National Climate Change Action Plans:

Interim Report for Developing and Transition Countries

October 1997

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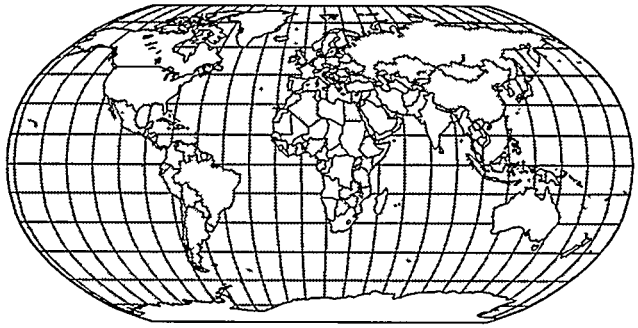

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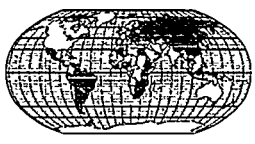

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FOREWORD

The threat of climate change has obliged the international community to realize that we inhabit a single planet, and share a common, but differentiated, responsibility to preserve its well-being. The challenge posed by climate change is so overwhelming that we have been forced to act together as never before, as evidenced by the United Nations Framework Convention on Climate Change (UNFCCC). Continued good will is essential in order to meet this global threat, which transcends national borders, circumstances, and capacities. Given these facts, it is evident that international cooperation in transferring both financial and technological resources to developing and transition countries is an integral part of the global effort to mitigate, and adapt to, climate change.

The U.S. Country Studies Program (USCSP) has taken the lead in helping countries that are developing national action plans. This assistance includes training on different aspects of climate change, analytical tools, and technical guidance as well as financial support. These action plans will eventually support national communications, as required by the UNFCCC.

This report presents the experiences of 11 developing and transition countries in formulating their national action plans. It outlines each country's specific approach to assessing and prioritizing different mitigation and adaptation policies and measures. The lessons learned by each country are profound; careful examination of these lessons will help to refine future activities. One of the key lessons is that capacity building is both essential and difficult; it requires not a one-shot task, but rather a long-term effort that needs continual support.

This report is a clear indication of the sincere commitment and effort of several countries to meet their obligations under the UNFCCC.

Ibrahim Abdel Gelil

Chairman
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EXECUTIVE SUMMARY

Under its Support for National Action Plans (SNAP) initiative, the U.S. Country Studies Program is providing financial and technical assistance to 18 countries for the development of climate change action plans. Although most of the countries have not yet completed their plans, the important lessons learned thus far are valuable and should be shared with other countries and international institutions that have an interest in the process of action plan development. This interim report describes the experiences of 11 countries that are the furthest along in their planning activity and who have offered to share their results to date with the larger community of interested nations. These action plans delineate specific mitigation and adaptation measures that the countries will implement and integrate into their ongoing development programs. This report focuses on the measures the countries have selected and the methods they used to prepare their action plans.

This executive summary presents key lessons and common themes using a structure similar to that used in the individual country chapters.

Plan Objectives

As Table 1 shows, participating countries are developing action plans to fulfill their commitments under the UNFCCC. However, while all of the countries participating in this report have committed to reducing greenhouse gas (GHG) emissions, improving their domestic

Table1. Objectives of the National Action Plans

Stated Objectives of the Plan	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
Fulfill UNFCCC commitments, including national communications	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Ensure integration with other development priorities	✔	✔		✔	✔	✔	✔		✔	✔	
Raise public awareness of climate change issues	✔	✔	✔	✔	✔			✔		✔	✔
Create broader support among decision makers	✔	✔	✔	✔	✔		✔	✔	✔		
Increase domestic technological capabilities	✔			✔				✔	✔	✔	

economic situation is, for all of them, a higher priority. For this reason, the countries are using their action plans to help integrate climate change issues with other development priorities. Most of the countries are also using their action plans to raise public awareness of climate change issues and create broader support for a climate change strategy among decision makers and other stakeholders. In addition, several countries view implementation of the action plan as a way to strengthen their domestic technological capabilities in the area of climate research and analysis.

Methods Used to Prepare Plan

Most of the countries are developing their action plans using a process similar to the one outlined in *Steps in Preparing Climate Change Action Plans: A Handbook* (Benioff and Warren, 1996), prepared by the USCSP. However, specific steps have been tailored to their unique circumstances, and many countries are implementing these steps in parallel, rather than following a strictly linear sequence. Figure 1 shows a typical action plan development process.

All of the countries included in this report have recognized the importance of involving, and effectively coordinating, the various government agencies that will be involved in implementing the action plan. Without exception, all of them have established interagency teams to lead the preparation of their plans. These teams typically include representatives from the agriculture, energy, environment, forestry, and other affected agencies. Many countries have also included the general public and nongovernmental organizations (NGOs) in the planning process.

Most countries have used the results of earlier research under the U.S. Country Studies Program to establish broad priorities for further investigation and elaboration in their plans. Virtually all of the countries used some kind of participatory process to discuss options and determine priority sectors. In most cases, this took the form of one or more scoping workshops attended by representatives of each economic sector and various government ministries and agencies.

Potential mitigation and adaptation measures in each sector have been screened and evaluated in a variety of ways. Several countries have relied on technology assessments to help determine the most viable measures. Cost-benefit or cost-effectiveness analysis was typically used. Some countries simply required that the measures be economically feasible. Others stipulated that the selected measures should be "no regrets," with a positive economic return; in other words, have economic value even if predicted climate change does not occur. A few countries have established dedicated sectoral teams to develop, screen, and evaluate measures for different sectors of the economy.

Most countries are going to great lengths to make sure that, by the time the action plan is presented to the government for official adoption, the document will have received the approval of a representative sample of all of the other stakeholders, including technical and economic experts and sectoral policy makers. None of the plans have yet been officially sanctioned, but most countries intend to integrate their climate change action plan into other social and economic development plans once it is adopted by the government.

Figure 1. Steps Involved in Action Plan Development and Implementation

1. Design an Effective Planning Process
2. Define the Overall Plan Objectives and Sectors to be Addressed
3. Prepare a Comprehensive Work Plan
4. Evaluate and Develop Sectoral Measures
5. Perform a Comparative Analysis of Measures Across Sectors
6. Prepare Implementation Strategies for Selected Measures
7. Prepare and Adopt the Climate Change Action Plan
8. Integrate the Plan with Other Development Plans and Programs
9. Implement the Climate Change Action Plan

Action Plan Measures

All of the countries participating in this report have identified priority sectors for mitigation and adaptation. As Table 2 shows, energy, forestry, and agriculture are the most commonly addressed sectors for mitigation, whereas adaptation measures tend to focus on forestry, agriculture, and water resources.

Table 2. Priority Sectors Identified for Mitigation and Adaptation

Priority Sectors	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
Mitigation											
Energy	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Forestry	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
Agriculture	✔	✔	✔	✔			✔	✔	✔	✔	✔
Waste Management		✔		✔							
Adaptation											
Forestry	✔	✔	✔					✔	✔	✔	
Agriculture	✔	✔	✔	✔	✔		✔	✔	✔	✔	
Water Resources	✔		✔	✔	✔		✔		✔		
Coastal Resources	n/a		n/a	✔		n/a	n/a				
Human Health									✔		

n/a = not applicable (no coastline)

Since most of the countries have not yet finalized their action plans or the selection of their measures, however, this report's discussion of measures should be regarded as tentative. In addition, several countries commented that they have had to ignore some potentially important sectors, such as adaptation in coastal resources and human health, due to a lack of resources to investigate and/or implement measures in those sectors.

The countries are developing a wide variety of measures appropriate to their circumstances, both to reduce emissions and to adapt to the impacts of climate change. In almost all cases, the countries have identified a broad portfolio of "no regrets" measures that are cost effective and also have other economic, social, and/or environmental benefits. All have developed measures that are consistent with their current development objectives. The measures address a broad spectrum of policies, programs, and projects, including:

- Educational initiatives
- Legislative regulations and guidelines
- Voluntary agreements
- Economic (fiscal) instruments and incentives
- Research and development programs
- Demonstration projects.

Implementation Issues

Although none of the countries has yet established an implementation schedule, most of them have already given some consideration to implementing their portfolio of mitigation and adaptation measures. All of the countries are confronting four key issues in developing implementation strategies.

1. Assigning Responsibility for Implementation

In most countries, but not all, the ultimate responsibility for implementing the action plan falls to the same

coordinating body that had responsibility for developing the plan. In some cases, responsibility is devolved to individual ministries and agencies with a sectoral focus; the original coordinating body then retains responsibility solely for intersectoral coordination. In other cases, the body responsible for plan development hands responsibility over to its parent ministry or another interagency group consisting of high-ranking government ministers and other officials.

2. Raising Public Awareness

Several countries have identified a pressing need to improve the awareness of the general public about the potential threats of climate change. A few also mentioned the need to improve recognition by decision makers of the importance of climate change relative to other development priorities. Another issue that emerged is the poor understanding of climate change science in several countries, which is one reason why some of them have expressed a desire to strengthen their domestic analytical capabilities in this field.

3. Tapping Existing Domestic Resources

Most of the countries participating in this report are facing significant economic challenges that make it difficult to justify diverting resources to climate change mitigation. Although all of them are looking for financial support from international donors to implement action plan measures, most have also identified existing government resources available to support measures, especially those that have multiple benefits. However, estimates of a country's ability to finance its action plan vary greatly, from virtually none to about three-quarters of the total cost.

4. Securing International Donor/Investor Support

All of the countries in this report have identified a general need for international assistance with plan implementation, either financial assistance with measures and projects, or technical assistance with climate change mitigation and adaptation technologies. In addition to funding by international climate change and development agencies, several countries have identified a need for business investment and technology cooperation with donors. Although none of the countries has yet completed an action plan, almost half of them have identified specific projects or measures that require assistance.

INTRODUCTION

Background Information on the SNAP Program

In 1992, U.S. President Bush announced the initiation of the U.S. Country Studies Program to assist developing countries and countries with economies in transition in meeting their obligations under the United Nations Framework Convention on Climate Change (UNFCCC). Through this program, the U.S. Government is providing financial and technical support to 55 developing and transition countries for climate change studies. The first phase of these studies included greenhouse gas emission inventories, evaluations of the country's vulnerability to the impacts of climate change, and assessments of mitigation and adaptation options. The overall objectives of the U.S. Country Studies Program are to strengthen the technical, institutional, and human capacity of developing and transition countries to address climate change issues and to increase support for the objectives and principles of the UNFCCC.

The U.S. Country Studies Program is an interagency initiative that has received funding and personnel from ten government agencies:

- Environmental Protection Agency
- Department of Energy
- Agency for International Development
- Department of State
- National Oceanic and Atmospheric Administration
- Department of Agriculture
- National Aeronautics and Space Administration
- National Science Foundation
- Department of Health and Human Services
- Department of the Interior

These agencies established an interagency team, the U.S. Country Studies Management Team, to direct program operations under the oversight of an interagency coordinating committee. The program has established an extensive technical assistance program that draws from the expertise of the various federal agencies supporting the program, and from laboratories, academic institutions, NGOs, and consultants. The technical assistance program provides training on assessment methods and steps in preparing climate change plans (over 1000 officials from the 55 countries have received such training through the program) and makes U.S. and international experts available for direct consultations with the countries. The program has prepared numerous guidance documents including guidance on vulnerability and adaptation assessment, mitigation assessment, and steps in preparing climate change action plans.

In response to requests from more than 40 countries, the United States launched the next phase of the USCSP, at the First Conference of the Parties, to provide Support for National Action Plans (SNAP). The SNAP program provides financial and technical support for developing national climate change action plans to countries that have completed climate change country studies. The action plans delineate specific mitigation and adaptation measures that countries will implement and integrate into their ongoing development programs. These plans will form the basis for the national communications that countries submit to the UNFCCC Secretariat. Under SNAP, countries are also receiving support for technology assessments to evaluate barriers to technology deployment and design programs or projects to overcome these barriers. Through SNAP, the U.S. Government is currently assisting 18 countries with the preparation of their plans.

The USCSP has established a multifaceted technical assistance program to assist the countries with plan preparation. This technical assistance package includes handbooks, training workshops, consultation with various U.S. and international experts on the selection and design of measures, and workshops where countries can share their initial experiences with each other. The technical assistance team includes experts from U.S. federal agencies, state energy offices, NGOs, and consulting firms, as well as international experts. The USCSP has spon-

sored two international workshops on the preparation of action plans.

Supporting materials from the USCSP include *Steps in Preparing Climate Change Action Plans: A Handbook* (Benioff and Warren, 1996), which describes a ten-step process that countries can follow in the preparation of their plans. It contains separate sections on the development of mitigation and adaptation measures for various sectors (e.g., energy, transportation, forestry, agriculture, waste management, coal mining, water resources, coastal resources, fisheries, health, etc.) and cross-sectoral options. In addition to this handbook, the USCSP, together with the U.S. EPA, U.S. AID, and American Forests, has prepared handbooks on mitigation measures for methane, forests, and the energy sector.

Purpose and Structure of the Synthesis Report

This report describes the experiences of 11 countries with the development of their national climate change action plans. The countries that contributed chapters to the report are in different stages of developing their plans. The report provides an overview of the planning process used by these countries and presents interim results of their work. The U.S. Country Studies Program has designed this report to give other countries and international institutions an opportunity to learn about, and benefit from, the initial experiences of countries preparing climate change action plans.

Global Summary — The first chapter in the report is a global summary that synthesizes the experiences of the various countries, providing overview tables of measures and brief descriptions of common themes and experiences with preparing the national action plans.

Country Chapters — The bulk of the report consists of the 11 country chapters, each of which has been structured to include the following sections whenever possible:

- *Summary* — A brief overview of the country's objectives and approach, usually including a summary table of priority sectors and measures.
- *Introduction* — A review of past studies concerning the country's vulnerability to climate change, adaptation options, its emissions inventory, and mitigation options. This section also includes an introduction to current national climate change programs.
- *Objectives* — Discusses the primary goals the country has set for its action plan.
- *Methods* — Describes the steps and methods used by the country to develop its action plan, including the process of establishing a planning team; selecting, evaluating, and designing mitigation and adaptation measures; integrating measures with current programs; and obtaining official approval for the plan.
- *Measures* — A description of proposed mitigation and adaptation actions, and their projected impacts, usually presented in a summary table, followed by more detailed elaborations of measures in priority sectors.
- *Implementation Strategies* — Describes how the country intends to implement its action plan, including procedures for cross-sectoral implementation and proposed outreach activities.
- *Issues and Lessons* — A brief review of key lessons learned or problems encountered by the country during preparation of the plan.
- *International Cooperation* — A summary of technical and financial help needed, including, in some cases, a list of specific mitigation or adaptation projects requiring assistance.

National Climate Change Action Plans

GLOBAL SUMMARY

The 11 national climate change action plans described in this report reflect a diversity of approaches, each country having tailored its climate change measures to its unique circumstances. The plans are at varying stages of completion. While none have yet been officially approved, most of the countries have identified a preliminary portfolio of mitigation and adaptation measures that will likely form the foundation for their plans. In most cases, the countries have identified a wide array of "no regrets" response measures that they can implement at little or no cost, while achieving other environmental, social, and economic benefits. The countries have also determined where existing domestic resources can support measure implementation and where donor funding is required. Most of the countries are expecting to complete their plans in 1998.

Plan Objectives

Table 1 provides a quick overview of some common objectives identified in the individual national action plans.

Fulfill UNFCCC Commitments

While all of the countries participating in this report have committed to reducing greenhouse gas emissions, improving the domestic economic situation is, for all of them, a higher priority. Most countries are finding creative ways to work within this constraint. All of the countries participating in this report will use their action plans as a basis for preparing and refining their national communications.

Ensure Integration with Other Development Priorities

Ensuring integration with other development priorities is a two-way process. On the one hand, integrating climate change into a country's general planning process makes it possible to ensure that other macroeconomic and sectoral policies can be adjusted to take climate change into consideration. On the other hand, it makes it easier to ensure that whatever climate change initiatives are implemented will be in line with sustainable national development and won't add to the already significant economic burdens of developing and transition countries.

Hungary, for example, which has already experienced a large drop in emissions due to a deep economic recession, is faced with a pressing need to restructure its obsolete energy supply sector to form the foundation for future economic growth. It is choosing to do this in ways that will avoid high emissions in the future. That way, the country accomplishes two national objectives — economic reform and emissions mitigation — with a single win-win solution.

Raise Public Awareness

Most of the countries noted that raising public awareness of climate change issues is one of the key objectives of their action plan. Tanzania, for example, intends to develop a permanent climate change information service to guarantee dissemination of accurate information to the public.

Create Broader Support Among Decision Makers

Most countries are also acutely aware of the importance of building consensus on climate change issues among decision makers. Several countries broadened this objective to encompass not just government decision makers, but also the other public, academic, and private institutions in the country that are working to implement adaptation measures for ecosystems and to mitigate emissions of greenhouse gases. As Bolivia stated it, "This is being done to promote a significant change in the national

Table1. Objectives of the National Action Plans

Stated Objectives of the Plan	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
Fulfill UNFCCC commitments, including national communications	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Ensure integration with other development priorities	✔	✔		✔	✔	✔	✔		✔	✔	
Raise public awareness of climate change issues	✔	✔	✔	✔	✔			✔		✔	✔
Create broader support among decision makers	✔	✔	✔	✔	✔		✔	✔	✔		
Increase domestic technological capabilities	✔			✔				✔	✔	✔	

policies that will contribute to the reduction of greenhouse gas emissions while creating a positive impact on the economy."

Increase Domestic Technological Capabilities

About half of the countries identified technology diffusion as a key objective of their action plans. Through the process of implementing the measures outlined in its action plan, Mexico expects to find opportunities for technology transfer and continued development of the technical and policy analysis capabilities of key personnel and processes. Egypt makes it clear that it does not have the technological capability to ensure adequate implementation of all climate change measures, and Russia stipulates that some jointly funded projects should involve "appropriate investments in the Russian territory."

Other Objectives

In addition to the above objectives, several countries mentioned important goals for the plan and the process of plan development. Kazakhstan, for example, noted that developing the plan would help it to establish a legal and institutional framework for implementing climate change measures; Russia went so far as to make this objective one of the key mitigation measures identified in its initial rough-cut plan. Bolivia stated its desire to identify climate change projects that would be suitable for international financing. Bulgaria commented that, as part of developing the plan, it would have to identify the domestic and international resources available for funding development projects. Mexico indicated that developing its action plan would also support current efforts to develop criteria for joint implementation projects. And Tanzania noted that one of its objectives was to identify barriers to reducing emissions in sectoral programs.

Methods Used

Steps Followed To Prepare the Plan

Most of the countries have followed a similar process to develop their action plans. However, specific steps were tailored to their unique circumstances. Figure 1 shows the process used by Bulgaria to develop its action plan.

Establishing the Planning Process

Table 2 provides a general indication of how the countries have structured their planning processes.

The Coordinating Team

All of the countries included in this report have recognized the importance of involving, in plan development,

Figure 1. Steps Used by Bulgaria for Overall Plan Development

1. **Design an Effective Planning Process**
   Create an organizational framework for preparing the action plan, including establishing an interagency analysis team, government agency teams, and a project steering committee.
2. **Define the Overall Plan Objectives and Sectors to be Addressed**
   Outline the action plan so that it integrates climate change concerns into the planning process of the energy, forestry, agriculture, and waste management sectors; and makes provisions for raising public awareness of plan implementation.
3. **Prepare a Comprehensive Work Plan**
   Develop a sequence of actions.
4. **Evaluate and Develop Sectoral Measures**
   Prioritize and select measures for different sectors of the economy.
5. **Perform a Comparative Analysis of Measures Across Sectors**
   Conduct a comparative assessment of the likely effects, costs, and barriers to implementation, to determine priorities for investment.
6. **Prepare Implementation Strategies for Selected Measures**
   Identify organizations with responsibility for lead implementation, resources for implementation, and schedules.
7. **Prepare and Adopt the Climate Change Action Plan**
   Prepare a draft of the plan and discuss it with government agencies, NGOs, and the public.
8. **Integrate the Plan with Other Development Plans and Programs**
   Integrate the action plan with other national plans, such as the energy master plan, the industrial energy efficiency plan, and the environmental strategy.
9. **Implement the Climate Change Action Plan**

This sequence of steps is very similar to the process outlined in *Steps in Preparing Climate Change Action Plans: A Handbook* (Benioff and Warren, 1996), prepared by the USCSP. It is worth noting, however, that many countries are implementing these steps in parallel, rather than following a strictly linear sequence.

the various government agencies that will be involved in implementing the action plan. Without exception, all of them have established interagency teams to lead the preparation of their plans. These teams typically include representatives from the agriculture, energy, environment, forestry, and other affected agencies. By engaging the implementing agencies in the process of plan development, the country teams are helping to ensure that these agencies take ownership of the plan and integrate the climate change measures into their sectoral programs and plans. In many cases, the countries have also created sectoral teams to coordinate the design of measures for specific sectors. In some countries, sectoral task forces have not been created because sectoral representation to the study team was considered sufficient, or because sectoral experts will have the opportunity to analyze and evaluate sectoral adaptation and mitigation measures before the plan is finalized.

Plan development always happens under the auspices of one or more government agencies. The table shows which government ministry or department has been given principal oversight for developing the national action plan. This varies little from country to country. All have placed responsibility with the environment ministry, but in a few cases ultimate responsibility for the plan is shared with other agencies.

Public Involvement

More than half of the countries have included a mechanism for building public support for their action plans. Some have sought public participation in the planning process, either during the initial scoping stage, or else through some kind of participatory process while the plan is still in draft form. Others chose to generate support through media activities at the time the plan is launched.

Table 2. Overview of Entities Participating in the Planning Process

Participation in the Planning Process	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
The Coordinating Team											
Government department(s) with principal oversight:											
Agriculture		✔			✔						
Energy		✔									
Environment / Natural Resources	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Foreign Affairs				✔							
Sectoral teams created		✔		✔	✔				✔		
Public Involvement											
During initial fact-finding					✔						
Prior to final completion of plan	✔	✔			✔					✔	
Through public presentation of completed plan	✔				✔		✔	✔		✔	
Participation by NGOs											
Consulted during planning	✔	✔		✔	✔	✔		✔		✔	✔
Given responsibilities for implementation					✔		✔				

The Gambia chose to involve the public at every stage of the plan's evolution, using a bottom-up approach to plan development. During the initial fact-finding stage, meetings were held throughout the country, drawing participants from all walks of life, including farmers, fishermen, herders, local leaders and elders, youth and women's group leaders, educators, foresters, and local administrators. At these meetings, people had the opportunity to discuss their concerns and experiences relating to climate variability. Their comments were recorded and incorporated into reports. These local level reports were then synthesized and discussed at the regional level. These regional level reports are, in turn, to be discussed at a national forum to be held at the end of 1997 or beginning of 1998. The document emerging from the national forum will be the national action plan.

Participation by NGOs

Most of the countries are relying on NGOs, either for their expertise during the planning stage, or to help with implementation after the plan has been officially approved. Many NGOs are funded by international development organizations or other financial sources outside the country's borders, and can play important roles in securing resources for plan implementation. In a few cases, the NGOs will also, in return, be given support by the national government. Bolivia, for example, is providing various kinds of technical support to NGOs involved in the consultation process, including training on mitigation of greenhouse gas emissions and adaptation of ecosystems.

Establishing Objectives and Priorities

Most countries used the results of earlier studies under the U.S. Country Studies Program to establish initial priorities for mitigation and adaptation measures.

Virtually all of the countries used some kind of participatory process to determine priorities. In most cases, this took the form of one or more scoping workshops attended by representatives of each economic sector and various government ministries and agencies. Egypt relied heavily on this process, holding orientation meetings for NGOs and several scoping meetings for the media, energy experts, agriculture experts, and others. The purpose of these meetings was to accomplish the following objectives:

- To review the results of past climate change studies, other relevant studies, and relevant planning documents (five year plans, environmental action plans, power generation expansion plans, the framework for the national action plan, etc.)
- To select initial priority sectors and possible measures
- To identify the national institutions that should participate in plan development, and create the planning teams in different sectors
- To raise the awareness of decision makers, NGOs, and the public
- To identify national expertise available to contribute to plan development

In Mexico, the national emissions inventory had identified energy production and consumption as the biggest contributors to the country's greenhouse gas emissions. Land use changes, deforestation, and livestock were also significant contributors. Considering these facts, and the investment opportunities offered by Mexico's current economic reforms, the country's interagency working group decided to emphasize technological options for mitigation, and recommended the analysis of 12 technologies in both the energy and non-energy sectors. Russia similarly decided to place emphasis on establishing a "bank of new technologies." Both countries have identified technology diffusion as one of the key objectives of their national action plans.

Preparing a Work Plan

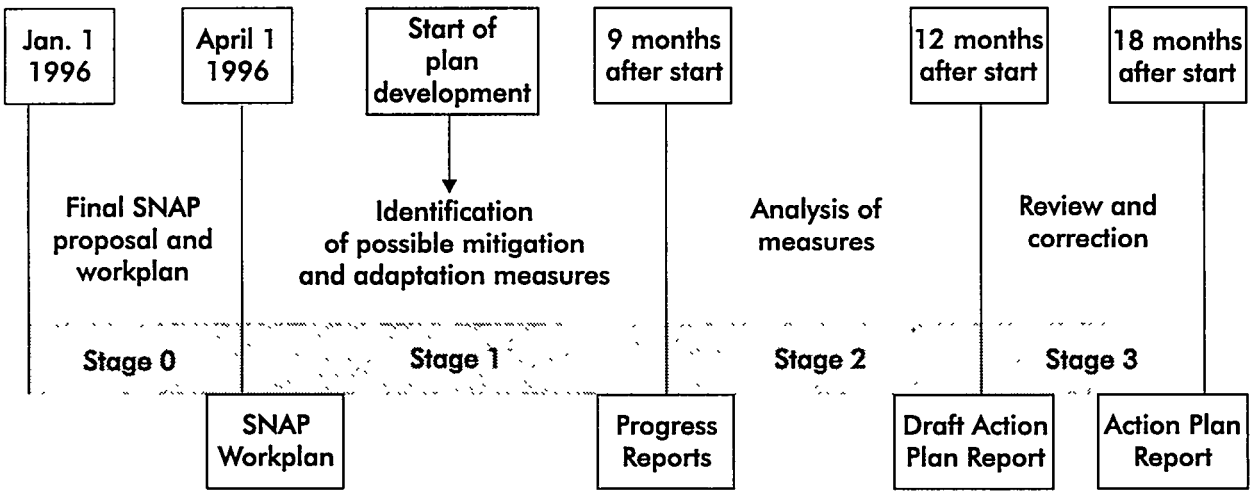
The countries have developed detailed work plans that delineate the steps, schedule, and products of plan development. Figure 2 provides an example, showing the steps and schedule of action plan development in Russia.

Evaluation and Development of Measures

Technology Assessments

Technology assessments have been of varying importance in plan development. These assessments include in-depth

Figure 2. Russia's Schedule of Action Plan Activities and Products



evaluations of the performance, costs, and impacts of alternative technologies. These assessments also evaluate implementation barriers and help countries to design measures to overcome these barriers.

Mexico is one of the countries that has relied most heavily on technology assessments. The country team decided to emphasize technological options for mitigation, and to begin plan development with detailed assessments of these technologies. The Mexican team is conducting these assessments in two phases (see Figure 3).

Screening and Evaluating Measures

A few of the countries have provided detailed information about the criteria they are using to screen and evaluate measures. The criteria vary depending on the sector and whether the measure is for adaptation or mitigation. Some of the countries also applied overriding general criteria to all of the measures. See Figure 4 for an example of a four-tiered approach to selecting measures.

Several countries emphasized the importance of selecting measures that will have a positive economic return. Another way to express this is that the measure should be "no regrets," i.e., have economic value even if predicted climate change does not occur. However, not all of the countries stipulated that measures must have a positive economic return. Many countries also considered other environmental and social impacts (both positive and negative) of the identified options and used these as part of their selection criteria. In most cases, the availability of funding also limited the choice of measures, as countries considered which measures could be implemented with available government funds or with international assistance.

The countries are using a variety of different analytical tools to analyze the impacts and costs of each potential measure. Although cost-benefit analysis is the standard approach used to enable comparisons between measures, the Bulgarian team commented that it was very difficult to assign a monetary value to the full range of benefits — such as human health, ecosystem integrity, and food security — of their measures. They chose to base their analysis on the cost-effectiveness of the measures.

Figure 3. The Two Technology Assessment Phases Used by Mexico

1. Rough-cut technology assessments

The rough cut assessments for the 12 technologies selected are based on generic cost and applicability information. The initial assessments rely heavily on data gathered though the country studies process. The assessments examine the likely technical, market, institutional, and social factors, and the economic costs or benefits, that could influence the acceptability and penetration of the technology. These initial assessments also identify likely partners or allies (such as specific business or industry associations, municipalities, and others) who could assist in implementing the option. The 12 technologies selected are:

- Efficient industrial electric motors
- Efficient industrial boilers
- Industrial cogeneration
- Commercial and residential efficient lighting
- Efficient water pumping systems
- Passenger transportation in the Mexico City Metropolitan Area (MCMA): electric and hybrid vehicles
- Passenger transportation in the MCMA: intermodal substitution
- Retail logistics for freight transportation in the MCMA
- Power generation: fluidized bed combustion
- Power generation: wind power
- Land use changes
- Efficient large-scale cattle farms.

2. In-depth analysis of promising options

Of the rough-cut assessments, three to four highly promising but marginal options will be identified for in-depth analysis. These analyses will include consultation with possible partners and allies who could help with the technologies, including representatives from the relevant economic sectors, researchers, and government officials. The most appropriate mechanisms for promoting technology implementation will also be evaluated. These could include voluntary programs, regulations and codes, public promotions, joint implementation, and other policies or programs.

Figure 4. Criteria Governing Selection of Water Resource Adaptation Measures in Bolivia

1. **Criteria for selecting all adaptation and mitigation measures:**
   - They must be consistent with Bolivia's General Plan for Economic and Social Development (1994)
   - It must be possible to integrate these measures into the sectoral development plans emanating from this national development strategy.
2. **Criteria for evaluating all adaptation measures:**
   - They must be achievable
   - They must have benefits with and without climate change
   - They must have low costs of implementation
   - They must not face any significant administrative, legislative, or other barriers.
3. **Criteria for evaluating water resource adaptation measures:**
   - Ability to maintain the quality of drinking water
   - Ability to guarantee the availability of water for irrigation
   - Ability to guarantee the quality of rivers
   - Ability to improve the control of water flows
   - Ability to ensure that water resources can be used for transportation
4. **Cost-effectiveness:**
   Viable options were then subjected to a cost-effectiveness analysis to determine the best choice for implementation.

Developing Sectoral Plans

The countries have used a wide variety of approaches to developing sectoral measures. Some countries created separate teams for each sector, while in other cases, the overall interagency team developed the sectoral measures. In certain cases, measures were developed through a stakeholder consultation process; in others, a team of analysts selected and designed the measures. Figure 5 shows the participatory approach used by The Gambia.

Official Adoption of Plan

Most countries have gone to great lengths to make sure that, by the time the action plan is presented to the government for official approval, the document will have the support of all of the key stakeholders. Egypt also made the point that, even after its plan has received official approval, it will be a living document, subject to continuing revision.

Thailand's process for adopting the plan is typical. The country team will present a draft plan to the general public for evaluation and amendment. After subsequent review by experts, the plan will be further reviewed by the Ministry of Science, Technology, and Environment; the National Environmental Board; and the National Committee on Climate Change. On approval by these groups, the plan will be presented to the National Economic and Social Development Board for consideration, and will then be sent to the Cabinet for final government approval. The final plan is expected to be integrated into the National Economic and Social Development Plan. It will then be shared through existing national communication channels, and possibly via the Internet.

Action Plan Measures

As mentioned, most of the countries participating in this report have not yet finalized their action plans or the selection of their measures. Because of this, the individual chapters, and the following summary tables, indicate measures that have been proposed but not yet officially approved.

When considering the range of action plan measures proposed, a couple of dominant themes emerge:

1. The various countries are developing a wide variety of measures, both to reduce emissions and to adapt to the various impacts of climate change.
2. Because climate change is not the highest development priority for any of these countries, most of them have identified a broad portfolio of "no regrets" measures that are cost-effective and also have other economic, social, and/or environmental benefits. All have developed measures that are consistent with their current development objectives.

Figure 5. Steps Used by The Gambia to Develop Sectoral Plans

1. Form sectoral task force by identifying institutions whose participation is required in the development of the plan and information gathering.
2. Identify lead and alternate agencies from the sectoral task force that will be responsible for the coordination and writing of the sectoral plan, and submission of information relevant to the national communications.
3. Conduct community-level scoping meetings to identify concerns at the grassroots level, and set priorities based on the national development plans and results of studies already conducted.
4. Identify and select measures by reviewing and screening the concerns expressed and the priorities set.
5. Evaluate and rank selected mitigation measures by determining their effectiveness.
6. Choose measures to include in the sectoral mitigation and adaptation plans.
7. Develop implementation strategies for each measure.
8. Write the sectoral mitigation and adaptation plans.
9. Submit comprehensive documented information that will form the sectoral contribution to the national communications.

Priority Sectors

Energy, forestry, and agriculture are the most commonly addressed sectors for mitigation, while adaptation measures tend to focus on forestry, agriculture, and water resources (see Table 3). None of the countries identified adaptation measures in the energy or fisheries sectors, and several countries highlighted the need for integration of mitigation and adaptation measures in the forestry sector. It is important to note that these are just the sectors that have been identified as key priorities to date. In some cases, omission of a particular sector solely reflects the fact that no detailed analysis of options in that sector have been conducted.

Consideration of the Country's Circumstances

Selection of measures depends largely on the specific circumstances of each country, either today or in the future. The Gambia, for example, has large areas of degraded and devegetated lands, so replanting with timber and fruit trees, and the use of agroforestry techniques, are particularly appropriate measures there. Hungary, on the other hand, has an age-old tradition of sustainable forest management, so it has less denuded land to replant. And Hungary's resources are already stretched so thin that its climate change strategy is based solely on enhancing ongoing government programs — in the energy and forestry sectors — that have incidental mitigating effects. As discussed under Methods, options for mitigation and adaptation cannot be considered in isolation from the economic, social, and cultural circumstances in the country. Bolivia cited some examples: property rights, current expansion of agricultural frontiers, traditional crop and livestock practices, and control over the use of forests. In other words, a sector or measure may be excluded because of overwhelming obstacles that are not related to technological hurdles.

Bulgaria has chosen to give a lot of attention to the transportation subsector of the energy sector. Although this sector is not currently a large source of greenhouse gas emissions, expected changes in lifestyle in the country are likely to significantly increase the demand for transportation. This would, in turn, result in a substantial growth of emissions originating from transportation activities, so the Bulgarian team has chosen to preemptively evaluate measures that will be important in the future.

Mitigation/Adaptation Balance

The countries have all strived for a balance between mitigation and adaptation. Because Russia is not currently facing any urgent adaptation issues, it has decided to divide funds equally between mitigation and adaptation measures. However, it also mentioned that, if some urgent adaptation measures become necessary, these will take priority over mitigation. Among mitigation measures, Egypt has given the greatest attention to reducing emissions in the energy sector because this is by far the country's biggest source of greenhouse gas emissions. On the other hand, the agriculture sector, water resources,

Table 3. Priority Sectors Identified for Mitigation and Adaptation

Priority Sectors	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
Mitigation											
Energy	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Forestry	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔
Agriculture	✔	✔		✔			✔	✔	✔	✔	✔
Waste Management		✔		✔							
Adaptation											
Forestry	✔	✔	✔					✔	✔	✔	
Agriculture	✔	✔	✔	✔	✔		✔	✔	✔	✔	
Water Resources	✔		✔	✔	✔		✔		✔		
Coastal Resources	n/a		n/a	✔		n/a	n/a				
Human Health									✔		

n/a = not applicable (no coastline)

and coastal resources are the sectors that are the most vulnerable to the possible impact of climate change, so these are the primary targets for future adaptation measures.

Cross-Sectoral Measures

A few countries are considering cross-sectoral measures for both mitigation and adaptation, including:

- Education to raise awareness of climate change and its possible consequences
- Information gathering to improve the scientific data on climate change and ecosystem responses
- Increasing research and development
- Strengthening institutional frameworks
- Examining and monitoring the impact of individual sectoral policies on the rest of economy

Russia is the country that appears to be most interested in analyzing cross-sectoral and regional interactions. The country intends to establish a centralized database of such interactions. About 30% of the budget in its initial, rough-cut action plan is for information gathering and dissemination activities, including standardizing observation methodologies and strengthening its network of measuring stations to collect better data on ecosystems, carbon stocks, and climate change.

Types of Measures

The various measures under development can be grouped into several classes, including:

- Educational programs
- Regulations, standards, and guidelines
- Voluntary agreements and programs
- Economic (fiscal) instruments and incentives
- Research and development programs
- Demonstration projects

Mitigation Measures

The countries participating in this report have put the greatest emphasis on the energy and forestry sectors to reduce GHG emissions and enhance carbon sinks. However, several countries are also developing mitigation measures for the agriculture and waste management sectors.

Energy Sector. Table 4 provides an overview of some of the measures proposed for the various energy subsectors. Among potential mitigation measures in the energy sector, by far the most commonly proposed solution to reducing greenhouse gas emissions involves increased use of renewable resources in the energy supply subsector. Other commonly proposed measures include efficiency upgrades to power plants, increased use of natural gas in energy supply, increased use of mass transit systems in the transportation subsector, a variety of efficiency measures

Table 4. Preliminary Energy Sector Mitigation Measures

Proposed Measures	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
Energy Supply											
Increase use of renewable resources	✔	✔	✔	✔	✔	✔	✔	✔		✔	✔
Upgrade/replace existing power plants		✔		✔		✔	✔	✔		✔	✔
Increase use of natural gas	✔	✔	✔	✔			✔			✔	✔
Increase use of nuclear power			✔								
Energy Demand: *General*											
Alter pricing structure to smooth/reduce demand		✔	✔					✔			
Energy Demand: *Residences*											
Efficiency measures in heating/cooking	✔	✔	✔	✔			✔		✔	✔	
Efficiency standards for household appliances	✔	✔	✔	✔					✔	✔	
Efficiency measures in lighting	✔	✔		✔				✔		✔	
Increase insulation		✔	✔								
Reduce the use of fuel wood					✔						
Energy Demand: *Public/Commercial Buildings*											
Efficiency measures in lighting	✔	✔		✔		✔		✔		✔	
Efficiency improvements in equipment	✔	✔		✔						✔	
Energy Demand: Industry											
Efficiency improvements in industrial equipment	✔	✔		✔			✔	✔	✔	✔	✔
Encourage cogeneration		✔		✔				✔		✔	✔
Conduct energy audits		✔					✔		✔		✔
Efficiency measures in heating		✔		✔				✔			✔
Efficiency improvements in industrial processes	✔								✔	✔	✔
Efficiency measures in lighting		✔		✔							✔
Transportation											
Develop/improve public transportation systems		✔	✔	✔				✔		✔	
Integrated transportation planning		✔	✔					✔		✔	✔
Efficiency improvements to gasoline vehicles	✔	✔	✔							✔	✔
Increase use of gas-powered vehicles	✔		✔	✔							✔
Improve traffic management			✔							✔	
Increase use of electric vehicles								✔			

in the residential sector, and improvements to the efficiency of equipment in the industrial subsector.

