately 75% of total primary energy in 2025. For the IS-92d case, major cost reductions in solar and renewable technologies stimulate an increase in their contribution to global primary energy supply in 2025, reaching 25% compared to only 15% in the IS-92a scenario. Availability of commercial biofuels increases by 50% in IS-92d compared to IS-92a, and the price of biofuels declines from $70/bbl to in IS-92a to $55/bbl in IS-92d.

[b] In the IS-92a case, the annual rate of improvement in energy intensity in the OECD (i.e. primary energy use per dollar of GNP) decreases from an initial value between 1.4% to an average value of 0.9% for the years 2025 to 2100. The average annual rate of improvement in energy intensity in China for the years 1990 to 2025 was assumed to be approximately 1.9% per year; the rate of improvement declined after 2025, but remained more rapid than did the rate for the OECD. The energy intensity of most other developing countries was assumed to be flat until 2025, then to improve at a rate in excess 0.9% per year after 2025. For the IS-92d scenario energy efficiency was assumed to improve more rapidly due to increased prices of fossil fuels resulting from the introduction of emissions controls.

[c] In the IS-92a case, current emission control technologies are assumed. In the IS-92d case, more stringent controls on conventional air pollutants raise the cost of fossil energy supplies by 30%.

[d] In the IS-92a case, the Montreal Protocol is assumed to come into force and apply through 2100, with 100% participation by developed countries and 70% participation by developing countries. In the IS-92d case, CFC production is fully phased out by 1997 worldwide, and HCFC production phase occurs over the next several decades. In this case, CFCs are replaced by substitutes with no radiative or ozone-depleting effects.

[e] Tropical deforestation increases gradually in the IS-92a case. Tropical deforestation is halted by voluntary actions in the IS-92d case.