The energy sector is, for most countries, the largest anthropogenic source of greenhouse gas emissions and, therefore, an important target for mitigation. See Figure 6 for a description of effective, no-cost mitigation measures in Egypt.

Other countries also have the potential to save significant amounts of CO_2 through changes in the electricity supply sector. Kazakhstan has estimated that upgrades to existing power plants, in conjunction with increased use of renewable energy, would save a total of about 68 Tg of CO_2 in the years 2000–2020. In some countries, such as Hungary, existing power plants are currently in dire need of refurbishment, making this an excellent opportunity to implement carbon-saving efficiency upgrades or to switch to new, more efficient generating technologies.

Forestry. Table 5 provides an overview of some mitigation measures proposed for the forestry sector in each country. The most common approaches naturally involve afforestation, reforestation, and measures to protect existing forests.

Because of the importance of trees as a carbon sink and their sensitivity to changes in climate, forestry is the sector that shows the greatest need for integration of mitigation and adaptation measures. The Czech Republic, for example, has extensive forest cover today, but many of the tree species in those forests are at the edge of their ecological range. Hence, the viability of these trees is threatened by the predicted changes in climate. The preservation of existing forests as carbon sinks, and enhanced carbon sequestration by expanding the forest cover, both depend on introducing new species that are better adapted to the new climate. In other words, in the Czech forests, effective mitigation requires effective adaptation.

Agriculture. Although more than half of the countries represented in this report identified the agriculture sector as a target for mitigation, most of their agricultural measures concentrated on adaptation to climate change. There were, however, a few exceptions, illustrating the range of possible responses in this sector.

In Kazakhstan, for example, wheat is often grown on marginal, semidesert land with extremely low yields. Climate models predict that much of this land will be unable to support crops in the future. Planting these areas with perennial grasses and bushy vegetation would increase carbon reaccumulation in the soil after 7–8 years, at a rate of 300–650 thousand tonnes of carbon per year throughout Kazakhstan. Kazakhstan has also determined that it could save roughly 150 Gg/year of methane by reducing its livestock population, which consists mainly of sheep. By switching to different breeds, productivity could be increased enough to maintain total yields.

Thailand, Egypt, and Tanzania are exploring ways to cut their agricultural methane emissions by either reducing the area of land under rice cultivation or by altering rice-growing practices. Specific measures being considered include changing fertilizer inputs, reducing the duration of the period that the rice crop is submerged, or switching to upland rice varieties that do not require flooding. Bolivia is investigating ways to reduce the use of fertilizers for all of its crops.

Figure 6. "No Regrets" Mitigation Measures in Egypt's Energy Sector

In Egypt, the energy sector is 92% dependent on fossil fuels, contributing about 71% of the nation's greenhouse gas emissions. Because of this, Egypt has devoted most of its attention to developing mitigation measures for the energy sector. Although the country's plan is not yet finished, the action plan team has already identified more than 50 mitigation options for the energy sector that have negative cost; in other words, implementing any one of these measures is a "no regrets" strategy for Egypt, bringing a positive economic return even without taking climate change into consideration. Examples of "no regrets" options include cogeneration with back pressure steam turbines, which has a positive economic return of US$52 per tonne of CO_2; using twenty 60–MW wind farms for electricity production (US$38/tonne of CO_2); replacing 1 million lamps with efficient lighting systems (US$29/tonne of CO_2); cogeneration using gas turbines (US$12/tonne of CO_2); and waste heat recovery using boiler air preheating (US$5/tonne of CO_2). Of all the energy measures considered in Egypt, the use of wind for electricity generation was found to have the most positive social impacts. The Egyptian government has commenced construction of an 80–MW wind farm in the Gulf of Suez and plans to have 600 MW of installed wind capacity by the year 2005.

Table 5. Selected Forestry Mitigation Measures

Proposed Measures	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
Physical Measures											
Preserve/manage existing forests	✔	✔	✔			✔		✔	✔	✔	✔
Expand forests (afforestation/reforestation)	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Introduce new, more resilient species	✔	✔	✔			✔				✔	
Societal Measures											
Implement agroforestry	✔				✔			✔		✔	
Encourage community forestry	✔				✔						
Encourage grassroots tree planting					✔						
Increase punishment for cutting/burning					✔						

Egypt and Tanzania are also considering reducing methane emissions from anaerobic fermentation by improving the nutrition of farm animals. Egypt is contemplating installing farm-scale digesters to convert manure to methane gas for energy. And Mexico is interested in the use of large-scale cattle farms, where methane capture would be easier than on open ranges.

Waste Management. Only a few of the countries have elaborated measures that address emissions from waste. Bulgaria has identified the need to capture landfill methane, and Russia, which did not identify waste management as a priority sector, has already begun a joint implementation project (with the Netherlands) to capture methane at two large landfills in the Moscow area and use the gas to generate electricity. Figure 7 describes a waste-to-energy project in Tanzania.

Adaptation Measures

For the 11 countries in this report, the forestry, agriculture, water, and coastal sectors are the most common priority areas for adaptation measures.

Forestry. Most of the measures proposed for the forestry sector naturally relate to mitigation of greenhouse gas emissions by using forests as a carbon sink. Bolivia, Bulgaria, the Czech Republic, Hungary, and Tanzania have identified the need to introduce new, more resilient species of trees in order to maintain their forest cover. The forests of the Czech Republic are particularly vulnerable to changes in climate, and the government wants to improve forest access to facilitate a comprehensive program aimed at improving the viability of its forests, partly for their value as a carbon sink, and partly for their importance in reducing surface runoff. Mexico has gone so far as to identify forest adaptation as a key priority, but has not yet elaborated which measures it will adopt.

Agriculture. Most of the countries identified adaptation measures in the agriculture sector. Table 6 presents some of these measures.

Several countries have noted that, in some cases, encouraging farmers to diversify their crops and livestock holdings may be sufficient to ensure stable food production under changing climatic conditions. In other cases, however, especially where the predicted changes in climate are likely to have a significant detrimental effect on existing crop varieties, it will be necessary to introduce crops that are specifically adapted to, and more likely to thrive under, the new climatic conditions. Strengthening

Figure 7. A Waste-to-Energy Measure in Tanzania

The *Takagas* Waste-to-Energy Project

One example of a measure to reduce greenhouse gas emissions in Tanzania is a pilot project on energy recovery from municipal waste. Popularly known as Takagas, this initiative is to be implemented in Dar es Salaam. Taka is a Swahili word for waste, and Takagas is therefore gas from waste. The goal of the Takagas project is to reduce emissions of GHGs in Tanzania by substituting bioenergy (methane gas and electricity) — produced from anaerobic digestion of industrial and municipal waste in the Dar es Salaam area — for fossil fuels. Additional GHG reduction will be achieved by reducing the uncontrolled release of methane from improperly disposed organic wastes. Organic fertilizer will be produced at the same time. The plant will have a capacity to treat about 57 tonnes of organic waste per day, or about 3% of the daily waste generated in Dar es Salaam. The project combines methane emission reduction for GHG mitigation, with production of electricity, fuel for transportation, and fertilizer production. The installed capacity of the biogas plant will be 1 MW. The project is being funded by the GEF and the Danish International Development Agency (DANIDA). This project is a collaborative effort of the Ministry of Energy and Minerals, the Dar es Salaam City Council, and the University of Dar es Salaam.

Table 6. Preliminary Agricultural Adaptation Measures

Proposed Measures	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
General											
Increase diversity of agricultural production			✔		✔						
Provide advice to farmers	✔				✔				✔		
Crops											
Introduce/switch to climate-adapted crops	✔	✔	✔	✔	✔		✔	✔	✔		
Improve soil management to reduce erosion/runoff	✔	✔	✔		✔		✔				
Improve long-range forecasts for pests and diseases		✔					✔				
Livestock											
Reduce population to match carrying capacity					✔						
Redirect grazing to better ranges							✔		✔		

a country's agricultural base typically involves careful screening of current and proposed crop cultivars to determine which varieties are likely to be resilient enough to withstand the potential climate changes. In Bolivia, introducing climate-adapted crops means reintroducing native species, which the team has identified as being more resilient than current crop varieties. By reintroducing hardy native plants that can be used for livestock fodder, this measure will also help to reduce the vulnerability of livestock to climate change.

In Kazakhstan, wheat production is already affected by pests and disease, a problem that is predicted to get worse under anticipated climate change. One way to minimize the impact of this is to improve the ability of agricultural research institutions to make accurate, long-range forecasts of impending infestations. This would give farmers the time to acquire and apply the appropriate insecticides and/or fungicides.

Water Resources. A handful of countries identified adaptation measures for dealing with projected changes in their freshwater supplies. Table 7 presents some of the more commonly proposed measures, although the individual country chapters discuss a much wider range of approaches.

Because water is so important for agricultural production, there is often an overlap of adaptation measures in these two sectors. In The Gambia, for example, the saline/freshwater interface in the River Gambia is expected to move 40 km farther inland, reducing the availability of freshwater from the river for agricultural purposes. One of The Gambia's proposed adaptation measures is to introduce early-maturing and salt-tolerant crops to minimize the requirements for fresh irrigation water.

Egypt is one of the countries in this study that has the most to gain from finding appropriate adaptation measures to deal with reductions in supply. The country has extremely limited freshwater resources, and is more than 90% dependent on sources originating outside its national borders. However, the country's adaptation measures are still under development, so Egypt's full strategy is not reflected in the table.

Coastal Resources. Adaptation to the threat from rising sea levels is usually one of the more important considerations in connection with potential climate change. However, of the 11 countries submitting chapters for this report, four (Bolivia, the Czech Republic, Hungary, and Kazakhstan) do not have ocean coastlines and one (Bul-

Table 7. Selected Freshwater Adaptation Measures

Proposed Measures	Bolivia	Bulgaria	Czech Republic	Egypt	Gambia	Hungary	Kazakhstan	Mexico	Russian Federation	Tanzania	Thailand
Water supply											
Expand rainfall catchment and containment							✔				
Increase use of groundwater resources					✔		✔				
Promote decentralized rainfall harvesting					✔						
Control water flows to stabilize supply	✔		✔								
Water demand											
Improve monitoring of usage rates					✔						
Reduce agricultural demand by switching crops				✔	✔						
Switch to low-water technologies							✔				

garia) has a coastline along the Black Sea. Therefore, adaptation to rising sea-levels receives less attention in this report than it would if more of the participating countries had vulnerable coastlines. Figure 8 presents some of the coastal adaptation options being considered by Thailand.

The coastal zones of Egypt are highly vulnerable to the impacts of a rise in sea level, particularly in the fertile lowlands of the Nile Delta. Several highly populated cities are located in this area, encompassing a large portion of Egypt's industrial and economic sectors. Alexandria alone hosts the country's main harbor and about 40% of Egypt's industrial activities. Egypt is a clear candidate for coastal adaptation; however, its assessment of adaptation measures is still under way.

Tanzania also noted the potential vulnerability of its coastal resources, but chose to focus its action plan on measures in the energy, forestry, and agriculture sectors. Measures in other sectors that were deemed important, including coastal resources, water, and health, would not be covered because of limited resources to carry out the investigation.

Implementation Strategies

While none of the countries has yet established an implementation schedule, most of them have already given some consideration to implementing their portfolio of mitigation and adaptation measures. This section reflects some of the components of plan implementation that are common to most of the countries.

Responsibility for Implementation

In most countries, but not all, the ultimate responsibility for implementing the action plan falls to the same coordinating body that had responsibility for developing the plan. In some cases, responsibility is devolved to individual ministries and agencies with a sectoral focus; the original coordinating body then retains responsibility solely for intersectoral coordination. In other cases, the body responsible for plan development hands responsibility over to its parent ministry or another interagency group consisting of high-ranking government ministers and other officials.

The Gambia and Kazakhstan have specifically identified the importance of involving NGOs in implementation of the plan. In Kazakhstan, NGOs and nonprofit organizations will be responsible for implementing smaller, lower cost projects. The country's action plan includes provisions for providing additional training to project managers and to some of the personnel responsible for technical fulfillment of projects.

Financing

While all of the countries are looking for financial support from international donors to implement action plan measures, most have also identified existing government resources available to support measures, especially those

Figure 8. Coastal Adaptation in Thailand

Thailand's case is a good illustration of some of the measures that can be proposed. Its coastal regions are also vulnerable, and the Thai country team has considered a number of adaptation options, including:

- **Artificial preservation of coastal ecosystems through the use of weirs**
- **Artificial introduction of fresh water to counter increased salinity on coastal farmland**
- **Construction of sea walls to reduce erosion and flooding**
- **Artificial replenishment of beaches at resorts**
- **Abandonment of marginal coastal farmland**
- **Relocation of coastal villages**
- **Redesign of wastewater treatment plants in areas where wastewater is released to the sea by gravity flow.**

However, Thailand is still in the early stages of preparing its plan and has not yet decided whether coastal resources are going to be included as one of the target sectors.

that have multiple benefits. However, estimates of a country's ability to finance its action plan vary greatly, from virtually none to about three-quarters of the total cost. The following three examples illustrate the wide range of circumstances in different countries.

The main priorities for Bolivia, as with many other developing countries, are to reduce its high levels of poverty and unemployment, and to improve the health and education of its people. While Bolivia has identified a series of effective mitigation measures, the country's chapter also makes it clear that these measures can be carried out only with international financial and technical support, and that Bolivia does not have any resources to devote specifically to climate change issues. However, the country also underscores its desire and commitment to find jointly implemented solutions to prevent climate-related global disasters.

Kazakhstan has determined that its government can undertake about 15–20% of the total cost of the measures proposed in its plan. These financial resources will initially be drawn from Kazakhstan's fund for nature protection, which consists of receipts from waste removal taxes, pollution taxes, fines for damaging the environment, etc. Additional financing could come from funds set aside for medical insurance, agriculture, and energy conservation. Because of a lack of private investment financing in Kazakhstan, additional financing will have to come from foreign investors and international financial organizations, including a recently created World Bank fund for supporting privatization.

Russia has determined that its government can cover 72% of all expenses associated with implementation of its Federal Target Program on Climate Change, a three-year program that unifies all initiatives on climate change within the country, including joint implementation projects and its national action plan. The country has also underscored the importance of encouraging private investors to finance climate change projects.

Outreach

As Kazakhstan points out, implementation of the action plan is impossible without widespread public education and enlightenment of political and governmental officials, manufacturers, and private businessmen on the problems of climate change. One of Kazakhstan's NGOs is preparing a series of telecasts on climate change issues for the most popular television channels. A series of articles and brochures are also being planned that will explain the problems of climate change, the activities of people that prevent the possible negative consequences of global warming, and ways to reduce GHG emissions and adapt to impending climate change. And Mexico, in addition to other outreach initiatives, has set up a separate government office to ensure timely outreach to the industrial sector.

Monitoring Plan Effectiveness

Few countries addressed this aspect, partly because they are not far enough along in developing their action plans. In Mexico, the central coordinating body will monitor the effectiveness of the plan through annual reports from the various agencies involved in implementation. In Kazakhstan, once the plan has been adopted by the government, arrangements will be made to establish a special group for monitoring the implementation of projects, estimating their efficacy, and developing feasibility studies. This group will also manage the competitive selection of projects, corrections to work content, and finding additional financial resources to implement the plan.

Common Issues and Lessons

Understanding of Climate Change Issues

Several countries observed a lack of awareness among the general public about the potential threats of climate change. Egypt noted that, although it is one of the countries that is highly vulnerable to the possible impacts of climate change, "the volume and potential risks of that vulnerability are still unknown to a large segment of the society. There is an urgent need for public awareness and mass communication to give the climate change issue a place among other pressing local environmental and developmental priorities."

The Gambia's experience, however, was quite different. The country's initial community-level scoping meetings revealed that people in these communities knew more than was expected about climate change, and many have already learned to adapt to climate variability and change from their ancestors. The communities have actually detected the variability of the climate and some of its consequences. They have noticed, for example, that many reservoirs have dried up; streams have silted up, blocking flow of water from the main river; and they see the connection between this and the overall drop in production from agriculture and fisheries. At these meetings, participants were able to list most of the flora and fauna that have been lost due to the drier conditions resulting from the series of droughts in the 1970s and 1980s. People in

these communities had excellent ideas on mitigation and adaptation to climate variability and change, many of which are being translated into measures and activities in the country's action plan. The Gambian team commented that, because of the high degree of awareness among the public, and their high level of participation, the Gambian action plan truly belongs to the people, something that will probably improve its chances of success. The plan will be taken back to the communities for them to implement, with coordination and guidance from the National Climate Committee and the sectoral task forces.

The science of climate change is also not well-understood in many countries, which is part of the reason why several of them have identified the need to strengthen their domestic analytical capabilities in this field. The most commonly suggested solution involves training by representatives of countries in which the science of climate change is more fully developed, but this is just a stop-gap measure. As Egypt points out, climate science needs to be taught in local universities at graduate and undergraduate levels. This is one aspect of the long-term process to strengthen the country's own capacity to deal with climate change. A few countries also mentioned the need to improve recognition of the importance of climate change issues relative to other developmental priorities among decision makers.

The Need for Financing and International Cooperation

As noted earlier, some countries have indicated a strong need for donor funding to implement their action plans, while others expect to rely primarily on existing domestic resources.

Most of the countries in this report noted the economic challenges they face and the difficulty they have in justifying the diversion of resources to climate change mitigation and adaptation. In some cases, such as Hungary's, the only option is to build on existing government programs that also will contribute to GHG reduction. This is the reason why Hungary is concentrating its initiatives in the energy and forestry sectors.

Many countries identified a crucial need for international cooperation to facilitate technology transfer and deployment. According to Egypt, barriers to technology transfer should be removed. Such barriers could include: intellectual property, weak institutional capacity, lack of technology information, lack of financing mechanisms for clean technologies, lack of incentives to promote technology transfer, and lack of infrastructure to support technology transfer.

Challenges Specific to Countries in Transition

All of the transition countries are experiencing similar challenges as a consequence of making the shift from a centrally planned to a market-driven economy. In Bulgaria, for example, the attention of the government and populace is focused on the successful implementation of market reform, privatization, and the establishment of capital markets, in addition to solving urgent social problems arising in the transitional period. Furthermore, Bulgaria's environmental policy agenda includes issues with higher priority than climate change, issues such as air quality and transboundary pollution that call for near-term solutions. These factors made it difficult to assign sufficient resources to the preparation of Bulgaria's action plan.

Hungary's emissions inventory showed a 25% drop in greenhouse gas emissions between the 1985–1987 average and 1994, an observation common to several transition countries. However, this decrease was caused primarily by a deep economic recession. Therefore, Hungary's policy makers, as with policy makers in other transition countries, face the challenge of achieving economic recovery without significantly increasing GHG emissions.

Because Kazakhstan is such a newly independent country, its government structure is in a state of flux. For the past few years, the country has been implementing institutional reforms to reduce the number of civil servants and to streamline and rationalize decision making. This makes it difficult to create a clear picture of how the action plan will be implemented, and to identify which agency or department will be responsible for each implementation activity. This is not a problem peculiar to Kazakhstan; it is a consequence of the dramatic changes that many transition countries have experienced in recent years. Another issue that could impair effective action on climate change issues is the present lack of coordination among the various parties involved, again a consequence of shifting priorities and responsibilities during the period since the team was originally formed in 1993. However, the country team has taken steps to remedy this situation, and the government will shortly be creating a new interagency commission to coordinate implementation of the country's national action plan.

International Cooperation

All of the countries in this report have identified a general need for international assistance with plan implementation, either financial assistance with measures and projects, or technical assistance with climate change mitigation and adaptation technologies. However, because most of the countries have not completed their action plans, they have not yet identified specific projects or measures that require assistance.

Five countries did identify specific opportunities for international assistance, and some of their projects and measures are summarized below. A more comprehensive list of projects is provided in the International Cooperation section in each country's chapter.

Bolivia has already contacted foreign agencies and others that might be interested in helping to develop projects related to reducing greenhouse gas emissions. The country's chapter lists several projects, which include reduced flaring and increased recovery of natural gas, finding alternatives to burning forests and pastures while allowing the extension of cultivable areas, and undertaking demonstration projects to reduce the emissions of methane from cattle.

Egypt lists a number of projects related to technology transfer, including technical assistance with projects, establishment of energy service companies, assistance with securing project financing for clean energy technologies, as well as assistance with climate research, observation, and monitoring.

Hungary is seeking assistance with ongoing mitigation activities, which have slowed down due to a lack of funding, or with new projects in geothermal energy and efficiency improvements to public buildings.

Kazakhstan stated a need for assistance with a number of renewable energy projects using solar, wind, and hydro resources, and has identified at least 25 locations that are suitable for small hydropower plants. It also expressed interest in obtaining assistance with coal-bed methane collection and utilization at the Karagandy coal basin, and with collecting and utilizing the gas encountered when drilling for oil.

Tanzania lists several technical assistance needs, including a variety of analytical tools, training on conducting technology assessments, and help from international experts with policy design and drafting. A few countries, Tanzania among them, identified the importance of learning from the experiences of other developing and transition countries, especially those in the same geographic region.

Although The Gambia has not yet developed a specific list of projects or measures requiring assistance, the country's chapter does note that, as a least developed country, The Gambia will rely heavily on international assistance and cooperation to implement the projects contained in its action plan. Assistance will be required in the form of financing and capacity-building, especially in the development, acquisition, and diffusion of appropriate technologies.

In addition to funding by international climate change and development agencies, several countries are seeking to attract business investors. Kazakhstan, for example, is seeking commercial investment to construct its 40-MW Djungar Gate wind power plant. And Bulgaria is currently in the process of adopting new regulations and legislation to improve the investment environment for both domestic and foreign investors.

BOLIVIA

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Summary

The general objective of the Bolivian National Climate Change Action Plan is to develop a plan that will include all the measures concerning climate change issues and its corresponding process planning and programs. These programs are aimed at meeting specific goals for ecosystems adaptation and for greenhouse gas (GHG) mitigation in the energy and non-energy sectors. The National Climate Change Action Plan will also be used as a basis and support for the Bolivian National Communication to be presented to the United Nations Framework Convention on Climate Change (UNFCCC).

The primary sectors to be addressed in this plan are the energy and forestry sectors. This determination is a result of the initial technical studies carried out in Bolivia in reference to GHG emissions and vulnerability of the ecosystems as a response to a potential climate change. The magnitude of emissions resulting from these two sectors were the most significant among the GHG emissions, using 1990 as the base year.

Although there are several recommended measures for improving energy efficiency, they have not yet been finalized and approved at an intersectoral level. The proposed energy efficiency measures cover the residential, commercial, and industrial sectors. They also include the increased use of natural gas in the residential and transportation sectors, and growth in the use of renewable energy in the rural areas of the country. In the same manner, the Plan also proposes the use of new technologies in the cement industry, which plays an important part in the industrial processes sector.

In the forestry sector, the measures include increasing the capacity of forests to act as carbon sinks and investigating alternatives to burning, promoting sustainable management practices, and supporting the laws and regulations that reduce deforestation. At the same time, they will support the implementation of programs to adapt forests to potential climate change.

Finally, the goals are intended to establish policies for adapting the agriculture, livestock, and water resource sectors to potential climate changes. The sector priorities, referring to measures of mitigation and adaptation, are presented in Table 1.

Introduction

Results of Past Studies

The National Climate Change Program of the Vice-Ministry of Sustainable Development and Environment of the Ministry of Sustainable Development and Planning, with the support of the U.S. Environmental Protection Agency (EPA), has developed the first national inventory of anthropogenic GHG emissions, vulnerability and adaptation analyses of the main economic sectors to potential climate change, and studies of GHG mitigation options.

Vulnerability

The preliminary analysis establishes the level of vulnerability that four sectors (forests, water, livestock, and agriculture) will suffer due to potential climate change. A general result of the study is that Bolivia, a self-sustained, landlocked Andean country with geographic contrasts, is very vulnerable to climate changes.

Forestry Sector. Analysis of General Circulation Model (GCM) scenarios for a doubling of CO_2 and incremental scenarios (+2° C and +/–10% precipitation) indicate that the area of humid subtropical forests could decline, whereas the areas of dry and humid tropical forests are predicted to increase. However, the total area of forest will not be reduced; rather, the type of forest will change.

Water Resources. All the scenarios presented predict reductions in water flows, although there are also some

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Proposed Measures
Mitigation	
Energy: *Residential — Urban and Rural*	■ Energy Efficiency
Commercial	■ Energy Conservation
Industrial	■ Energy Conservation
Transportation	■ Increased Use of Natural Gas
Natural Gas Production	■ Energy Conservation
Electricity Generation	■ Increased Use of Renewable Energy
Industrial Processes: *Cement Industry*	■ New Technologies
Forestry: *Forests and Grasslands*	■ Forest Management and Afforestation
	■ Regeneration of Forests and Pastures
Protected Areas	■ Legislation and Control
Agroforestry Systems	■ Investigation of Alternatives to Burning
Land & Cattle: *Rice Crops*	■ Improving Rice-Drying Techniques
Highlands and Valleys	■ Replacing Use of Fertilizers
	■ Prevention and Control of Land Degradation
Productive Infrastructure	■ Improving the Irrigation Infrastructure
Adaptation	
Forestry: *Forests and Grasslands*	■ Reforestation and Afforestation
	■ Sustainable Management of Forests
	■ Reduction of Habitat Fragmentation
	■ Introduction of Tolerant Forest Species
Land & Cattle: *Highlands and Valleys*	■ Biodiversity Management
	■ Water & Soil Management
Productive Techniques and Infrastructure	■ Improving Productive Infrastructure
Education	■ Technology Transfer
Hydro Resources: *Main Basins*	■ River Basin Planning

predictions of relative increases during low-water periods. These results should be taken with caution.

Livestock Sector. Although the study showed that livestock and pastureland are affected by climate change, the GISS model indicates that the weight of animals would increase with changes in climate patterns, whereas the UK89 model indicates a weight loss with climate adjustments and a doubling of CO_2. Both models show that changes in green biomass depend on variations in the length of the seasons.

Agriculture Sector. The analysis modeled four representative crops: potato for the Andean zone, corn for the valley area, and rice and soybeans for the plains. These crops constitute the most important economic factor for these regions in terms of self-consumption, export, and the generation of foreign currency. This is particularly true for soybeans, whose agricultural production constitutes one of the pillars of the Bolivian economy.

Potato. Analysis indicates a rise in temperature and rainfall on the Altiplano areas, which will benefit the quality of the soil and increase the potato crop yields.

Corn. The analysis shows that the reaction of corn differs in accordance with hydrological conditions. Under wetter regimes and temperature increases, there would be an appreciable reduction in the vegetative cycle and, hence, corn yields. As a rule, however, yields under dry conditions increase by up to 50%.

Rice. Rice-growing areas are predicted to have increased rainfall and floods; however, rice could be produced in an optimum way, boding a large potential for national consumption. If rice cultivation is expanded under climate change conditions, however, it would be necessary to perform an analysis of the methane emissions.

Soybeans. The analysis indicates that the yield variations should only be affected by an increase of carbon dioxide. This fact seems to be a determinant factor in the soybeans crops. The next two decades are indicated as

the most critical scenarios in soybean production because greater support will be required until the quantity of carbon dioxide becomes significant and suitable for the growth of the crop.

Emissions Inventory

Table 2 shows the results of the Bolivian emissions inventory of GHGs for 1990, which was calculated in accordance with the "IPPC Guidelines for National Inventories, 1995." Although not indicated in the table, Bolivian CO_2 emissions from the energy and industrial sectors constitute only 0.027% of the worldwide emissions and 0.55% of the Latin American emissions. Bolivia's CO_2 emissions from agriculture and land use comprised only 0.85% of worldwide emissions.

Adaptation and Mitigation Options

The analyses identify cost-effective measures for adaptation to climate change and for mitigation of GHG. Of the many options considered, those that were most cost-effective, while meeting the objectives of both the National Development Strategy and the National Climate Change Action Plan, were given highest priority. Although Bolivia recognizes the importance of climate change issues, cost-effectiveness is critical because of the country's insufficient economic resources. Bolivia faces acute poverty and educational and health problems. Thus, it will be difficult for the country to give priority to investments related only to the effects of climate change. Even cost-effective measures will require aid from the international community.

Adaptation Measures. Adaptation measures were identified for forests, water resources, crops, and livestock and grasslands.

Forest Resources. In order to minimize the negative impacts that climate change and anthropogenic activities have on forests, specific adaptation measures were outlined. The cost-effectiveness analysis identified the lowest costs that will enable reaching five objectives: conservation of biodiversity, rational exploitation of resources, socioeconomic development, efficient wood production, and conservation of protected areas. The application of clearing techniques generates greater benefits than the other options.

Water Resources. The proposed adaptation measures were prioritized according to the following objectives: improve the quality of the drinking water, guarantee availability of water for irrigation, guarantee the quality of rivers, improve the control of water flows, and guarantee water resources for transportation. The option chosen in the cost-effectiveness study was the one that applied to the Planning of Basins. According to this, the country will have the capacity to have adequate control and management of the basins.

Table 2. Emissions of Greenhouse Gases, 1990

Sources	Emissions (Gg)					
	CO_2	CH_4	N_2O	NO_x	CO	NMVOCs
National Emissions	56,513.93	597.04	0.847	30.52	1,088.69	0.00
Energy Sector	6,246.75	13.90	0.000	0.00	0.00	
Combustion	6,246.75	0.00				
Fugitive Emissions	0.00	13.90				
Industrial Processes	260.46					
Agriculture		457.80	0.057	2.06	86.45	
Land Use Change and Forestry	50,006.72	114.54	0.790	28.46	1,002.24	
Waste		10.80				

Source: Paz et al., 1997a

Crops. The options chosen were the ones that had the greatest number of factors in their favor, including: management of water and soils, protection of biodiversity, education, transfer of research and technology, and adaptation of crops to new climate conditions. In general, selected options present similar implementation characteristics in terms of costs and application. But a preference is given to projects that develop public awareness while educating and training the participants in this process.

Livestock and Grasslands. The adaptation analysis examined several factors, including: identification of persistent pastures; introduction of native pastures; introduction of another type of livestock; migrations to other sites; changing the periods when animals are put out to pasture; and supplementary diets. The objectives of the adaptation analysis were identified as: conservation of biodiversity, benefits in the production of forages, efficiency of livestock production, prioritization of native species, and palatability of fodder for different types of cattle. The options chosen in the cost-effectiveness study were the identification of persistent pastures and the introduction of native pastures.

Mitigation Analysis. This analysis identified measures in both the energy and non-energy (forestry) sectors.

Energy Sector. It is estimated that Bolivia's energy demand will be 1.88 times higher in 2010 than it was in 1990, and 3.66 times higher by the year 2030. The analysis identified several measures for mitigating GHG emissions, including increasing the efficiency of lighting in the residential and commercial sectors, increasing the efficiency of wood-burning stoves, increasing the efficiency of residential refrigeration systems, increasing the use of natural gas in the residential and transportation sectors, increasing the efficiency of commercial use of biomass, implementing commercial and industrial energy conservation, reducing the burning of natural gas in the exploitation fields, increasing the use of solar energy in the residential sector, and changing the country's plans to expand generating capacity.

Under these measures, Bolivia's energy sector is expected to reduce its energy use by 4.8% for the year 2000, 8.96% for the year 2010, 10.91% for the year 2020, and 15.71% for the year 2030. This will reduce total CO_2 emissions by 6.35% in 2000, 12.05% in 2010, 15.82% in 2020, and 21.75% for the year 2030.

Non-Energy Sector. The analysis calls for implementing the new Bolivian Forestry Law and the Law of the National Agrarian Reform Institute. The application of these laws will cut the current deforestation rate, which will result in an increase in expected carbon sinks, especially in the east region of the country. The analysis also contemplates the creation of new protected areas with international support.

Current Programs

Bolivia ratified the United Nations Framework Convention on Climate Change (UNFCCC) in July 1994. This was done through Decree No. 1576. This act was approved by the UNFCCC in November 1994. The Former Ministry of Sustainable Development and Environment (now the Ministry of Sustainable Development and Planning), through the National Secretary of Natural Resources and Environment (now the Vice-Ministry of Sustainable Development and Environment) and the National Climate Change Program (NCCP), initiated work aimed at meeting the country's obligations under the UNFCCC.

The NCCP, with the cooperation of the U.S. EPA, developed the project "National Emission Inventories of Anthropogenic GHG and its Impact on Ecosystems." Currently, the NCCP is working on the National Climate Change Action Plan.

With the support of the United Nations Development Program, the NCCP is working with the League of Defense for the Environment, an NGO, to prepare the Implementation Strategy of the UNFCCC. In the same manner, the government of The Netherlands is providing technical and financial support for complementary work on emissions inventories, climate scenarios, and mitigation options for the non-energy sectors.

Information is being provided by the former National Secretary of Energy, the former National Secretary of Agriculture and Livestock, the National Service of Meteorology and Hydrology, the National Institute of Statistics, the former National Secretary of Natural Resources and Environment, and others.

Similarly, the team is preparing the National Program on Joint Implementation, which will be created to support Joint Implementation activities approved in the First Conference of Parties (COP 1) in Berlin. The National Program on Joint Implementation will be formed by governmental, nongovernmental, and academic institutions, and the office will be within the Ministry of Sustainable Development and Planning.

In terms of developing strategies to reduce GHG and to establish carbon sinks, the team is working with the Vice-Ministry of Energy and Hydrocarbons and the Gen-

eral Direction of Biodiversity. It is expected that the National Climate Change Action Plan will be approved at an interagency level and will be part of the National Development Strategy.

National Communication

The National Climate Change Action Plan, along with the National Inventory of GHGs and other studies, is the main source for the National Communication. This last document will reflect the results of the Country Study, the adaptation and mitigation options, and the evaluation of technologies and their development. The National Communication will also show the implementation process of the National Climate Change Action Plan.

The National Communication will also show the effort made by each participating institution. The goals of the implementation through international agreements will be based on the work performed by these institutions. The main goal will be to reach a coordinated plan that will meet the goals of the Environmental Law and the commitment made to the UNFCCC.

Objectives

General Objective

The general objective is to develop a plan that encompasses all of the measures, programs, plans, and projects that have specific goals for adaptation of ecosystems and for mitigation of emissions of GHGs in the energy and non-energy sectors.

Another objective is to establish the basis and the determination of the elements to support the National Communication.

Specific Objectives

The Bolivian National Climate Change Action Plan will also accomplish the following specific objectives:

- Evaluate the response capacity of ecosystems to the adaptation measures of ecosystems and the mitigation of GHG emissions previously identified in the Bolivian National Climate Change Program for the agricultural, energy, and forestry sectors.
- Formulate implementation strategies for adaptation measures to ecosystems and of the mitigation of emissions of GHG identified by the National Climate Change Program in Bolivia.
- Develop consensus among the governmental decision-making levels and other public, academic, and private institutions to implement adaptation measures for ecosystems and to mitigate emissions of GHGs in the agricultural, energy, and forestry sectors. This is being done to promote a significant change in the national energy, agriculture, and forestry policies that will contribute to the reduction of GHG emissions and create a positive impact on the economy of the country.
- Develop the capacity of the country to prepare evaluations of technology for climate change issues and formulate development programs of technology initiatives related to climate changes.
- Facilitate the exchange of information and technical support in reference to technology measures concerning climate change for the agricultural, energy, and forestry sectors.
- Develop the necessary expertise in the use and management of analytical tools, such as decision models, and data bases to be used in the sectors to be analyzed. This expertise will allow the team to formulate and implement measures in reference to climate change issues.
- Strengthen the capacity of the Bolivian National Climate Change Program to update and review the emission inventories, the vulnerability and adaptation of ecosystems analysis, and the GHG mitigation analysis.
- Identify sectoral climate change action projects that can be financed by international organizations or by Annex 1 countries of the UNFCCC.
- Establish mechanisms for education and information dissemination at all levels.

Methods

Institutional Involvement

To develop the National Climate Change Action Plan and achieve the goals outlined in it, the country relies on the Ministry of Sustainable Development and Planning, Portfolio of State, which is delegated to comply with the related activities of the UNFCCC in Bolivia, and which has, as its fundamental assignment, the guiding of the development of the country within a framework of balance and coordination among human development, environmental quality, and the maintenance and recuperation of the natural renewable resources. Within this Ministry is the Vice-Ministry of Sustainable Devel-

opment and Environment (VMSDE), whose fundamental objective is to establish policies and strategies for environmental protection and conservation of natural resources, and to develop guidelines oriented to this objective. To comply with the obligations of the country under the UNFCCC, the VMSDE includes the National Climate Change Program which, in conjunction with the specialized team that is developing the National Climate Change Action Plan, was responsible for the elaboration of the Country Study of Bolivia.

The organizations that are participating in the development of the National Climate Change Action Plan are distributed on three levels:

- *Decision level* — limited to the Ministry of Sustainable Development and Planning which, through the VMSDE, is responsible for the general direction of environmental policies and norms.
- *Operative level* — limited to the National Climate Change Program, which is under the responsibility of the Program Coordinator, in cooperation with the consulting team that is developing the National Climate Change Action Plan.
- *Support and Implementation level* — participation at this level is coordinated among state and academic institutions, the private sector, and NGOs (nongovernmental organizations).

The Ministry of Sustainable Development and Planning, through the Vice-Ministry of Sustainable Development and the Environment, will design, revise, and approve Bolivia's National Climate Change Action Plan. The Ministry will then present the Plan to the National Council of Economic Policy (NCEP) for its consideration. The NCEP coordinates and defines national policies of economic development, with capacity to dictate or agree to actions, and propose policies and norms.

In addition, the Ministry of Sustainable Development and Planning will:

- Be responsible, at the government level, for executing the elements of the Plan
- Coordinate the proposed activities at the institutional level
- Carry out inter-institutional agreements to implement, launch, and complete the objectives of the National Climate Change Action Plan.

The principal institutions and organizations are shown in Figure 1.

NGOs will support the National Action Plan by means of their own mechanisms and will receive diverse levels of technical support, such as qualifying courses about mitigation of greenhouse gas emissions and adaptation of ecosystems.

Another purpose of the National Climate Change Action Plan is to serve as a force for stimulating participation by state institutions and organizations, departmental governments, NGOs, and the private sector in responding to climate change.

Evaluation and Development of Measures

Bolivia, with its economic reality and because of the important necessity of resolving urgent problems like poverty, education, and health, will only with great difficulty be able to prioritize tasks and infrastructure that can be used to resolve the long-range problems that would be generated by climate change.

In this context, it is best to take action to expand awareness at the intersectoral government level, especially in the energy and forestry sectors; and to incorporate nongovernmental organizations, private enterprises, and universities in the effort to apply the referred-to measures of dealing with climate change.

The selection of measures of adaptation and of mitigation for each sector was based on the results of the Country Study of Bolivia and on the analysis made by the experts of each involved sector. Revisions and analysis of the plans and programs for national and sectoral development were made in order to identify national and sectoral priorities, which serve as the basis for the criteria of selection of measures. Afterwards, the final decision concerning the adaptation and mitigation measures was made in sectoral meetings between the team consultant of the National Climate Change Program and experts designated by involved institutions, including NGOs, for the development of the Plan. This final selection is currently underway.

Criteria

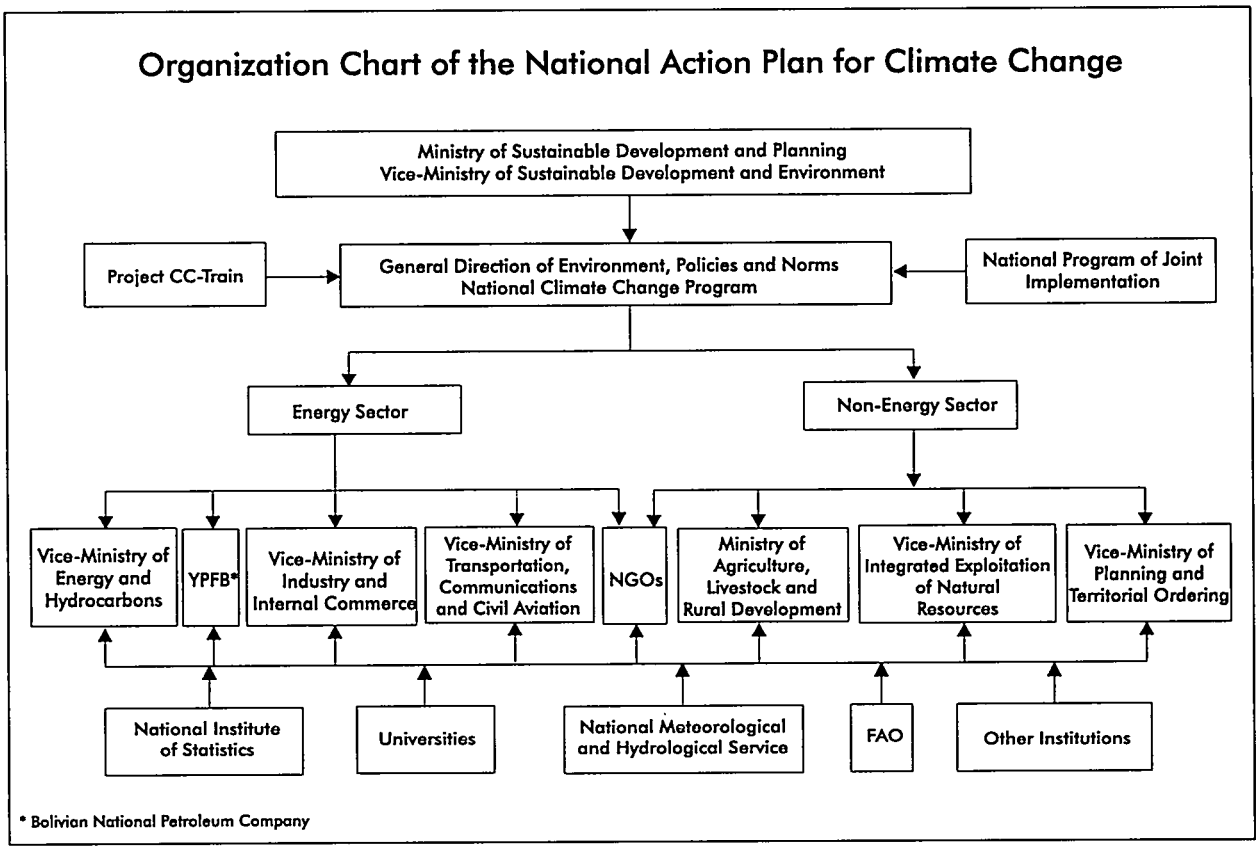
For selecting adaptation and mitigation measures, the most important criteria used were that:

- The measures had to be consistent with Bolivia's National Development Strategy
- The measures had to have the opportunity of being integrated into the sectoral programs and plans emanating from this national development strategy.

For evaluating adaptation measures, the principal criteria used were that the measures should:

- Be achievable

Figure 1. Organizations Involved in Developing the Bolivian National Action Plan



- Be equally as effective in scenarios with climate change as without
- Attain connected benefits
- Have low costs of implementation
- Have no significant administrative, legislative, and other barriers.

For evaluating mitigation measures, the principal criteria were the following:

- Priority and consistency with national and sectoral development plans
- Potential to mitigate emissions
- Feasibility of implementation
- Attainment of connected benefits and costs.

These criteria are consistent with existing national policies, programs, and projects being developed that are intimately connected to climate change issues. They will permit analysis of the adaptation and mitigation options that are best suited to the economic, political, social, and environmental reality of Bolivia.

For non-energy sectors, the fundamental point for evaluating measures was their applicability under recently passed legislation, namely the Forestry Law and the Law of the Institute of Agrarian Reform. For this reason, for the forestry sector, the analysis of cost-effectiveness was directed toward identifying measures that could help the country meet five objectives, including conservation of biodiversity, rational resource exploitation, socioeconomic development, efficiency in the production of wood, and the conservation of protected areas.

For the agricultural sector, in accordance with the evaluated results and the actual values of production, it is necessary to bring forward policies that favor the adaptation of cultivation to the new conditions to which it would be subject in the following decades. Under climate change conditions, droughts, freezes, and inundations would increase, causing economic loss and other negative impacts, the solutions to which would be difficult to find, especially in light of the country's limited economic resources.

For the water resources sector, the adaptation measures were prioritized according to the following objectives: improving the quality of the drinking water, guaranteeing the availability of water for irrigation, guaranteeing the quality of rivers, improving the control of

water flows, and guaranteeing water resources for transportation.

For the ecosystems of pastures and rangelands, the following objectives were used to prioritize adaptation options: conservation of biodiversity; prioritization of native species; benefits from the production of forages; efficiency in cattle raising; and palatability of forage. The first two objectives have the greatest weight, for which international financing is of vital importance.

For the energy sector, the following national priorities were used as selection criteria: the great mitigation potential in the residential, commercial crafts, industrial, and land transportation sectors; the need to incorporate biomass in the national energy matrix; the need to supply energy to rural areas; the importance of efficient and rational management of energy development and use; the need to increase the use of natural gas in the different energy demand sectors; and the need to consider renewable resources in the country's electrification process.

Expected Products

In order of priority, the most important products from this study are:

- The National Climate Change Action Plan
- The National Communication
- The Work Plans
- Training and technical assistance workshops.

The first two elements will be initially prepared in the form of a preliminary document, in which all the criteria for selection of the objectives and the sectors involved in the application will be included. The analysis and evaluation of the proposed measures and a preliminary technological evaluation of the proposed measures will be carried out by the responsible organizations. Following a consensus process and a final evaluation, the final document will be elaborated.

The work plans have already been prepared in the initial stage of the Plan development. The work plans have already identified priority areas, measures and methods, identification and evaluation of products, and a draft report to be presented to the consideration of the experts and corresponding authorities.

The training and technical assistance workshops will serve as fundamental support in the planning process, in the analysis of the development of measures, and in the application of decision models as a data base for the use of the consulting group. These are considered important analytical tools.

The final result of this work will be the implementation of adaptation measures for ecosystems and mitigation options for GHGs. For this effort to be successful, it is necessary to obtain the consensus of all the sectors participating in this study. It is also important to obtain the necessary human and financial resources, and the efficient monitoring and evaluation of the processes. Finally, the effort should include a plan for actualization of the processes, especially an updating procedure of the National Climate Change Action Plan.

Measures

Summary

Measures for the plan will be directed as much toward mitigation as toward adaptation. Mitigation measures will be applied to the energy, forestry, and agriculture sectors. Adaptation measures will be applied to the forestry, crops and livestock, and water resource sectors. In summary, the plan's priorities and objectives will be as follows:

- Energy Sector:
  - Improve energy efficiency in the residential, commercial, craft industry, and industry sectors
  - Increase the use of natural gas in the residential and transportation sectors
  - Expand the use of renewable energy in rural areas
- Industry sector:
  - Implement new technologies to reduce greenhouse gases in the cement industry.
- Forestry Sector:
  - Increase the capacity of forests to act as greenhouse gas sink
  - Implement sustainable management practices for forests
  - Implement sectoral laws and regulations for reducing deforestation
  - Implement programs of adaptation for forests.
- Crops and Livestock Sector:
  - Implement adaptation policies for crops, livestock, pastures, and water resources.

Implementing these measures will reduce atmospheric emissions, prevent contamination of soils and water, prevent erosion, attenuate processes of desertification, and preserve biodiversity.

Table 3 presents a summary of those mitigation measures that have the greatest priority for implementation. Net financial resources needed to implement the measures are preliminary and haven't been determined in all

Table 3. Priority Mitigation Measures, Impacts, and Resources

Mitigation Measures	Leading Institution	Reduction in CO_2 (thousands of tons) 2010	2020	2030	Reduction in CH_4 (thousands of tons) 2010	2020	2030	Other Environmental Benefits	Total Funding Required (US$ millions) & Funding Source
Energy Sector									
Efficiency in residential illumination	Vice-Ministry of Energy and Hydrocarbons	45.28	22.64 (partial)	TBD	—	—	—	Reduction in particulate emissions	39.29–International financing
Efficiency in stoves using biomass	Vice-Ministry of Energy and Hydrocarbons	148.84	439.14	734.44	—	—	—	Reduction in emissions of CO, hydrocarbons, NO_x, SO_x, and particulates	2.28–International financing
Efficiency in residential refrigeration	Vice-Ministry of Energy and Hydrocarbons	26.24	13.12 (partial)	TBD	—	—	—		35.29–International financing
Increase in residential use of natural gas	Vice-Ministry of Energy and Hydrocarbons	TBD	TBD	TBD	TBD	TBD	TBD	Reduction in emissions of CO and NO_x	94.44–International financing
Increase in use of solar energy in heating residential water	Vice-Ministry of Energy and Hydrocarbons	16.17	13.01 (partial)	9.85 (partial)	—	—	—	Reduction in emissions of CO, hydrocarbons, NO_x, and particulates	34.13–International financing
Efficiency of public commercial illumination	Vice-Ministry of Energy and Hydrocarbons	52.92	26.46 (partial)	TBD	—	—	—	Reduction in emission of particulates	4.43–International financing
Efficiency in commercial use of biomass	Vice-Ministry of Energy and Hydrocarbons	60.26	81.49	102.72	0.009	0.012	0.015	Reduction in emissions of CO, hydrocarbons, NO_x and particulates	0.145–International financing
Conservation of elect. energy in commercial uses	Vice-Ministry of Energy and Hydrocarbons	53.88	26.94 (partial)	TBD	—	—	—		44.68–International financing
Conservation of industrial energy	Vice-Ministry of Energy and Hydrocarbons	326.32	522.04 (partial)	717.75 (partial)	—	0.95 (partial)	1.58 (partial)	Reduction in emissions of CO, hydrocarbons, NO_x, N_2O, SO_x, and particulates	44.25–International financing
Increase use of natural gas in ground transport	Vice-Ministry of Energy and Hydrocarbons	360	1,690	3,020	—	—	—	Reduction in emissions of CO, hydrocarbons, NO_x, SO_x, and particulates	168.33–International financing
Reduction of natural gas flaring in exploitation fields	YPFB and Vice-Ministry of Energy and Hydrocarbons	868.19	868.19	868.19	18.36	18.36	18.36		201.95 (First estimation)–International financing
Redistribution of the Plan of Expansion of the Electric Energy Generation Sector	Vice-Ministry of Energy and Hydrocarbons	3.52	TBD	TBD	—	—	—		TBD

Table 3. Priority Mitigation Measures, Impacts, and Resources (continued)

Mitigation Measures	Leading Institution	Reduction in CO_2 (thousands of tons)			Reduction in CH_4 (thousands of tons)			Other Environmental Benefits	Total Funding Required (US$ millions) & Funding Source
		2010	*2020*	*2030*	*2010*	*2020*	*2030*		
Forestry Sector									
Afforestation	General Direction of Forests	75.61	TBD	TBD	—	—	—	Protection from erosion and improving chemical properties of soil	15.80–International financing
Regeneration of forests, pastures	General Direction of Forests	TBD	TBD	TBD	—	—	—	Increasing organic material in soil and feed for cattle	TBD
Implementation of agroforestry systems	CIAT–Vice-Ministry of Agriculture and Livestock	TBD	TBD	TBD	—	—	—	Preservation of biodiversity and improving properties of the soil	TBD
Implementation of the Forestry Law	General Direction of Forests	TBD	TBD	TBD	—	—	—	Sustainable use of forest resources	TBD
Control of protected areas	General Direction of Biodiversity	TBD	TBD	TBD	—	—	—	Preservation of biodiversity	TBD
Search for alternatives to burning	Institute of Ecology–Major University of Greater Saint Andrew	TBD	TBD	TBD	—	—	—	Preservation of biodiversity; sustainable use of resources; reduction of emissions of other GHGs	TBD
Crops and Livestock									
Improve rice-drying crops techniques	CIAT–Ministry of Agriculture, Livestock and Rural Development	—	—	—	TBD	TBD	TBD	Improvement in yield, production, and economic revenues	TBD
Replacing use of fertilizers	CIAT/IBTA–Ministry of Agriculture, Livestock and Rural Development	TBD	TBD	TBD	—	—	—	Improving properties of the soil and recuperation of degraded soils	TBD
Prevention and control of degradation of land	PRONALDES–Ministry of Agriculture, Livestock and Rural Development	TBD	TBD	TBD	—	—	—	Conservation and recuperation of degraded soils	TBD
Implementation of systems of irrigation in the high plains and valleys	National Irrigation Program–Ministry of Agriculture, Livestock and Rural Development	TBD	TBD	TBD	—	—	—	Improving yield crops and cultivation and economic revenues	TBD

TBD = To be determined

cases, because costs for some of the measures are still being analyzed; also, there is an element of uncertainty in the country's economic conditions (especially for the energy sector), due to its profound reforms, which could generate important changes in energy prices and in the energy scenarios.

Table 4 presents a summary of adaptation measures with the highest priority for implementation — measures that are directed primarily to the sectors of forestry and of crops and livestock. These measures, along with the financial resources required for implementing them, are presently being evaluated, and should be considered preliminary.

Based on previous work, Bolivia is already developing awareness at an intersectoral level, which is particularly important in the energy and forestry sectors, and involving NGOs, private industry, and universities.

Energy Sector

Summary

The preliminary analysis has identified a series of mitigation measures in the energy sector that will reduce the emissions of GHGs. However, these measures can be carried out only through international financial and technical support. Most of the mitigation options are related to

Table 4. Priority Adaptation Measures and Resources

Measures of Adaptation	Leading Institutions	Descriptions of the Measure	Total Funding Required (U.S. dollars) & Funding Source
Forestry Sector			
Reforestation and forestation	Ministry of Agriculture, Livestock and Rural Development	Establishment of forest planting	TBD
Sustainable management of forests	Ministry of Agriculture, Livestock and Rural Development	Developing forest products in a sustainable manner	TBD
Techniques of tree cutting and harvesting	National Universities	Promoting diversification of forests	TBD
Reduction of fragmentation of habitat	Forestry Council	Incentive program for multiple uses of forests	TBD
Planting of tolerant forest species	National Universities and Ministry of Agriculture, Livestock and Rural Development	Investigation into selecting tolerant species and genotypes that adapt to climate change	TBD
Land/Cattle Sector			
Managing biodiversity	National Board of Biodiversity	Implementing systems for better use of phytogenetic resources	TBD
Managing water and soils	IBTA–Ministry of Agriculture, Livestock and Rural Development	Implementation of adequate systems of agricultural production	TBD
Improving productive infrastructure	IBTA–Ministry of Agriculture, Livestock and Rural Development	Changes in productive agricultural infrastructure	TBD
Education and technology transfer	Nongovernmental Organizations	Implementation of measures for agricultural technology transfer generated in centers of investigation	TBD
Water Resources			
Planning for river basins	Ministry of Agriculture, Livestock and Rural Development	Implementing systems of control and management of river basins throughout the country	30–40 million International financing

TBD = To be determined

the energy efficiency of the residential sector: lighting, use of wood stoves, refrigeration, and more intensive use of natural gas and solar energy. In the commercial and industrial sectors, the measures are oriented toward increasing the efficiency of energy use. In the commercial craft industry sector, for example, the option is related to the efficient use of biomass. In the transportation sectors, the measures are aimed at increasing the use of natural gas and, in the energy supply sector, the measures are aimed at reducing natural gas burning at the exploitation sites. There are no particular adaptation options recommended for the energy sector.

If this scheme is followed, total energy consumption is expected to be reduced by 4.8% for the year 2000. The expected reductions for the subsequent years are: 8.96% for the year 2010, 10.91% for the year 2020, and 15.71% for the year 2030. These results will translate into the following CO_2 reductions: 6.35% for the year 2000, 12.05% for 2010, 15.82% for 2020, and 21.75% for the year 2030.

All of these measures are incorporated within the Rural National Strategy and the National Efficiency Strategy that fundamentally look to the establishment of better technological, social, and economic options that will provide the environment for a sustainable energy policy in the long-run and to the achievement of higher energy benefits that will minimize negative environmental impacts. These considerations are linked to the objectives of the National Climate Change Action Plan and will provide a higher probability of success. The amount of financing needed to achieve these goals has not yet been established, but the Plan will include a chapter on financing because of its critical importance.

Mitigation Measures

The study determined that the sectors responsible for most of the GHG emissions are the industrial, transportation, residential, and commercial sectors. It also identifies the processes of energy transformation, including electric generation, natural gas production, and petroleum refining. The measures considered and the assumptions included in the mitigation scenarios are in general conservative. They do not consider fuel conversion or introduction of efficiency measures with rapid growth rates.

- *Efficient lighting in the residential sector.* The study recommends the introduction of compact fluorescent lamps to replace incandescent lamps in all the subsectors.
- *Efficient stoves that use biomass in the residential sector.* The study recommends an increase in the efficiency of wood stoves and other stoves that use other types of biomass, which are mainly used in the preparation of meals and for heating water.
- *Efficient refrigeration systems in the residential sector.* The study also recommends the introduction of low-energy consumption refrigerators in all the subsectors of the residential areas.
- *Increasing the use of natural gas in the residential sector.* For this measure the study suggests an introduction of massive residential use of natural gas for cooking and water-heating purposes in the urban residential sector.
- *Increasing the use of solar energy for water heating purposes in the residential sector.* The study concludes that the use of solar energy can be significantly increased in the urban electrified subsectors and in the rural sectors.
- *Efficient commercial-sector lighting.* The study encourages the introduction of more energy-efficient lamps for public lighting. This measure would reduce the overall consumption of power-generated energy.
- *Efficient commercial use of biomass.* In the commercial and small-scale industrial sectors, which are formed by artisans, bricklaying, and related activities, the study suggests reducing the intensity of biomass consumption.
- *Conserving electricity in the commercial sector.* This would be accomplished with the gradual introduction of more efficient devices in the overall commercial sector. This will help reduce consumption of electricity.
- *Conserving energy in the industry sector.* The study included a comparative analysis of the GDP and energy consumption for the years 1988–1994. The results of the analysis indicated that the growth rates in energy consumption were higher than GDP growth rates. This implies that the industry has been progressively more inefficient with respect to energy use. However, starting in 1992, a slight reduction in the intensity of energy use was observed. Recommendations include further reducing the intensity of energy use in heat and power processes in the general industry subsector, and the intensity of energy use in power processes in the mining subsector. Among the alternatives to improving energy efficiency in the industrial sector are: internal reorganization, which will provide savings of 5% to 10%; improvement of system maintenance, for savings of 10% to 12%; and improvements in processes and technology, for savings of 10% to 15%.
- *Increasing the use of natural gas in the transportation sector.* Lately, there has been a gradual introduction of compressed natural gas for ground transportation. The

study recommends an expansion and acceleration of natural gas use for this purpose. The use of natural gas would replace the use of gasoline and diesel fuel.

- *Reducing natural gas flaring in exploitation fields.* The Bolivian National Petroleum Company (YPFB) has initiated the implementation of a number of measures since 1995. These measures are oriented to reduce burning of natural gas and to increase the retrieval, treatment, reinjection, and recycling of natural gas and separation of liquid fuels. The measure involves reducing natural gas flaring to the lowest technically achievable levels.
- *Redistribution of the expansion plan in the power generation sector.* The mitigation options previously considered establish that the demand growth for electricity will be smaller in the mitigation scenario than in the base case scenario. For this reason, the mitigation scenario reflects a lower growth in additions to electricity generating capacity with the same installed capacity as in the base case scenario. It also involves expanding power generation over a longer period of time. This plan covers up to the year 2012 and takes into account the utilization of renewable energy, such as hydro and geothermal energy, for the final stages.

Results of the Mitigation Scenario

It is possible to reduce total energy consumption by 2,856.2 kBOE (thousands of barrels of oil equivalent) for the year 2000 (4.80% reduction), 6,402.9 kBOE for the year 2010 (8.96% reduction), 9,330.4 kBOE for the year 2020 (10.91% reduction), and finally 16,453.8 kBOE for the year 2030 (15.71% reduction). The total emissions of CO_2 with respect to the base scenario could be reduced by approximately 6.35% for the year 2000, by 12.5% for the year 2010, 15.82% for the year 2020, and 21.75% for the year 2030. All the other GHGs, except N_20, will be also reduced following this plan. N_20 is expected to increase by 2.24% by the year 2030.

The Vice-Ministry of Energy and Hydrocarbons is the institution responsible for carrying out the mitigation measures and for reaching the emissions reductions of GHGs under the supervision of the National Climate Change Program. However, before this endeavor begins, all the necessary financial needs must be assessed and quantified. Once these financial needs are established, they will be presented for international consideration because it is the international community that will make this technical and financial support possible.

Non-Energy Sector

Summary

Currently, Bolivia has a total forest area of about 53.4 million hectares; if we consider that 0.5 % of this area is in a growth process, then the CO_2 sequestered could be estimated at 454.6 million tonnes per year.

The Bolivian National Climate Change Action Plan will identify adequate measures to increase the capacity for absorption of GHGs in the forests, through sustainable management practices.

In the same manner, the adaptation measures in the forestry sector that will be analyzed, will be the ones that best correspond to the economic, political, social, and environmental reality in Bolivia.

It is very difficult to select the most adequate mitigation options because they are closely intertwined with other economic, social, and cultural problems in the country. Examples of these problems are land property rights, expansion of the agricultural frontiers, traditional crop and livestock practices, and control of the rational and productive use of forests.

The application of the new Forestry Law and the Law of the Institute of Agrarian Reform will be used as a starting point in the analysis of the mitigation options for the non-energy sector.

The existence of National Parks and Protected Areas, and the desire to increase the number of similar areas is an alternative option in the non-energy sector. This approach will permit a reduction in the levels of deforestation and an increase of carbon sinks.

The analysis of mitigation options for the non-energy sector is currently undergoing final review. The results of this analysis will permit selection of the most adequate options that will be consistent with national economic and social policies. They will also allow the selection of the options that will lead to higher reductions of GHG in the future. This development will be measured in the years 2000, 2010, 2020, and 2030.

Adaptation Measures

Among the adaptation options that are considered feasible are the following:

- *New Applications of Reforestation and Afforestation.* In the forestry sector this measure will permit achievement of a number of objectives, such as conservation of biodiversity, rational resource exploitation of forests, socioeconomic development, efficiency in the

production of wood, and conservation of protected areas. The analysis of cost effectiveness supports the advantages of this adaptation option.

- *Planning of the Basins.* Of all the adaptation measures analyzed in the area of water resources, planning of basins is the one option that shows the lowest unitary cost corresponding to an incremental benefit. At the same time, it allows attainment of important economic and social benefits, such as a guarantee of the availability of water for transportation purposes, and of the availability of clean potable and irrigation water. It also permits control of the water flows in order to prevent floods and/or droughts.
- *Education, Outreach, and Training.* This is the measure that shows the most effective cost in the crops sector. This is due to the participation in this sector of the producers and all the consumers in general. Due to the wide scope of participation, investments are easier to obtain. Other alternatives, such as an increase in the productive infrastructure and genetic engineering, are very costly.
- *Reintroduction of Native Species.* The reintroduction of native species is a very important adaptation measure, given the potential impacts of climate change on pastures and rangelands. This measure permits meeting several objectives of the study, such as conservation of biodiversity, benefits of the forage production, efficiency in the livestock production, and palatability of forage. All of these measures shall be analyzed in more detail in order to determine implementation costs.

The Ministry of Agriculture, Livestock and Rural Development will be the institution in charge of implementing these measures and all the mitigation options proposed for the forestry and agricultural sectors. This area will require the active economic cooperation of the international environmental community.

Implementation Strategies

Although it is not possible to determine the precise implementation mechanisms at this stage, it is possible to give an overview of the institutions that will participate in the implementation of the National Climate Change Action Plan and to list the steps that will be necessary to meet this goal.

For the energy sector, these institutions are: the Vice-Ministry of Energy and Hydrocarbons; the Bolivian Petroleum Company (YPFB); the Vice-Ministry of Industry and Internal Commerce; and the Vice-Ministry of Transportation, Communications, and Civil Aeronautics. For the non-energy sector, the main institution is the Ministry of Agriculture, Livestock and Rural Development. The Vice-Ministry of Planning and Territorial Ordering will also collaborate in this effort. In the same manner, the public universities, the National Institute of Statistics, the Local Governments, and the National Service of Meteorology and Hydrology will provide additional support, especially when it relates to providing information.

These institutions and organizations will be in charge of contributing to the development and coordination of processes and programs directed to meet specific adaptation goals and mitigation of GHG. NGOs will support the National Climate Change Action Plan through their own mechanisms and will receive adequate technical support in the areas of options for ecosystem adaptation and options for GHG mitigation.

Issues and Lessons

The following conclusions can be drawn from plan development activities to date:

- The different institutions involved in the development and implementation of the plan have demonstrated their interest in developing climate change measures.
- A series of contacts has been initiated with donors and foreign parties interested in developing projects related to GHG reduction.
- The national government is not counting on its own economic resources to implement mitigation measures; what it really needs is international economic assistance.
- Various institutions are creating sectoral development plans that incorporate plans and programs that indirectly mitigate greenhouse gas emissions.

The National Climate Change Action Plan will be tied integrally with the plans for national development and will respond to the same. In this way, the elaboration of the National Climate Change Action Plan is intimately bound to the national priorities of economic development, reduction of poverty, improvement in the indices of health, and generation of employment and education.

The institutional capacity of the country to confront climate change issues in Bolivia is in the development phase, owing to the need to reinforce institutional coordination. For this reason, technical and financial assistance will be indispensable in these areas.

International Cooperation

For the objectives of the Plan to become a reality it is crucial to have international financial support. This support is particularly expected to be received from the countries that are members of Annex 1 of the UNFCCC.

Bolivia has established that its main priorities and national policies are aimed at reducing the high poverty index and high unemployment rate, and at improving health and educational levels. Within this framework, Bolivia does not have resources specifically dedicated to the climate change issue. For a developing country, the problems concerning climate change are not a priority. However, after performing the inventory of GHG gases, analyzing vulnerability and adaptation and mitigation options, and, finally completing the National Climate Change Action Plan, Bolivia wants to state its desire and commitment to collaborate in joint actions that will prevent global disasters resulting from climate change.

As was previously expressed, it should be affirmed that there exists a wide variety of opportunities for international cooperation in support of implementing the National Climate Change Action Plan. Among the many projects that require international aid are projects to:

- Disseminate efficient residential stoves that use biomass and study ways to increase their efficiency according to fuels used in the sector
- Increase energy efficiency in the use of biomass for artisan production of bricks, plaster, lime, rice dryers, chestnut processors, etc.
- Apply conservation and energy efficiency measures to representative industries and mining activities in industrial demonstration zones
- Install efficient illumination in residential, commercial, and public sectors
- Increase the use of compressed natural gas in ground transport
- Increase the use of compressed natural gas in the residential sector for cooking, water heating, and space heating
- Recuperate natural gas in fields of exploitation and reduce its flaring
- Increase the use of solar energy in the residential sector for water heating and for generating electric energy (rural communities)
- Electricity generation with renewable energy: solar, wind, and minihydro (especially in rural areas)
- Improve technology in cement-making processes
- Seek alternatives to burning forests and pastures, with the purpose of extending cultivable area
- Forest and pasture regeneration, reforestation, and afforestation
- Implement systems of agroforestry
- Replace the use of fertilizers
- Irrigate in the zones of the high plains and valleys
- Demonstrate the reduction of emissions of methane originating from cattle

This list is incomplete and represents only some of the possibilities. Other opportunities for international cooperation could address the most important barriers to implementing these measures, including the absence of regulations on standards and tariffs, the absence of information and technical know-how, and institutional impediments to the development of programs and projects related to renewable energy and to climate change issues in general.

Finally, the opportunities for international cooperation should also be directed to building institutional capacity, including developing educational programs in all facets of climate change; coordinating seminars, exhibitions, and training courses; editing and printing publications and other information materials.

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BULGARIA

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Summary

This paper provides an overview of the approaches and methodology used to prepare the Bulgarian Climate Change Action Plan (BCCAP) and its progress to date. The results of the *Bulgarian Country Study to Address Climate Change* — an inventory of greenhouse gas (GHG) emissions by sources and sinks, vulnerability to climate change, and adaptation and mitigation assessment — were used to prepare the BCCAP and are also summarized here. With regard to the methodology used, this paper describes Bulgaria's efforts to create a comprehensive institutional framework for preparing the BCCAP, organize and conduct a scoping workshop, adopt criteria for evaluating mitigation and adaptation measures, screen and evaluate a number of feasible measures, adopt a general strategy to draft the plan, and build consensus on plan implementation.

Because the key word in preparation of the BCCAP is "implementation," our efforts have been focused on just a few sectors, including energy, industry, transportation, forestry, agriculture, and waste management. Several measures and programs are under consideration within each sector, particularly those that have high potential for mitigating GHG emissions and for helping Bulgaria adapt to climate change, are in line with Bulgaria's national and sectoral development priorities, are economically feasible, and are easy to implement.

Table 1 provides a summary of proposed mitigation and adaptation measures for priority sectors.

Introduction

Bulgaria signed the United Nations Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro in June 1992. The UNFCCC was ratified by the Bulgarian Parliament in March 1995. In compliance with article 4, sections 6 and 2b of the Convention, Bulgaria chose to adopt 1988, not 1990, as the base year against which to compare levels of anthropogenic emissions of CO_2 and other greenhouse gases not subject to control by the Montreal Protocol. This means that the Bulgarian target for the UNFCCC is to limit anthropogenic greenhouse gas emissions in the year 2000 to 1988 levels.

Results of Past Studies

From 1993 to 1996, Bulgaria participated in the U.S. Country Studies Program and prepared the *Bulgarian Country Study to Address Climate Change*. The key objective of the study was to assist government institutions and ministries in identifying, formulating, and implementing the national policy pursuant to Bulgaria's commitments as a party to the UNFCCC. The study was the primary source used to prepare *The First National Communication on Climate Change of the Republic of Bulgaria* (Republic of Bulgaria, 1996).

Practically all problems addressed in the national communication were addressed in the country study, including:

- Assessment of vulnerability and adaptation to climate change
- Inventory of GHG emissions
- Screening of the greenhouse gas mitigation measures
- Evaluation of the effects of mitigation measures and emissions projections

The most important results of the study are summarized below.

Vulnerability and Adaptation

The vulnerability and adaptation study focused on two systems: forests and crops. The most probable climatic and ecological changes for these systems were deter-

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Proposed Measures
Mitigation	
Energy: *Electricity Generation*	■ Improve conventional power plants ■ Increase use of integrated gasification combined cycle (IGCC) power ■ Use advanced technologies and concepts, such as cogeneration, district heating, and fuel switching ■ Draw on alternative energy sources including biofuels, hydropower, and nuclear power
Energy: *Renewable Energy*	■ Evaluate current policy; appraise renewable energy potential ■ Determine which technologies show most near- and mid-term promise; analyze results of pilot projects
Energy: *Industry*	■ Conduct energy audits ■ Improve boiler efficiency ■ Encourage use of heat recovery techniques, industrial cogeneration, fuel substitution, efficient lighting, and efficient motors
Transportation	■ Introduce improved vehicle standards ■ Implement infrastructure projects, municipal transportation, and integrated transportation planning
Households and Services	■ Improve boiler efficiency ■ Install efficient lighting; improve insulation ■ Set higher standards for electric appliances
Waste Management: *Urban and Agricultural*	■ Introduce methane mitigation techniques ■ Use landfill methane for energy purposes
Forestry	■ Develop and implement afforestation practices to sequester GHG emissions
Adaptation	
Forests	■ Change current afforestation policy ■ Replant vulnerable forests with new species that are able to resist global warming
Agriculture	■ Develop and use appropriate new species, primarily maize and wheat

mined by applying various climate change scenarios, including scenarios for global atmosphere circulation (GCM), to Bulgaria over the next century.

A doubling of the CO_2 concentration in the atmosphere is estimated to effect a change in forest conditions from "cool temperate moist forest" to "warm temperate dry forest" in northern Bulgaria, while southern Bulgaria is expected to keep its "warm temperate dry forest" conditions. Possible adaptation measures for forest vegetation include:

- Different approaches for afforestation in different regions of the country
- Increased planting of native tree species that can grow in a drier and warmer environment
- Introduction of new tree species for afforestation in semi-arid areas
- Improvement in the age structure of forests
- Preservation of biodiversity

In addition to the analytical results and policy recommendations derived from the forest vulnerability and adaptation study, proposals for two afforestation projects were developed. If implemented, these projects would afford practical experience with the measures suggested in the vulnerability and adaptation study. Different mechanisms for financing and implementing such projects could be explored through international cooperation.

With regard to crops, a doubling of atmospheric CO_2 would result in increased temperatures that would raise the agroclimatic thermal potential in Bulgaria. In this

scenario, model predictions are inconclusive concerning changes in precipitation during the growing period. However, precipitation is estimated to drop during the nongrowing period. The yield from maize crops is expected to decline by more than 29% and from winter wheat crops by about 15%–17%. The main adaptation measures formulated in the study include, but are not limited to, changing crop hybrids and cultivars, changing agricultural management practices, and introducing a new zone structure for land below 1000 m of elevation.

Emissions Inventory

Results of the GHG inventory indicate that Bulgaria has a similar GHG profile to other countries that are in transition from a centrally planned to a free market economy. Carbon dioxide was confirmed as being the most significant anthropogenic greenhouse gas in 1988, when it accounted for 68.5% of total GHG emissions (in terms of their global warming potential), corresponding to 96,878 thousand tonnes of emissions. It is followed by methane (24.5%) and nitrous oxide (7%). Fuel combustion is the largest source of GHG emissions, with stationary and mobile sources responsible for 64.2% and 7.7% respectively, or roughly 72% from both sources together. This is followed by industrial processes (6.6%) and other sources, including agriculture and waste management.

Special attention was given to the carbon off-set potential of forests. Inventory results for 1988 indicate that the forest off-set potential is 5% of total CO_2 emissions. The results of the GHG emissions inventory serve as a reference for identifying and evaluating various mitigation options for different mitigation scenarios.

Mitigation Assessment

A baseline scenario and various mitigation scenarios were developed to analyze the potential of different policies and measures to mitigate climate change (Simeonova, 1996a; Simeonova et al., 1995b; Tzvetanov et al., 1996; Christov et al., 1996). Scenarios were used to analyze the following mitigation options:

- Rapidly changing Bulgaria's macroeconomic structure by shifting away from industry toward the service sector and by shifting from heavy to light industry within the industrial sector
- Accelerating penetration of new, state-of-the-art manufacturing technologies that require less energy
- Implementing vigorous energy efficiency and demand-side management policies
- Increasing the share of hydroelectric energy using both conventional and micro-hydro plants
- Increasing the use of nonhydro renewable energy technologies
- Preserving the share of nuclear energy while increasing operational safety
- Fuel switching from coal to natural gas in cogeneration power plants
- Rehabilitating and upgrading existing coal-fired power plants
- Reducing losses in both the electric transmission and distribution network, and the heat distribution networks
- Improving the tariff structure and, hence, the distribution of energy demand

With almost no exceptions, the options analyzed are those which would produce economic benefits even if climate change were not a factor. This is in line with approaches adopted by other Central and Eastern European countries that are having difficulties in making the transition from centrally planned to market-driven economies (Simeonova, 1996b).

Study results indicate that the level of GHG emissions in the year 2000 will be lower than the level in 1988 (and 1990) even if none of these mitigation options are implemented. After the year 2000, however, the expected growth of the Bulgarian economy and associated GHG emissions will require a well-coordinated national policy on climate change.

Bulgaria can fulfill its commitments under the UNFCCC only by implementing primarily "no regret" (economically advantageous) mitigation measures at all levels of the national economy. Due to the complex nature of these measures and the time required for their implementation, the study concluded that Bulgaria's climate change action plan would have to be refined and its measures and programs implemented within the next decade.

Current Projects

There are several projects — mostly concerning energy efficiency improvements — that are related to the *Bulgarian Country Study to Address Climate Change*. These projects were largely developed by the Bulgarian government in association with international agencies, including the European Union's Poland and Hungary Action for Reconstruction of Economy (PHARE) program, the U.N. Global Environmental Facility (GEF) and the

U.N. Economic Commission for Europe (ECE). The results of these projects will be used as an important information source in preparing the BCCAP (Republic of Bulgaria, 1996).

Objectives

The overall objective of the BCCAP is to facilitate the fulfillment of Bulgaria's commitments under the UNFCCC. This general objective will be achieved through preparation of a detailed national action plan that will address UNFCCC requirements while remaining consistent with Bulgaria's other national development priorities, thereby integrating climate change into a broader planning process.

Screening of mitigation and adaptation policies and measures will be performed with emphasis on those analyzed in the *Bulgarian Country Study to Address Climate Change*. The objective is to prioritize the measures, identifying those which are the most technically and economically efficient given Bulgaria's particular circumstances.

Once priority measures have been identified and discussed, strategies for their implementation will be designed. Another objective, therefore, will be to build consensus on the implementation of the plan by raising public awareness, improving environmental education, and developing public support for government initiatives in the field of climate change.

Priority actions to be taken by different sectors will be defined in the BCCAP and public support for their implementation will be encouraged. In addition, the necessary domestic and international financial resources will be identified. The final goal of the BCCAP will be to serve as a foundation for the preparation of the second Bulgarian communication to the UNFCCC.

Bulgaria's approach to climate change involves a combination of initiatives, including policies in energy, transportation, forestry, agriculture, and waste management. Preparation of the BCCAP will be a major step in determining and implementing these policies.

Methods

The BCCAP is being prepared using the methodology presented in the handbook *Steps in Preparing Climate Change Action Plans* (Benioff and Warren, 1996). Several major steps were selected from the handbook and tailored to fit country-specific circumstances and accomplish the objectives described above. The steps involved in preparing the BCCAP are illustrated in Figure 1. Comments on steps already performed or under way are provided following the flow chart.

Establishment of Planning Teams

The BCCAP is being developed by an interagency analysis team working in cooperation with government agency teams. Energoproekt Research Institute is a key national coordinator on the interagency team, while the Ministries of Environment and Energy act as lead government agencies. Figure 2 shows the organizational framework that has been created to prepare the BCCAP.