FIGURE A2.8
Global Primary Energy Use, Scenario IS-92a

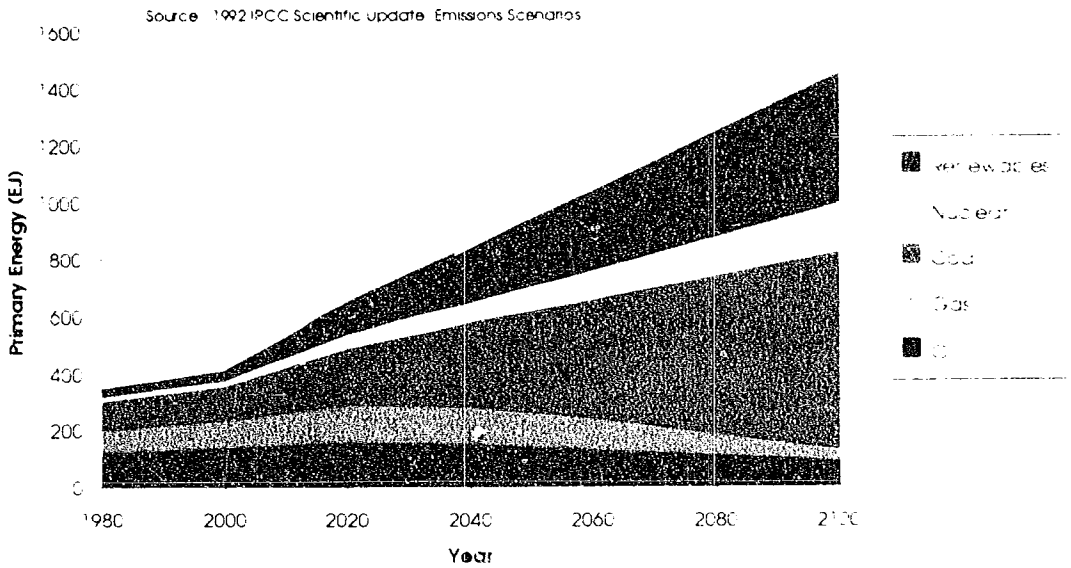


Figure A2.9
Global Primary Energy Use, Scenario IS-92d

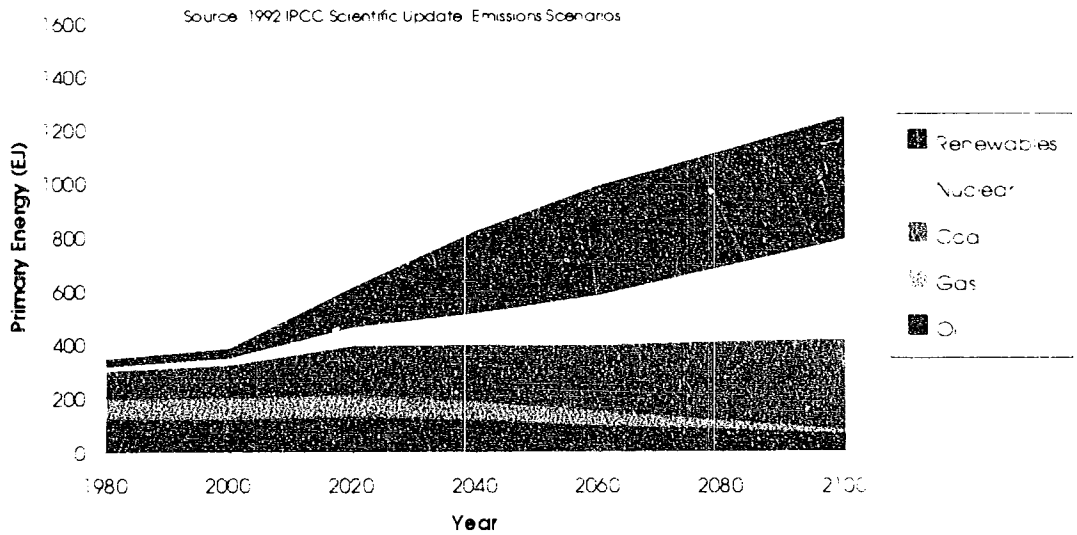


FIGURE A2.10
Carbon Dioxide Emissions, Cases IS-92a and IS-92d

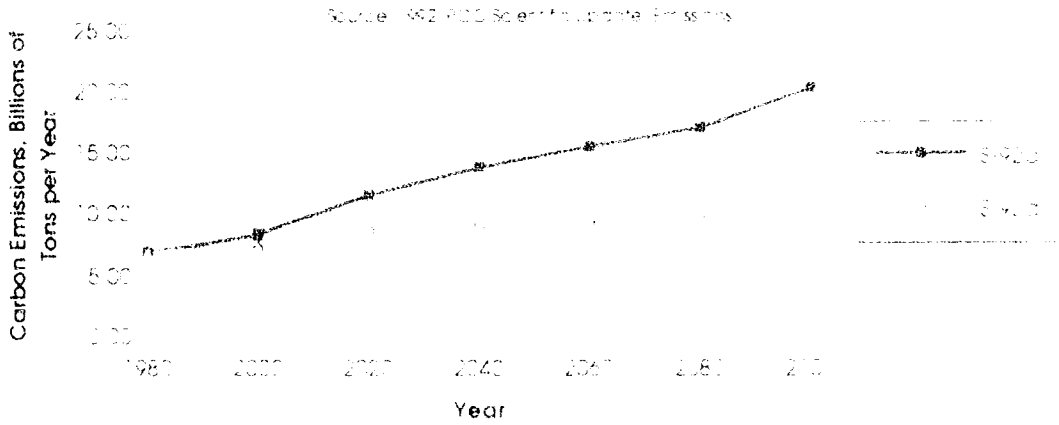


FIGURE A2.11
Greenhouse Gas Emissions, Cases IS-92a and IS92d
Carbon Equivalent Basis

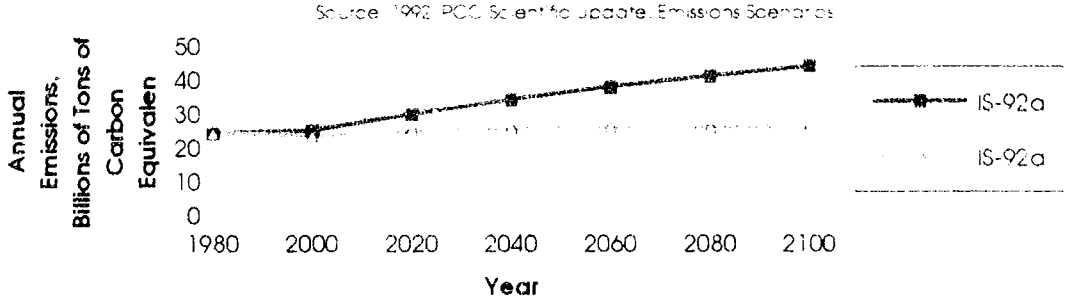


FIGURE A2.12
CO2 Concentration
2030 High Emissions Scenario

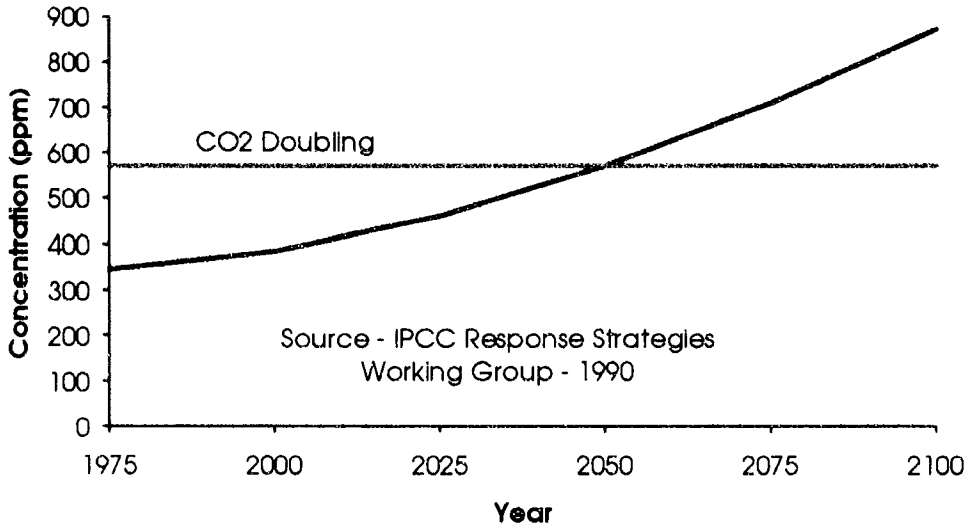
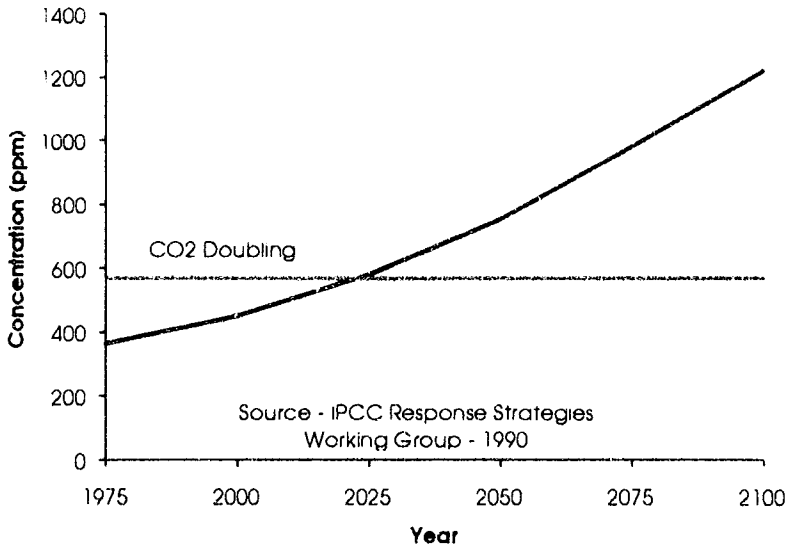