Interagency Analysis Team

The Interagency Analysis Team consists mainly of management, scientific, and technical experts who have already taken part in Bulgaria's country study, as well as experts from nongovernmental organizations (NGOs). The following members comprise the team: Energoproekt, the Forest Research Institute at the Bulgarian Academy of Science (BAS), the Institute for Nuclear Research and Nuclear Energy at BAS, the Institute of Economy at BAS, the National Institute of Meteorology and Hydrology at BAS, the National Electric Company, the Ecomonitoring Club (an NGO), and EnEffect (an NGO).

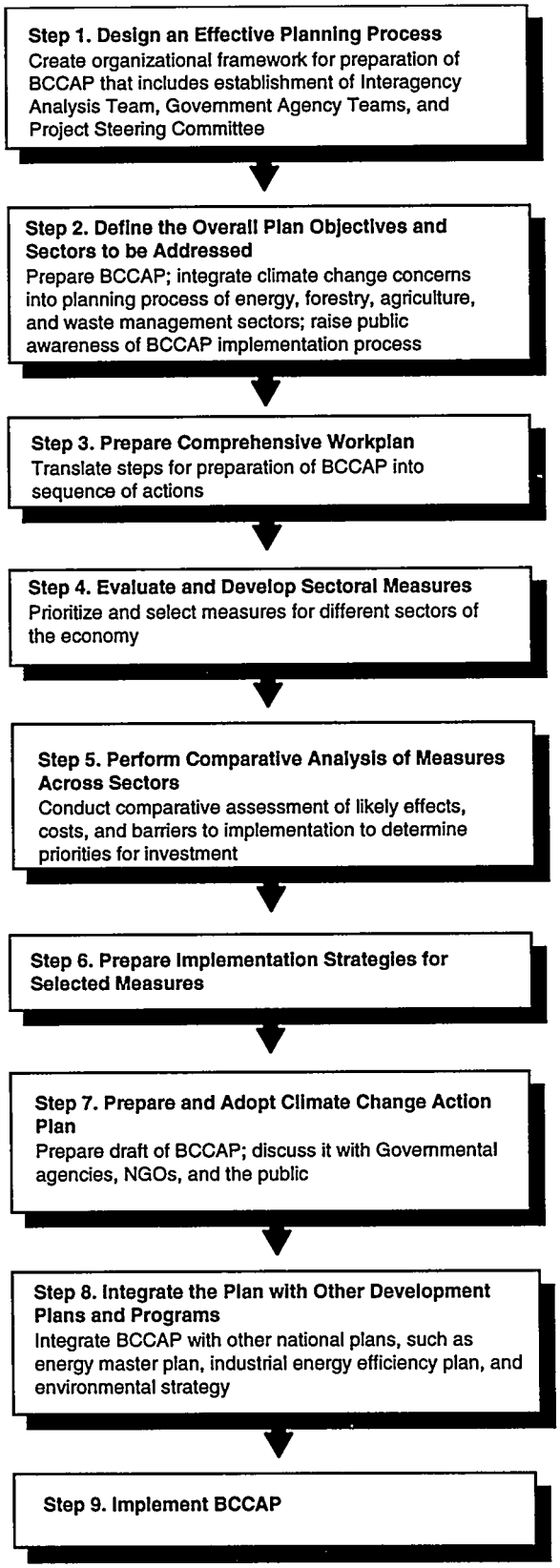
The Interagency Analysis Team supports the sectoral analyses and coordinates integration of sectoral plans at the national level.

NGO participation is envisaged in the process of developing the action plan. It is important, not only for the planning process itself, but also for raising public interest in the implementation of the plan. EnEffect and the Ecomonitoring Club participate in the Interagency Analysis Team in the tasks that are relevant to their activities in the fields of energy efficiency and forestry.

Government Agency Teams

The government teams include individual experts or teams from the following ministries: Energy, Environment, Transportation, Forestry, Industry, Agriculture, Justice, Education, and Territorial Planning. These teams support the development of the action plan at the sectoral level by engaging research and development institutions that can help with technology assessments or that are working in areas pertaining to identification and analysis of mitigation and adaptation measures.

Figure 1. Steps to Prepare and Implement the BCCAP



Climate Change Steering Committee

The Climate Change Steering Committee was established to facilitate Bulgaria's climate change study. The committee proved to be both useful and efficient with regard to formulating the key assumptions of and possible approaches to climate change and analyzing results and their possible impacts on various economic sectors.

In preparing the BCCAP, the Climate Change Steering Committee will continue to have a leading role in (1) making major decisions on possible policies and measures to be evaluated, (2) validating the results received, and (3) choosing the most efficient strategies for implementing policies and measures that are cost-efficient and have the greatest potential.

The Steering Committee holds its meetings at least once a quarter to discuss interim results and further development of the project.

State Climate Change Commission

The State Climate Change Commission will be established by the Council of Ministers at an advanced stage of plan implementation. The Commission will be chaired by the Minister of Environment. The Deputy Ministers of Environment and of Energy will be deputy chairmen.

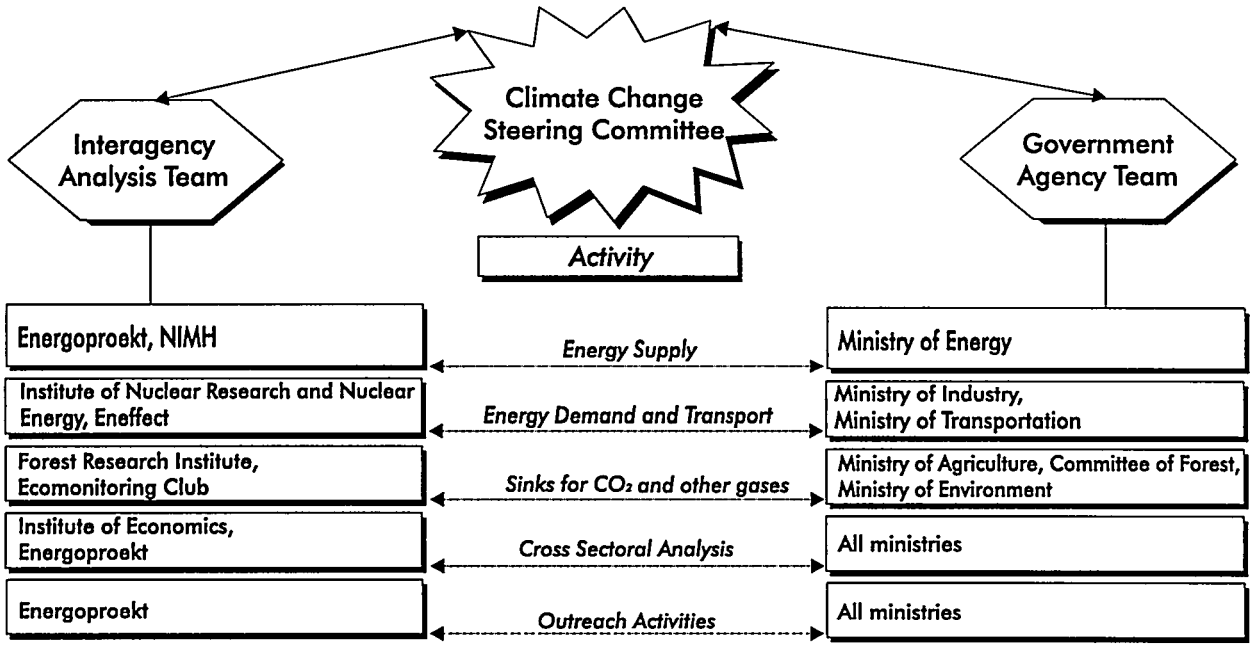
Deputy Ministers from the following ministries are expected to serve as commission members and would be responsible for planning and development: Economic Development, Finance, Justice, Industry, Transportation, Agriculture, Education, and Forestry.

The State Climate Change Commission will ensure the participation of sectoral agencies in development of the action plan, approve the action plan, and facilitate the integration of the plan's recommendations into the sectoral development plans. The Country Study Team will support the work of the commission.

Definition of Overall Plan Objectives and Sectors to be Addressed

The underlying philosophy of the action plan is that it should coordinate and reinforce policies and programs already adopted or planned for other reasons (e.g., energy efficiency). For this reason, it is important that action plan measures be integrated with the planning process in the relevant sectors. Active participation of government agencies in preparing the action plan, disseminating the project results, and raising public awareness will facilitate integration of the

Figure 2. BCCAP Organizational Framework and Activities



action plan within other development programs and plans.

Coordination of Scoping Workshop

Once the organizational structure of the plan was established and a detailed work plan was prepared, a scoping workshop was held to select and evaluate the measures for the BCCAP. Senior governmental officials and experts and scientists from research institutes and NGOs participated in the workshop. Participants discussed potential impacts of climate change, basic response strategies to be incorporated in the action plan, and technical options to be considered as part of the technology assessments. They selected the economic sectors to be addressed, identified research priorities, and identified key stakeholders in the planning process.

Criteria for screening and evaluating measures in different sectors of the economy were also identified. Among the criteria identified were the technical, economic, and market potential for GHG mitigation; social and political feasibility of the measures; and ease of implementation. Specific criteria relating to the energy and forestry sectors were discussed and adopted. The adopted criteria in each sector are outlined in Table 2.

Completion of Technology Assessments

Technology assessment is an integral part of the preparation of the BCCAP. It involves the analysis of technological, economic, institutional, and social factors associated with the implementation of the measures selected for the action plan. Feasibility analysis is being accomplished by identifying options for overcoming barriers to implementation. The overall effectiveness of the plan is being assessed. Attention is being focused on those technically and economically feasible measures identified in the *Bulgarian Country Study to Address Climate Change* as having great potential to mitigate climate change. These include the following:

- Improving energy efficiency in industry, agriculture, households, and services
- Improving energy standards for building and for the labeling of appliances
- Analyzing and installing new energy supply technologies
- Increasing use of renewable energy
- Implementing energy taxes, subsidies, and related policies
- Completing a cross-sectoral assessment of the measures.

Table 2. Criteria Used for Screening and Evaluating Measures, by Sector

Energy	Forestry		Agriculture		Waste Management
Mitigation	**Mitigation**	**Adaptation**	**Mitigation**	**Adaptation**	**Mitigation**
1. Potential to reduce CO_2 emissions	1. Potential to increase the CO_2 off-set capacity of forests	1. Is measure a high priority for adaptation?	1. Potential to reduce GHGs	1. Does measure address high-priority adaptation?	1. Potential to reduce methane emissions
2. Economic feasibility	2. Does measure have biodiversity preservation potential?	2. Is measure linked to infrastructure development, the planning process, and research?	2. Compatibility with agricultural policy and priorities	2. Effectiveness of the measure for adaptation	2. Compatibility with objectives and priorities of national waste management policy
3. Impact on the environment, including reduction of particulate, sulfur dioxide, and nitrous oxide emissions	3. Potential to preserve and improve quality of water resources	3. Effectiveness of measure	3. Potential economic, environmental, and social benfits	3. Other benefits to the economy and the environment	3. Economic, social, and environmental feasibility
4. Compatibility with development priorities for the energy sector	4. Potential to increase wood production	4. Additional environmental benefits		4. Is measure affordable?	
		5. Economic effectiveness and feasibility		5. Existence of barriers to implementation	
				6. Compatibility with adaptation measures in other sectors	

The Marcal-Macro model is being used for technology assessment by upgrading the Bulgarian Marcal model that was built during the *Bulgarian Country Study to Address Climate Change* (Simeonova et al., 1995a). It is also being used to analyze sensitivity to energy taxes and price changes, subsidies, and energy production and buildings standards.

Consideration of Funding Options

Great attention is being devoted to the problem of financing projects incorporated in the action plan. Proposals for several projects for energy efficiency, cogeneration, and renewables are expected as a basic product under the project. Different options for obtaining funds will be compared for these projects in order to convince managers, government, and society of the profitability and reliability of the project.

Approaches to Analyzing Measures

Different approaches were used to evaluate the efficiency of mitigation and adaptation measures outlined in the *Bulgarian Country Study to Address Climate Change*. Most of them are being used in the BCCAP preparation process. For example, macroeconomic analysis is being used

to describe the current structure of the economy and possible structural changes, both with and without implementation of the action plan.

Approaches to evaluating measures in different sectors of the economy are very diverse. For the energy sector, end-use forecasting and integrated energy demand and supply simulation are being used to estimate the impact of the energy efficiency policies and programs on different sectors of the economy. Cost-benefit analysis is being used, enabling comparisons between specific measures by weighting the costs against the benefits.

In the case of renewable energy, decision analysis methods are being used to identify and evaluate the most promising policy and technology options. The Bulgarian team has already used the Analytical Hierarchy Process (AHP) model for screening and evaluating renewable energy options and will continue to use it for ranking measures in terms of criteria that are both quantitative (such as cost data), or qualitative (such as social acceptance of the specific option).

Similar approaches are used to estimate the effectiveness of adaptation measures in the agriculture and forestry sectors. It is very difficult to assign a monetary value to most of the benefits — such as human health and life, ecosystem integrity, and food security — of adaptation options in these sectors. This is why an analysis based on cost-effectiveness is preferred here. It makes it possible to identify the most efficient adaptation measures by comparing the cost of each adaptation measure with its benefits, even when those benefits are not expressed in monetary terms.

Preparation and Adoption of Plan

The Interagency Analysis Team and the Government Agency Teams have the primary responsibility to select, analyze, and rank the measures and programs for the national action plan. The Climate Change Steering Committee will be responsible for making high-level decisions about the policies and measures to be evaluated, the validation of the results received, and for choosing the best implementation strategies for the chosen policies and measures. It will also recommend the draft BCCAP for approval by the State Climate Change Commission, the Government, or Parliament.

The State Climate Change Commission will officially adopt the BCCAP on behalf of the Government and will be responsible for the overall implementation of the plan. The commission will also recommend that the findings of the action plan be considered in the planning process of both the Government and the Parliament.

Expected Products

The main products to be produced under the study are the draft national action plan, the national action plan, and the technology assessment. Proposals for several mitigation and adaptation projects will be prepared as well.

Measures

The Bulgarian team is currently in the early stages of preparing the action plan. This section therefore provides only a brief overview of the mitigation and adaptation measures that will be applied in key sectors of the economy. See Table 1 (page 37) for a list of mitigation and adaptation measures that have already been identified. These measures are currently being analyzed.

As Table 1 shows, most of the measures will be selected and implemented in the energy sector, since it is the major source of GHG emissions in Bulgaria. The focus will be on both energy supply and energy demand mitigation policies and measures. Another priority is the transportation sector. Although this sector is not currently a large source of GHG emissions, lifestyle changes are likely to significantly increase the demand for transportation. This will, in turn, result in a substantial growth of GHG emissions originating from transportation activities. Although the waste management sector is not a large emitter of GHGs, several measures will be identified, selected, and implemented in this sector because of its great technical potential for mitigation.

The vulnerability of forests and agriculture to possible climate change was assessed in the *Bulgarian Country Study to Address Climate Change*. This assessment will be enhanced, with a focus on the identification, selection, and implementation of several feasible adaptation policies and measures.

Cross-sectoral measures for both mitigation and adaptation include: educating the public, raising public awareness, increasing research and development, increasing technology development, strengthening institutional frameworks, and examining the impact of the energy policy on the rest of economy.

Types of measures under consideration include: regulations and guidelines, economic instruments and

incentives, voluntary agreements, demonstration projects, educational programs, and research and development.

Issues and Lessons

The BCCAP is being prepared at a time when Bulgaria is experiencing great difficulties in making the transition from a centrally planned to a market driven economy. As in other countries making this transition, the attention of the Bulgarian government and populace is focused on the successful implementation of market reform, privatization, and the establishment of capital markets, in addition to solving urgent social problems arising in the transitional period (Simeonova, 1996b). Furthermore, Bulgaria's environmental policy agenda includes issues with higher priority than climate change, issues such as air quality and transboundary pollution that call for near-term solutions. These factors make it difficult to assign sufficient resources to the preparation of the BCCAP.

International Cooperation

As a consequence of the issues described above, international cooperation could play a crucial role in the implementation of the BCCAP by providing financial resources for specific measures and projects and by enabling accelerated transfer of climate change mitigation technologies.

Despite the challenges it faces today, Bulgaria has the clear political will to participate in and support international cooperation in the field of climate change — whether bilateral or multilateral — including actions implemented jointly (Republic of Bulgaria, 1996). In addition, Bulgaria is currently in the process of adopting new regulations and legislation to improve the domestic investment environment and to secure foreign investments.

So far, there are only two international climate change projects in Bulgaria and no joint implementation projects. These are the U.S.-Bulgarian cooperation on the *Bulgarian Country Study to Address Climate Change* and to prepare the BCCAP, and a project supported by the GEF, the Gabrovo Demonstration Zone for Energy Efficiency.

One of the main tasks in preparing the BCCAP is to identify projects for mitigation and adaptation that will require international support and foreign investment. Some candidates have already been identified in the *Bulgarian Country Study to Address Climate Change*, including two afforestation projects and projects for fuel switching and upgrading cogeneration facilities. In addition, several proposals for renewable energy and energy efficiency projects are expected to be identified as part of the BCCAP.

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CZECH REPUBLIC

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Summary

The Czech Republic ratified the United Nations Framework Convention on Climate Change (UNFCCC) on October 7, 1993, thus becoming the 36th Party to the Convention. The country has been fulfilling the commitments of Annex I countries as one of the succeeding states of the former Czechoslovakia. The First National Communication (FNC) was submitted to the Secretariat of the Convention in the fall of 1994, the in-depth review has been completed, and the result published in the report *FCCC/IDR.1/CZE*. The international team of experts pointed out that the Czech Republic had met its commitments as a Party of Annex I.

The Support for National Action Plan (SNAP) project started in 1995 as a logical continuation of the Country Study to Assess Climate Change. The results of the Country Study are summarized in the Introduction. The SNAP project is now completed. As a result of this study, 22 emission mitigation and 23 adaptation measures or policies were identified and their impact assessed. They are briefly summarized in the section on Measures.

The first group of adaptation measures to be implemented involves research projects and educational projects to raise awareness of the possible impact of climate change issues. The second group involves subsidies directed at encouraging a more sustainable type of husbandry in forestry and agriculture. Highly capital-intensive measures, such as the construction of water reservoirs and irrigation systems, will be considered next.

During preparation of the Second National Communication (SNC), a few of these measures were included in the document as being under consideration. Because of the economic pressures currently faced by the Czech Republic, there is currently little chance that the government will adopt measures beyond those mentioned in the SNC, or that it will adopt a comprehensive policy on climate change. However, several important measures are nonetheless very close to realization, especially those relating to household energy prices, which are rapidly escalating. Implementation of the full value added tax (VAT), which will give the right signal to all energy consumers, has already passed through the Czech Parliament, and a law governing energy use is expected shortly.

The National Climate Program (NKP) and its members — mainly SEVEn, the Energy Efficiency Center — is negotiating with an interdepartmental committee representing relevant ministries, especially the Ministry of Environment and the Ministry of Industry and Trade, to promote the measures.

Introduction

The National Climate Program (NKP), which is an association of several academic and applied research institutes and nonprofit consultancies, began the first studies on GHG emissions and climate change in 1991. In 1993, the NKP signed a contract with the U.S. Environmental Protection Agency (EPA) to perform the Czech Country Study to Assess Climate Change (CZCS). The study was conducted during 1993–1995 under the framework of the U.S. Country Studies Program. Some of the results (a preliminary inventory) were used in the First National Communication (FNC), but most of the FNC (projections and mitigation assessments) was based on independent effort. The main findings of this effort were used in the CZCS. The SNC, (Czech Republic, 1997), which is to be submitted this year, is primarily based on the results of the CZCS and the SNAP project. The SNAP project is an extension of the CZCS and was completed in September 1997.

This chapter summarizes the results of the CZCS, the SNAP project, and some work performed to prepare both national communications. Other projects are identified in the references at the end of the chapter.

The first part of the Introduction, Results of Past Studies, summarizes the results of the CZCS. The FNC con-

tained a list of technologies and policies concerning emission mitigation. Even though they were not designed in the framework of the CZCS, they are described under Current Mitigation Programs later in the Introduction.

The Measures section contains a list of potential government policies and measures for mitigation and adaptation; it was developed under the framework of SNAP. The state administration can draw upon this list when formulating climate change policies in the Czech Republic. It consists solely of recommendations for actions by the government (and its subordinate bodies) that are aimed at mitigating emissions and improving the country's adaptability to climate change; however, it does not include descriptions of technology solutions that will be or could be used for the given purpose.

Note: In this chapter, "technology" refers to technical solutions to the problem of mitigation or adaptation, e.g., installing insulation in a house or changing the structure of field crops. "Government" measures are instruments — most often financial or legislative — aimed at accomplishing the goals of emissions reduction or increased adaptability, and which may make use of some of the technologies.

The main thrust of mitigation measures is to reduce CO_2 emissions from combustion processes because of the prominent position of this greenhouse gas (GHG) in Czech emissions. Other measures are aimed at increasing the adaptation abilities of forests, agriculture, and water resources.

Results of Past Studies

The CZCS was organized into five parts. The first three focused on applied research and the development of practical recommendations. The five parts were as follows:

- Creating the GHG emissions inventory
- Identifying potential climate change scenarios for the Czech Republic and its consequences for water management, agriculture, and forestry
- Projecting emissions over a 20-year period and assessing technologies and policy options to mitigate those emissions (based on the research conducted for part 1)
- Summarizing the research conducted in parts 1–3
- Conducting outreach activities, such as video screenings and seminars to publicize the results

Vulnerability and Adaptation

Results of the studies indicated that the expected climate change would seriously affect the following three areas of the Czech Republic's economy: water management, agriculture, and forestry.

Water Management. If temperatures rise by 2° C and precipitation stays the same, the original runoff level will decrease by 10%–25%. If temperatures rise by 4° C, runoff will decrease by 25%–30%. A 5% decrease in precipitation, together with rising temperatures, would reduce runoff by 30%–50%; this is the most pessimistic scenario. Even a 5% increase in precipitation would not be enough to maintain the original groundwater runoff level, if temperatures were to rise by 2° to 4° C. With steadily declining precipitation, the groundwater runoff level could even decrease in river basins, where much of the groundwater accumulates.

Agriculture. If CO_2 concentrations double, the agriculturally exploitable production (above-ground parts) of grasslands and yields of winter wheat (the main grain crop) will likely increase. However, this would require increased rainfall during the growing season, which is uncertain. Higher temperatures and regular precipitation create better conditions for agricultural diseases as well as helping pests to develop and mature, adding to the uncertainty of predictions of agricultural yield.

Forests. The species composition of forests in the Czech Republic is strongly influenced by forestry management practices, and the forests contain many tree species that are at the edge of their ecological range. For these reasons, Czech forests are particularly sensitive to the slightest change in climate. This is especially true in the case of Norwegian spruce. A large proportion of forests are monocultures and are consequently less stable and more vulnerable to diseases, pests, and abiotic factors.

Emissions Inventory and Projections. Initially, the emissions of several GHGs were calculated for 1990. Then, emission inventories for 1991 through 1995 were performed and the inventory for the base year 1990 was corrected. All inventories were done according to IPCC methodology. Results of these inventories showed a substantial reduction in emissions of the three main greenhouse gases — carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) — during the period 1991–1995. Emissions of these GHGs were reduced by 23.3%, from 193.2 million tonnes of CO_2 equivalent ($CO_{2\,eq}$) to 148.2 million tonnes of $CO_{2\,eq}$, and emissions of CO_2 itself decreased by 24.4%, from 163.2 million tonnes to 123.4 million tonnes within that same period. The greatest reduction occurred in 1991.

CO_2 is the most significant GHG, accounting for approximately 84% of total GHG emissions. Fuel combustion is the main source of CO_2, some 97% of the total. Emissions from fuel combustion are the main source (86%) of all GHG emissions. Transportation (including mobile sources except for electric vehicles, which are counted in the energy production sector) is a relatively small part (6%) of total emissions. Another 9% of GHG emissions come from coal mining and iron, steel, and cement production, which are also highly connected to energy production activities. The remainder (5%) of GHG emissions come from agriculture and waste management.

Emissions projections for the period 1996–2010 involve two scenarios from opposite ends of the spectrum of possibilities, with the assumption that the actual scenario will be somewhere in the middle:

1. The base-case, "most unfavorable development," scenario has the highest volume of emissions. It is characterized by fast economic growth and the absence of restructuring or new technologies and policies.
2. The "favorable development" scenario outlines a path of development with the lowest volume of expected emissions. It is based on a slower growth of gross domestic product (GDP) and assumes that there will be a variety of both market and regulatory incentives for energy conservation. It does not, however, specify the impact of individual measures because of the difficulty of estimating their influence and possible synergy.

Both scenarios take into account two factors that are expected to substantially limit CO_2 emissions in the next 3 years: commencement of electricity generation at the Temelín Nuclear Power Plant (2 × 1000 MWe), and consistent enforcement of emission limits based on the Clean Air Act and subsequent decrees.

Figure 1 graphically depicts the general macroeconomic trends underlying both of the emissions scenarios presented in Figure 2.

A decline in energy intensity is expected to slow the rate of growth of total energy consumption (relative to GDP) in both scenarios. The consumption of primary energy sources is also expected to grow more slowly than GDP, and most of the increase after the year 2000 is expected to be met with gas and nuclear power. However, the favorable development scenario (see Figure 2) assumes a lower (3%) GDP growth rate.

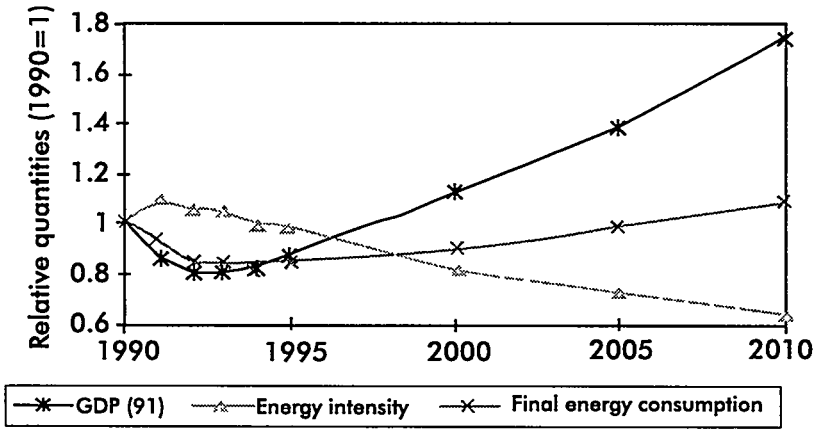
Current Mitigation Programs

Although the Czech Republic does not have a comprehensive climate change strategy, it does have several programs, described in the FNC, that are likely to reduce GHG emissions.

Legislative Measures

The Clean Air Act and subsequent decrees are among the most potent measures. The Clean Air Act will come into full force by 1999, and its effect was included in the baseline scenario. Compulsory measurement of energy consumption in housing was changed to an option and is, therefore, substantially softer. Stricter insulation standards have been in effect since 1994. Despite the fact that they are not binding (except for cases in which state money is invested), they are generally observed and the measure can be regarded as permanent.

Figure 1. Projections of GDP, Final Energy Consumption, and Energy Intensity



Tax Relief

VAT is lower for environmentally friendly products, and income tax rates are lower for renewable energy sources. Both have temporary status and their effect is considered minor.

Subsidies

The most powerful program, the National Program for Healing the Atmosphere, has the primary aim of reducing local emissions from small- and medium-sized sources. The most common type of project subsidized is fuel-switching from coal to gas. The program has spent CZK 6 billion (US$1 = CZK 34 in August 1997). Its benefits are estimated at 0.6–2.4 kt CO_2/year. Furthermore, approximate reductions of 10% in SO_2 emissions, 6% in CO emissions, and 8% in solid particles are also expected. The program's projects will continue while funds last (i.e., for 15–25 years).

The Czech Energy Agency (CEA) organizes programs to reduce energy consumption in public and residential buildings, support investment in renewable and alternative energy sources, and introduce small-scale combined heat and power (CHP) units for district heating systems.

The "Oleoprograme" for production of fatty acid methylate from rapeseed oil (MERO) has been launched with the support of the Ministry of Agriculture. This support took the form of zero-interest loans covering 80% of the total investment (approximately CZK 750 million). The maximum CO_2 emissions reduction potential from this measure is approximately 170 kt/year.

A program subsidizing the sale of compact fluorescent lamps financed by CEZ (an electricity generating utility) and CEA resulted in reductions in CO_2 emissions of about 9 kt CO_2/year.

A state-subsidized program for reforestation has been launched and may be extended. Although only 1,340 hectares have so far been forested, reforestation under this program is planned to cover roughly 80,000 hectares. This program is described in more detail in the Measures section.

Several other measures mentioned in the FNC as being "in preparation or consideration" were further elaborated and they are also described in the Measures section.

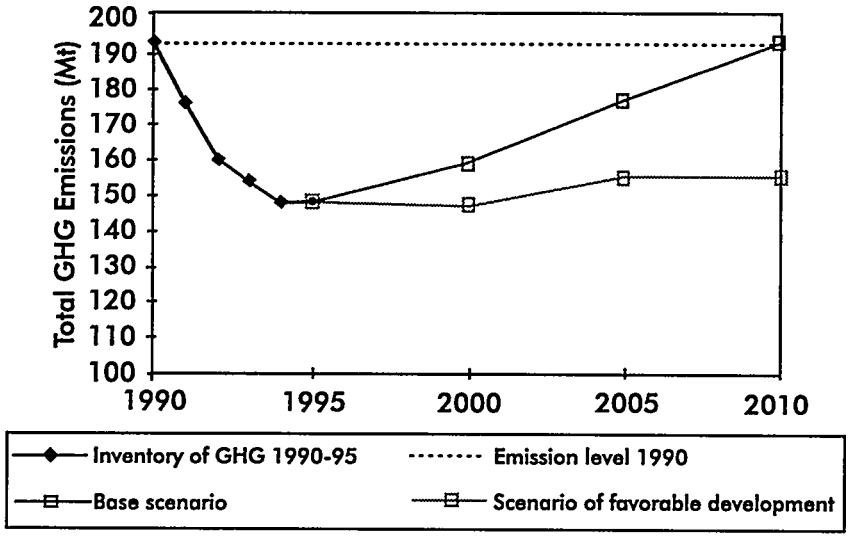
Objectives

The objective and commitment of the Czech Republic is to stabilize emissions in the year 2000 to the 1990 level.

Methods

In the Czech Republic, no framework on a comprehensive national action plan for climate change mitigation has yet been approved or adopted by the Government. An interdepartmental commission headed by the Deputy Minister of the Environment has been established to organize work on the FNC; sets of mitigation measures were identified for this purpose (FNC–94). The scoping meet-

Figure 2. Projections of GHG Emissions



ing of the SNAP project, called to identify mitigation and adaptation measures, was carried out together with SNC preparatory work by the same commission. The commission consists of representatives of the concerned ministries and several other agencies and institutions. The ministries represented are Environment, Trade and Industry, Finance, Foreign Affairs, Transportation, and Agriculture. The organizations involved were primarily the National Climate Program and two of its members: SEVEn and the Czech Hydrometeorological Institute. The major energy producer, the utility ÈEZ, has also participated in the work of the commission. During the work on the SNC, the draft version of SNAP was considered and some of the proposed options were included in the SNC (Czech Republic, 1997).

The Ministry of the Environment (ME) plays a leading role in all programs relating to sustainable development, including climate change issues. In the energy sector, the ministry cooperates with the Ministry of Industry and Trade (MIT). The NKP, especially SEVEn, frequently discusses policy options with the Strategy Policy Department of the ME and the Energy Policy Department of MIT. A few instances of partial success are discussed below.

At present, global warming and its associated effects have low priority in domestic affairs. Success of the process to develop a climate change policy strictly depends on the success of the transformation of the economy, which is still not completely finished. Problems in the financial sector, together with underdeveloped governing structures in industry, effectively block industry restructuring, which is the key factor in reducing energy intensity. Social issues undermine efforts to liberalize the energy market, although some substantial improvements have already been achieved. Household prices are increasing at a higher rate than previously planned. Since July 1, 1997, the subsidy for centralized heat has been reduced substantially. The law concerning the increase of the VAT rate for energy has already been passed by the Parliament and will go into effect by January 1, 1998.

New versions of the energy policy, currently being drafted, contain no mention of the mitigation of CO_2 emissions, but there is substantial effort by NKP and SEVEn to reintroduce this aspect to the policy. The responsible ministry (MIT) has been preparing the "Law on energy use" and legislation concerning the introduction of energy standards with substantial expert help from SEVEn.

The current situation is characterized, on the one hand, by the reluctance of the Government to adopt comprehensive material concerning a certain area (e.g., climate change or sustainable development) that could endanger the growth of the economy or affect earlier economic plans. On the other hand, responsible members of the cabinet clearly understand the necessity of reducing energy intensity in all sectors, which would result in the above-mentioned improvements. The process of raising general awareness of global warming among concerned citizens, especially decision makers, enough to result in a comprehensive approach to climate change, could take a long time (1–2 years).

The Czech Republic is cooperating increasingly with European Union (EU) member countries, Organization for Economic Cooperation & Development (OECD) countries, and a number of other Central European and Eastern European countries. The country is harmonizing its legislation with EU legislation and is actively participating in various international studies focused on mitigating the impact of climate change. One such study is the Study on a National Strategy for JI in the Czech Republic. It is supported by the World Bank, and the NKP and SEVEn are participating in.

Measures

The following description of measures and policies, and estimates of their potential impacts and costs, is the result of the work of a great number of experts. A list of these experts can be found in Tichý et al. (1997) in the full text of the National Action Plan.

We tried to characterize each of the measures according to their mitigation potential (only for the mitigating measures) and total (or annual) costs. The costs of the measures are based on current prices, and no dramatic changes are envisaged. They can, therefore, be used as a basis for comparison. Note, however, that, in most cases, the specific costs per tonne of CO_2 cited for individual measures are only very rough estimates, and should be regarded as such; policy selection based on these values could be very misleading. Although we have made every effort to minimize subjectivity in these numbers, estimates of the mitigation potential of a particular technological approach are also, for the most part, the subjective view of an expert. For this reason, we decided not to provide a summary table, which would encourage comparisons and conclusions that could present a false picture of the situation.

Mitigation Measures

Most of the mitigation measures selected are directed at demand-side options in the residential and commercial sectors (which includes the administrative sector), for the following reasons:

- When savings are implemented on the demand side, the energy lost and emissions created during transmission and transformation are saved as well. (In electric heating, for example, this represents three-fourths of the energy used.)
- In a market economy, energy prices affect costs and profits in industry, providing enough of an incentive to conserve energy in this sector.
- On January 1, 1999, relatively strict emission limits will enter into full effect. These limits will compel energy producers to renew their generating equipment (primarily involving a switch from coal to gas), which will lower greenhouse gas (GHG) emissions without requiring further incentives from the state.

Legislation and Standardization Policies

1. Introducing Energy Audit Standards in Buildings. This measure will create and codify the methodological basis for the performance of energy audits in residential, administrative, and commercial buildings that can be used within the framework of three legally introduced obligations, as follows:

- To carry out an energy audit and its recommendation in all buildings owned by the state and/or in buildings for which the state pays the energy bills
- To present the energy audit as a part of the purchase contract for an intangible asset and to recommend energy audits during building construction or renovation
- To support applications for state subsidies for construction, renovation, or purchase of a building with the energy audit

The upper estimate of the savings potential from heating in residential houses is 100 kt CO_2/year. State investments in buildings administered by the state will be directly compensated by the reduction in energy use. In the case of residential houses, the cost will be borne by the owners. The only other costs are related to amending the Building Act, the Commercial Code, and/or other legislative regulations, and they are negligible.

2. Introducing Energy Labels on Appliances. This measure is designed to introduce and enforce legislation that will gradually require producers to label the following popular household appliances: refrigerators, freezers, automatic washing machines, electric boilers, dryers, and dishwashers. Information labels would provide data on annual energy consumption (and/or consumed energy cost) and other information. The average mitigation potential is estimated at 28 kt CO_2/year. State budget demands are negligible; they consist only of some administrative costs during the preparation and unification of similar legislation in the EU countries.

3. Introducing Energy Standards for Appliances. This will introduce and enforce legislation that will check the observance of the energy standards for refrigerators, freezers, automatic washing machines, electric boilers, dryers, and dishwashers for households. The achievable savings potential is 60 GWh/year, i.e., 48 kt CO_2/year. State budget demands are negligible and consist only of administrative costs during the preparation and unification of similar legislation in the EU countries.

4. Enforcing Fuel Consumption Levels for Newly Developed Vehicles. This action will set maximum fuel consumption standards for newly developed road vehicles. The values will be determined gradually and will be based on standards accepted by the EU. Their verification will be a part of homologation (certification) tests.

Tax Policies

1. Providing a Tax Exemption for Profits from Municipal Bonds. Exempting municipal bonds from tax will make available more investment sources for the municipal infrastructure. A condition would be imposed that part of the income obtained from the sale of bonds should be invested into projects to mitigate CO_2 emissions (municipality gasification; energy conservation in residential buildings, schools, hospitals, etc.; and the construction of energy-saving buildings, e.g., for the elderly). The mitigation potential is estimated at roughly 15–200 kt CO_2/year. State budget demands would be CZK 15 million/year.

2. Shortening the Depreciation Period for Energy-Saving Devices. An amendment of the Income Tax Act aimed at changing the equipment for heat energy production or transmission (boiler rooms and exchange stations) into other depreciation groups is suggested to correct a disproportion between the 45-year depreciation period and equipment lifetime (10–15 years). Consequent equipment upgrades are expected to have a mitigation potential of 25 kt CO_2/year. State budget demands relate

only to the administrative amendment of the Income Tax Act wording.

3. Introducing a Carbon Tax and an Energy Consumption Tax. Introduction of a carbon tax and an energy consumption tax is suggested, with the aim of motivating the consumer to be economical in making use of energy sources and raw materials. It suggests that the tax burden be transferred from direct income taxes to the indirect energy consumption tax. The introduction of this tax will be coordinated with the EU countries (isolated introduction of this tax in the Czech Republic is improbable). The impact of the measure is estimated as follows:

- The presupposed 5% increase in energy prices caused by the tax burden should not have a significant impact on the total cost of goods, including household goods.
- A 20% increase in the tax burden accounts for an average price increase by nearly one per cent (0.86%); in some categories it is, however, more than 2% (e.g., paper, glass, china, earthenware, and transportation). When indirect links are taken into account, the price indices may climb up to 6%. This would be enough of a stimulus for a number of consumers, and a response in market relations and process innovations may be expected.

State budget demands are minimal. All costs related to this measure are administrative costs associated with introducing a new tax system that will be in compliance with that in other EU countries.

4. Modifying the Value Added Tax for Energy. All energy sources should be subject to the full rate of value added tax (22%) instead of 5% as at present. The lower tax rate can be reserved for energy from renewable sources. The upper estimate of the mitigation potential is a yearly emissions decrease of approximately 2 Mt CO_2/year. State budget costs are negligible, consisting only of amending the VAT Act. State budget benefits are estimated to be about CZK 6.5 billion/year. According to information available at the time this chapter was written, this measure will be introduced on January 1, 1998.

5. Providing Tax Relief in Transportation. The tax benefit will support municipal public transport and combined transport:

- The development of municipal public transportation will be funded by tax relief for municipalities.
- The Road Tax Act enables differentiated tax relief up to the total tax exemption for combined transport with the use of railway or water transport.

6. Including External Costs in Transportation. It is necessary to gradually include all external costs, i.e., costs ensuing from air pollution, noise production, accidents, land use, and the use of traffic routes into transportation tariffs (prices). The measure will be linked to similar measures abroad with the aim of creating real and equal market conditions under which a more favorable economic and ecological use of the transportation system would be achieved.

Subsidy Measures

1. Abolishing All Energy Price Subsidies; New Tariff Policy for Households. It is recommended that heat subsidies be abolished totally within 3 years and specific social assistance be introduced for families with low incomes, which will gradually decrease with the rise in average wages in the Czech Republic. The heat energy price would continue to be regulated (a regulation based on proved costs) and the owners of residential buildings would pay for heat on the basis of proved delivery costs. Abolition of the heat price subsidy has to be accompanied by the creation of a new tariff policy for electricity, gas, and heat that would respect the production and distribution costs and reasonable profit (so as not to repress the installation of new technologies). A partial abolition of heat subsidies is intended for June 30, 1998, and only heat costing more than 350 CZK/GJ will continue to be subsidized. The corresponding decrease in consumption; is expected to account for a yearly emissions reduction of 130 kt CO_2/year. The costs connected with this measure are only administrative costs. The total average yearly state budget revenue (during the period when subsidies are being abolished) would be CZK 1.9 billion a year.

2. Converting Heat Subsidies to Savings Subsidies. This measure would come into consideration if the heat subsidies are not abolished totally. It is recommended that the current program of the Czech Energy Agency be extended to other targets. The result of the energy audit will be a basic document for the allotment of state support. This support may be in the form of direct subsidy (20% of total investment cost), reimbursement (8%) of interest of commercial credit, or a guarantee for commercial credit. The mitigation potential is estimated to be 75 kt CO_2/year. The actual costs would, however, be paid by a transfer from the heat subsidy item. Specific investment costs are CZK 5300/kt of CO_2.

3. Providing Operational Subsidies for Renewable Energy. An operational support is suggested, i.e., a subsidy linked to energy production, to complete/substitute for investment support. Wind and small-hydro energy systems for electricity production, solar energy for heat and water heating, and biomass combustion for heat and power come into consideration. If an operational subsidy for renewable energy sources is applied, production of about 7 PJ/year may be expected. The total yearly emission mitigation potential is about 1.4 Mt CO_2/year. The total demand for subsidies are almost CZK 2 billion/year.

4. Providing Cheaper Mortgages for Energy Efficient Houses. Introduction of a supplementary subsidy in the form of a contribution decreasing mortgage interest by 2% is suggested (in addition to existing state support) when energy consumption criteria are complied with and verified by an energy audit. If the program lasts 15 years, the average annual savings is about 120 kt CO_2/year. The mean value of state budget demands amounts to approximately CZK 380 million/year. The corresponding specific cost is CZK 3,200/t of CO_2.

5. Establishing a Fund for Energy-Saving Projects. This measure involves establishing a fund for investments in energy conservation technologies in buildings administered by the state or municipalities, which would be used in combination with commercial project financing. The aim will be to verify the financing of energy efficiency projects in the form of loans and payment thereof from the achieved savings (revolving fund). The estimated value of the reduction in emissions is approximately 60 kt CO_2/year. State budget demand would be CZK 33 million/year.

6. Encouraging the Leasing of Energy Conservation Technologies. A program to support leasing energy-saving technologies is suggested. It consists of a contribution to cover the interest on refinancing credits of leasing companies and price-advantaged guarantees for leasing obligations, both 5% p.a. Moreover, it is proposed that the investment stimulus be increased from the current 10% of the input price of tangible property, by which the basis for a direct tax may be decreased, to 15% for energy-saving technologies. Also proposed is a decrease in the tax burden of leasing companies that lease energy-saving technologies (decrease in direct tax base by 50% of income inuring from the lease of energy-saving technologies). An average annual decrease in CO_2 emissions of 300 kt CO_2/year is expected, and the corresponding cost to the state will be CZK 330 million/year. An average value of specific costs is CZK 850/t of CO_2.

7. Encouraging Afforestation. This measure consists of one-time state subsidies of CZK 50,000/hectare to encourage the planting of new forests; the whole program will last 15 years. The new forest stands will fix 28 Mt of CO_2 after 15 years and 58 Mt of CO_2 after 100 years; i.e., the long-term average value is 0.6 Mt CO_2/year. The upper estimate of the total cost borne by the state budget is CZK 250 million/year. The average cost of the absorbed CO_2 is thus CZK 127/t of CO_2 over the medium term (15 years), and CZK 61/t of CO_2 over the long term (100 years).

8. Maximizing Biomass Reserves in Forest Ecosystems — educational project. The Ministry of Environment and the Ministry of Agriculture will organize a proposal for a project to Support Biomass Stock Maximization in Forest Ecosystems through Education. The 20-year project will include lectures, seminars, and operation of a demonstration plot. The project includes activities that explain the application of interventions that may significantly increase biomass stock in forest ecosystems. These interventions include increasing application of a shelterwood system, extension of the rotation period, improving nutrition, and full use of the productive area. The upper estimate of the technology's potential (i.e., if every forest owner applied it on an applicable area within 52 kt C/124 years, the assumed rotation period) is that it would sequester 1.5Mt CO_2/year. The average yearly cost is CZK 70 million/year.

9. Subsidizing Mass Passenger and Goods Transportation. The state (the Ministry of Transportation and the Ministry of Regional Development) will continue subsidizing the transportation sector. The purpose of the subsidies will be to make investments in a combined transportation infrastructure, optimize traffic flows on selected roads, develop municipal mass passenger transport, and research and introduce vehicles using alternative drives and fuels.

Negotiations with Producers and Distributors

1. Implementing Voluntary Emissions Controls among Energy Producers. It is suggested that a contract be concluded with the main energy producers on the amount of GHGs emitted by 2010, with the government committing support to this effort (e.g., by household tariff devel-

opment, an unambiguous attitude toward nuclear power engineering, and/or loan guarantees for new decentralized sources).

2. **Supporting Technology Development.** It is suggested that the development be supported of small gas boilers for household heating (10–30 kW) and/or hot water, in the form of technology procurement. The customer would be an association of sellers or a large wholesale business, and the state guarantor (or donator) would be the Czech Energy Agency or an independent consulting company.

3. **Organizing Awards for Producers.** This measure would involve modification of seals and/or voluntary standards, such as "Ecological Product" or "Czech Made," on the basis of GHG emissions criteria. The possibility of creating competitions for these awards is also being considered. Products meeting these pre-announced criteria would then be eligible for an award. It is not appropriate to make such an award contingent on the decision of a commission or political executive.

Adaptation Measures

Cross-Sectoral Measures

1. **Raising Awareness of the Possible Impacts of Climate Change on Agriculture, Forestry, and Water Management — educational project.** The Ministry of Environment will organize a tender for a project to Publicize Possible Climate Change Impacts on Agriculture, Forestry, and Water Management and Subsequent Measures. The project will include producing seminars for experts, and publications and programs for the mass media. The main benefits are increased knowledge, resulting in more precise recommendations in strategic studies, and the assurance of sustained agricultural production. The total cost of the project is CZK 1.5 million.

Forestry

1. **Improving the Composition of Forest Tree Species — extension of current subsidy.** This measure consists of subsidies (CZK 8,000/ha) to ensure a minimum admixture of improved and reinforcing species in today's mostly unmixed conifer stands. The purpose of this is to gradually strengthen the species composition of forests. The basic benefit of the measure is to prevent further decline in the ecological and economic stability of forests by improving the health of the forest stands. By increasing the share of natural forest stand regeneration and decreasing salvage felling, this subsidy will lead to an increase in the beneficial influence of forests on the wider environment, e.g., reducing the danger of erosion and improving their water management functions. The total average annual subsidy will be CZK 104 million/year.

2. **Increasing the Proportion of Natural Regeneration in Forests — new subsidy.** This measure consists of subsidies (CZK 10,000/ha) in support of natural forest regeneration. Benefits include the salvation and proliferation of gene sources, insurance against the consequences of potential changes in climate, and the creation and maintenance of a suitable forest environment. The upper estimate of the cost of the measure is CZK 40 million/year.

3. **Tending Forest Stands Younger than 40 Years — new subsidy.** This measure consists of subsidies (CZK 5,000/ha) for tending young forest stands, mainly to increase their stability. Additional benefits include suitable modification of tree species composition, a reduction in incidental felling, the establishment of parameters for desirable volume yield, and identification of suitable non-wood-producing functions of forests. The cost of the measure is CZK 120 million/year.

4. **Strengthening Forest Environmental Functions — new subsidy.** This measure consists of subsidies to change the technology of logging, improve the maintenance of access roads in forests with important environmental functions, and replant forests that have primary soil-conservation and climatic functions. The main benefit, for forests with water management functions, is a decrease in concentrated surface water runoff. The annual subsidy, including direct costs above normal maintenance costs, is CZK 147.2 million/year.

5. **Developing a Database of Biological Factors Dangerous for Forestry — cognitive project.** The Ministry of Agriculture will support a project to Develop a List of Dangerous, Quarantine, and Risk Factors Harmful for Forestry in the Central European Region. The project will assess harmful factors and will include a brief survey of the extension, biology, ill effects, and degree of danger for the forest management of the Czech Republic. The project will identify preventive measures and eradication possibilities. The cost is CZK 350,000/year for 2 years, i.e., CZK 700,000 in total.

6. Protecting Forests Against Dangerous Factors — fund establishment and subsidizing. This project will establish a Fund for Forest Protection against Quarantine and Dangerous Harmful Factors. The basic size of the fund will be CZK 1 million, and average subsidies will be CZK 400,000/year.

Agriculture

1. Increasing Soil Fertility with Slurry and Compost — new subsidy item. This measure includes subsidies (CZK 300/ha) for fertilizing application of slurry produced by the litterless operation of animal husbandry. Slurry fertilization is more expensive than fertilization with mineral fertilizers, but it will help to enrich the country's currently deficient soils. It is important to apply the slurry in the economically and ecologically most advantageous way (as a liquid). This measure also includes subsidies (CZK 500/t) for compost, which currently cannot be profitably produced. The benefits of both measures include soil enrichment, a decrease in consumption of industrial fertilizers, and a decrease in emissions from incinerating plants and landfills. The cost is CZK 182.5 million/year.

2. Ensuring Optimum Levels of Mineral Fertilization — new subsidy item. This measure consists of subsidies (CZK 350/ha) to optimize the level of mineral fertilization of arable lands and is aimed at maintaining their fertility. The subsidies will help in ensuring, particularly in naturally fertile lands, an increase in fertilization levels of approximately 30%, from the estimated 180 kg/ha of net nutrients to 240 kg/ha. The other main benefit is more effective utilization of water by plants. The suggested subsidies will cost CZK 500 million/year.

3. Identifying the Optimum Structure of Field Crops for Climate Change — development project. The Ministry of Agriculture will organize a project to Assess the Optimum Structure of Field Crops and Their Varieties for Possible Climate Change. Current agricultural crop types will be bred for resistance and tolerance to drought and higher temperatures, early maturation, and greater resistance to harmful factors. This project, which is planned to run for 15 years, will have a substantial impact on assuring food safety in the Czech Republic. The cost of breeding and research is approximately CZK 30 million/year.

4. Developing New Technologies for Soil Preparation and Crop Growing — development project. The Ministry of Agriculture will organize a project to Develop New Technologies of Soil Preparation and Development of Soil-Protecting Methods of Crops Growing. Research into new soil-protecting technologies that can replace, or at least partially eliminate, traditional plowing will be carried out, and free consulting services will be provided. This project will also increase food security. The technologies developed will assure an increase in the yield stability of crops, decrease the energy intensity of agriculture, and reduce the exposure of soil to erosion. The research will cost CZK 10 million/year, and the consulting will cost CZK 4.5 million/year.

5. Introducing Crops Resilient to Climate Change — new subsidy. This measure consists of subsidies (CZK 3,000/ha) for purchasing seed stock, farm machinery, and consulting services. This measure will utilize the results of the two research projects (identification and breeding of crops, and development of new technologies). The aims of the subsidies are to maintain production potential under changed climate conditions, acceptable profitability of crop production, and reasonable production costs, and to assure the use of ecological procedures in the growing of agricultural crops. The cost is estimated to be approximately CZK 10 million/year.

6. Stabilizing and Maintaining Extremely Dry Areas — new subsidy. This measure consists of subsidies for stabilizing and maintaining extremely dry areas unsuitable for agricultural production by means of afforestation, where appropriate, and sowing grass. The subsidy (CZK 5,000/ha for sowing, CZK 2,000/ha for maintaining grasslands) will assure the stability of the land in extremely dry locations. The subsidy cost is estimated as CZK 100 million/year (declining from the third year). This subsidy should be interconnected with the afforestation subsidy.

7. Establishing a Soil Protection Service — new role of state institution. The Ministry of Agriculture will establish a state soil service to provide expert aid, check implementation, and develop protective measures in projects of comprehensive land treatment. The agency will also ensure that land-use methods are respected and that agreements on specific subsidies granted to landowners are observed. As the structure and capacity of the current land office will be used, no increased costs are expected.

8. Protecting Soil Endangered by Erosion — new subsidy. This measure consists of subsidies (CZK 1,500/ha

for organizational and cultural practices, CZK 5,750/ha for construction and technical measures) to protect land endangered by erosion caused by climate change. The main benefit of the erosion control measures will be protection of the quantity and quality of soil. The cost of increased erosion control protection caused by possible climate change is estimated to be CZK 756 million/year.

Water Management

1. Introducing Water Resource Usage Fees — environmental tax. This tax would have two components: (1) a nationwide rate to ensure respect for the scarcity of water resources and fund national measures to adapt to their depletion, and (2) a local rate that would reflect the local costs of the production, treatment, and distribution of water. Collections under the local rate would go to local agencies. This measure creates a financial incentive to protect water resources. As this is an administrative measure, no special costs are expected.

2. Developing and Operating a Climate Variability Monitoring System — development project. In agreement with the Ministry of Agriculture, the Ministry of Environment will organize a project to Develop a System to Monitor Climate Variability and Changes in Water Resources. The project will include the extension of existing hydrosphere monitoring activities, connecting them to international monitoring systems, and producing information on climate-caused changes in water regimes. The one-time cost for project elaboration is CZK 300,000, and cost of annual operation of the information system is CZK 200,000/year.

3. Establishing Procedures to Ensure Optimum Water Use — project to suggest procedures. In agreement with the Ministry of Environment, the Ministry of Agriculture will organize a project to Establish Economic and Education Measures for Optimum Water Use. The project will include a study of the influence of ecological taxes for protection of the environment. The project will also identify subsidies and penalties that could limit economic activities in areas in which the cleanliness of water resources must be protected. The project will include information and education campaigns on economical water usage for the public and businessmen. Total cost of the measure is estimated to be CZK 4.5 million.

4. Managing Hydraulic Structures Under Unsteady Conditions — development project. The Ministry of Agriculture and/or the Ministry of Environment will organize a research and educational task to Manage Hydraulic Structures under Unsteady Climatic and Hydrologic Conditions. The project will include research and subsequent training on methods of water management appropriate to the Czech Republic. It will also lead to the elaboration of a draft decree following the amended Water Act. The total cost of this measure is expected to be CZK 5.4 million.

5. Developing a Hydrologic Forecasting System — development project. The Ministry of Agriculture of the Czech Republic, in agreement with the Ministry of Environment, will organize a project to Develop a Hydrologic Forecasting System in Basins of Smaller Streams of Agricultural-Forest Landscape. It will be a comprehensive concept for a hydrologic forecast system that would enable issuing warnings, alarms, estimates, and/or forecasts of runoff situations in real time and on small scales. The total cost of the project is CZK 5 million. The success of the project is connected to that of projects on annual regional hydrological balances and control of water management systems.

6. Developing and Operating an Annual Hydrological Balance System — development project. The Ministry of Environment (and the Ministry of Agriculture) will organize a research and education project on Data Acquisition Systems and Assessment of the Annual Hydrological Balance and its Operation. The project will include designing a system for acquiring meteorological (precipitation) and hydrological data, establishing a methodology for complete hydrological balance of individual basins, and developing a proposal for a corresponding decree. Investment costs for the hydrological balance system project are CZK 2 million, and the cost of routine system operation is CZK 0.5 million/year.

7. Protecting Areas Designated for Water Accumulation — area mapping project. The Ministry of Environment will organize a project to Examine Areas Designated for Water Accumulation. Within its framework, areas for contingent water accumulation will be identified and regional water management balance will be carried out. A proposal will also be included for a decree ensuring the protection of territories intended for water accumulation. The aim is to limit construction and other permanent activities that could in the future irreversibly prevent accumulations of water in the localities listed. The total cost of the measure is CZK 21 million.

8. Constructing and Operating Irrigation Systems — new subsidy. A subsidy for irrigation system development and operation (80% of the required investment) would stabilize harvests in the event of adverse climate change. The aim is to extend and modernize current irrigation systems on 6% of arable land during a slower rate of climate change, or on 35% of arable land during a faster rate of climate change, predominantly in the warmest and most fertile areas of the country. A subsidy for irrigation-water resources would make irrigation water more available. The state budget requirement is CZK 1.55 billion/year in the first climate-change scenario, and CZK 24.25 billion/year in the second scenario, for a period of 20 years each.

International Cooperation

A number of experts and institutions in the Czech Republic (a great many of whom are associated with the National Climate Program) are studying possible climate changes and their consequences. The U.S. Country Study Program provides the framework for much of this cooperation. This program also initiated intensive informal cooperation among countries of the Central European region. Czech experts are also planning to work with OECD countries and the International Energy Agency (IEA) (Common Actions Program).

The Czech Republic has been involved in several other programs. The greatest level of cooperation, however, is within the PHARE program (as the Czech Republic is a country associated with the EU). The Ministry of the Environment of the Czech Republic will support mainly scientific collaborations within the IPCC framework. The Czech Republic is also involved in the Energy Efficiency 2000 project.

AIJ/JI activities are also very important. The Czech Republic has repeatedly expressed hopefulness about the joint implementation of projects to reduce greenhouse gas emissions. One of the first such projects, a fuel switching and cogeneration project in the city of Dìèín, has commenced; however, agreement to allow its announcement to the UNFCCC Secretariat as an AIJ project has not been reached. An afforestation project in Krkonoše National Park, which is a very successful cooperation with the Face Foundation (Netherlands), began in 1992 and has now acquired AIJ status. Several other projects were suggested to the Ministry of the Environment of the Czech Republic, and the ministry prepared rules for assessing conceptions for the pilot phase of AIJ projects (*SNC–97*).

Collaboration in the area of environmental education is also important. Positive results can be seen from both the Blue Sky and GLOBE programs. Centers for environmental education in the Czech Republic, along with other local nongovernmental organizations (NGOs) working with children and youth, are interested in similar collaboration with foreign NGOs.

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EGYPT

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Summary

Egypt's climate change action plan aims to integrate climate change concerns into national planning processes and programs by enhancing policy dialogue, raising national awareness, and building national capacity to deal with climate change, and designing priority policies and measures to mitigate and adapt to possible impacts of climate change. The plan is currently under development, and a set of policies and measures to mitigate and adapt to possible climate change is being established. The expected completion date for the plan document is July 1998. While Egypt is not contributing much to global greenhouse gas (GHG) emissions, it has been identified as one of the countries that are vulnerable to possible impacts of climate change — as indicated in the second assessment report (SAR) of the Intergovernmental Panel on Climate Change (IPCC). Assessing "no regret" mitigation technologies would enhance economic efficiency and have many other economic and environmental benefits for the national economy. Furthermore, implementing different adaptation options — specifically in priority sectors that are vulnerable — would help to ensure a sustainable development path for Egypt.

This chapter focuses on Egypt's efforts to deal with global climate change in terms of projects that have already been implemented or are under way, institutional arrangements that are currently being shaped, and steps that are being taken to develop a climate change action plan.

Table 1 summarizes the priority sectors and measures that will be addressed by the plan.

Introduction

Egypt signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, and ratified it in March 1994. Since then, Egypt has conducted several projects and programs related to climate change.

Results of Past Studies

Egypt has special circumstances that dictate its position in response to the climate change issue. Among those special circumstances are the following:

- Egypt's large and tightly packed population makes it highly vulnerable to the possible threats of climate change. Most of the 60 million inhabitants live on only 5% of the total land. Human settlements would be a critical issue in case of possible climate change.
- Egypt is already deficient in food production (especially grains), and agricultural land is only 5% of the total land area. Agricultural resources and food production would be highly vulnerable to climate change.
- Egypt's freshwater resources are limited, and more than 90% dependent on sources originating outside its national borders. The Nile basin itself is one of the regions that is highly sensitive to the possible effects of climate change.
- The lowlands of the Nile Delta and coastal resources would be vulnerable to sea-level rise. The second assessment report of the IPCC estimated a 1% loss of total land of Egypt by 2100 due to sea level rise.

Thus, Egypt's vulnerability to the possible impacts of climate change has driven its active involvement in international efforts to face such possible environmental problems.

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Measures
Mitigation	
Energy: *Industry*	■ Waste heat recovery ■ Cogeneration ■ Combustion control ■ Switching to natural gas ■ Using condensate recovery systems ■ Efficiency standards
Energy: *Commercial/residential*	■ Efficient lighting systems ■ Cogeneration ■ Switching to natural gas ■ Building codes ■ Appliance efficiency standards
Energy: *Electricity generation*	■ Wind power ■ Solar thermal ■ Power purchase agreements ■ Switching to natural gas combined cycle
Energy: *Transportation*	■ Compressed natural gas ■ Improved public transportation
Waste management: *Solid waste*	■ Composting
Waste management: *Liquid waste*	■ Under development
Agriculture	■ Reduction of area of cultivated rice production ■ Improved management of rice cultivation ■ Improved nutrition on small farm units ■ Widespread use of small on-farm digesters ■ Planting of shelter belts on the northern coast
Adaptation	
Coastal resources	■ Under development
Agriculture	■ New cultivars ■ Less water consuming crops ■ Change cropping patterns
Freshwater resources	■ Under development

Vulnerability

As explained earlier, vulnerability is a critical issue for Egypt's response to climate change. Vulnerability assessments in priority sectors have been undertaken as part of the process of developing the national action plan.

Agriculture. The potential impact of climate change on the production of various field crops in Egypt was assessed. It was found that climate change would decrease national production of many crops (ranging from a decrease of 11% for rice to a 28% decrease for soybeans) by the year 2050 compared to their current production. The impact on wheat, maize, and cotton production in Egypt was evaluated by simulating crop production under different climatic scenarios — in the case of wheat and maize — and by analyzing sensitivity to temperature — in the case of cotton — in the three main agricultural regions of Egypt. According to the simulation, the impact of climate change on national wheat and maize production would be severe, while the seed cotton yield could increase up to 31% compared to current climate conditions. Water demand for summer crops could increase by up to 16% within the same time period.

Coastal Zones. The coastal zones of Egypt are highly vulnerable to the impacts of climate change, not only because of the impact of sea-level rise, but also because of the impacts on water resources, agricultural resources,

tourism, and human settlements. The shoreline of Egypt extends for more than 3500 km along the Mediterranean Sea and the Red Sea. It includes a large portion of the most fertile lowland of the River Nile Delta. In addition, the coastal zones host a large number of highly populated cities, notably Alexandria, Port Said, Rosetta, and Damietta on the northern coast. These cities also encompass a large portion of the Egyptian industrial and economic sectors. As a result, the coastal zones suffer from a number of problems including population pressure, land use conflicts, and lack of institutional capabilities for integrated resource management. It has been generally recognized that the coastal zone of the Nile Delta is most vulnerable to the impact of sea-level rise. Not only because sizable parts of the coastal zones are expected to be under the risk of inundation and salt water intrusion, but also because other resources in the coastal zones such as water, food, tourism, and human settlements could be threatened by the possible impacts of climate change.

The vulnerability of Alexandria, Rosetta, Port Said, and Damietta to sea-level rise has been quantitatively assessed using remote sensing, GIS techniques, and field surveys. The IPCC vulnerability assessment methodology was used to identify and quantify potential risks of each environmental sector for each district of these cities.

Alexandria is the second largest city in Egypt. It hosts the largest and main harbor of the country and about 40% of Egypt's industrial activities. It has a population of about 4 million, and is considered the premier summer resort in the country. Scenarios of 0.25m, 0.5m, and 1.0m sea-level rise over the next century (by the year 2100) were explored, taking land subsidence (2.5mm/yr), into consideration. The percentages of population, land areas, and land uses at risk for each scenario were identified and quantified. Table 2 shows results for each scenario, assuming no action is taken. These results are used to assess potential loss of employment for each sector. Analysis of the results indicated that, if no action is taken, an area of about 30% of the city will be lost due to inundation, almost 2 million people will have to abandon their homes, 195,000 jobs will be lost, and an economic loss of over US$35 billion can be expected over the next century using current figures of employment, population density, and dollar values. The most severely impacted sectors are agriculture, industry, and tourism. To respond to such devastating environmental threats, potential adaptation measures are currently under development.

Table 2. Impact of Rising Sea Levels on the City of Alexandria over the Next Century (Percentages)

Affected Sector	Projected Sea Level Rise* 0.0m	0.25m	0.5m	1.0m
Population displaced	45	60	67	76
Land area inundated				
Beaches	1	11	48	64
Urban	38	44	56	67
Vegetation	55	59	63	75
Wetlands	47	49	58	98
Bare soil	15	24	29	31
Land use losses				
Residential	26	28	39	52
Industry	54	56	66	72
Services	45	55	76	82
Tourism	28	31	49	62
Restricted areas	20	21	25	27

* Taking into consideration continuing land subsidence of 2.5mm/yr

Water Resources. Egypt's freshwater resources are the lifeblood of the nation. Although the River Nile satisfies more than 95% of the country's need for water, there are other freshwater resources, including rainfall and groundwater. Various assessments have shown that water resources in Egypt would be vulnerable to possible impacts of climate change. It is important to assess the vulnerability of both demand and supply as they are related. Also, there will be areas of overlap between water resources and some other systems — especially agriculture, which is the major water-consuming sector in Egypt. It should also be noted that not only water quantity would be affected by climate change, but also water quality, which is critical to the health of humans and animals, as well as plants and soil.

The vulnerability assessment of the River Nile showed that its flow is influenced by the climate conditions in the 10 river basin countries, namely Kenya, Burundi, Uganda, Rwanda, Zaire, Tanzania, Ethiopia, Eritria, Sudan, and Egypt. If climate change were to improve the intensity, distribution, and duration of the

precipitation in the equatorial lake area and in the Ethiopian Highlands, then higher flows of the River Nile would be realized in Egypt; otherwise, lower flows will reach the Aswan high dam. Furthermore, if the climate conditions in those countries create lower evaporation rates and lower seepage, again the river flows to Egypt are likely to increase; otherwise, these flows will fall. Most of the groundwater resources in the Western desert, Eastern desert, and Sinai Peninsula are fossil, i.e., not renewable. So, they are not directly affected by climate change. In addition, the technology to assess the effects of expected climate change on regional rainfall is still immature.

Higher temperatures could also increase the demand for water for industrial, agricultural, and domestic uses. However, the threat of water shortage from increased use in these sectors is expected to be marginal when compared to the future increase in demand due to population growth.

Adaptation

An assessment of adaptation measures for coastal resources on the northern Mediterranean coast that are vulnerable to sea-level rise is still under way. An assessment of adaptation to possible changes in freshwater resources is lacking due to the absence of reliable vulnerability data.

Emissions Inventory

The first GHG inventory of Egypt was conducted in 1994, and recently refined based on the 1995 IPCC guidelines and default emission factors. The total net GHG emissions are equal to 106.708 thousand tonnes of CO_2 equivalent using the 1995 GWPs. Figure 1 shows the GHG inventory by gas, using global warming potentials. With 92% dependence on fossil fuels, the energy sector is expected to be the major source of GHG emissions, contributing about 71% of the national total, followed by the agriculture sector which accounts for 15% — mainly in the form of methane emissions from rice cultivation. Emissions of CO_2 by sources are shown in Figure 2.

Mitigation

Mitigation analysis has shown that some policies and measures have a good potential to reduce GHG emissions. These are energy efficiency; fuel switching to low-carbon fuels, namely natural gas; and promotion of renewable energy sources. Adoption of such policies and measures of the "no regrets" type, would have a multitude of economic and environmental benefits.

Current Programs

A Climate Change Interministerial Committee has been formed, chaired by the Chief Executive Officer of the Egyptian Environmental Affairs Agency (EEAA). This committee will oversee the process of plan development. In addition, a lead institution has been identified to coordinate the plan development and develop national communications. This is the Organization For Energy Conservation and Planning (OECP).

There are a number of ongoing programs that would contribute to the development of the climate change national action plan. These include, but are not limited to:

- A national program to switch from oil to natural gas in electricity generation, industry, transportation, and residential and commercial sectors

Figure 1. Percentage Share of Major Greenhouse Gases (CO_2 equivalent)

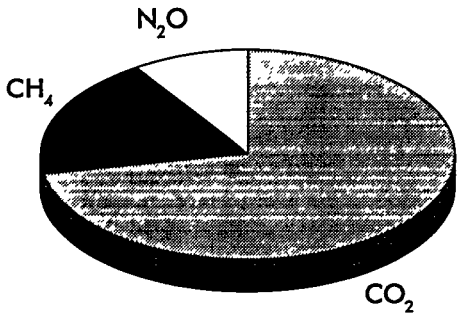
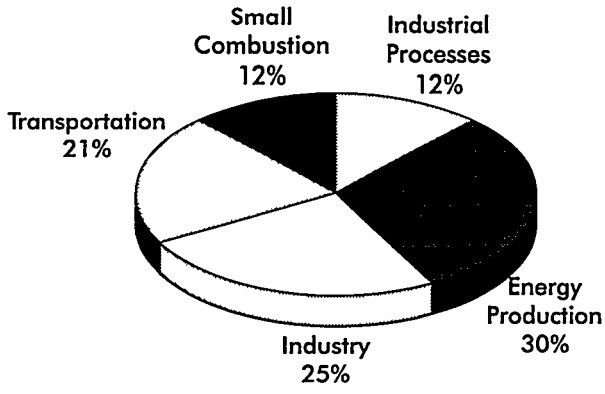


Figure 2. CO_2 Emissions from Main Sectors



- A national program for promotion of wind power for grid-connected electricity generation
- A pilot demand-side management project jointly implemented by some major key institutions of the energy sector
- A national action plan for solid waste management and assessment of the potential of waste-to-energy projects
- An energy conservation and environmental protection project (ECEP) funded by USAID
- A huge land reclamation project
- A program to use compressed natural gas (CNG) as transportation fuel
- An expansion plan for the Cairo underground metro to improve public transport
- A project for building communication capacity for Egypt to respond to UNFCCC obligations, cofunded by the Global Environmental Facility (GEF) and the Government of Egypt (GOE)

Given the existing capacities in Egypt, it is recognized that it needs assistance to be able to respond to its obligations under the Convention. Three immediate objectives are indicated in the project document. These are:

- Strengthening capacity in Egypt to comply with the requirements of the UNFCCC
- Institutionalizing the national communication to comply with the UNFCCC
- Contributing to the emergence of Egyptian approaches and responses to the UNFCCC

These objectives are to be realized by building institutional capacities within Egypt. Approaches that will be employed include:

- Training of experts to improve their technical capacities to assemble, interpret, and disseminate data relevant to GHG emissions and mitigation of climate change
- Sponsoring national training seminars, workshops, and studies on topics related to climate change
- Benefiting from joint training programs such as CC:TRAIN and the CC:FORUM consultative process

It is clear that the project activities will complement those of the national action plan, and a close coordination between the two has been secured. Although there is no climate change strategy so far, these programs, as they develop, will comprise Egypt's long-term response to climate change.

Objectives

Based on a document titled *Framework of National Action Plan for Climate Change*, which was developed within the USCSP, a set of objectives to develop the national action plan was identified:

1. *Integrating climate change concerns into national planning processes and programs*. Egypt, as most of the developing countries, has its own pressing development problems that determine its national priorities. At present, climate change is not one of those priorities. National planners and policy makers have never taken the threat of climate change into account; neither their planning tools nor practices are suitable for this. National climate change policy is still in the early stages of formulation as well. The national plan will address these concerns and aim at integrating climate change issues into national planning processes and programs through enhancing policy dialogue.

2. *Raising national awareness and building national capacity to deal with climate change issues*. General awareness of climate change issues is relatively low and needs some time to be raised. National capacity to deal with the complexity of the climate change issue is weak. This is well recognized in the *Framework of National Action Plan for Climate Change*. It is crucial that the national plan should address the importance of raising awareness and promoting capacity building.

3. *Design of priority policies and measures*. Implementing "no regrets" mitigation technologies would enhance economic efficiency and have other economic and environmental benefits. The national action plan must address the need for technology transfer to ensure that Egypt will be capable of dealing with different aspects of climate change.

Methods

Developing a national action plan for climate change is an ongoing process that involves a vast array of national institutions and individuals. This process would take into account the normal planning practices used in the country, other planning documents in existence, and the available resources in terms of time, money, and expertise.

Development of the planning process evolves as time goes by. It should also be noted that the plan document, even when completed, will be a live document subject to continuing revisions and/or updates. Due to lack of sufficient capacity and as the national institutional arrangement is not yet well prepared to deal with climate change issues, the planning process will contribute to enhancement of the national capacity and policy development. The document entitled *Framework of National Action Plan for Dealing with Climate Change*, developed earlier within the USCSP, serves as a guidance document that highlights the existing national capacity, identifies existing gaps in different areas, and determines priority sectors and measures.

A national lead agency, the Organization for Energy Conservation and Planning (OECP) has been chosen to coordinate the process of plan development and preparation of the national communication. It will be closely coordinated with the Egyptian Environmental Affairs Agency (EEAA) — the national focal point of the UNFCCC — and the Ministry of Foreign Affairs (MOFA). The coordination mechanism is further strengthened through the Inter-Ministerial Committee (IMC), which is comprised of government officials representing relevant sectors, NGOs, and national experts. Several workshops will be organized to present the plan to the different stakeholders and to receive their input into it. The IMC will endorse the plan document when it is completed, before presenting it to the board of directors of EEAA for approval, followed by final approval by the Cabinet before it becomes part of the country's development plans.

Scoping Meetings

As an important part of the planning process, a number of scoping meetings have already been conducted to review the results of past climate change or other relevant studies; review other relevant planning documents (five-year plans, environmental action plans, power generation expansion plans, the framework for national action plan, etc.); identify the national institutions that should participate in the plan development; initiate the planning process; create the planning teams in different sectors; raise awareness of decision makers, NGOs, and the public; and identify national expertise available to contribute to plan development. Examples of those meetings include scoping meetings for the media, energy sector experts, agriculture sector experts, and several orientation meetings for NGOs.

Identification of Key Organizations and Personnel

Under the oversight of the OECP, the action plan is being developed jointly by a group of Egyptian institutions as follows:

- *Egyptian Environmental Affairs Agency (EEAA)* — The national focal point for coordination of climate change activities.
- *Egyptian Organization for Energy Conservation and Planning (OECP)* — Given its current resources and expertise specifically in the areas of energy planning, energy policy analysis, and energy efficiency, the OECP will act as the implementing agency for development of the national action plan and preparation of national communication.
- *Ministry of Electricity and Energy (MEE)* — Through its leading institutions, the Egyptian Electricity Authority (EEA) and the New and Renewable Energy Authority (NREA), the MEE will contribute to the estimation of future GHG emissions, and assessment of mitigation technologies and measures.
- *Ministry of Petroleum (MOP)* — OECP itself is an affiliate to MOP. Furthermore, The Egyptian General Petroleum Corporation (EGPC) will also contribute to the estimation of future GHG emissions and assessment of mitigation options.
- *Ministry of Agriculture* — Its leading research body, the Agriculture Research Center (ARC) will contribute to the assessment of vulnerability and adaptation for the Egyptian agricultural sector.
- *University of Alexandria* — The Institute of Graduate Studies and Research will undertake the work related to the coastal resources; the faculty of engineering will contribute to the work related to the transport sector.
- *Ministry of Industry (MOI)* — It will contribute to the work related to mitigation options and technology assessment for the industrial sector.
- *Ministry of Public Works and Water Resources* — It will be the focal point of work related to vulnerability and adaptation of water resources.
- *Cairo University* — Faculty members will participate in the technology assessments work teams.
- *Arab Office Of Youth and Environment (AOYE)* — An active NGO in the area of public awareness.

Evaluation and Development of Measures

The document entitled *Framework of National Action Plan for Dealing with Climate Change* identified the priority sectors to be focused on in the plan development. These are the energy sector, agriculture, water resources, and coastal resources. For assessing potential measures in each sector, Technical Working Groups (TWGs) have been identified, one or more for each sector. Terms of references for the TWGs were developed by the planning team within the coordinating institution, OECP. The National Interministerial Committee (NIC) is overseeing the overall process of plan development. Within each sector, a set of criteria has been developed and used to screen lists of policies and measures to be evaluated. Table 3 shows different criteria used to screen different measures in different sectors.

Energy Sector

In the energy sector, a set of seven energy efficiency technologies have been chosen to be thoroughly assessed. An evaluation framework has been established to facilitate integration of the outputs into the national plan. This includes:

- Evaluation of potential of technology penetration, and its impact on CO_2 reduction
- Evaluation of the cost of each technology
- Estimation of the specific costs of CO_2 abatement (US$/tonne CO_2), using unified assumptions of energy prices, discount rates, inflation rates, and other relevant variables
- Evaluation of the technical, economical, social, and environmental impacts of each selected technology
- Estimation of the near-term opportunities to promote the diffusion of the selected option under the current market conditions

Based on the results of the technology assessments, those options of zero or negative costs will be used to design different mitigation scenarios. It should be noted here that Egypt has no emissions reduction target, however, and in accordance with its development plan objectives, no-regrets policies and measures would be adopted. In fact, energy efficiency, switching to natural gas instead of oil, and promotion of renewable energy resources are integral parts of Egypt's energy policy. The climate change action plan will include measures that would meet such policy objectives.

Agriculture Sector

It is worth highlighting the process of screening of mitigation measures in the agriculture sector. This was done using a predefined set of criteria. Based on that screening, the following broad types of mitigation options were selected for further review:

- *Reduction of area of rice cultivation.* One way to reduce methane emissions is to reduce the area of rice cultivation. The government of Egypt is currently exploring this option as a part of its overall agricultural policy.
- *Improved management of rice cultivation.* By reducing nitrogen fertilizer inputs and duration of the irrigation period when the crop is submerged, or by switching to upland rice varieties, which do not require flooding, methane and nitrous oxide emissions can be reduced.
- *Reduction in methane emissions from anaerobic fermentation.* This option was included based on a DANIDA project to explore the feasibility of installing a large number of small farm-level digesters in Egypt to convert manure to methane gas for energy. Because of the structure of the agricultural sector, the capital intensive nature of this mitigation option, and the energy situation in Egypt, the feasibility of this type of project was called into question. However, because the information for estimating the benefits and costs of this option appears to be available, it was included.
- *Planting green belts on the northern coast of Egypt.* The government is currently evaluating the option to install a green belt on the northern Egyptian coast. This program may have some carbon sequestration benefits and should receive further investigation.
- *Urban forestry.* Not much information was available about existing government plans to plant trees in cities. It is worth determining if such programs have been proposed and evaluating the carbon sequestration benefits and costs of these programs.
- *Reduce nitrous oxide emissions from soils.* This measure, in general, is hard to evaluate because it requires soil, climate-, and management-specific types of information that usually require field experimental plot data.