FIGURE A2.13
Equivalent CO2 Concentration
2030 High Emissions Scenario



A2.C.1 Greenhouse Gas Emissions in the IPCC Scenarios

Greenhouse gas emissions will continue to rise rapidly if no policy actions are taken by the international community. A summary of the emissions for several of the key greenhouse gases is shown in Table A2.5 for Scenario IS-92a, the "Business-As-Usual" scenario. The summary for emissions of carbon dioxide from the energy sector and the anthropogenic emissions of methane and nitrous oxide is presented by major country classification. In this scenario, for example, the global share of commercial energy-related emissions of carbon dioxide from developing countries increases from 25% to 45% by 2025. On a per capita basis, however, the developing countries will still produce substantially less emissions than the industrialized countries as shown in Table A2.6 for the EIS/AFOS Reference Scenario in the 1990 IPCC study.

Table A2.5
Energy Emissions of CO_2 and Anthropogenic Emissions of CH_4 and N_2O
(Scenario IS-92a)

Region	CO_2[a] (GtC)			Anthropogenic N_2O (TgN)			Anthropogenic CH_4[b] (Tg)		
	1990	2025	2100	1990	2025	2100	1990	2025	2100
OECD	2.8	3.5	4.3	1.4	2.0	1.7	74	90	143
Central & Eastern Europe	1.7	2.4	2.5	0.8	1.0	0.9	70	62	113
China and CP[c] Asia	0.6	1.6	4.2	0.5	0.8	0.9	37	53	73
Other	0.9	3.2	8.8	1.9	3.7	5.1	146	260	380
Total	6.0	10.7	19.8	4.6	7.5	8.7	326	465	709

[a]Includes energy sector only, not deforestation or cement production
[b]Excludes CH_4 from domestic sewage which was not estimated on a regional basis
[c]CP=Centrally planned economies
Gt = Gigatonnes; Tg = Terragrams

Table A2.6[a]
Gross CO_2 Emissions from the Energy Sector
(From the IPCC 1990 EIS/AFOS Reference Scenario)

Region		CO_2 Emissions (Gt Carbon)		CO_2 Emissions (tonnes Carbon per Capita)	
		1985	2025	1985	2025
Industrialized		3.83	6.95	3.12	4.65
	North America	1.34	2.37	5.08	7.12
	Western Europe	0.85	1.19	2.14	2.69
	OECD Pacific	0.31	0.62	2.14	3.68
	Centrally Planned Europe	1.33	2.77	3.19	5.02
Developing		1.33	5.48	0.36	0.84
	Africa	0.17	0.80	0.29	0.54
	Centrally Planned Asia	0.54	1.80	0.47	1.15
	Latin America	0.22	0.65	0.55	0.91
	Middle East	0.13	0.67	1.20	2.41
	South and East Asia	0.27	1.55	0.19	0.64
Global Totals		5.15	12.43	1.06	1.56

[a]This table presents regional CO_2 emissions and does not include CFCs, CH_4, O_3, N_2O, or sinks. Climate change critically depends on all GHG from all economic sectors. Totals and subtotals reflect rounding. This table should be interpreted with care.
Gt = Gigatonnes

Emissions from Energy

The largest source of greenhouse gas emissions is fossil fuels. In the IPCC scenarios, annual global primary energy supply increases from about 344 exajoules (EJ) in 1990 to 1244 EJ in the IS-92d scenario and to 1453 EJ in the IS-92a scenario by 2100. Historically, global energy requirements have been met primarily with fossil fuels. In the IPCC scenarios presented here, where no actions to respond to climate change are assumed, fossil fuels continue to be the dominant energy source, supplying 74% of total energy requirements through 2025 in IS-92a and 62% of total commercial energy in the IS-92d case (see Figures A2.8 and A2.9). Energy consumption in the non-OECD countries follows a similar pattern as their economies and populations continue to expand. Their percentage of global energy consumption increases from about 53% in 1990 to about 67% by 2025 (See Table A2.5).

Emissions from Deforestation

In the IS-92a case, global net emissions from tropical deforestation fall from 1,300 million metric tonnes (MMT) of carbon in 1990 to 1,100 MMT of carbon in 2025. By contrast, in the IS-92d scenario, global net emissions of carbon from deforestation fall to 300 MMT by 2025. Deforestation from temperate regions is assumed to be balanced by reforestation.

Emissions from CFCs

CFCs are controlled under the terms of the Montreal Protocol, which requires significant reductions in the use of these chemicals in order to reduce the threat to the stratospheric ozone layer. CFC emissions are expected to be greatly reduced in the future, although the amount in use will depend on the number of countries that sign the Protocol and the extent to which the signatories comply with its provisions. In the past, CFCs have been used primarily by the industrialized nations. Under the terms of the Montreal Protocol, developing countries are entitled to increase their CFC usage to meet industrial requirements. In the IS-92a case, 30% of the developing world does not sign the London Amendments to the Montreal Protocol. Nonetheless, these countries eventually phase out the use of CFCs and halons. This slow phase-out assumes an on-going process of technology transfer of safe CFC substitutes to the developing countries. In the IS-92d case, CFC use is fully phased out on a worldwide basis by 1997. In addition, all HCFC-22 use in developed countries is reduced by 25% from the IS-92a level by 1995, by 60% from the 1995 IS-92a levels in 2000, and phased down to 5% of the IS-92a 1995 levels by 2005. The same phase-down policy is implemented for developing countries in this scenario, following a ten-year lag-time.

Emissions from Agriculture

Estimates for emissions from agricultural activities were developed for both of the IPCC scenarios discussed in this report. In these scenarios, the rates of greenhouse gas emissions as a function of the unit of agricultural activity (e.g., CH_4 emissions per hectare of land used for paddy rice cultivation) were assumed to remain constant over time. However, levels of agricultural activities (e.g., total area of land under paddy rice cultivation) changed through time as population and economic growth occurred. The specific emission estimates for the major agricultural categories are summarized in Table A2.7 for case IS-92a.

Table A2.7
Emissions from Major Agricultural Activities
(Tg)

Source	1990	2025	2100
CH_4 from Animal Wastes and Enteric Fermentation	110	181	260
CH_4 from Rice	60	78	84
N_2O from Fertilizers	2.2	3.8	4.5

A2.D Climate Change Implications of the IPCC Scenarios

Both the IS-92a and IS-92d scenarios lead to a continuing buildup of greenhouse gases, albeit at very different rates. In the case of the IS-92a scenario the total greenhouse gas concentration will reach a level by 2025 that has a warming potential equivalent to twice the pre-industrial CO_2 level. The warming effects of this greenhouse gas buildup will likely be realized and observable by around 2050. In the case of scenario IS-92d, the planet will experience a similar warming equivalent by about 2080, with the warming realized at approximately the end of the century.

Scientists cannot predict with confidence the regional effects of global warming. But experiments with advanced coupled ocean-atmosphere GCMs, are able to suggest the broad outlines of the impacts of a warming created by an increase in greenhouse gases equivalent to the doubling of the pre-industrial level of carbon dioxide. The IPCC Scientific Assessment indicates -- and the IPCC 1992 Supplement confirms -- that such a buildup will lead to an increase in average global surface temperature at equilibrium of approximately 1.5-4.5°C, with a best estimate of 2.5°C. Scientists expect that such a warming will be accompanied by a rise in average global sea levels between 20 and 70 cm.

The warming, however, will not be evenly distributed worldwide. The warming at high latitudes will probably be about 2-3 times the global average, especially in the Northern Hemisphere. The warming in the tropics will probably be limited to about 50-75% of the global average. Because the warming will be greatest at high latitudes and least in the tropics, the natural thermal gradient between the poles and the Equator will decrease. This decrease will alter the pattern of upper atmospheric winds and ocean currents in complex and presently uncertain ways. Many scientists believe that during the transition to a new climate equilibrium state, these changes may significantly increase the frequency and severity of extreme weather events.

According to the IPCC, the best computer model experiments indicate that global precipitation will increase significantly in a warmer world. The larger the average warming, the greater the expected increase in precipitation. By the time the effective CO_2 concentration has doubled, the global precipitation is projected to increase by about 3-15%. Evaporation would increase by a similar amount. It should be noted, however, that the change in precipitation will not be uniform in all regions. For example, under the CO_2 doubling conditions, precipitation is expected to increase significantly at mid-latitudes in winter. Average precipitation values will increase somewhat less in the tropics, with some areas likely to see a net decrease. The IPCC expects little change in precipitation in sub-tropical arid areas.

Because of the fundamental limitations of existing computer models, scientists cannot accurately predict the seasonal changes in timing, distribution, or severity of rainfall and snowfall under these future conditions. Although many scientists expect the frequency and severity of weather-related extreme events to increase in a warmer world, the accuracy of these expectations cannot be determined. There is general agreement, however, that the risks of rapid climate change will increase in proportion to the rate of greenhouse gas buildup (i.e., the more rapid the increase in atmospheric concentrations of greenhouse gases, the more likely it will be that the future will include dangerous disruptions of regional weather and climate).

A2.E Impacts of and Adaptation to Climate Change

Countries will be affected differently by global climate change, in part because their climate will change in different ways, and in part because their economic and ecological systems vary in their vulnerability to climatic change. As indicated above, GCMs do not reliably predict changes in temperature, precipitation, or the frequency and severity of extreme weather events at the national, regional, or local level. Countries with a high reliance on agriculture and forest production, and countries dependent on low-lying coastal areas, are likely to be the most affected should climate change rapidly. The following sections discuss possible impacts of climate change on various economic sectors, as well as possible measures that countries might take to adapt to an altered climate.

A2.E.1 Agriculture/Food Security

Drought poses a greater climate change risk to agriculture than increased temperature (IPCC, 1992), so agricultural production systems in regions that become drier are the most vulnerable. As noted in the previous section, the IPCC predictions indicate little change in precipitation in sub-tropical arid regions. However, precipitation could be reduced in some locales making existing drought conditions even worse. Drought stress also lowers plant resistance to insects and disease, so increased pest populations will likely reduce crop, livestock, and forest production in some countries. The effects of climate change on soil productivity are not clear. For example, increased soil erosion due to more intense rainfall and an increased rate of oxidation of soil organic matter caused by increased temperature may be countered by greater organic matter production and denser ground cover because of augmented CO_2 fertilization in areas of increased precipitation.

Adaptation of existing agricultural production systems to climate change should be possible, permitting the maintenance or increase of food production to maintain food security. Changes in crop species, new cultivars that are resistant to drought, increased precipitation and pests, and modified cropping systems to increase water use efficiency and manage soil and microclimate, are examples of possible adaptation measures. Permanent crops such as orchards and forest plantations will be more vulnerable to climate change and might require expensive replacement with alternative crops or cultivars. The international agricultural research centers and national governmental and non-governmental research and technology transfer institutions will be required to develop adaptation technologies and promote them among small farmers in developing countries.

A2.E.2 Natural Terrestrial Ecosystems and Biodiversity

Ecosystems are made up of a complex of species adapted to their abiotic environment, which in turn interact with other species in the ecosystem through competition, commensalism, mutualism, or symbiosis. As the climate changes, each species' relative fitness and competitive ability will change, in many cases reducing its ability to reproduce, and even its ability to survive. In some cases, a species might be adapted to the new abiotic environment, but other species of its original ecosystem upon which it depends for some critical life process may not, resulting in the disappearance of both species. Climate change will have a distinct impact on the ranges of the component species of natural terrestrial ecosystems, resulting in changes in species composition at the community, landscape, and ecosystem level.