A more detailed screening process was then used to screen these options, based on information obtained from about 20 Egyptian agricultural sector experts. In a scoping meeting, attended by an expert from the UNCCEE, the Egyptian experts were asked to score these broad mitigation options based on the following criteria: relative magnitude of GHG reduction, relative cost, associated

infrastructure needs, ease of implementation, and other — possibly adverse — environmental impacts. The experts were also asked to rank their own expertise in each of the broad mitigation options and to provide qualitative comments about the strengths and weaknesses of each of these option areas. The ranking of the options in the second screening was as follows:

- Reduction of area of cultivated rice production
- Improved management of rice (nitrogen, water, new cultivars)
- Improved nutrition on small farm units
- Widespread use of small on-farm digesters
- Planting of shelter belts on the northern coast

The five broad categories of mitigation options, suggested above, must be further refined before they can be considered as specific mitigation options.

Adoption of the Plan

After completion of the first draft of the plan document, it will be presented to different stakeholders, then to the national Inter-Ministerial Committee for endorsement. The plan would then be presented to the board of directors of EEAA for approval. Resources identified in the plan which would be needed for implementation will be included in the budgets of respective government agencies after final approval of the plan by the Cabinet. The action plan would then be an integral part of the country's development plans

Measures

As outlined before, the priority sectors to be focused on in the plan development are energy, agriculture, water resources, and coastal resources. From the analysis of the GHG inventory (Figure 1), the energy sector has the highest potential for reducing GHG emissions. On the other hand, the agriculture sector, water resources, and coastal resources are the most vulnerable sectors to the possible impact of climate change, and thus would be the targets of any future adaptation measures. See Table 1 for an overview of mitigation and adaptation measures that have already been identified for these sectors.

Energy Sector

As pointed out earlier, and given the current energy situation in Egypt with high dependency on fossil fuels, and based on the analysis of the GHG inventory, the energy sector has the largest potential for CO_2 mitigation. The subsectors addressed in the action plan for consideration include industry, transportation, electricity generation, and the residential and commercial sectors.

Mitigation scenarios are under development to assess the impacts of energy efficiency, switching to renewable energy resources, and switching from oil to natural gas on future emissions of GHGs. Some technology options have also been identified for in-depth evaluation. Most of these technologies have already been demonstrated in Egypt, so country-specific data is available. Table 4 indicates the cost of mitigation of one tonne of CO_2 for each option. It should be noted that most of these options are found to be of the "no regrets" type which match the national energy policy objectives.

Social impacts have also been evaluated, including effects on employment, social acceptability, and enhancement of local capacity. Preliminary results were positive and offered some ranking of measures in regard to their social impacts. Use of wind energy for electricity genera-

Table 3. Criteria Used for Screening Measures in Different Sectors

Sectors	Criteria
Agriculture	■ Structural applicability to Egyptian agriculture ■ Ease of implementation ■ Information available for conducting the analysis
Energy	■ Zero or negative cost to the economy ■ Consistency with national energy policy objectives ■ Prior demonstration or use in Egypt ■ Potential for local manufacturing

Table 4. Cost of GHG Mitigation for Assessed Technology Options

	Assessed Technology Option	Cost of Mitigation ($/Tonne CO_2)	Annual CO_2 Savings (1,000Tonnes)
1	Fuel substitution of 20% gas oil with natural gas	–103.00	1,520.00
2	Cogeneration using back pressure steam turbines	–52.00	1,505.00
3	Cogeneration using extraction steam turbines*	–41.00	0.00
4	Low steam condensate recovery in foodstuff industry	–41.00	18.03
5	Low steam condensate recovery in chemical industry	–40.00	17.78
6	Low steam condensate recovery in metallurgical industry	–39.00	3.05
7	Medium steam condensate recovery in foodstuff industry	–38.00	36.06
8	Medium steam condensate recovery in metallurgical industry	–36.00	4.43
9	Using wind farm for electricity production (20 Units, 60 MW/Unit).	–35.00	3,287.40
10	Using wind farm for electricity production (10 Units, 60 MW/Unit).	–35.00	1,643.70
11	Medium steam condensate recovery in chemical industry	–35.00	29.63
12	Low steam condensate recovery in textile industry	–35.00	15.28
13	High steam condensate recovery in foodstuff industry	–33.00	81.14
14	Low steam condensate recovery in commercial sector	–33.00	1.42
15	Low steam condensate recovery in petroleum industry	–31.00	6.36
16	High steam condensate recovery in metallurgical industry	–30.00	7.38
17	Medium steam condensate recovery in commercial sector	–30.00	9.23
18	Using water treatment for waste heat recovery under natural gas scenario	–29.79	533.00
19	Medium steam condensate recovery in textile industry	–29.00	25.86
20	Replacement of 5 million lamps by efficient lighting systems	–28.93	2,033.00
21	Replacement of 1 million lamps by efficient lighting systems	–28.89	407.00
22	Replacement of 10 million lamps by efficient lighting systems	–28.45	4,011.00
23	Replacement of 20 million lamps by efficient lighting systems	–27.99	7,849.00
24	Replacement of 40 million lamps by efficient lighting systems	–27.99	15,698.00
25	Replacement of 80 million lamps by efficient lighting systems	–27.03	30,259.00
26	Replacement of 100 million lamps by efficient lighting systems	–27.03	37,823.00
27	Replacement of 190 million lamps by efficient lighting systems	–25.39	67,518.00
28	High steam condensate recovery in chemical industry	–25.00	47.42
29	Waste heat recovery using water treatment	–24.76	725.90
30	Replacement of 160 million lamps by efficient lighting systems	–24.60	54,983.00
31	Waste heat recovery using regenerative burner	–24.58	91.00
32	Pressure modulating combustion control	–24.57	408.91
33	Medium steam condensate recovery in petroleum industry	–24.00	10.64
34	High steam condensate recovery in commercial sector	–23.00	13.18
35	Combustion control using fuel-air ratio	–22.57	1,512.38
36	Combustion control using portable gas analyzer	–18.07	835.00
37	High steam condensate recovery in textile industry	–18.00	47.01
38	Using metallic recuperater for waste heat recovery under natural gas scenario	–16.11	43.00
39	Fuel substitution of 20% of fuel oil to natural gas	–14.00	3,472.00

Table 4. Cost of GHG Mitigation for Assessed Technology Options (continued)

40	Waste heat recovery using metallic recuperater	–12.72	59.00
41	Cogeneration using gas turbines	–12.00	1,657.00
42	Cogeneration using gas engines	–11.00	169.00
43	Using preheating system for waste heat recovery under natural gas scenario	–10.33	0.47
44	High steam condensate recovery in petroleum industry	–10.00	20.66
45	Waste heat recovery using preheating system for feeding materials	–9.59	0.65
46	Waste heat boilers for waste heat recovery under natural gas scenario	–8.62	23.20
47	Waste heat recovery using waste heat boilers	–8.37	31.00
48	Using boiler air preheating for waste heat recovery under natural gas scenario	–4.86	62.00
49	Waste heat recovery using boiler air preheating	–4.54	84.00
50	Waste heat recovery using boiler feed water preheating system	–3.13	301.00
51	Using boiler feed water preheating system for waste heat recovery under natural gas scenario	–3.13	221.60
52	Cogeneration using diesel engines	0.00	79.00
53	Using regenerative burners for waste heat recovery under natural gas scenario	6.30	71.00
54	Waste heat recovery using economizers	9.02	15.70
55	Using economizers for waste heat recovery under natural gas scenario	14.87	11.50

Source: *Support for National Action Plan Stand-Alone Technology Assessment Reports*, OECP 1997
* The share of extraction steam turbine will be deducted from the back pressure steam turbine or gas turbine

tion was found to have the most positive social impacts. It should be noted that these results need further evaluation before they can be included in the action plan.

Agriculture

See *Evaluation and Development of Measures*, earlier, for a list of mitigation options in the agriculture sector. These options are currently being analyzed. Future adaptation strategies may involve the development of new, more heat-tolerant cultivars, new crops, modification of cropping patterns, reducing the area under cultivation of high water-consuming crops such as sugarcane and rice, and changing agricultural practices.

Water Resources

Different adaptation options to meet future risks of climate change have not yet been developed. This is mainly due to the uncertainty associated with the possible impacts of climate change on the water resources in Egypt, and the lack of mature methodology to estimate costs of these adaptation measures. This should be seen as an area for future international cooperation. The Egyptian climate change action plan will emphasize the need for further assessing vulnerability and adaptation of water resources in Egypt.

Implementation Strategies

The plan is still under development, and it is too early now to report a time schedule for its implementation. However, it is intended that the plan document will be the basis for preparation of the first national communication.

Issues and Lessons

As the planning process is under way, some lessons have already been learned. These include:

- Weak recognition of the climate change issue relative to other development issues at different levels of decision making. Though Egypt is one of the most vulnerable countries to possible impacts of climate change, the nature and magnitude of the potential risks are still unknown to a large segment of the society. There

is, therefore, an urgent need for public awareness and mass communication to give the climate change issue a place among other pressing local environmental and development priorities.

- The science of climate change is still poorly understood domestically and needs to be taught at undergraduate and graduate levels. A recent seminar held at the University of Alexandria indicated the importance of integrating climate change and other environmental issues into the University curricula. Research related to climate change is nonexistent due to the lack of financial and trained human resources.
- Integrating climate change issues into national plans is not an easy task in developing countries where the institutional structure is weak or not existing.
- Capacity building is not a one-shot process, but rather a long term learning curve that requires sustainable support.
- Due to lack of resources, international cooperation in the area of climate change is crucial, and barriers to clean technology transfer should be removed. Such barriers can be one or more of the following: intellectual property, market barriers, weak institutional capacity, lack of technology information, lack of financing mechanisms for clean technologies, lack of incentives to promote technology transfer, and lack of infrastructure to support technology transfer.
- Strategies for mitigating and adapting to climate change should be flexible and broad enough to meet different national circumstances and should be integrated into other national development strategies.

International Cooperation

Given the fact that Egypt has limited capacity to deal with different aspects of possible climate change, and due to weak or evolving institutional arrangements, and as a result of the vulnerability of some major economic sectors to possible impacts of climate change — particularly sea-level rise — it is crucial that Egypt should receive international assistance with its climate change efforts. The action plan would form a sound basis to identify specific needs for international cooperation. These include:

- Removing barriers to greater energy efficiency, and promotion of renewable sources of energy such as development of local business capacity, establishment of energy service companies, transfer of efficient technologies, technical assistance on technology applications, and assistance in securing project financing.
- Support in assessment and implementation of adaptation measures.
- Support in capacity building, training and climate research, observation and monitoring.
- Support in advancing the current level of understanding of vulnerability.
- Adaptation of water resources at the national and regional levels.
- Support in climate change education and mass communication.

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THE GAMBIA

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Summary

The main long-term objective of The Gambia National Climate Change Action Plan is to have a set of strategies and measures that will assist the country in achieving specific national mitigation and adaptation goals, in meeting commitments to the United Nations Framework Convention on Climate Change (UNFCCC), and in forming a basis for the National Communications to the UNFCCC Secretariat and Conference of Parties (CoP). The immediate objectives are to develop the awareness of the general public, decision makers, and policy makers about climate change issues, with a view to:

1. Building consensus and support for climate change mitigation and adaptation measures
2. Integrating climate change concerns and measures into other development and planning processes and programs, with a focus on sustainable development

So far, a bottom-up approach has been used, starting with zonal- and grassroots-level meetings that are held throughout the country. At these meetings, participants are drawn from all walks of life (farmers, fishermen, herders, local leaders and elders, youth and women's group leaders, educators, foresters, and administrators) and are brought together at a central point within an administrative district. Concerns and experiences related to climate variability and change are discussed and recorded. Documents from zonal meetings are further discussed at divisional level meetings. A divisional level report is developed from a synthesis of the zonal level documents and issues raised at the divisional meeting. The divisional level reports will be discussed at a National Forum to be held at the end of 1997 or beginning of 1998. The document emerging from the National Forum will be the National Action Plan (NAP) and will form an annex of the National Communication which is being developed simultaneously.

Introduction

Results of Past Studies

Vulnerability

Combining observed climatological data from a 40-year period (1951–1990) with equilibrium General Circulation Model (GCM) outputs, climate change scenarios for The Gambia show annual mean temperature increases between 10% and 18%, mean annual rainfall variations between –21% and 87%, and an increase in potential evapotranspiration rates between 4% and 7% by 2075. The models used were those developed by the Goddard Institute for Space Studies (GISS) (Hansen et al., 1983), the Geophysical Fluid Dynamics Laboratory (GFDL–R30) (Mitchel et al., 1990), and the United Kingdom Meteorological Office (UKMO).

In agriculture, the projected climate change will lead to a decrease in yield in all of the cereal crops simulated, but an increase in yield of the major cash crop, groundnuts, between 40% and 52% (Jaiteh, 1997).

A 1-meter sea level rise is expected to lead to the submergence of the capital city of Banjul in the next 50–60 years (Jallow et al., 1996; Jallow and Barrow, 1997) and about US$217 million worth of land is estimated to be lost.

In the forest sector, simulations using the Holdridge Life Zone Classification Model (Holdridge, 1967), indicate that, under an equilibrium climate, the land cover of The Gambia is likely to be in the "very dry forest" classification (Jallow and Danso, 1997). Simulations using the Forest Gap Model (Smith, 1994), show that average-stand biomass is estimated to increase from 2.15 tonnes per hectare (t/ha) in the first year of simulation (assumed to be 1971) to 49.66 t/ha in 2075 and 59.15 t/ha in 2100. The basal area is negligible in the first year, but increases to 5.51 square meters per hectare (m^2/ha) by 2075 and 6.31 m^2/ha in 2100.

In the rangelands of The Gambia, monthly total live biomass shows a reduction of –43% to –14%. However, species-specific simulations show a varying picture. Biomass production for warm season grasses increases above current climate scenarios but decreases below current climate scenarios for cool season forbs as temperature increases under a warmer climate.

In terms of freshwater resources, simulations show that a 1% change in rainfall will result in a 3% change in runoff in the catchment of the River Gambia. Runoff changes under climate change scenarios vary from –69% to 63%. On average, the location of the saline/freshwater interface is expected to move about 40 km further upstream from where it is at present (Manneh, 1997), reducing the availability of freshwater for agricultural purposes.

For fisheries, assessment of the effects of temperature on productivity of the River Gambia shows that annual productivity of the fishery sector increases between 10% and 15% under climate change scenarios. The Habitat Suitability Index method for fish shows that the potential warming of between 3° C and 5° C projected for the next century has little or no effect on the suitability of the present habitat for shad, flounder, and shrimp species. However, the warming will favor the habitats for trout and salmon species. A warming of 3° C will have negative impacts on habitats for catfish and, above 4° C, the suitability of the present habitat for herring is reduced (Jallow, 1997b). Results of the assessment of the effects of temperature changes on shrimp yield show that under temperature scenarios projected by the various GCMs, shrimp yields could increase by between 38% and 54%.

The decrease in cereal production, saltwater intrusion into the estuary, and flooding of coastal wetlands and swamps are expected to lead to higher order impacts, which include reduction in the productivity of the marine fishery, food insecurity, and associated health impacts.

Emissions Inventory

Table 1 provides an overview of The Gambia's greenhouse gas emissions in 1993.

Carbon Dioxide (CO_2). Land use change and forestry was responsible for 89% of the total CO_2 emissions from The Gambia in 1993. The net emissions of 1,647,594 tonnes from this sector represented emissions of 1,661,196 tonnes from forest clearing and sequestration of 13,602 tonnes from managed forests (NCC, 1994). Consumption of fossil fuel products was responsible for the remaining 11% of the total national CO_2 emissions.

Methane (CH_4). The agriculture sector is the largest emitter of methane in The Gambia. This sector emitted 65% of the national emissions of 31,679 tonnes CH_4. The waste management category emitted 22%, the energy sector emitted about 8%, and the land use change and forestry sector emitted about 5% of the total CH_4 emissions.

Carbon Monoxide (CO), Nitrogen Oxide (NO_x), and Nitrous Oxide (N_2O). A total of 40,554 tonnes of CO were emitted. All the emissions came from combustion of biomass, with 54% coming from burning of traditional biomass fuels for energy, 36% from on-site burning of cleared forests, 8% from burning of savanna, and the remaining 2% from burning of agricultural crop residues. Emissions of NO_x (740 tonnes NO_x) and N_2O (11 tonnes N_2O) were relatively insignificant.

Total Emissions. Based on the Global Warming Potential (GWP) Index, the land use change and forestry sector was the largest emitter of greenhouse gases in The Gambia. This sector emitted 64% of the total CO_2-equivalent gases. Agriculture was the second highest emitter (19%), followed by the energy sector (10%), and then the wastes category (6%). A total of 2,639,634 tonnes of CO_2-equivalent gases were emitted and 70.2% was due to CO_2 emissions, 29.4% was due to CH_4 emissions, and 0.4% was due to N_2O emissions. The per capita emission was 2.573 tonnes of CO_2 per person per year. This ranks The Gambia among the highest per capita emitters in Africa.

Current Programs

Beginning in 1977, several sectoral, national, regional, and international planning and environmental programs have been developed in The Gambia. These include the Program for Sustainable Development (PSD), the National Forestry Plan, the Water Resources Management Master Plan, the Wildlife and Parks Development Plan, and the Gambia Environmental Action Plan (GEAP). The Climate Change Action Plan will be integrated into and synthesized with these and other development plans. The achievements of these planning and development programs and the level of integration and synthesis with the National Climate Change Action Plan will be communicated to the international community through the National Communications to the UNFCCC. Through the integration and synthesis process, close links will be initiated with economic, financial, technical, and development planning institutions to ensure their cooperation

Table 1. Summary of Greenhouse Gas Emissions in 1993 (gigagrams)

	Carbon Dioxide (CO_2)	Methane (CH_4)	Nitrous Oxide (N_2O)	Carbon Monoxide (CO)	Nitrogen Oxide (NO_x)
Energy					
CO_2 from Energy	205.976				
Methane and other gases from traditional biomass fuels burned for energy		2.499	0.017	21.867	0.405
Subtotal	205.976	2.499	0.017	21.867	0.405
Agriculture					
Methane emissions from animals and animal manure		12.771			
Methane emissions from rice production		7.662			
Savanna burning, release of non-CO_2 trace gases		0.128	0.002	3.365	0.037
Field burning of agricultural residues, release of non-CO_2 trace gases		0.041	0.001	0.852	0.030
Subtotal		20.602	0.003	4.217	0.067
Land-Use Change & Forestry					
Forest clearing	1661.196				
On-site burning of cleared forests		1.654	0.011	14.470	0.268
Managed forests	-13.602				
Subtotal	1647.594	1.654	0.011	14.470	0.268
Waste					
Methane emissions from landfills		6.873			
Methane emissions from municipal wastewater		0.013			
Methane emissions from industrial wastewater		0.039			
Subtotal		6.925			
Total	**1853.570**	**31.679**	**0.031**	**40.554**	**0.740**
Global Warming Potential (GWP) (100 years integration)	1	24.5	320		
1000 tonnes of CO_2 equivalent	1853.570	776.144	9.920		
Percentage (%)	70.2	29.4	0.4		

and active participation in the process of developing the Action Plan and Communications. Political support, which is already encouraging, will also be harnessed. Education and media institutions, some of which are already members of the National Climate Committee, will be encouraged to cooperate in raising awareness of the potential value of the National Action Plan and Communications.

Having completed the development of a GEF/UNEP-funded Greenhouse Gas Emissions Inventory in 1993 and the USCSP-funded Vulnerability and Adaptation Assessment Study in 1996, the major climate change programs that the Government of The Gambia (GOTG) is currently implementing are the USCSP-funded Mitigation Assessment study, the Global RE-LEAF/American Forests-funded NGO Capacity Building on Implementation of Greenhouse Gas Mitigation Project in the Forestry Sector, and the GEF/UNDP-funded Development of the National Action Plan and Communications.

In the Mitigation and Adaptation Assessment study, inadequate data and expertise has hindered progress. However, it has been agreed that funds from the GEF/UNDP project on the Development of National Action Plan and Communications can be used to generate data for

the mitigation assessment. In the same project, funds are allocated for the quantitative assessment of adaptation measures identified in the Vulnerability and Adaptation Assessment Study.

In the Global RE-LEAF/American Forests NGO Capacity Building Project, an indigenous NGO, The Gambia Rural Development Agency (GARDA), which was selected as the national counterpart to American Forests, was found to possess inadequate expertise in development and implementation of climate change mitigation projects. Thus, from the scoping meetings held in The Gambia, with funding from American Forests, it was recommended that for effective partnership, GARDA's expertise should be enhanced. American Forests was able to secure US$4,000 from GLOBAL RE-LEAF for this purpose and GARDA started implementation of the pilot project in June 1996. American Forests visited the project site in December 1996 and was impressed with progress made and was able to secure an additional US$3,000 for expansion of the site by 1 hectare. This money will help provide adequate water supplies at the project site, as this was the primary constraint identified by the local people working with GARDA in the implementation of the pilot project. The local people have allocated 10 hectares for subsequent expansion.

The development of the National Action Plan and Communications is the most recent program the Government of The Gambia is implementing. The initial funding request was submitted to USCSP in 1996 but, due to limited funds, the USCSP marketed the proposal for The Gambia instead, and was able to secure funding from GEF/UNDP in New York. Funding by UNDP began in September 1997 but some of the activities have been under way since November 1996 using Capacity 21 Funds at the Office of the President of The Gambia.

Objectives

The Gambia National Climate Change Action Plan will have the following objectives:

- Build awareness of climate change issues and increase the national consensus and willingness to take action.
- Provide the international community with information on the inventory and trends of sources and sinks of greenhouse gas emissions in The Gambia and a profile of mitigation measures planned in the future.
- Provide information on the potential vulnerability of the economy of The Gambia to the projected climate change and the potential measures to adapt to the projected change.
- Integrate climate change into the broader development planning process of the country and realign policies to take climate change into consideration.
- Identify and prioritize sectors and areas in which specific manageable activities need to be implemented in line with sustainable national development.
- Integrate climate change considerations into the planning and implementation of sectoral efforts and other national development plans.
- Form the basis of The Gambia's National Communications to the UNFCCC.

Methods

Establishing the Planning Team

Figure 1 shows the relationship between the various institutions and other entities participating in the development and implementation of the National Action Plan and the National Communications of The Gambia.

Implementation of all climate change studies and projects is under the mandate of the National Climate Committee, a technical level body, and the Agriculture and Natural Resources Working Group, a policy level body. The National Climate Committee (NCC) is composed of about 35 representatives from Government and Nongovernmental Organizations. The Department of Water Resources, the parent department to the Department of Meteorological Services, is the lead agency and the National Environment Agency is the Secretary to the Committee. The NCC is a task force of the Agriculture and Natural Resources Working Group (ANR-WG), which has the National Environment Agency as the Secretariat and the State Department of the Presidency, Fisheries and Natural Resources as the Chair. The ANR-WG has as its members all of the directors of the Agriculture and Natural Resources sectors and the Permanent Secretary of the State Department of the Presidency chairs meetings. All members of the NCC are involved in the implementation of the programs described in the Current Programs section, above.

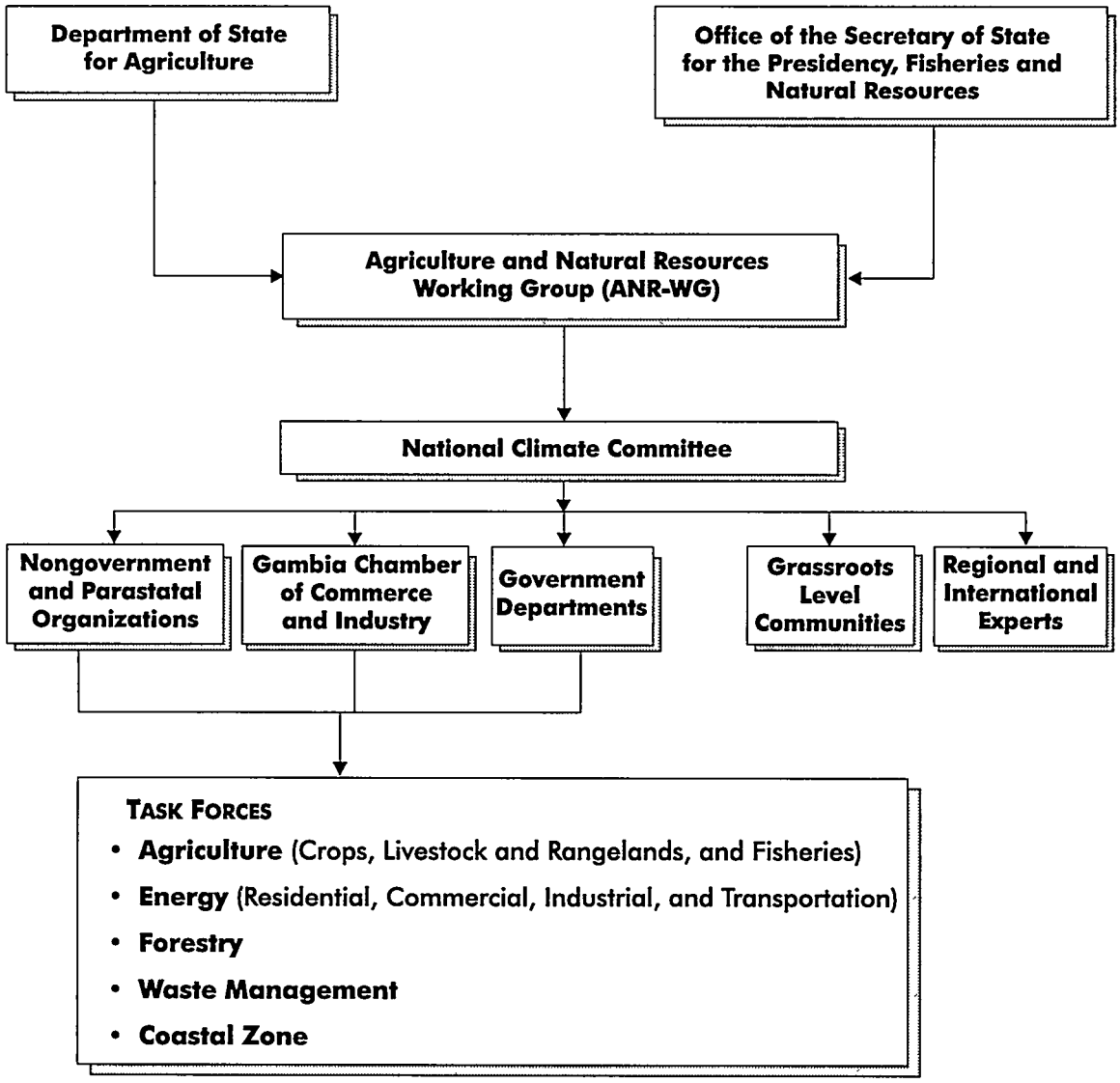
In the implementation of past programs the ANR Working Group was only briefed on the progress of implementation by the National Climate Committee. However, in the development of the National Action Plan and Communications, scheduled for the 16 months beginning September 1997, the ANR-WG will be the major

player as the process must involve the identification and realignment of policies that take into consideration climate change.

The development of the National Action Plan is the sole responsibility of the National Climate Committee and the Agriculture and Natural Resources Working Group. This will be achieved through the five task force teams indicated in Figure 1. Participation in the activities of these teams is open to all members of the National Climate Committee. The process of development of the NAP and Communications will be community-driven using the bottom-up approach. Grassroots-level concerns will be identified and prioritized. Participation in the planning will include community representatives, private and public sector officials, and NGOs.

The Forest Task Force will be responsible for the development of the forest sector plan of the NAP. The Department of Forestry is the lead agency of the task force, with The Gambia Rural Development Agency (GARDA) and the Gambia Environment Association, two local NGOs, serving as alternate lead agencies. Other members of the task force are the Department of Parks and Wildlife and the Department of Fisheries. However, all members of the National Climate Committee will participate in the planning and implementation of the activities of the task force.

Figure 1. Organization Chart for Climate Change Activities in the Gambia



The Agriculture Sector Plan will be developed by a task force led by the Department of Planning of the Ministry of Agriculture, with the Catholic Relief Service (CRS), an NGO, as the alternate lead agency. Other members of the task force include the Department of Agricultural Services and the Department of Planning, but all members of the NCC will contribute toward the success of the development of the Plan.

The Energy Sector Plan is expected to cover the Transportation, Residential, Commercial, and Industry subsectors. The lead agencies for the Energy Sector are the Departments of Statistics and Energy of the Ministry of Trade, Industry, and Employment; and the Division of Transport and Planning of the Ministry of Works, Communications, and Information. The Gambia Public Transport Corporation (GPTC), the National Water and Electricity Corporation (NAWEC), and Watermann, an NGO, are the alternate lead agencies. Membership in the task force is open to all members of the National Climate Committee.

The Waste Management Sector Plan will be developed by a task force with the National Environment Agency (NEA) as the lead agency and the municipalities of the cities of Banjul and Kanifing Municipal areas as the alternate agencies.

The Role of NGOs

As indicated above, NGOs will serve in all of the task forces as alternate lead agencies. Based on programs and projects proposed so far, the NGOs will be responsible for leading the local-level implementation based on their experiences in operating at the grassroots level.

Coordination of the Planning Process

Since the inception of the implementation of the UNFCCC in The Gambia in 1992, the NCC has always adopted the approach of sharing responsibility and, where an activity cannot be conducted by the Committee itself, advice and assistance are sought from the applicable region or any other region. The development of the National Action Plan will be coordinated, at the technical level, by the Chairman of the NCC or his representative from the Department of Water Resources. Agencies and institutions that form the task forces will be responsible for the development of the sectoral plans and submission of information relevant to the National Action Plan and Communications. The Department of Water Resources, as the lead agency of the Climate Change Convention and of the National Climate Committee, will be responsible for the coordination of inputs from all participating sectors and agencies and will provide regular reports and information to the ANR–WG. The ANR–WG will work with the Chairman of the NCC in coordinating inputs at the policy level.

Development of Sectoral Plans

The development of the sectoral plans and contribution to the Communications follow the steps indicated below:

1. Form sectoral task force by identifying institutions whose participation is required in the development of the Plan and information gathering.
2. Identify lead and alternate agencies from the task force that will be responsible for the coordination and writing of the sectoral plan, and submission of information relevant to the Communications.
3. Conduct community-level scoping meetings to identify concerns at the grassroots level, and set priorities based on the national development plans and results of studies conducted.
4. Identify and select mitigation measures by reviewing and screening the concerns expressed and the priorities set.
5. Evaluate and rank selected mitigation measures by determining their effectiveness.
6. Choose measures to include in the sectoral mitigation plan.
7. Develop implementation strategies for each measure.
8. Write the Sectoral Mitigation Plan.
9. Submit comprehensive documented information that will form the sectoral contribution to the Communications.

Evaluation and Development of Measures

Selection of Sectoral Measures

Sectoral measures to mitigate greenhouse gas emissions and adapt to predicted climate change were selected through scoping meetings. For the Forestry sector these scoping meetings were held in 1995 and funded by American Forests, a U.S. NGO. The Task Force members were requested to come up with ideas for measures and projects, to be discussed at a 3-day scoping meeting. Measures and ideas were received from the Forestry Department and a large number of NGOs. At the three-day scoping meeting, these ideas were integrated and the Task Force came up with four proposals concerning Natural Forest Management, Fruit Tree Plantations, Agroforestry, and NGO Capacity Building. At a follow-up meeting of American

*Table 2. Summary of Mitigation Measures and Lead Agencies**

Priority Sectors and Subsectors	Proposed Measures	Agencies
Forestry	■ Promote and encourage community forestry ■ Set up Forest Management Committees at the village, district, and divisional levels ■ Build awareness of, and inculcate attitudinal changes in, the public ■ Strengthen and build the capacity of local-level Forestry Task Forces to be more responsive to forest management issues ■ Ban the establishment of new settlements for 30 years ■ Prepare fire belts around settlements and Forest Parks ■ Institute heavy fines for people found to be responsible for starting fires ■ Ban smoking in public places and in vehicles ■ Decentralize tree planting activities to the grassroots level ■ Encourage and promote the establishment of private fruit tree plantations	Department of Forestry
Energy: *Power Generation*	■ Switch from fossil-fuel generating plants to natural gas plants (this may be expensive as natural gas must be imported) ■ Switch from fossil fuel to renewable (solar, wind, geothermal) energy sources ■ Promote the use of efficient power generators	State Dept. of Trade, Industry, and Employment; State Dept. of Finance and Economic Affairs
Energy: *Transportation*	■ Promote the use of efficient vehicles ■ Regulate the importation of used cars ■ Promote and encourage mass road and water transportation ■ Encourage development and efficiency of public transportation corporations by providing them appropriate incentives such as tax waivers on imported vehicles ■ Build the capacity of the authorities and institutions responsible for the implementation of regulatory measures	
Energy: *Residential, Industrial, and Commercial*	■ Promote the use of alternative and renewable energy for lighting, heating, and cooking ■ Promote the use of improved and efficient cooking stoves to reduce the demand on wood for fuel ■ Expand the use of butane (LPG) gas to local levels	
Waste Management: *Solid Waste*	■ Develop the capacity of the organization responsible for solid waste management ■ Create and develop a database on waste generated ■ Introduce and promote composting and recycling of waste ■ Promote awareness of the appropriate management of wastes ■ Avoid the burning of crop residues in the field	National Environment Agency; Banjul Kanifing and Brikama Municipal Councils; National Water and Electricity Corporation
Waste Management: *Waste Water*	■ Develop the capacity of the organization responsible for waste water management ■ Create and develop a database on waste generated ■ Cover all gutters and pit latrines	

*Extracted from zonal and division meetings of the Task Force on National Plans on Biodiversity, Desertification, and Climate Change and the Local Environment Action Plan (Jallow, 1997d; Baldeh, 1997; Bojang, 1997, Camara, 1997; and Bojang et al., 1997)

Forests in The Gambia in December 1996, Community Forestry (see text box in Measures) was included in the measures. These measures will now be translated into full project proposals to form part of the National Action Plan.

For all other sectors, zonal-level meetings were held at all the Administrative Divisions of the country. Communities were allowed to organize their own meetings, coordinated by the Divisional Coordinating Committee (DCC), which is headed by the Commissioner (Head of Administration) of the Division and facilitated by a Task Force of National Resource Persons (TFNRP). The DCC is composed of all heads of government and NGO institutions, and local leaders (Chiefs) within the Division. The TFNRP is composed of the Focal Points of the Local Environment Action Plan and the international Conventions on Biodiversity, Desertification, and Climate Change. The conclusions of the zonal meetings (16 Zonal Reports) were refined and updated with additional information at Divisional meetings. From the Divisional scoping meetings, five synthesis reports (Jallow, 1997d; Baldeh, 1997; Bojang 1997; Camara, 1997; and Bojang et al., 1997) have emerged. These synthesis reports will be discussed at a National Forum to be held toward the end of 1997, and four national reports will be produced, one each for the Local Environment Action Plan, and the Action Plans for the Conventions on Biodiversity, Desertification, and Climate Change. The marriage between the Conventions then breaks up and the National Climate Committee uses the Zonal, Divisional, and National Forum reports as input to develop the National Action Plan on Climate Change and Communications to the UNFCCC.

Criteria for Screening and Evaluating Measures

The measures identified, selected and included in the Zonal, Divisional, and National Forum Reports discussed above will be screened and evaluated by the sectoral task teams. The screening and evaluation will be based on the measure's effectiveness at meeting the objectives of the UNFCCC through:

- Estimating carbon flows and benefits
- Determining the opinions of experts and policy-makers
- Fulfilling the national policy objective of sustainable development
- Reducing environmental pollution
- 'Having a positive economic return
- Overcoming barriers to implementation

The evaluation procedure will be the same for all sectors. However, since the National Climate Committee is very weak in the economics of climate change, the assistance of experts from outside of The Gambia will be sought in the performance of this task. Organizations already contacted are Hagler Bailly in the United States; American Forests in the United States; the Center for Energy, Environment, Science, and Technology (CEEST) in Tanzania; the Center for Renewable Energy and Sustainable Technology (CREST) in the United States; Pollution, Environment, Energy, and Resources (PEER) in South Africa; and the Solar Electric Light Fund (SELF) in the United States.

Technology Assessments

Technology assessments will be conducted. The methods to be used will depend on the analytical tools available but must consider the applicability of the technology in the Gambian environment. Technical assistance and expert opinion will be useful in carrying out the assessment and will be sought from regional and international experts and organizations.

Methods to be Used in Evaluating Measures

Analytical tools such as cost-benefit analysis and the EPA's multi-attribute decision support analysis will be used to evaluate specific measures. The results of the analysis will be documented, sent to the various State Departments of the Government, NGOs, and the Gambia Chamber of Commerce and Industry (GCCI) for their review and comments. The revised analysis will then be finalized and presented at a workshop for the whole of the NCC, NGOs, and decision- and policy-makers. However, as the Agriculture and Natural Resources Working Group is a decision- and policy-level body, and the NCC regularly reports its activities to the body, decision makers are informed of all activities.

Major Products and Schedule of Deliverables

The major products and schedule of deliverables for the whole process of development of the National Action Plan and Communication are as follows:

- A publication containing details of the Sectoral Scoping Process (December 1997). This document contains the national priorities set, mitigation measures identified, and the implementation strategies for each measure.
- Sectoral Mitigation Plans (February 1998), which will include a summary of the national priorities, analysis

of selected measures, a summary of recommended measures, and the implementation plan.
- Meetings (September and December 1997; March, June September, and December 1998).
- Conference and Workshop Reports (December 1998).
- The National Climate Change Action Plan and National Communications (November 1998).

Adoption of the National Action Plan and Communications

Having completed the development of the National Action Plan and Communications, these documents will be launched at a ceremony to be chaired by the Secretary of State for the Presidency responsible for Fisheries and Natural Resources. The documents will then be communicated to the UNFCCC with the National Action Plan being an annex to the National Communications.

Measures

Mitigation Measures

As the study on mitigation options, sponsored by the U.S. Country Study Program, is yet to be completed, only qualitative statements on mitigation measures and strategies can be made. As The Gambia has large areas of degraded and devegetated lands, afforestation, reforestation, enhanced regeneration, agroforestry, and community forestry have been identified as the most cost-effective mitigation options. This conclusion was arrived at during scoping meetings in The Gambia sponsored by American Forests, a U.S. NGO, and at zonal meetings organized by the Task Force on the Development of Local Environment Action Plans (LEAP) and Action Plans for the International Conventions on Biodiversity, Desertification, and Climate Change. These meetings identified Community Forestry (CF) to be the most appropriate option in The Gambia and this decision is based on the experience of The Gambia-German Forestry Program (GGFP) for the past 15 years. See the text box on the next page for a description of how the Community Forestry process can be implemented.