Species have a range of temperatures and water regimes over which they are naturally distributed. The survival of individual species will first be affected by increased temperature, drought, or increased precipitation at the limit of its natural range that is determined by temperature or precipitation. As the climate becomes warmer, drier, or wetter, species within a community that are suited to these modified conditions will become more prevalent than other species that are less

suited to the altered climate (i.e. species that are at a limit of their range determined by the changing climatic factor).

The rate of climate change will be the major factor determining the type and severity of impacts on natural ecosystems (IPCC, 1992). The dispersal capacity of species will determine whether they can migrate to new areas where the climate is suitable for the survival of both their progeny and the other species upon which they depend. New natural communities, and possibly new ecosystems, will develop over time through species migration and evolution if the climate stabilizes at a new equilibrium.

Loss of biological diversity will accompany climate change as species that have limited distributions and dispersal capability, or that depend on other species with limited dispersal capability become extinct. Species that are unable to migrate because they are surrounded by habitat unsuitable for their survival, such as species restricted to islands, isolated mountain peaks, and parks and wildlife reserves surrounded by agriculture, will be at greater risk of extinction (Wilson, 1992; Peters & Darling, 1985; Peters, 1989).

Specific measures to adapt natural terrestrial ecosystems to climate change are more difficult to identify than are measures to adapt agricultural production systems. Our insufficient knowledge of the abiotic and biotic factors determining species abundance within existing ecosystems will not allow us to predict the species composition of communities that may eventually develop under an altered climate. Therefore, we are unable to predict adapted community composition and artificially establish adapted communities.

Increasing our knowledge of how temperature, precipitation, CO_2 levels, and inter-specific interactions determine the abundance of species will better equip us to predict the impacts of climate change on natural ecosystems and the likely composition of adapted communities, and to develop adaptation strategies. Ecosystem research by the Center for International Forestry Research, the International Centre for Agroforestry Research, national research institutions, and universities will contribute to the knowledge required to adapt natural terrestrial ecosystems to climate change.

Modifying conditions within isolated reserves might be necessary to preserve some species (Peters & Darling, 1985). Possible interventions in response to altered precipitation could affect irrigation or drainage. Transplantation of species to other reserves within the species' suitable temperature or moisture range is another possible measure. Climate change should be taken into consideration when establishing new parks and reserves. If reserves are established to protect a particular species, then they should be located as far as possible from the edge of the species' range where the impacts of climate change will first be expressed. Biological corridors between reserves, proposed by some biologists as a measure to allow the exchange of genetic material within species to minimize genetic

deterioration from inbreeding, might also serve as migration corridors for species affected by climate change.

A2.E.3 Coastal Zones

The greatest impact of climate change on coastal zones will be sea level rise, affecting both land and marine ecosystems. Increased frequency and severity of storms are also predicted, and these events may affect both land and marine ecosystems. Increased water temperatures and UV-B radiation will affect marine ecosystems (IPCC, 1992). Coasts that are uplifting due to tectonic or volcanic movement or glacial rebound will have little relative rise in sea level, while areas that are naturally subsiding will be more affected by sea level rise.

Agricultural production on coastal plains could be affected. Coastal forests would likely be affected by sea level rise. Mangrove forests and marshes will probably be able to migrate along with the coastline. However, altered hydrological regimes may affect salinity, and therefore species composition, of these coastal ecosystems.

Coral organisms grow sufficiently fast to keep up with likely rates of sea level rise, but other stresses (storms, sedimentation, river discharge, radiation, etc.), which may be increased by climate change, may slow down reef growth significantly.

Other possible impacts of rising sea levels include increased exposure to contaminants, bacteria, and viruses leached from coastal waste disposal sites and sewerage systems. These contaminants would affect the marine ecosystem, humans who consume contaminated organisms, and fish and shellfish industries.

Sea level rise and more frequent and severe storms could have significant impacts on coastal cities and small islands, particularly islands with little elevation above sea level. Because all areas on small islands are essentially coastal, climate change will have profound impacts on their entire economy and ecology.

In coastal areas of very high economic value, investment in dikes and similar structures may be cost-effective measures to adapt to sea level rise and more frequent and severe storms. In other coastal areas and on some small islands, migration of populations and abandonment of coastal plain agriculture may be the only economically feasible response to climate change.

A2.E.4 Hydrology and Water Resources

GCMs consistently predict that global climate change will result in more variable streamflows in all regions, with amplified extremes. Flood volumes and peak flows will be greater, and there will

be more periods of low flows. Increased floods and droughts will require a re-evaluation of guidelines for management of water systems and contingency planning for areas prone to flooding.

Altered hydrological regimes will affect the ecology of streams, rivers, lakes, and coastal areas. Further analysis is required to determine the impacts of these changes on the biological diversity of these ecosystems. Water tables in areas suffering increased drought will drop, unless aquifer recharge areas are distant and receive equal or greater precipitation. Coastal aquifers will likely suffer increased saltwater intrusion as sea levels rise. Developing countries, with generally less development of water resources, will likely be more adversely affected by hydrological changes resulting from climate change (IPCC, 1992).

Impacts on domestic water supplies, agriculture, and industry may be alleviated through increased water control, regulation, and management. Investments in institutions and infrastructure could be made in developing countries to increase the degree of water control, regulation, and management. Any water management schemes must be scrutinized with respect to environmental and social impacts, and must be designed with sustainability in mind.

A2.E.5 Population, Human Health, and Migration

The world's population totals over 5.5 billion people today, and is increasing by approximately 90 million each year. Most of the growth is occurring in the poorest countries (Population Report, 1992). The impact of population growth touches virtually all the specific ways that human beings interact with the environment, including many of the impacts discussed above: agriculture and food security; forests and biodiversity; water resources and land use; energy; human health; and sustainable development.

Various expanding human activities release a growing amount of polluting gases into the atmosphere. There is a direct relationship between population increase and the emissions of various greenhouse gases.

The developing countries constitute an increasing new source of pollution due to both rapid population growth and rising incomes. Within 35 years they could be producing half of the world's municipal solid wastes, up from one-quarter in 1985.

As populations increase, local environments are less able to provide for the inhabitants due to increasing scarcity and degradation of resources, damage to the existing ecosystem, and further exacerbation of regional and global environmental problems such as climate change. As these changes occur, the economic and social fabric of a country or region could be dramatically affected, leading to unparalleled migration, and political and social destabilization.

The complicated and interwoven relationship between population and global climate change make predicting the affect of climate change on human populations difficult. Some of the more direct consequences of climate change are expected to be desertification leading to food shortages, sea-level rise forcing migration of large populations from low-lying areas, increased health problems due to an increase in disease-carrying insects, and other disruptions.

A2.E.6 Impacts on Sustainable Development

Climate change will have impacts on the sustainability of existing agricultural production systems, domestic water supplies, and natural terrestrial and marine ecosystems. National research, analysis, and planning institutions must factor climate change into their programs and activities. Increased precision in the inventory of natural resources, determination of the productivity of renewable natural resources, and efficient allocation of financial, human, technological, and renewable and non-renewable natural resources should increase the sustainability of development and adaptability of the economy to climate change.

Appendix 3

US Global Change Research Program:

Fiscal Year 1993-1994
Budget by Project

Summary by Agency

Agency	FY 1993 $ million	FY 1994 $ million
Department of Commerce	66.9	69.9
Department of Defense	6.6	6.8
Department of Energy	89.3	98.3
Department of the Interior	37.7	34.0
Environmental Protection Agency	25.8	27.5
Health and Human Services	1.2	1.5
National Aeronautics and Space Administration	921.1	1,013.1
National Science Foundation	124.0	169.0
Smithsonian Institute	7.3	7.3
Tennessee Valley Authority	0.1	0.1
Department of Agriculture	46.0	47.6
Total	1,326.0	1,475.1

Budgets by Project

Agency	Bureau	Project	FY '93 $million	FY'94 $million
DOC	NOAA	Long-term Ocean Observations	6.90	6.9
		Operational Measurements	4.3	4.3
		Measurement Technique Development	0.3	0.3
		Information Management	4.2	4.2
		Tropical Oceans/Global Atmosphere (TOGA)	8.0	8.0
		Clouds, Energy, Water (GEWEX)	4.2	4.2
		Ocean Circulation/Biogeochemisty	12.7	12.7
		Climate Modeling and Analysis	12.1	15.1
		Atmospheric Chemistry	7.5	7.5
		Marine Ecosystem Response	3.0	3.0
		Paleoclimate	3.0	3.0
		Economics Research	0.6	0.6
		Solar Variability	0.1	0.1
DOD	ONR	High Latitude Dynamics - Arctic Sediment	0.2	0.3
		Ocean Measurements	0.6	1.1
		Ocean Ecological Dynamics	1.0	1.0
		Boundary Layer Dynamics	1.1	1.0
		High Latitude Dynamics - Artic Lead	2.2	1.5
		Regional Resolving Models	1.0	1.3
	CRREL	Regional Resolving Models	0.2	0.3
		High Latitude Dynamics - Impacts	0.3	0.3

Agency	Bureau	Project	FY '93 $million	FY'94 $million
DOI	USGS	Land Characterization	2.0	2.0
		Land Data	5.4	5.4
		Volcano Emissions	0.4	0.4
		Cold Regions Research	1.4	1.4
		Climates of Arid & Semi Arid Regions	0.9	0.9
		Paleoclimates	7.7	7.6
		Biogeochemical Exchanges	1.2	2.2
		Coastal Erosion & Wetlands Processes	3.0	0.0
		Sensitivity of Water Resources	1.0	0.0
		Interaction of Climate & Hydrologic Systems	5.0	5.0
	BIA	Uneven-Aged BIA Forests	0.1	0.1
	BOR	Sensitivity of Hydrological Systems	1.1	0.0
		Regional Studies	1.2	1.2
	FWS	Coastal Wetland Change & Dynamics	1.1	1.1
		Monitoring Fish & Wildlife Impacts	2.0	2.1
	NPS	Integrated Studies of NPS Ecosystems	2.9	3.3
		Dynamics of Coastal Systems	0.1	0.1
	BLM	Ecological Change in Environmentally Stressed Ecosystem of the Western and Northern U.S.	1.1	1.1
	BOM	Methane Emissions from Coal Seams	0.1	0.1
DOE	OHER	CORE CO2 Research	19.1	17.6
		CHAMMP - Computer Hardware, Advanced Math & Models	11.4	11.9
		National Institute for Global Environmental Change	10.9	9.6
		Oceans Research	5.1	5.4
		Quantitative Links	5.1	5.3
		ARM - Atmospheric Radiation Measurements	31.1	40.6
		Education	2.8	2.9
		Information/Coordination	2.2	2.3
		Unmanned Aerospace Vehicles (UVAs)	0.0	1.0
		Economics	1.6	1.7