Other options in the forestry sector include establishment of fruit tree plantations and promotion of agroforestry. Fruit tree plantations are mostly established by individuals, NGOs, and village communities. Barriers to the establishment of extensive fruit tree plantations include the reluctance of the Departments of Forestry and Parks and Wildlife to promote it extensively; the basis for their reluctance is that a lot of biodiversity is irreplaceably lost in the process.

Some of the mitigation options identified at zonal meetings for other sectors are included in Table 2. Among these, the use of renewable and alternative energy sources is the strongest candidate.

Adaptation Measures

Adaptation measures identified under the vulnerability study are still only qualitative (except for the Coastal Sector) and will be fully analyzed, costed, and prioritized during the development of the National Action Plan. These measures are summarized in Table 3.

Agriculture

In the crop production sector, identified adaptation options include efficient management of soil and water so as to reduce runoff and nitrogen leaching, especially in the cereal crop production ecology. In the poor soils associated with the groundnut growing ecology, crop residue farming, fallowing, and crop rotation are adaptation measures that could help in the maintenance of soil structure. Although the present policy on agricultural production in The Gambia already emphasizes diversification by promoting horticulture, livestock, and fisheries, greater efforts should be made toward the improvement of current, and the amelioration of projected, negative effects on crop production. Greater efforts should be directed toward crop cultivar screening, training of rural development agents, and on-farm adaptive research on crop management practices. Drought- and salt-tolerant crop species should be introduced. In addition, the capacity of the agencies responsible for crop production research and farming operations should be expanded.

Coastal Resources (Sea-Level Rise)

Both response strategies and adaptation options to the projected sea-level rise have been identified. The response strategies identified include innovative sand management at the Palm Grove Hotel area and the rehabilitation of the growing systems along the coast between the Palm Grove and Atlantic hotels. In the long term, construction of revetments or low-cost sea walls around the capital city of Banjul is recommended. For the settlements bordering the wetlands it is sufficient to construct dikes so as to protect both life and property.

*Table 3. Summary of Adaptation Measures**

Priority Sectors	Proposed Measures
Agriculture	■ Efficient management of soil and water to reduce runoff and nitrogen leaching
	■ Promote contour farming
	■ Encourage fallowing and crop rotation
	■ Develop on-farm adaptive research on crop management practices
	■ Build capacity of agricultural and rural development agents
Coastal Resources (Sea-Level Rise)	■ Protect important and developed areas
	■ Adopt proactive measures such as increasing the height of coastal infrastructure, building on sites located away from sensitive lands, and offering of incentives to people to relocate to less vulnerable sites
	■ Develop and implement a Coastal Zone Management Plan
Forestry	■ Develop seed banks
	■ Promote effective management practices and flexible criteria for intervention
Water Resources	■ Set maximum and sustainable extraction rates of water for irrigation
	■ Introduce legislative measures to enable monitoring of extraction
	■ Introduce early maturing and salt-tolerant crops to minimize irrigation water requirements
	■ Promote the use of more-efficient irrigation systems
	■ Develop the capacity of organizations responsible for management and monitoring of water resources
	■ Construct an antisalinity barrage about 110 kilometers upstream to control saltwater intrusion downstream and increase freshwater supplies for irrigation
	■ Encourage tidal irrigation and introduce appropriate technology and socioeconomic measures for its effective and efficient management
	■ Introduce and promote water harvesting techniques
	■ Encourage the use of groundwater resources
	■ Develop a predictive and operational saltwater intrusion model for use as a planning and early warning tool for short- and medium-term adaptation measures
	■ Develop appropriate policies and strategies for conservation and development of the water resources of The Gambia
Fisheries	■ Implement strict biological monitoring of stocks
	■ Institute tighter control of fishing methods and gears
	■ Develop the capacity of institutions and fishermen to adopt more sustainable exploitation and management of the fish resources
Rangelands and Livestock	■ Because of the nature of the rangelands, it is necessary to assess the comparative utilization of each range with particular attention to use by small livestock and wildlife
	■ Encourage and promote reductions in livestock population, especially larger animals, to match the carrying capacity of the range system

* Based on the USCSP-funded Gambia Government/USCSP Study, Climate Change Vulnerability and Adaptation Assessment in The Gambia

Forestry

Adaptation options and measures identified include development of seed banks and promotion of effective management practices. Development and maintenance of forest seed banks, especially indigenous forest species, will allow access to seedlings in time of crisis.

Water Resources

Adaptation measures identified in the water resources sector include maintaining a predetermined minimum flow during the dry season, establishing a maximum extraction rate of 0.7 m^3/s, instead of the present 1.0 m^3/s limit for irrigation water use, and introducing legislative measures such as licensing and permits for use of river water for irrigation. The introduction of early maturing rice varieties, and low-water-use and salt-tolerant crops and varieties is recommended so as to minimize irrigation water requirements, especially when coupled with better managed and efficient irrigation systems.

Implementing Community Forestry in The Gambia

The Community Forestry (CF) concept involves management of the natural forest by the community through effective planning, forest fire control strategies, sustainable exploitation of the forest, and reforestation. The specific approach aims at identifying the Community Forestry Reserve (CFR) and its extent on the ground by demarcating the corner points, reaching a common understanding about CFR and Forestry Project management, and filing the application for a Preliminary Community Forest Management Agreement (PCFMA).

The basic idea of the PCFMA is to probe the bargaining room of all involved parties, to develop a suitable procedure for managing the conflicts and conducting negotiations, and to see how seriously participants take the protection of "their" forests. Other reasons for having a preliminary pilot phase are: the high rate of forest degradation and, thus, the need to quickly bring as much forest land under management as possible; personnel constraints within the Forestry Department; and to allow nature time to initiate the restoration process once the forests are protected from fire.

The PCFMA is valid for a maximum of 3 years and is then replaced by a permanent and full Community Forest Management Agreement (CFMA), if the community fulfilled its duties. Depending on the community's performance and capacity, the CFMA can also be granted earlier. Because, under the PCFMA, only temporary user permits, instead of long-term user rights, are granted to the community, PCFMAs can be issued by the Director of the Forestry Department. The issuance procedure therefore takes a comparatively short period of time. The PCFMA considers just a few activities related to capacity building, environmental education, and forest demarcation. It is more or less designed to speed up the transfer of responsibility over the identified forest area to the community by promising resource ownership whenever an effective forest protection system is in place.

The cost of launching a Community Forestry Project varies from one community to another. Under the PCFMA, initial personnel inputs are the highest during the process of launching CF projects until the forest reserve is identified, a simple work plan prepared, and the PCFMA signed. Then personnel inputs can be reduced. Other reductions in the human and material cost of CF projects are possible whenever the community has gained enough managerial and technical skills, and a forest management plan is jointly developed. Thereafter, it is assumed that one forest ranger is able to supervise CFR area of some 5,000 ha.

The River Gambia is virtually undeveloped. Because the river cuts through four countries, water supply adaptations are better implemented at the regional or river-basin level. The antisalinity barrage proposed at Balingho, some 130 kilometers from the river mouth, would be quite an appropriate measure to control saltwater intrusion and increase available freshwater supplies for irrigation. Tidal irrigation should be encouraged and expanded so as to reduce any stress on the need for pump irrigation. The delivery systems for tidal irrigation schemes and their maintenance should be improved by introducing appropriate technology. Overland flows in the estuary sub-basin are substantial and sometimes as high as three times the effective rainfall (rainfall minus evaporation). Therefore, water harvesting through collection of surface runoff and rainwater would do much to satisfy or supplement nonpotable uses in growth centers and in remote rural settlements. This would reduce some of the stresses on the supply of river water for livestock, wildlife, and domestic uses.

In the area of research and development (R&D), a predictive/operational saltwater intrusion model that takes the effect of rainfall and evaporation into account, and is capable of simulating daily variations, should be developed or adopted and used as a planning tool and an early warning system. To reduce the runoff lost and the soil moisture level, dikes or small dams would lengthen the period of available moisture for crop production and horticultural activities on the banks of small streams. Development and management of better planning tools such as aquifer simulation models would assist in implementing appropriate policies and strategies for the conservation and development of the water resources of the country.

Fisheries

Climate change is expected to place some ecological constraints on the fish populations of The Gambia. Since society has to operate within the constraints inherent in the ecosystem, limitations must be placed on those pa-

rameters which society has the ability to control, such as the total catch. Future inquiries into this issue should discern how the constraints placed on the system by climate change and human interventions influence fish availability and stock replacement. In order to reduce the possibility of fishery devastation, strict biological monitoring needs to be implemented and fully enforced. Fishing controls must be instituted. In this way it will be possible to keep stock replacement levels stable in the face of the physical stress caused by climate change and other environmental phenomena, while still meeting the growing demand for fish meal and other fish products by the ever-increasing population.

Implementation Strategies

The Gambia National Climate Change Action Plan will contain sectoral strategies and activities to address the mitigation and adaptation measures chosen during the analysis. The Office of the Secretary of State for Presidential Affairs, Fisheries and Natural Resources, through the Agriculture and Natural Resources Working Group, will be responsible for the execution of the National Action Plan. The National Climate Committee will be responsible for the coordination of the implementation of the Action Plan with each sectoral Task Force being responsible for the implementation of the measures and activities specific to its sector.

Issues and Lessons

The process of gathering concerns about and issues on climate variability and change from the grassroots level communities during scoping meetings was challenging and educational. It was realized that these communities know more than expected and have learned to adapt to climate variability and change from their ancestors. The communities have actually detected the variability of the climate and the consequences that befall them. A lot of water reservoirs have dried up; streams have silted up, thus blocking flow of water from the main river; and the overall consequence has been a drop in production from agriculture and fisheries. At these meetings, attendees were able to list most of the flora and fauna that have been lost due to the drier conditions resulting from the series of droughts of the 1970s and 1980s.

Excellent ideas on mitigation and adaptation to climate variability and change were provided by the communities and these will be translated into measures and activities in the Action Plan. The Plan will be taken back to the communities, as it is theirs, for them to implement with coordination and guidance from the National Climate Committee and the Sectoral Task Forces.

International Cooperation

The National Action Plan will contain strategies and measures to address climate change in The Gambia. These strategies and measures will be translated into technical assistance and development projects that will be implemented to address global warming and climate change. As a least developed country, The Gambia will rely heavily on international assistance and cooperation to implement the projects contained in the Action Plan.

Assistance will be required in the form of financing and capacity-building, especially in the development, acquisition, and diffusion of appropriate technologies.

For 5 years, The Gambia has been working with the international community, particularly the IPCC, UNEP, and the U.S. Country Study Program, to address global warming and climate change. The National Climate Committee can offer expertise in the development of national inventories, assessment of vulnerability to climate change, and conducting grassroots-level scoping meetings to gather concerns and issues that will lead to the development of mitigation and adaptation measures as part of a National Climate Change Action Plan.

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HUNGARY

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Summary

This chapter summarizes the main focuses and priorities of the Hungarian mitigation plan. The country's strategy is based on ongoing programs in the energy and forestry sectors. The main tasks in the near future are as follows:

- The efficiency of power generation will be increased by application of up-to-date technologies, which will replace aged and inefficient coal-fired power plants.
- The utilization of renewable resources, especially of geothermal sources, will be enhanced.
- New areas will be afforested to increase carbon sequestration.

These programs are being conducted in the midst of an ongoing privatization process, which raises several obstacles to implementation.

Introduction

In the framework of the U.S. Country Studies Program, the Hungarian Country Study Team developed the national greenhouse gas (GHG) emission inventory and elaborated the mitigation options for different sectors of the economy in 1995–1996. In 1997, the development of a National Action Plan (NAP) has begun as a continuation of this work. This interim report contains the initial results. The study should be completed and published by the beginning of 1998.

Results of Past Studies

Emissions Inventory

Results of the inventory study showed that GHG emissions decreased from the selected base level (i.e., from the yearly average emissions of 1985–1987) until 1994 by about 25%. However, this decrease was caused primarily by a deep economic recession. Therefore, our policy makers have to face the problem of economic recovery without a significant increase in GHG emissions in the near future. This is the main focus of our mitigation analysis and national action plan.

Mitigation Assessment

Analyses showed that Hungary has the best opportunities for stabilizing or reducing GHGs in the energy and in the forestry sectors. In these sectors there are already ongoing governmental programs that may contribute to the GHG emission reduction, although these programs were primarily designed for other purposes (energy savings, job creation, etc.).

Objectives

The Hungarian National Action Plan on climate change has the following general objectives and considerations:

- The economic development predicted for the near future must not lead to a drastic increase of GHG emissions. Therefore, the NAP should concentrate on economic restructuring, first of all in the energy sector. It also has to take into account the special problems arising from the privatization of all sectors of the economy.
- The resources for financing environmental protection measures are still very limited. Therefore, the NAP should be based on ongoing programs that may also serve environmental goals, such as the reduction of GHG emissions.
- The NAP is devoted also to promoting the development of the National Communications.

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Proposed Measures
Mitigation	
Energy	■ Replace inefficient coal-fired power plants ■ Increase use of natural gas ■ Increase use of renewable energy ■ Conduct efficiency improvements in public buildings
Forestry	■ Expand the area of forests for wood products ■ Establish fuelwood plantations ■ Introduce new, more resilient species

Methods

Establishing the Planning Team

In Hungary, the Ministry for Environment and Regional Policy is responsible for the development of the National Communications and the NAP. In this work, the Ministry relies on Systemexpert Consulting Ltd., which is the main supporting institute in this field. Systemexpert is the focal-point institute of the U.S. Country Studies Program on behalf of Hungary. A great number of experts are being drawn into these activities from institutions such as the following:

- Ministry of Industry, Trade, and Tourism
- Hungarian Energy Office
- Forest Research Institute
- Budapest University of Economics
- Budapest University of Technology
- Budapest University of Horticulture
- Research Institute of Computer Sciences and Automation

The Hungarian Country Study Team also includes a member of the Hungarian Commission on Sustainable Development. This governmental commission, led by the Minister of Environment and Regional Policy, is responsible for the submission of the National Communication. Measures have been, and are continuing to be, selected and evaluated in regular scoping meetings. Nongovernmental organizations (NGOs) are involved in the development of the NAP through the Commission, which includes two seats for NGOs.

Evaluating and Developing Measures

When reviewing the measures for the different sectors, the experts will select those that are both technically and economically feasible. This phase of the work has not been completed yet, although some progress has been made in the forestry sector (see Measures). Obviously, the economic situation is an overriding concern in selection of the measures. Because of this, priority will be given to mitigation actions that can be integrated into ongoing government programs and projects, such as the state afforestation program or the energy efficiency program conducted by the Ministry of Industry, Trade, and Tourism. However, implementation of even these programs has slowed down because of financial problems. One avenue for financing mitigation measures could be through Joint Implementation projects. At the moment there is only one pilot project (on reducing emissions by city buses), but further projects are planned within this framework (see International Cooperation).

The Country Study Team members have had many years of experience in the field of modeling; therefore, they actively use sectoral and macro models in planning. For the forestry sector, COMAP is being used. For the energy sector, two well-known models are being used to evaluate the scenarios from an environmental viewpoint: the ENPEP program package and the EFOM_ENV. The results of the last two models have significantly influenced the development of the long-term strategies of the Hungarian Power Companies in the past 3 years.

Measures

Energy

Restructuring the power generation sector is the main focus of the Hungarian mitigation strategy. Most existing power plants are old, and their efficiency is very low. The sector has been partly privatized, and the government intends to sell further plants in the near future. And with the predicted increases in demand, it will be necessary to construct at least 900 MW of new generating capacity by the year 2000.

Conventional Power Generation

The Hungarian team has forecasted CO_2 emissions for the Hungarian power plant system using the EFOM_ENV model. Results show that the planned restructuring of the system may prevent a significant increase even in the mid-term. However, since a significant increase in the demand for electricity is expected over the next decade, a 3–5 Mt CO_2 increase seems to be unavoidable. This does not contradict the requirements of the Framework Convention on Climate Change (FCCC), since current overall CO_2 emissions are far lower than those of the base period, i.e., of the yearly average for 1985–1987. (We recall that countries with economies in transition could select a base year or period other than the generally recommended 1990.) Overall anthropogenic CO_2 emissions in Hungary were more than 80 Mt in the base period. They dropped to about 60 Mt as a result of the serious economic crisis that led to the collapse of the previous economic-political systems of the region at the end of the 1980s. However, without restructuring in the power generation sector, the CO_2 increase would be two times higher.

The following conventional power generation technologies are likely to be installed in Hungary in the near future:

- Combined-cycle units (CCGT)
  - CCGT in cogeneration units
  - CCGT in condensation units
  - CCGT using inert gas (60–80 MWe)
- Coal-fired units (650 MWe)
  - Fluid units (150–200 MWe)
  - Conventional lignite power plants (2 × 500 MWe)
- Gas turbines for system regulation

There is, as yet, no final decision about constructing additional nuclear capacity in Hungary. However, nuclear power plants are unlikely to be built in the near future, partly because their share in the power generation mix is already too large.

Timetable for Restructuring. The first phase of the privatization of the electric industry was completed in 1995. Six electricity providers and three power station companies (Mátra, Dunamenti, and Csepel) have been acquired by foreign owners.

In the second round of power station privatization in 1996, the Tiszai Erõmû Rt. was successfully sold, and a decision was made about selling the shares of the Budapesti Erõmû Rt. In the third round, three power station companies with mines in the Trans-Danubian region have again been offered for sale.

Renewable Energy

Current utilization of renewable energy in Hungary has been estimated as 30–35 PJ/year (about 3% of total primary energy demand, TPED). The country's current goal is to increase this share in 2000 to at least 5%–6% of the TPED, and to 175 PJ in 2010. The initial emphasis will be on increased utilization of agricultural residues and the by-products of the logging, forestry, agroindustrial production, and food industries. This goal is realistic and economically viable.

Taking into consideration the potential of renewable energy, the prices and characteristics of the renewable energy sources in Hungary, a wide range of renewable energy technologies may be expected to grow in significance during the next few decades. These are discussed below.

Solar Energy. In Hungary, solar insolation is in the range of 1,150–1,400 kWh/m²/year (4.14–5.04 GJ/m²/year), averaging about 1,265 kWh/m²/year (4.55 GJ/m²/year). The total direct solar energy received in a year may be estimated to be about 430 EJ in Hungary, which is about 370 times higher than the TPED of the country (1,065 PJ) at present.

Hungary already makes direct use of solar energy for heating water and greenhouses and for drying crops. Although the solar resource is seasonal, prices of collectors are expected to drop enough to encourage increased penetration of low-temperature collectors, especially if penetration is promoted by providing special loans to consumers.

The use of solar energy to generate electricity is currently limited to remote, off-grid applications, in which the load is at least 2 km from the distribution grid. Hungary actually produces photovoltaic cells, but imported cells are cheaper and more reliable at present. Increased penetration will depend on decreases in both the price of

energy storage (for off-grid applications) and the cost of the photovoltaic cells and modules.

Biomass Energy. The solar energy stored in the leaves, stems, and branches of plants may be estimated as about half of the annual energy consumption of the country at present. The quantity of the yearly biomass production in Hungary may be estimated in the range of 450 PJ, of which 120 PJ could potentially be used, and about 30–34 PJ could be used economically. The quantity of primary biomass is about 54 million tons in a year: 46 Mt from agriculture and 8 Mt from forestry, of which about 20 Mt (65 PJ) may be utilized economically.

The area covered by forests will increase in the future. Some low-quality croplands will be converted to forests; thus, the fuel-wood production together with the trimming will also increase. Biomass power generation in a closed-loop system, i.e., using wood from these new forest areas, could limit future emissions from the power sector if it is used instead of adding more conventional power plants.

Hydropower. Hungary's hydropower potential has been estimated to be as much as 12 TWh (a fuel equivalent of 42–126 PJ) per year, of which about 7–7.5 TWh is technically exploitable. A determination of economically exploitable capacity is more difficult but, at present, environmental and political factors are decisive.

Current installed hydropower capacity is 48.4 MW. Because of the high cost of construction and hydropower machinery, expansion of Hungary's hydropower capacity is not currently planned.

Wind Power. The average wind speed is very low in Hungary, so special multibladed wind converters are needed, which can start and produce electricity even at low wind speeds. Similarly, their energy output is very low, so relatively big rotors are needed to produce even that small output. Thus, the extensive utilization of wind energy is not economical in Hungary, except for consumers who are at least 2 km from the distribution network.

Geothermal Energy. Hungary has usable geothermal resources. The geothermal gradient in the Carpathian basin (5–6° C/100 m) is double the world average (3° C/100 m). However, geothermal energy is not currently used for power generation because of a lack of the high-temperature (>200° C) resources needed for economical electricity generation using current technologies.

Waste Incineration. Recent studies indicate that one of Hungary's most important sources of anthropogenic methane emissions is the landfill disposal of wastes. The installation of waste incinerators could reduce methane emissions from landfills while serving as a viable management strategy for domestic wastes. To reduce methane emissions associated with open dumping of wastes in rural areas, one solution is to install biogas reactors. If agricultural residues and livestock manure are used in these reactors, they will reduce methane emissions while generating electricity for farms.

Potential for Reducing Emissions. When calculating the reduction in the emissions of the most important GHGs, carbon dioxide and methane, one has to take into consideration that the penetration of renewable energy sources in the energy market will depend on the future price structure of traditional fossil fuels and on the technical status of the devices and appliances utilizing renewable energy sources. If a significant advance occurs in the technologies in the future, this penetration will certainly be accelerated. The following projections assume normal technical development, and are based on only the most credible forecasts. It should also be noted that even these projections of market penetration depend on infrastructure and service systems that do not currently exist. It is, however, supposed that in the transition period of the Hungarian economy, the development of the service sector will accelerate. The expected penetration of renewable energy sources, given these assumptions, is shown in Table 2.

In estimating the reduction in carbon dioxide and methane emissions, it was supposed that the use of solid fuels and electrical energy will be reduced. Table 3 presents estimates of GHG emission reductions.

The reduction in methane emissions is connected mostly with waste incineration, because methane emissions from landfills will be reduced. Table 4 summarizes the different mitigation options envisioned for the energy sector in the near future.

Forestry

Forestry is one of the few branches of the economy that enables the direct sequestration of carbon from the atmosphere. Hungary has great potential to mitigate dangerous levels of carbon dioxide in the atmosphere. Steps will be taken to preserve the level of carbon fixation in soil, vegetation, and wood, and measures that enhance

Table 2. Forecast of Utilization of Renewable Resources (PJ)

Resource	1995	2000	2010	2020
Solar: *direct use*	2.7	8	15	25
Solar: *electricity generation*	0.01	0.05	0.1	0.3
Biomass (agricultural waste, manure, and fuel wood)	25	35	65	85
Hydropower	1.65	1.65	1.65	1.65
Wind power	0.1	0.2	0.3	0.5
Geothermal energy	6.5	9	12	15
Waste incineration and biogas	1.9	1.9	3.8	7.6

Table 3. Forecasts of GHG Emission Reduction by Using Renewable Resources (Kilotonnes)

Greenhouse Gas	1995	2000	2010	2020
Carbon dioxide	5860	8488	15174	20550
Methane	33.0	34.3	68.3	134.5

Table 4. Qualitative Ranking of Mitigation Options in the Energy Sector
(More stars indicate greater potential or greater expected utilization)

Category	Mitigation Option	GHG Reduction Potential	Expected Utilization
Conventional Power and Heat Generation	New CCGT in cogeneration units	****	*****
	New CCGT in condensation units	**	*
	New CCGT running on inert gas	*	***
	New fluid units	***	****
	A new conventional lignite plant	*	****
	A new conventional import coal power plant	*	*
	New gas turbines	***	***
	A new nuclear plant	*****	***
Renewables	Solar and biomass energy	***	**
	Hydropower and wind power	***	*****
	Geothermal energy	****	***
	Incinerators	***	***

carbon sequestration, primarily afforestation, will be given priority in Hungarian forestry.

With respect to forestry, Hungary is among the most developed countries in the world. The rules of sustainable forestry were established long ago, along with the professional, institutional, and legal requirements for sustainable management of forests. A new Forestry Act was enacted on June 18, 1996.

Nevertheless, some recent processes, namely the privatization of land and forests, as well as profound economic and political changes in the country, have perturbed the development of forestry. Privatization will be completed in a few years, and every piece of forested land will be owned by one of the many types of forest owners: a single individual, a group of people, cooperatives, companies, institutions, and the state. The economy

has entered a phase of growth, which will mean growing demand for wood products.

Priorities in the Forestry Sector

With respect to carbon mitigation, the priorities in forestry are rather clear. Mitigation measures can be grouped as either management for preservation or management for expanding carbon storage. Table 5 summarizes these measures and their relative significance.

Since forestry is fairly well developed in Hungary, little could be achieved by enhanced regeneration, agroforestry, or urban and community forestry. Among all measures, expanding the area of wood production forests and establishing wood fuel plantations are the most promising for carbon sequestration and will receive detailed analysis for implementation. Although both involve planting trees on abandoned land, the technology, financing, and other aspects can be quite different. They may, therefore, require different carbon-flow and cost-benefit analyses, as well as different implementation measures. Consequently, they are considered separately.

Implementation of Afforestation

According to recent surveys, more than 1 million hectares of former agricultural land will become available for afforestation. One reason for the size of the land to be converted is that, after a large-scale privatization program, a considerable part of the land will be owned by private landowners, many of whom are planning to develop a farm on which agriculture and forestry are combined.

Professional forestry companies are likely to be involved in afforesting these lands. These companies would also help private landowners to assess site conditions, select appropriate tree species, provide the landowners with improved propagation material, and to prescribe and assist in technology. The long traditions of afforestation, many nurseries, the expertise of tending and other silvicultural work, as well as other elements of the professional background of these forestry companies would ensure high efficiency in afforestation.

Most of the land to be converted used to be covered by forests before the intensive extension of arable land centuries ago. Roughly one-half of this area is found in the plain of the Eastern part of the country; the other half is scattered in the hilly parts of the Northern and Western parts. The majority of the afforestation would be for timber production, the rest for protection, mainly environmental protection. Land for conversion could include several thousand hectares of tree belts for arable land protection, channel and canal protection, roadside belts, and snow barriers. In addition to breeding, the latest achievements of research on silviculture and yield can also be used for optimizing tree growth and, hence, maximum CO_2 sequestration.

Mitigation Potential. Four different scenarios were considered:

- Baseline Scenario: Unlikely. This scenario assumes that no afforestation will take place before 2050.
- Mitigation Scenario I: Likely. This scenario assumes that the current rate of afforestation will continue, i.e., 3,000 ha of forests will be planted per year during the next 50 years.
- Mitigation Scenario II: Programmatic. This scenario involves afforesting 210,000 ha by 2010, an annual rate of 15,000 ha, which would require finding additional domestic financing and some foreign aid.

Table 5. Carbon Mitigation Measures in Forestry (More stars indicate greater significance)

Category	Measure	Significance
Preservation of carbon pools	Preservation of forest land	*
	Preservation of carbon density of stands	*
	Preservation of carbon in soil	***
	Preservation of carbon in wood products	*
Expanding carbon storage	Expanding the area of wood production forests	*****
	Establishing wood fuel plantations	***
	Increasing efficiency in forestry	*
	Increasing carbon content of existing stands	**
	Increasing carbon in wood products	*

- Mitigation Scenario III: Achievable. This scenario requires afforestation of almost 600,000 ha by 2050, an annual rate of 11,000 ha. This scenario would afforest all land where the site can be regarded as suitable for forest management with acceptable benefits. However, this rate of afforestation is not comparable any more with the production capability of the country, so foreign aid is needed to help decision makers to engage in this program.
- Mitigation Scenario IV: Technical Potential. This scenario involves afforestation of nearly 1 million ha by 2050, a rate of 18,000 ha per year. This program requires substantial aid for the country. This is, however, the most preferred scenario because of its beneficial effects.

Figure 1 shows the extent of carbon sequestration for each of these scenarios, and Table 6 shows the cost-effectiveness of implementing each scenario.

It is worth noting that most of the carbon sequestered is fixed in the second half of the period. This means that, despite heavy investments, the benefits of carbon sequestration appear only after a rather long period of time. Consequently, afforestation programs should be launched as quickly as possible. It should also be mentioned that the cost of carbon sequestration in forestry is much less than mitigation options in other branches of the economy.

The implementation of either mitigation scenario III or IV would be a major achievement for Hungarian forestry. According to some analyses, the forest cover in Hungary would be optimal at around 25%–30% of the land area. If either of these two scenarios were implemented, the forest cover would be raised to 25% and 28.5%, respectively. This would bring a lot of benefits to the people, as well as to the local and regional environment.

Either of these scenarios would increase the production of wood products, which would be beneficial for the import-export budget of the country. Currently, the country is struggling with a trade deficit, and it is currently reliant on importing timber products from other countries. Another benefit of a large-scale afforestation program would be job creation.

However, such a program requires considerable financial support. The planting and initial thinning costs could amount to several tens of millions of U.S. dollars. This is several times more than what the Hungarian economy is likely to be able to afford in the next decade.

Figure 1. Carbon Sequestration in Four Afforestation Scenarios

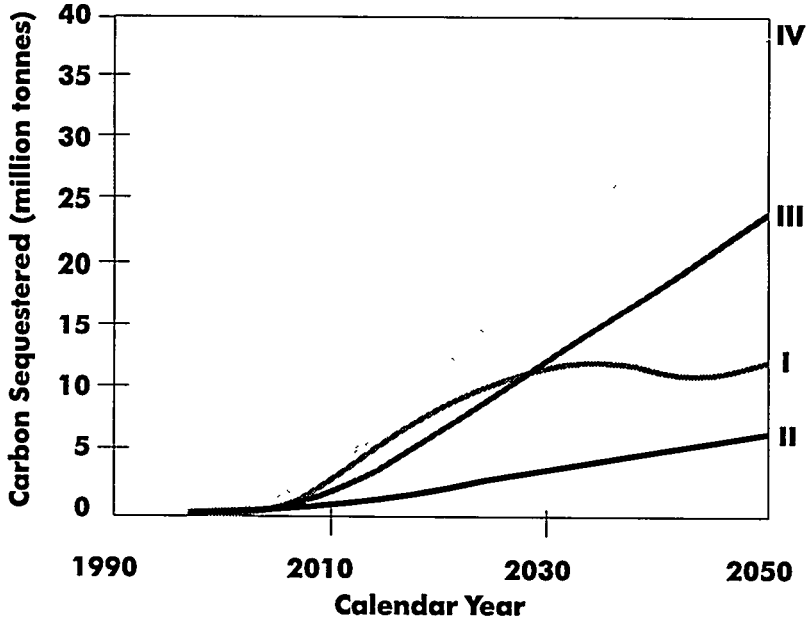

Table 6. Cost Effectiveness Indicators for the Four Mitigation Scenarios

Indicator	Mitigation Option I	II	III	IV
Initial Costs of Establishing Projects				
$/tC	0.007	0.014	0.004	0.002
$/ha	0.425	0.550	0.150	0.092
Total Endowment (Present Value of Costs of Establishing and Running Projects)				
$/tC	25.447	39.921	21.522	18.839
$/ha	1525.093	1616.604	871.549	762.895
Annual Benefits of Reducing Atmospheric Carbon (Present Value)				
$/tC per year	–0.526	–0.487	–0.486	–0.486
Net Benefits of Reducing Atmospheric Carbon (Present Value)				
$/tC	–7.018	–6.491	–6.481	–6.480
$/ha	–420.630	–262.842	–262.451	–262.394

Issues and Lessons

Hungary's mitigation strategy can be based only on ongoing governmental programs, which have originally been launched for other purposes, but which can contribute to a significant reduction of greenhouse gas emissions. These are the energy-saving and afforestation programs. Therefore, the main fields of emission mitigation will be in the energy and forestry sectors. The main reasons for this are as follows.

- Overall energy efficiency is far lower than that in industrialized market economies. Efficiency on both the demand and the supply side has to be increased, even in the short run. As far as the supply side is concerned, restructuring of the power plant system is unavoidable, since a lot of plants are old.
- There is a certain potential in the country for the utilization of renewable resources.
- Forestry management is already well developed, and there is enough land for a large afforestation program.

International Cooperation

Hungary is unlikely to find the domestic resources to support big mitigation projects in the near future. Therefore, opportunities for international cooperation — especially opportunities for Joint Implementation — must be considered. Foreign sources could support ongoing programs, which have slowed down because of financial problems, or new projects can be based on them. Hungary is currently seeking partners to finance the following projects:

- Efficiency improvements to lighting systems in some public buildings
- Afforestation of selected areas
- Utilization of geothermal resources in selected sites

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Summary

This chapter describes the process used to develop Kazakhstan's Climate Change National Action Plan (NAP), national measures and strategies related to climate change, opportunities for implementation, and opportunities for cooperation with other ecologically sound plans and programs. Developing the NAP is one of the practicable steps Kazakhstan is taking to comply with its obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC). The nation's main objectives in developing the NAP are to integrate climate change concerns into other national development plans and programs; define mitigation and adaptation measures that will contribute to sustainable development; provide a framework for national communication; and develop consensus, support, and an institutional structure for implementing climate change measures.

Kazakhstan's long-term national priorities are to improve its physical infrastructure, increase economic growth and employment, increase self-reliance, promote rural development, and preserve the environment. Table 1 presents the sectoral priorities for mitigation and adaptation measures that will be included in the NAP.

Introduction

Kazakhstan, a newly independent Euro-Asian republic, was created in 1991 with the dissolution of the former USSR. The total length of its borders is more than 15,000 kilometers, and it has an area of 2.7 million square kilometers. To the west of the country is Eastern Europe. To the east and southeast are the Altai and Tian Shian mountains. Kazakhstan borders China in the southeast, and Kyrgyzstan and Turkmenistan in the south. It has a coastline of 2320 kilometers on the Caspian Sea. The climate is continental, with wide variations throughout the territory. Average temperatures in January range from –18°C in the north to –3°C in the south; July averages are 19°C in the north and 30°C in the south. Precipitation is equally varied; average annual rainfall reaches 1600 mm in mountainous regions but less than 100 mm in the central desert areas.

In 1997, Kazakhstan's population is 15.86 million and consists of more than 100 different ethnic groups, though mainly Kazakh and Russian. In 1997, the rate of population decrease was 1.12%. The population density is estimated at 5.87 people per square kilometer. Average annual income in Kazakhstan was about US$1670 per person in 1993.

Kazakhstan signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992, and subsequently ratified the Convention in May 1995.

Results of Past Studies

Fulfilling its commitments under the UNFCCC, Kazakhstan — through the US Country Studies Program — has been involved in the following activities:

- Conducting vulnerability and adaptation assessments for important national economic sectors and ecosystems
- Developing a national inventory of anthropogenic emissions (by sources) and removals (by sinks) of all greenhouse gases (GHGs) not controlled by the Montreal Protocol
- Conducting an evaluation of the mitigation measures that control, reduce, or prevent anthropogenic GHG emissions in relevant sectors for the period through 2020.

Vulnerability and Adaptation

The vulnerability and adaptation assessment (Pilifosova et al., 1996) addressed the impact of climate change on biophysical components that play an important role in the country's socioeconomic development. These bio-

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Proposed Measures
Mitigation	
Energy: ■ *Electricity Generation* ■ *District Heating* ■ *Industry*	**Energy Production:** ■ Use renewable energy ■ Use more natural gas ■ Rehabilitate cogeneration systems **Energy Consumption:** ■ Establish legislation to implement energy conservation ■ Conduct energy audits ■ Install energy-measuring equipment ■ Use energy-saving technologies in electric power, district heating, nonferrous metals industry, fertilizer industry
Forestry	■ Afforestation to increase the area covered by forests
Agriculture: *Livestock*	■ Increase productivity ■ Reduce the population
Agriculture: *Wheat Production*	■ Convert less productive arable land into grasslands and rangelands ■ Intensify wheat production
Adaptation	
Agriculture: *Wheat Production*	■ Introduce legislation to strengthen agricultural economy ■ Develop and implement soil erosion protection technology ■ Develop long-term pest and disease forecasts ■ Preserve and improve wheat diversity
Water resources: *Ishim River Basin*	■ Implement water conservation ■ Divert water from other river basins ■ Regulate runoff with the use of new reservoirs ■ Use more water from underground sources

physical components are agriculture (spring and winter wheat), grasslands, livestock, and water resources.

In general, the results of the study for wheat and grasslands showed that negative impacts — depending both on the scenario used and on the area of Kazakhstan considered — are stronger than positive ones. The effect of rising temperatures on the breeding of sheep, the main type of livestock bred in Kazakhstan, is estimated to be overwhelmingly negative. A water resources vulnerability study has been completed for several mountain and plain basins. Water runoff is estimated to increase slightly by the year 2030 but, with a doubling of atmospheric CO_2, a decrease in runoff could occur in all basins studied.

For the agriculture sector, more than 20 possible responsive and anticipatory adaptation measures were considered. The highest priority anticipatory measures include: improving legislation to take into account severe changes in the agricultural economy, developing and implementing technology to prevent soil erosion, developing and distributing long-term forecasts of pest infestations and disease outbreaks, and preserving and improving wheat diversity.

In the livestock sector, the adaptation measures considered were primarily those that are responsive to climate change. They include shifting lambing and sheep-driving to earlier dates, breeding different kinds of sheep, and moving livestock to higher mountain grasslands.

Concerning water resources, the development of additional resources, such as groundwater, and better management of international water resources were considered.

Emissions Inventory

Kazakhstan's GHG inventory for the base year 1990 (Monocrovich et al., 1996) showed that total net emissions for 1990 were 64.579 Tg of carbon equivalent (CE). The most important emitting source is the energy sector, which accounts for 90% of emissions. The second most important source in Kazakhstan is agriculture, which accounts for 8% of total emissions. Kazakhstan's emissions were slightly offset by an uptake of carbon by forests of 1.094 Tg CE, or 2% of the country's net emissions.

Mitigation

The mitigation study (Pilifosova et al., 1997) examined measures in the energy, forestry, and livestock sectors. The total decrease of CO_2 emissions from energy sources is estimated at 37.9 Tg. Because there are extensive wind and hydro energy resources in Kazakhstan, the use of renewable energy has also been considered. Based on expert evaluation, CO_2 emissions declined 25% between 1990 and 1996 as a result of a general decline in economic activity. It is estimated that, in the reference scenario, emissions in the year 2000 will be 82% of those in 1990. Taking into account the availability of natural resources, and the existing scientific and technical studies, nine primary options for GHG mitigation were considered. For the integrated mitigation scenario, which includes all of the measures, the annual reduction in emissions amounts to 3% in 2000 and 11% in 2020 — when compared with the reference scenario. In the energy sector, small hydropower plants on existing channels and rehabilitation of thermal and electricity power plants are the most cost-effective and promising measures. In the other sectors, afforestation and reducing methane emissions from livestock are the most promising measures.

Objectives

The next important step toward further fulfillment of Kazakhstan's commitments under the UNFCCC is the development of the National Action Plan. According to the baseline projection, Kazakhstan's CO_2 emissions will not exceed 1990 levels until 2005. In Kazakhstan, as in any transition country, climate change is only a priority to the extent that it is related to another national objective — protecting the environment. Because of limited human and financial resources, actions in the context of climate change must fit into other development programs, and they will certainly require international assistance. Sustainable development plans have been established, as well as several programs and plans on energy, agriculture, the environment, and forestry that include policies and measures that have mitigation effects. To be successful, the NAP must be fully integrated with other plans and programs as well as with Kazakhstan's environmental protection laws. The Kazakhstan NAP has been developed in accordance with the National Principles of Ecological Safety of the Republic of Kazakhstan and integrated with the National Environmental Action Plan for Sustainable Development.