Agency	Bureau	Project	FY '93 $million	FY [illegible] $mil[illegible]
NSF	GEO	ARCSS-Arctic System Science	13.3	[illegible]
		CHP-Continental Hydrologic Processes	1.0	1.1
		Geosystems Databases	1.3	2.0
		ROCEW-Role of Clouds, Energy & Water	0.6	2.0
		CMAP-Climate Modeling Analysis & Prediction	2.0	6.0
		TOGA-Tropical Oceans Global Atmosphere	14.7	16.1
		WOCE-World Ocean Circulation Experiment	15.7	20.5
		GTCP-Global Tropospheric Chemistry Program	11.5	14.7
		JGOFS-Joint Global Ocean Flux Study	13.8	18.6
		Antarctic Ecosystems	1.5	1.5
		Ozone Depletion/UV Effects	5.6	5.6
		GLOBEC-Global Ocean Ecosystems Dynamics	3.8	8.2
		Abrupt Climate Change	0.1	0.9
		Geological Record of Global Change	2.9	4.7
		MESH-Marine Aspects of Earth System History	0.3	2.0
		Geodynamics	6.2	7.5
		RIDGE-Ridge Interdisciplinary Global Experiment	4.1	4.1
		CEDAR - Coupling, Energetics, & Dynamics of Atmospheric Regions	4.4	5.3
		GEM - Geospace Environment Monitoring	0.2	1.4
		SunRISE - Radiative Inputs of the Sun to Earth	0.0	0.9
	BIO	EROC - Ecological Rates of Change	3.0	4.1
		WEV - Water-Energy-Vegetation	4.9	5.8
	BIO/	LMER-Land-Margin Ecosystems Research	2.3	3.0
	GEO	Global Change Educating & Training	0.0	0.2
		Regional Research Institutes	2.0	5.0
	SBE	Human Dimensions of Global Change	4.2	5.4
		Economics Research on Global Change	4.6	6.4

Agency	Bureau	Project	FY '93 $million	FY'94 $million
HHS	NIEHS	Human Health Effects of CFC Replacement Chemicals	0.5	0.5
		Human Health Effects of Increased Exposure to Shorter Wavelength UV	0.7	1.5
NASA	Space Based			
	MTPE	Earth Probe	99.4	97.3
		Payload & Instrument Development	35.4	22.9
		Earth Observing System (EOS)	263.8	322.7
	Ground Based			
	MTPE	Mission Operations & Data Analysis (incl. Landsat)	147.6	160.8
		EOS-Data Information Systems (EOSDIS)	130.7	182.7
		Research and Analysis	166.2	181.5
		Airborne Program	20.7	25.2
		Construction of Facilities	57.3	20.0
SI	NMNH	Tropical Biological Diversity Program	1.2	1.2
		Tropical Coastal Ecosystems Program	0.4	0.4
		Human Ecology History	0.3	0.3
		Nile Delta Subsidence & Sea Level Rise	0.1	0.1
		Global Volcanism Program	0.4	0.4
		Paleoecological Effects of Climate Change	1.1	1.1
	STRI	Tropical Forest Science Program	0.9	0.9
		Patterns of Change in East African Savanna Ecosystems	0.0	0.0
		Tropical Agroforestry Program	0.2	0.2
	SERC	Chesapeake Bay Global Change Research	0.6	0.6
		Temperate & Tropical Forest Canopy Biology	0.4	0.4
	SAO	Atmospheric Physics and Chemistry	0.2	0.2
		Solar Studies/Global Change	0.1	0.1
		Space Geodetic Sea Level Monitoring	0.0	0.0
	NASM	Global Change in Earth's Drylands	0.3	0.3
	IC	SI/MAB Biological Diversity Program	0.1	0.1
	NZP	Predicting Species Responses	0.6	0.6
		Migratory Birds	0.3	0.3

Agency	Bureau	Project	FY '93 $million	FY'94 $million
TVA	RBO	Regional Climate Impact Assessment	0.1	0.1
USDA	ARS	Scale Effect of Hydro. Proc.	1.6	1.6
		Biogeochemical Fluxes	3.0	3.1
		Ecosystems Modeling	3.2	3.2
		Pred. Impact on Sustain. Wtr.	2.2	2.2
	FS	Ecological System Dynamics	10.5	10.4
		Atmosphere/Biosphere Gas & Energy Exchange	7.5	7.4
		Disturbance Ecology	3.3	3.2
		Integrating Human Activities & Natural Resources	1.0	1.3
	ERS	Econ. Sys. & Global Change	0.8	0.8
	CSRS	Global Change Research	9.4	9.9
		UV-B Network	2.0	3.0
	SCS	Climate Information	0.2	0.2
		Soil Carbon/Soil Genesis	0.9	0.9
		Soil Landscape Model	0.4	0.4
EPA	ORD	Anthropogenic Methane/RITG Emissions	4.0	4.0
		Tropospheric Chemistry	3.1	3.1
		Greenhouse Gas pools & Fluxes in Terrestrial Ecosystems	1.8	2.3
		Biospheric Carbon Pool & Fluxes	1.4	1.4
		Climate-Induced Biosperic Feedback from Soils	0.8	0.8
		Monitoring Forest Conversion/Biomass Burning	1.4	1.4
		Earth System Modeling Analysis	2.6	3.1
		North American Landscape Characterization	2.1	2.1
		Effects of Global Changes on Rice Yields	1.5	1.5
		Micro-to Macro-Scale Eco. Responses	3.8	4.2
		Stratospheric Ozone Depleting Chemicals	1.1	1.1
		Early Detection of the Greenhouse Signature	0.0	1.0
		UV-B Monitoring and Exposure Index	2.2	1.5

Appendix 4

Key Country

Selection Criteria:

Energy Sector

Emissions

Key Country Selection Criteria:

Energy Sector Emissions

Several criteria have been chosen to assist in the identification of developing countries that should receive significant assistance in the reduction of greenhouse gas emissions. The main categories are: a) importance of the country as an emitter of greenhouse gases; b) the tractability of working effectively in a country to implement GHG reduction programs; c) the indigenous renewable energy resources and energy efficiency potential; and d) the signatory status of the country with respect to the FCCC.

The accompanying table provides the results of a screening process that was used in the selection of key countries for GHG emission reduction programs. The results for the nine selected countries are shown here.

Ranking of individual countries from a standpoint of greenhouse gas emissions cannot be done accurately at this time. While a limited amount of data exists, most countries are still in the GHG inventory stage. Some countries in the OECD do have reasonable estimates of the emissions from industry and the power sector, but even in these countries the estimate of GHG sinks is less certain. In the lesser developed countries the data is even more sketchy. To correct this lack of basic data, the FCCC set up a requirement for all countries to develop GHG inventory information, and also established a mechanism for the developed countries to assist the developing countries in the preparation of GHG inventories. A series of country studies is being conducted by the UNEP and by several developed countries, among them the United States, to address the inventory issue as well as broader climate change problems. The inventories from the Country Studies program will catalogue the basic information using a standard format being developed by the OECD.

The first set of data shown in the table identifies relatively large GHG emitters. The IPCC methodology for weighing various greenhouse gases was used to provide an estimate of the total percentage of emissions by country. This procedure is currently being reevaluated and is now thought to be less reliable than when it was used for the original 1990 IPCC report. While this data may not be very accurate, it may still be used as a first order estimate of the overall GHG problem. Also included is a set of data that provides an estimate of the amount of carbon dioxide emissions from the energy and industrial sectors. Because CO_2 is the largest contributor of the various greenhouse gases, it is used here as an indicator of the seriousness of the problem in each country, at least in the industrial sector. Additional data does exist for other GHGs such as nitrous oxide, carbon monoxide, methane, and CFCs. Data for the first three gases is

generally consistent with the trends for carbon dioxide emission in that those countries with large CO_2 emissions also rank relatively high in the others. The CFCs are being addressed separately through the Montreal Protocol so they are not addressed specifically in this report.

Until a better database is developed, the existing data must be used to identify the countries that are emitting the most GHGs and that have the largest capacity for absorbing GHGs in natural sinks. Because of the preliminary nature of the data, caution should be exercised in using the rankings listed in the table above.

Qualitative evaluations of the tractability and indigenous resource availability are presented for each of the selected countries. In addition, each of these countries is a signatory to the FCCC.

	Former USSR	Russia	Ukraine	Kazakhstan	Mexico	India	Indonesia	Poland	Philippines	Brazil	USA[6]
1) Emissions											
% of current contributions to world greenhouse gas emissions[1]	13.6%	8.5% *	2.5% *	0.7% *	2.0%	4.1%	1.7%	1.5%	0.8%	3.9%	17.8%
CO_2 emissions (million tonnes C)[2]	1038	646 *	191 *	52 *	87	178	38	120	11	57	1329
CO_2 emissions per capita (metric tonnes C)[2]	3.62	N/A	N/A	N/A	1.01	0.21	0.21	3.15	0.18	0.38	5.37
% of current contributions to world CO_2 emissions from industrial processes (1989)[2]	17.4%	10.8% *	3.2% *	0.9% *	1.5%	3.0%	0.6%	2.0%	0.2%	0.9%	22.3%
Other type of greenhouse gases emitted[3]	CH_4 CFCs CO_2 from land use	N/A	N/A	N/A	CH_4 CFCs CO_2 from land use	CH_4 CFCs CO_2 from land use	CH_4 CFCs CO_2 from land usa	CH_4 CFCs	CH_4 CO_2 from land use	CH_4 CFCs CO_2 from land use	CH_4 CFCs CO_2 from land use

2) Tractability	Former USSR	Russia	Ukraine	Kazakhstan	Mexico	India	Indo nesia	Poland	Philip pines	Brazil	USA*
potential for capacity building	*	medium	medium	high	medium/ high	medium/ high	high	medium	high	medium/ high	high
political climate to encourage policy and institutional reform	*	high	low	high	medium/ high	medium/ high	medium/ high	high	high	medium	high
potential for leveraging private and MDB financing	*	medium	low	medium	high	medium/ high	high	medium/ high	medium	medium	high

	Former USSR	Russia	Ukraine	Kazakhstan	Mexico	India	Indonesia	Poland	Philippines	Brazil	USA*
3) Signatories											
signed the Framework for Global Climate Change Convention	*	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
4) Indigenous Resources											
energy efficiency potential	*	high	high	high	high	high	high	high	high	high	medium
renewable energy	*	medium	medium	medium	medium/ high	high	high	low	medium	high	high
coal	*	high	high	high	low	high	medium	high	low	low	high
gas	*	high	medium	medium	medium	low	medium	medium	medium	medium	high
petroleum	*	high	medium	high	high	low	high	low	high	medium	high

* Parameters apply only to individual countries, not to the former USSR

Sources:

1) World Resources, Table 13.4, World Resource Institute, 1993
   This is based on IPCC methodology for weighing greenhouse gases. Includes CO_2, CH_4, and CFC greenhouse gases. Data sources are Carbon Dioxide Information Analysis Center and the World Resources Institute.

2) Ibid, Table 24.1
   Includes energy from the energy sector and from the cement industry.

3) Ibid, Table 24.2

Notes:

a) Limited data is available for the individual NIS countries.
   Total energy use in the NIS in 1989 was as follows:

Russia = 38.4 qbtu (quadrillion Btu);	Ukraine = 11.38 qbtu;
Kazakhstan = 3.08 qbtu;	Uzbekistan = 2.04 qbtu;
Belarus = 1.7 qbtu;	Azerbaijan = 1.07 qbtu;
Lithuania = 0.64 qbtu;	Georgia = 0.62 qbtu;
Turkmenistan = 0.55 qbtu;	Latvia = 0.46 qbtu;
Armenia = 0.39 qbtu;	Moldovia = 0.38 qbtu;
Tajikistan = 0.37 qbtu;	Estonia = 0.36 qbtu;
Kyrgyzstan = 0.3 qbtu;	

   Total NIS = 61.74 qbtu (EIA/DOE, 1991).
   Estimates for the individual key countries were based on the percentage of overall energy used by the individual countries, and the total for the NIS.

b) Data for the United States is provided for comparative reference purposes only.

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