The main objectives in the development of the NAP are as follows:

- To integrate climate change concerns into other national development plans and programs
- To define mitigation and adaptation measures that will contribute to sustainable development
- To develop consensus, support, and an institutional base for implementing climate change measures
- To provide a framework for national communication

Methods

Establishing the Planning Team

The institutional capacity to deal with climate change problems in Kazakhstan is well developed, especially at the level of research. The ministry most closely involved in climate change and environmental issues is the Ministry of Ecology and Bioresources (MEB). According to the Regulation of the Cabinet of Ministries of the Republic of Kazakhstan, the Agency for Hydrometeorology and Natural Environment Monitoring (AHNEM) — which is directly under the responsibility of the MEB — is responsible for coordinating the work under the UNFCCC. The Climate Change Studies Laboratory (CCSL), through its Kazakh Scientific and Research Institute for Environment and Climate Monitoring (KazNIIMOSK), conducts climate change studies and coordinates the activities relating to implementation of Kazakhstan's commitments under the UNFCCC. Experts and scientists from seven related sectoral agencies are also involved in this work.

Other important ministries in this context are the Ministry of Agriculture (MA) — which includes departments dealing with water resources and forestry management — and the Ministry of Energy and Natural Resources

(MENR). There is an Energy Conservation Center (EC-Kazakhstan) under the MENR which has operated under the Law of the Republic of Kazakhstan and functions as a technical, innovative, and functional institution that coordinates the process of realizing the State Energy Savings Program of Kazakhstan. The Ministry of Economy and Trade (MET) provides macroeconomic assessments and socioeconomic projections.

Along with these governmental organizations, there are some nongovernmental organizations (NGOs) in Kazakhstan that deal with activities related to climate change and are supported mainly by international organizations. The intention is to involve some of these NGOs in the implementation of the NAP.

The work of these agencies and organizations is coordinated by a committee headed by a director of the Agency for Hydrometeorology and Natural Environment Monitoring. This committee was founded in 1993. It included representatives from nine ministries and departments. Since that time, many of those ministries have disappeared, having been integrated into other ministries. In the new phase of Kazakhstan's activity on climate change, new functions connected with developing the NAP have emerged. It is, therefore, necessary to establish a new planning and steering team to cover new types of activities and take into account the new structure and responsibilities of ministries and departments. One resolution of the NAP scoping workshop, held in April 1997, was to apply to the Government of the Republic of Kazakhstan to establish the National Coordinating Commission on Climate Change (NCCCC), and this process is currently under way.

Evaluating and Developing Measures

Selection of the adaptation and mitigation measures for each sector was based both on expert judgments from the lead agencies and on results of Kazakhstan Country Studies work. The team also evaluated existing programs and plans to identify measures that could be integrated into the NAP. This information was discussed at several of CCSL's Working Group of Experts (WGE) meetings. The final decision about high-priority mitigation and adaptation measures and options was made at the NAP development scoping meeting. Stakeholders from different ministries and departments took part in this meeting.

Several criteria were used to screen and evaluate mitigation and adaptation measures. The main criteria used to select an option or measure for the NAP were as follows:

- The existence of opportunities for integration with current sectoral and sustainable programs
- The availability of resources, including possible foreign assistance and investments.

Additional criteria used to evaluate mitigation measures were these:

- The extent of the GHG mitigation potential
- The cost of emission abatement
- The cost effectiveness of implementation
- Other environmental impacts of the measure
- Ease of implementation

Additional criteria used to evaluate adaptation measures were these:

- The contribution of the measure to Kazakhstan's development objectives
- The existence of a clear opportunity for implementation
- The effectiveness of the measure
- The existence of other benefits stemming from the measure
- Low implementation costs
- Low administrative, legislative, market, and other barriers

Kazakhstan's energy development programs focus on energy savings in the electric power, district heating, and nonferrous metals (specifically copper and zinc) sectors. All of these sectors are significant sources of GHG emissions. The methods of technology assessment include conducting a review of technology performance and implementation analysis in the area of renewable energy (hydropower, wind systems, and solar energy) and energy efficiency in industry and power generation.

In-depth evaluation, including a cost-benefit analysis, of chosen mitigation measures either has been completed or is going to be conducted. The methods used are the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) methodology for the Economic Evaluation of Energy Efficiency and Renewable Technologies, the World Bank's feasibility study methodology, and the TACIS methodology, among others.

In-depth evaluation, including a cost-benefit analysis, of several selected adaptation measures is being conducted in priority sectors. The methodology used is a cost-effectiveness analysis that incorporates several tools — including tables and decision matrices — for screening, evaluating, and selecting adaptation measures for sectors vulnerable to climate change. Developed by Hagler Bailly Services, this approach is described in *Steps in Preparing Climate Change Action Plans: A Handbook* (Benioff and Warren, 1996).

Figure 1. Planning Team for the National Action Plan

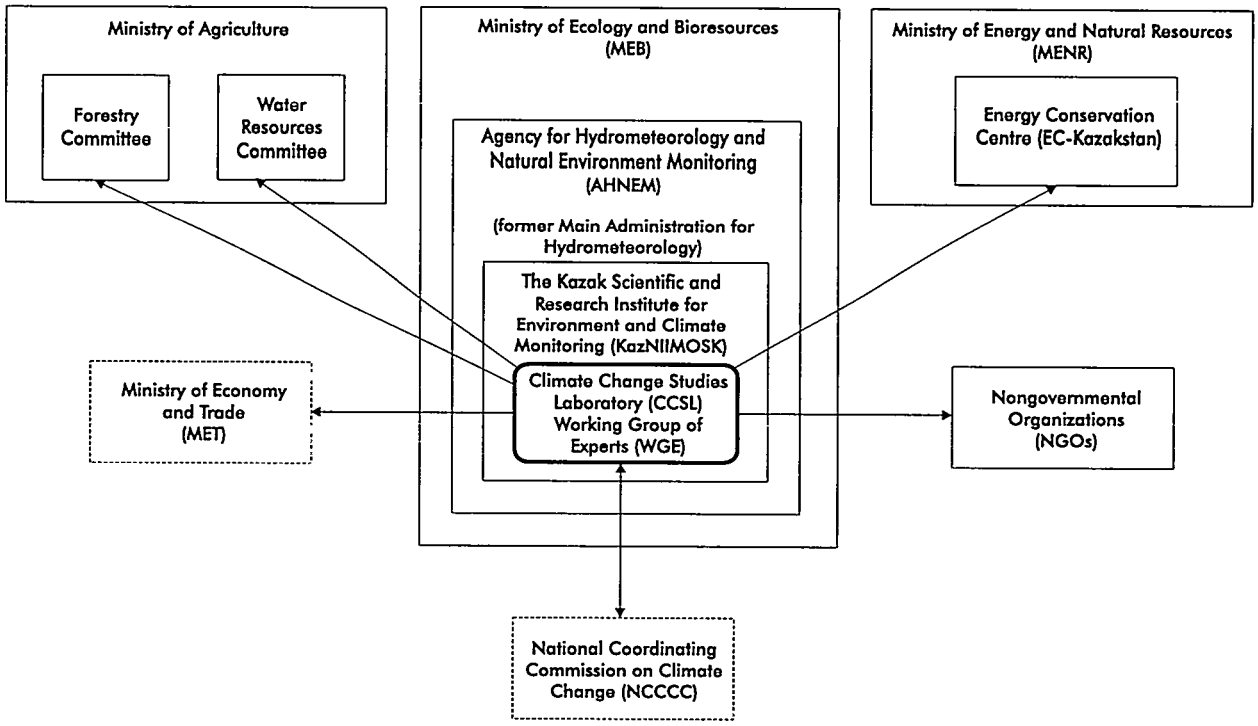

Table 2 describes the schedule for major milestones in the process of evaluating and developing mitigation and adaptation measures.

Adopting the Plan

The procedure for officially adopting the NAP, financing options, and avenues for implementation is currently under consideration. However, the following process has been outlined:

- The draft NAP is to be considered by the Interagency Commission.
- The NAP should be submitted to the Commission on Strategic Planning under the President of the Republic of Kazakhstan, and to the Government of the Republic of Kazakhstan, for endorsement.

Measures

Summary of Plan Measures

The main thrust of the NAP will be to address mitigation measures in the energy sector, although adaptation measures, especially in wheat production, are also very important. In considering an appropriate balance between mitigation and adaptation measures, one should remember that, given Kazakhstan's current stage of development, perhaps the most important step is to create a legal mechanism to support the implementation of the GHG mitigation and adaptation options. In general, we can set the following priorities for all mitigation and adaptation measures to be included in the NAP:

- Reducing GHG emissions in the energy production sector and energy-intensive branches of industry by increasing energy efficiency, implementing energy-saving measures, developing renewable energy, and switching from coal to natural gas
- Reducing greenhouse gas emissions by increasing the productivity of livestock, optimizing livestock populations, and converting relatively unproductive arable land into grasslands and rangelands
- Developing adaptation measures for wheat production and water resources
- Increasing CO_2 sinks by expanding the forest area.

As noted, there has been a 25% decline in CO_2 emissions between 1990 and 1996 because of the general decline of economic activity. It is estimated that, in the reference scenario, emissions in the year 2000 will be 82% of those in 1990. According to the baseline projection, Kazakhstan's CO_2 emissions will not exceed 1990 levels until 2005. Taking into consideration all of the mitiga-

Table 2. Summary Schedule for Evaluating and Developing Measures

Activity	Product	Schedule of Products: Interim Results	Schedule of Products: Final Results
Presentation and discussion of the results of country studies work at WGE meetings	List of sectors of interest; initial list of priority mitigation and adaptation measures		December 1996
Analysis of main principles, existing programs, and plans to identify measures that can be integrated with the NAP	List of measures already included in other plans and programs		March 1997
Hold scoping meeting on NAP development	Final decision on sectors of interest and possible mitigation and adaptation measures		April 1997
Selection of mitigation and adaptation measures	List of priority mitigation and adaptation measures due for technology assessment		June 1997
Technology assessment of mitigation and adaptation measures	Report. Analytical chapter for the NAP		October 1997
Evaluation of specific measures	Report. Proposals for national AIJ programs	August 1997	March 1998
Development of implementation plan	Draft implementation plan	January 1998	March 1998

tion options that will be included in the NAP, the total annual potential for reducing CO_2 emissions is about 3% in 2005 and that increases to 11% in 2020, in comparison to the projected baseline scenario for each of these years.

Almost all mitigation and adaptation measures have positive environmental effects, because their implementation would reduce emissions of other harmful gases into the atmosphere; prevent soil and water pollution, soil erosion by wind and water, and desertification; and preserve biodiversity, among other results.

Cost projections for the mitigation and adaptation options are highly uncertain owing to the specific circumstances of an economy in transition. It is, for example, impossible to forecast the price of such an important variable as electricity, because Kazakhstan has no precedent for estimating the costs to the economy of required expansions to, and modernization of, existing power-producing facilities.

Table 3 presents a summary of the highest priority mitigation measures. The net financial resources required to implement the measures are not listed, because costs for some measures are currently being determined. The annual reduction in gases are given in amounts of the specific greenhouse gas in question.

The quantitative mitigation assessment for the energy sector, which has been completed, was very much supply-side oriented (Monocrovich et al., 1996; Pilifosova et al., 1997). It analyzed the effect of (1) refurbishing existing old and obsolete power plants; (2) where possible, replacing the steam-coal cycle with a steam-gas cycle; and (3) combining electricity production with district heating systems (rehabilitation of cogeneration). The use of renewable energy was also considered because there are extensive wind, hydro, and solar resources in Kazakhstan. The total annual reduction in CO_2 emissions from energy sources is estimated at 3.3% by 2005. The cumulative reduction of CO_2 resulting from all of these measures for the years 2000 to 2020 would be about 68 Tg.

Table 3. Summary of Mitigation Measures, Impacts, and Resources

Mitigation Measures	Lead Agency and Start Date	Annual CO_2 Reduction (thousand tonnes) 2005	2020	Annual CH_4 Reduction (thousand tonnes) 2005	2020	Other Environmental Benefits	Funding Required (millions of US$)
Energy							
Establish institutional and legislative mechanisms to promote and implement energy conservation policy	MENR 1997	N/A	N/A	N/A	N/A	N/A	N/A
Energy efficiency and energy-saving measures:	MENR, EC-Kazakhstan						
Install energy-measuring equipment	1997[a]	TBD	TBD	TBD	TBD		958.6 (total)
Measures in nonferrous metals and fertilizer industries and district heating	1996[a]	TBD	TBD	TBD	TBD		TBD
Power Generation:							
Modernization and rehabilitation of cogeneration systems	MENR 1997	1.76	2.33	1.71	1.90	Reduction of SO_2, NOx, CO emissions and particulates	≈430 by 2005[b]; ≈1061 by 2020[b]
Small hydro	MENR 1997	0.14	3.74	0.16	2.65	As above	≈17 by 2005[b]; ≈578 by 2020[b]
Solar:	MENR					As above	
Collectors	N/A	0.06	0.06				10/year; ≈931 total by 2020[b]
Photovoltaic systems		0.196	1.739	0.22	3.70		
Wind	MENR 1997	0.632	3.139	0.70	2.24	As above	223 by 2005[b]; 937 by 2020[b]
Agriculture							
Increase productivity of livestock and optimize its population	MA 2000			≈150.0		Soil erosion protection	N/A
Convert less productive arable land into grasslands and rangelands, and intensify wheat production	MA 2000	300–650 thousand tonnes of carbon				Soil erosion protection	2.7-3.0 (total)
Forestry							
Afforestation	MA 2000	≈600	≈2,000			Biodiversity, Soil erosion protection	3,500 (total)

[a] Already being implemented through sectoral development programs
[b] Accumulated total by the year indicated

MENR = Ministry of Energy and Natural Resources
MA = Ministry of Agriculture
EC-Kazakhstan = Energy Conservation Center

The mitigation potential of industrial energy conservation and cogeneration have not been quantitatively assessed in previous mitigation analyses because the calculations involved are far more intensive in terms of both data handling and the human resources required. However, according to information and data compiled by the Ministry of Economy and the Ministry of Energy and Natural Resources, the potential for energy savings in this area over the longer term is immense. Approximately 30%–40% of total electric energy could be saved if a comprehensive energy-savings program in energy production and consumption were to be implemented. This would lead to correspondingly large reductions in GHG emissions (Ministry of Energy and Coal Industry, 1995).

Although the Government of Kazakhstan already provides some money to implement the energy-saving and renewables programs, it does not have — and is unlikely to have in the near future — enough funds in the budget to implement all of the measures. The Government therefore encourages greater use of renewable energy and energy efficiency technologies through national policies such as preferential terms for direct investments by foreign investors, incentives and portfolio standards for the private sector, and other similar measures.

Table 4 presents a summary of the highest priority adaptation measures.

Adaptation measures in response to climate change can reduce vulnerability in terms of wheat by at least half; if all the other anticipatory measures are implemented, all negative effects of possible climate change can be compensated. Water adaptation measures are effective and will be implemented even if the climate does not change. However, they should be implemented sooner under the threat of climate change.

Grasslands and rangelands are also essential for the sustainable economic development of the country. Generally, identified adaptation options for the natural vegetation cover involve altering grazing management, reducing undesirable plants, greater fertilizing, and seeding. Proposed adaptation options offered for sheep breeding are to shift the timing of lambing and other breeding activities and to breed sheep that have coarser wool and are better-adapted to hot weather.

It should be noted that, at the moment, adaptation country studies do not cover all the important economic sectors mentioned above in sufficient detail. For example, the adaptation assessment for water resources that was conducted for the Ishim River basin does not reflect the conditions in other important basins; while the proposed measures for livestock and grasslands can be implemented in response to climate change, it is not clear what should be done in anticipation of climate change. The analysis of the cost effectiveness of adaptive options in those sectors that have been considered should be refined. It is, therefore, necessary to continue studies on all of the above-mentioned sectors.

Special attention should be paid to the mountain regions of Kazakhstan, which cover more than 10% of the country. A preliminary study indicated an increasing probability of such extreme natural events as mud flows and landslides. A significant portion of the national population lives in these regions, making it particularly important to develop and/or improve strategies for protecting the people and the economy from possible climate change.

Energy Sector

As mentioned above, the GHG mitigation measures in the energy sector that will be included to the NAP relate to (1) improvements in the efficiency of energy use and energy conversion, and (2) switching to energy sources with low (natural gas) or no (hydropower, wind and solar energy) carbon content. Since such measures are very important for the national economy and energy development, mitigation strategies in the energy sector of Kazakhstan are directly connected with the general national strategy to develop the energy sector. Components from both of these groups are included in the main programs and plans for energy development adopted by the Government of Kazakhstan. The main program of energy development in Kazakhstan is the *National Program on Energy Saving* (1995).

Mitigation Measures

The main objective in implementing these measures is to support infrastructure development, especially in energy production and consumption. The priorities are to develop indigenous energy resources in order to reduce the country's dependence on expensive imported energy and to increase energy exports, while paying special attention to measures for the protection of the environment.

The mitigation action plan in the energy sector will focus on electric power, district heating, nonferrous metals — primarily copper — and fertilizers. These subsectors were chosen on the basis of the following criteria: they have high rates of energy consumption, they have a viable future, they are important to the economic development of Kazakhstan, and/or they have export potential.

Table 4. Summary of Adaptation Measures and Resources

Adaptation Measures	Lead Agency and Start Date	Description	Funding Required (US$)
Agriculture			
Responsive Measures	Ministry of Agriculture	Switch from spring wheat to winter wheat and other wheat varieties; implement water-saving technology; apply more fertilizers and pesticides; weed control.	385–535 million/year
Anticipatory Measures			
Legislation	Ministry of Agriculture, Parliament 1998	Improve existing, and develop new, rules and standards	To develop new rules: 10,000 (without implementation)
Soil erosion protection	Ministry of Agriculture 2000	Develop and implement special land management practices to reduce soil erosion on degraded arable land	5–6 billion (total)
Pests and disease forecasts	Ministry of Agriculture 2000	Develop and maintain long-term forecasts and prevent outbreaks of disease and pest infestations	≈25–30 million/ year
Preserving and improving wheat diversity	Ministry of Agriculture 1997	Create regional centers to preserve and improve spring and winter wheat diversity	266,227/year
Water Resources*			
Water conservation	Ministry of Agriculture	Strengthen standards of water use Water recycling	107.3 million
Additional water diversion into Ishim from other basins	Ministry of Agriculture		126.2 million
Increasing use of underground water	Ministry of Agriculture		309.4 million
Runoff regulation with use of new reservoirs	Ministry of Agriculture		89.86 million

* Adaptation measures were evaluated for the Ishim River basin.

Specific mitigation measures are summarized as follows:

- *Establish institutional and legislative mechanisms to promote and implement an energy conservation policy*. One of the key components of a successful energy-saving program is a high-level commitment of the Government of Kazakhstan. This commitment is necessary, not only to develop policies and legal regulations, but also to implement and enforce legislation once it is in place. Closely related to this is the need to clearly state in legislation which government entities will have responsibility and authority for specific energy conservation measures and to establish clear lines of reporting.

  One of the important options here is preparation and adoption by the Government of regulations on GHG emission reductions in the energy sector.
- *Install energy-measuring equipment*. Since energy conserved can be thought of as the difference between the energy consumed with and without the implementation of energy-saving measures or policies, measuring energy consumption is critical to any energy-saving program. This requires various types of meters and instruments. Investing in metering and other measuring

Djungar Gate Wind Power Plant Project

This project is one part of a larger GEF project that aims to remove barriers to commercial-scale, grid-connected, wind power production in Kazakhstan, thereby reducing the need for new fossil-fuel-based power plants and associated GHG emissions. The project is expected to achieve this goal by: (1) building institutional capacity for research, planning, and technology transfer related to wind power production; (2) reducing the uncertainties of costs and various technical issues related to wind power production; and (3) demonstrating the feasibility of wind power production in Kazakhstan in order to obtain the necessary political and financial support to move toward larger, commercial-scale applications.

Studies that the Kazakhstan Country Studies Team conducted within the USCSP showed that wind energy is one of the most attractive mitigation options to reduce CO_2 emissions. In June 1996, the World Bank launched a mission to conduct a Renewable Energy Resource Assessment of Kazakhstan, among others. The conclusions were (1) that the wind resources of Kazakhstan had been studied and mapped in the past and are of high quality, and (2) that these resources allow for an economical exploitation of wind energy. A prefeasibility study has indicated that a feasible first step would be the construction of a 40-MW demonstration plant, Djungar Gate. This site has been shown to have excellent wind resources, with average wind speeds of 9–10 m/s.

The project will make use of the expertise available in several of the leading institutions in Kazakhstan that are active in energy efficiency work and in renewable energy research and development. These include the Ministry of Energy and Natural Resources (MENR); the Agency for Hydrometeorology and Natural Environment Monitoring (AHNEM); and the Scientific Research Institute of Environmental Monitoring and Climate (KazNIIMOSK). The organization mainly responsible for implementation is MENR. The project began in February 1997.

The measure is expected to reduce annual CO_2 emissions by about 150 thousand tonnes. Other benefits include alleviation of poverty in specific areas by making additional energy available; reduction of local air pollution by replacing some use of coal and oil by wind; training manpower in management and organizational techniques for designing wind energy systems; and developing a more reliable database for wind power throughout the country, particularly in areas where the wind velocity is high.

The initial project development budget is US$481,800, of which US$350,000 is requested from the GEF; the remainder consists of expenditures already incurred by the Government of Kazakhstan. The total amount of funds necessary for the construction of a 40-MW plant is expected to be about US$50 million. Foreign investment is needed for complete project implementation.

systems so that higher energy prices will begin to influence the consumption patterns of individuals and enterprises should be given a high priority in Kazakhstan's Energy Saving Program. Measuring devices will enable more accurate accounting of end-use consumption, processing, and delivery system losses or theft. The cost of this measure is estimated to be about US$958.6 million.

- *Implement energy-saving measures in the nonferrous metals industry, fertilizer industry, and district heating.* These measures include energy audits, technology assessment, control for strict maintenance of technology processes, and the introduction of new energy-saving technologies.

It is difficult, at the moment, to estimate the total resources required to implement all the measures included in this section, as well as their total impact on GHG emissions. We can, however, estimate indirectly the mitigation potential of these measures through their energy-saving potential. As indicated in the Energy-Saving Program of the Republic of Kazakhstan, approximately 30%–40% of total electric energy could be saved if a comprehensive energy-savings program were implemented. For example, in district heating systems, a total reduction of approximately 50% in overall energy use is possible.

Another example involves implementing energy conservation measures in Leninogorsk, which is one of the largest centers of the metallurgical industry, producing about 10% of all nonferrous metals in Kazakhstan. The technological processes used in the industrial facilities in Leninogorsk are typical of about

40% of the industrial plants in the country. A complex of energy-saving measures there would save about 15% of energy consumed. Implementation of these measures requires about US$2 million.

- *Rehabilitate power plants*. This measure can achieve a reduction of 1.8 thousand tonnes in annual CO_2 emissions by 2000 and about 2.3 thousand tonnes by the year 2020. The cumulative reduction is 40 Tg for the whole period. This scenario involves rather low-cost emissions abatement. The cumulative total funds required is about US$430 million by 2005, reaching more than US$1 billion by 2020 (Table 3). This option has been included as the main priority among the medium- and short-term measures in the electricity generation sector.
- *Develop small hydro*. The mitigation potential of this measure is estimated to be from 0.1 to 3.7 thousand tonnes in 2005 and 2020, respectively. Small hydro is the only option that leads to electricity price reductions and therefore saves funds — US$0.4 billion in the period from 2005 to 2020, or US$24 million annually, in comparison to the baseline scenario. The total cumulative funds required for the installation of all planned small hydro stations is about US$17 million by 2005 and US$578 million by 2020. Developing hydropower has a very positive social effect. It will improve the electricity supply in southern and southeastern Kazakhstan, where the deficit of electricity is greatest.
- *Develop wind energy*. The mitigation potential of this measure is estimated to be from 0.6 to 3.1 thousand tonnes. Total funds required range from US$223 million by 2005 to almost US$1 billion by 2020. Developing wind energy is one of the most supported and sustainable options for long-term energy development in Kazakhstan.
- *Evaluate photovoltaic systems*. Adoption of photovoltaic technology could reduce GHG emissions by about 0.9% of the baseline level annually. Installation of solar plants, according to the scenario, could reduce imports by approximately US$10 million annually. It is, however, a rather expensive option.
- *Develop solar water heating*. Solar water heaters can heat 80 liters of water by 40°C per 1 kW of heater power. The resulting CO_2 reduction would be about 60 tonnes/year. It is a very promising and feasible option.

For all these measures, the levels of CH_4, NO_x, CO, and NMVOC emissions are incomparably less than the level of CO_2 emissions. The relative reductions in the other GHG emissions, SO_2, and particulate emissions under the different mitigation scenarios in mitigation measures considered in comparison to the baseline scenario are similar to those for CO_2. Implementation of all would also result in a reduction in coal and oil utilization as well as a reduction in electricity imports.

Forestry Sector

Currently, forest covers about 3.7% (9.6 million ha) of the country. Based on the data available, Kazakhstan's forests sequester 4,011 Gg of CO_2 annually.

Mitigation Measures

According to the Program, "Forests of Kazakhstan," which is going to be integrated with the NAP, forest cover should be increased to 4.6% of the country by 2010, and to 5.1% by 2020. The areas (about 3.8 million ha) are to be planted mostly with mixed softwoods. This would eventually increase sequestration by forests up to about 6,000 Gg of CO_2. The cost of implementing this option is estimated as US$3.5 billion. Foreign investment would be necessary to implement this measure.

Agriculture Sector

According to the *Conceptual Program of Development of the Agricultural and Industrial Complex of Kazakhstan to the Year 2000* (1994), considerable changes should be made in the structure of arable land and livestock populations and in the extent of meliorative and soil erosion protection activities. The specific measures and technologies recommended in this program make it possible to calculate mitigation effects directly.

Mitigation Measures

According to this program, the livestock population should be reduced and its productivity raised. Methane emissions could decrease by 18%–20% under two scenarios, totaling either 134.6 Gg/year or 168.2 Gg/year of CH_4 under the proposed options.

Another measure is to reduce the area planted with wheat. In some regions, wheat is grown not only in the steppe and arid-steppe zones, but even in the desert-steppe zone on light-chestnut and gray-brown desert soils. The soil and climate of that area allows a wheat yield of no more than 0.5–0.6 Mg ha^{-1}. According to Kazakh Agricultural Academy of Science research results, areas that now give low yields will no longer support crops. The available areas should be planted with perennial grassy and bushy vegetation for 7 or 8 years. After that, carbon

will reaccumulate in the soil. The expected range of annual carbon reaccumulated in the soil under five scenarios is shown in Table 3.

Adaptation Measures

Agriculture plays an important role in the socioeconomic development of Kazakhstan, which is located in a risky zone for agriculture. One of the main crops in Kazakhstan is wheat. Spring and winter wheat production is particularly vulnerable to potential global warming. In general, the results of the study for wheat showed that negative impacts — depending on the scenario used and on the area of Kazakhstan considered — are stronger than positive ones. Reductions of spring wheat yield are anticipated to be 30% on average, while winter wheat yields could increase about 20% in some regions. All of the adaptive options in wheat production could have significant benefits even if the climate does not change, but the effectiveness of the measures grows with a drier climate. That is why the development of adaptation measures for the wheat subsector is crucial for the sustainable development of agriculture in the Republic.

High-priority adaptation measures are listed in Table 4. Below is a short description of the measures.

Improve legislation, taking into account economic changes in agriculture and privatization. Currently, farms are being transferred to the private sector. This process is continuing until it is finished. Previous rules and standards are no longer applicable. Therefore, related rules and standards that meet free-market conditions must be developed. Such legislation will make agriculture more flexible and sustainable and more resilient to climate change. This work would be done by the Cabinet of Ministries of the Republic of Kazakhstan, the Parliament, the Ministry of Agriculture, and other departments.

The cost of developing new rules is estimated to be US$10,000. These estimates are based mainly on labor costs and may not include many other cost components that could amount to millions of dollars. We have not yet determined these components. This is an area for future investigation.

Develop and implement soil erosion protection technology. Desertification, caused by wind-and water-related erosion, is taking place over an area of more than 120 million hectares in Kazakhstan. Total arable land is currently 32.7 million hectares, 22.0 million hectares of which is situated on slopes of 2°. Current cultivation practices do not take into account the relief of the arable area, which is divided into square fields of 400 ha (2 km × 2 km). This leads to increasing erosion by wind and water. Under possible climate change, the share of eroded land is likely to increase substantially and wheat yields are likely to be dramatically reduced. This makes it highly necessary to develop complex agrolandscaping projects to recover degraded, relatively unproductive land. For each agrolandscape contour, special recommendations on soil-, water-, and energy-saving technologies for wheat cultivation should be developed and implemented.

The total cost of the measure is estimated to be US$5 billion to US$6 billion.

Develop and maintain long-term forecasts on pests and disease outbreaks. Wheat production in Kazakhstan has been affected by pests and disease. It is expected that the probability of these events will increase under regional climate change. Therefore, agricultural research institutions should distribute annual long-term forecasts on expected pests and diseases in order to enable the timely acquisition and application of appropriate insecticides and fungicides.

The total cost of the measure is estimated to be about US$25 million to US$30 million per year, of which US$20,000 per year for the development of forecasts and the rest is for implementing the necessary actions.

Create regional centers to preserve wheat diversity. Taking into account possible climate change, it is essential to have adequate supplies of drought-resistant, early-maturing wheat varieties. Therefore, it would be desirable to establish some institutions that could help preserve existing wheat varieties and develop new ones. One suggestion is to create two regional genetic banks for wheat varieties, based at existing agrarian research institutes: a northern center at the A. I. Baraev Kazakh Research Institute for crop cultivation, costing US$165,547 per year, and a southeastern center at the W. Williams Kazakh Research Institute, costing US$100,680 per year.

Water Resources

Water runoff in the highlands is expected to increase by 6%–20% by the year 2030 but, under a doubling of atmospheric CO_2, the runoff in all basins studied is expected to decrease by 20%–30% by the middle of the next century.

Adaptation Measures

The total amount of saved and additional water available after implementing all of the proposed measures is estimated to be 524.1 million cubic meters; the total financial resources required to implement these options is

estimated to be US$632.7 million. Specific adaptation measures are summarized as follows:

- *Implement water conservation*. This measure includes reduction of water use by introducing waterless and low water technologies; elimination of water leakage in water pipes and sewer systems; and rational use of irrigated land. These options are estimated to save 132.4 million cubic meters of water, at a cost of US$107.3 million.
- *Divert additional water into Ishim River from other basins*. This measure is estimated to save 213.1 million cubic meters of water, at an estimated cost of US$126.2 million.
- *Increase the use of underground water*. This measure is estimated to save 43.3 million cubic meters of water, at an estimated cost of US$309.4 million.
- *Regulate runoff with the use of new reservoirs*. This measure is estimated to save 135.2 million cubic meters of water, at an estimated cost of US$89.9 million.

Implementation Strategies

For the past few years, Kazakhstan has been in the process of implementing institutional reforms to reduce the number of civil servants and to streamline and rationalize decision making. This process makes it difficult to create a clear picture of how the NAP will be implemented and which agency and department will be responsible for the one type of activity or another. Another issue that could impair effective action on climate change issues is the lack of coordination among the various parties — ministries, institutes, etc. — involved. This is not a problem peculiar to Kazakhstan; it is a consequence of the dramatic changes that the economy and society have experienced in recent years.

Producing the NAP is a complex problem of national scope. It demands coordinated actions among all ministries and departments that have activities involving climate issues, economic policy, or ecological policy. It is expected that the Interagency Commission (hereinafter "the Commission") on the problems of climate change will coordinate the NAP implementation in Kazakhstan. This Commission will be created by a resolution of the Government of the Republic of Kazakhstan in 1997 or 1998.

The Implementation Commission

Owing to the reorganization of the government, and taking into account the new tasks associated with NAP development, the Commission must be reestablished and its functions expanded. High-ranking officials should be nominated to the Commission by the Cabinet of Ministers. Coordination of NAP implementation will be included in the sphere of it powers. The Commission will include the following ministries and departments:

- Ministry of Ecology and Bioresources
- Ministry of Energy and Natural Resources
- Ministry of Agriculture
- Committee on Emergency Situations
- Agency for Statistics and Analysis
- Ministry of Economy and Trade
- Ministry of Finance
- Ministry of Foreign Affairs.

The Commission will be headed by the director of the Agency for Hydrometeorology and Monitoring of the Natural Environment, which the Government assigned to address all questions connected to fulfillment of the UNFCCC obligations. In March 1997, this agency came into the structure of the Ministry of Ecology and Bioresources.

The basic task of the Climate Change Interagency Commission is coordination of the activities of ministries and departments presented in Table 5.

The leading institution, the Agency for Hydrometeorology, carries out the organizational and technical maintenance of the Commission's work. The meetings of the Commission are held not less than two times in a year.

The NAP is currently being developed. A draft of the plan is to be prepared in mid-1998. By that time, the list of measures and a schedule for their implementation will be defined.

The measures that are to be included in the NAP are supposed to be implemented by local branch organizations, private organizations, and NGOs. The NAP will include training and improving the qualifications of some of the personnel responsible for technical fulfillment of the projects, estimation of project efficiency, and the potential for GHG emission reductions. Managing personnel will be trained through special education and participation in international workshops. Nongovernmental and noncommercial organizations will be involved in implementing small, lower cost projects.

Financing

Financing the NAP through the state budget involves certain difficulties, caused by Kazakhstan's transition to a market economy. It will, therefore, be necessary to attract market-based tools of management, international finan-

Table 5. Basic Tasks of the Climate Change Interagency Commission

Areas of the Commission's Responsibilities	Related Activities
Fulfillment of Kazakhstan's obligations under the UNFCCC	Consideration and submission to the Government of the National Communications for UNFCCC Parties Conference
	Introducing appropriate proposals on questions (particularly the NAP) requiring the decision of the Government
	Participating in the development of the legislative and other normative acts of Kazakhstan on the issue of climate protection

cial organizations, and foreign investments to fund the NAP.

The Government can be expected to undertake less than 15–20% of the total cost of the Plan measures. These financial resources can be drawn from Kazakhstan's fund for nature protection, which will consist of receipts from payments for pollution, taxes for waste removal, compensation for ecological consequences of activities of enterprises, fines for damaging the environment, etc. Additional financing can come from other branch funds: medical insurance, support of agriculture, energy conservation, and the recently created regional fund of the World Bank for supporting privatization. There are, as yet, few sources of private financing in Kazakhstan.

In 1997, GEF aims to provide US$0.2 million for the small grant program for nongovernmental and noncommercial organizations for the resolution of ecological problems, including climate change. Investments can also be made within the framework of USIJI and AIJ, and from international organizations (USAID, ADB, and others).

Public Education

Implementation of the NAP is impossible without widespread public education and enlightenment of political and governmental officials, manufacturers, and private businessmen on the problems of climate change. One of the NGOs is preparing a series of telecasts on climate change issues for the most popular television channels. Series of articles and brochures are also being planned that will explain the problems of climate change, the activities of people that prevent the possible negative consequences of global warming, and ways to reduce GHG emissions and adapt to impending climate change.

Monitoring and Evaluation

After the plan is developed and is adopted by the Government, arrangements will be made to establish a special group — under the general coordination of the Interagency Commission — for monitoring the implementation of projects, estimating their efficacy, and developing feasibility studies. This group, which can be created within the Agency for Hydrometeorology, will also manage the competitive selection of projects, corrections to work content, and finding additional financial resources.

NAP development is an important component of the fulfillment of the UNFCCC obligations. A description of its contents will be included in the National Communication.

Issues and Lessons

The findings of our work to date include the following:

- The process of developing the NAP, results of past studies, and a review of existing and upcoming national programs and plans showed that the socio-economic and legislative conditions for the development and implementation of the NAP do exist in Kazakhstan. Foreign donor and investor interest is increasing.
- Successful implementation of the plan will require the Government of Kazakhstan to provide additional financial resources for realization of measures to mitigate climate change and to facilitate adequate adaptation to potential global warming.
- Due to limited human and financial resources, climate change initiatives must fit into other development programs, and certainly will require international

assistance. There are sustainable development plans, and several programs and plans on energy, agriculture, and forestry that include policies and measures that have mitigation and adaptation effects. The NAP is being developed in accordance with the National Principles of Ecological Safety of the Republic of Kazakhstan and is being integrated with the National Environmental Action Plan for Sustainable Development.

- The institutional capacity to deal with climate change problems in Kazakhstan is well developed, especially at the level of research. Kazakhstan has high standards of education but is often not in touch with the latest technological developments. One difficulty that could impair effective action on climate change issues is the lack of coordination between the various institutions (ministries, institutes, etc.) involved. Technical assistance in these areas is needed.

International Cooperation

There are immense opportunities for international cooperation to support the implementation of Kazakhstan's action plan. Some current and potential mitigation projects requiring external assistance are presented in Table 6.

This list is certainly far from complete and it represents only the some of the possibilities. Opportunities and needs for technology cooperation include several different types of activities. One is the development of a local business capacity. For example, in 1994, TACIS provided technical assistance to help set up the Energy Conservation Center. The Center needs continuing support to help develop standards concerning the efficient consumption of energy; so the formation and coordination of energy efficiency demonstration and pilot projects in industrial plants and commercial zones; elaboration and realization of programs and projects that use nontraditional and renewable resources of energy; and so on. Many energy enterprises, oil fields, and such are privatized now, and personnel need training and assistance with efficient energy use and up-to-date technologies.

Other areas for technological cooperation are technical assistance and training in technology applications, support for technology adaptation and assessment, and technical assistance with programs and policy design. For example, one of the mitigation measures that has great potential in Kazakhstan is the use of wind energy to supply isolated communities with electricity or feed directly into the national grid. There is a good database on wind profiles in Kazakhstan, but knowledge of the technology base needed to implement these measures is still very elementary.

In the field of energy efficiency, in spite of significant, cost-effective opportunities to improve energy efficiency and therefore mitigate GHG increases, such cost savings have not been properly exploited because so many barriers exist. These barriers include lack of information and know-how, lack of appropriate financial and eco-

Table 6. Some Mitigation Projects Requiring External Assistance

- Energy efficiency measures leading to GHG mitigation in the areas of heating and hot water supply
- Energy efficiency projects in nonferrous metals and fertilizer industries
- Small hydropower plants on existing channels (in Bartogai and at least 25 other locations)
- Wind and solar energy projects
- Coal bed methane collection and utilization at Karagandy coal basin
- Energy conservation in buildings
- Creation of demonstration zones for energy efficiency improvements (e.g., for the metallurgical industry in Leninogorsk and Almaty district heating)
- Utilization of the gas accompanying oil drills (for example in Kungor and Zhanazhol oil fields)
- Rehabilitating thermal power plants
- Afforestation
- Livestock methane utilization
- Study and creation of the legislative basis of liberalization, legal structure and energy pricing reform of the electricity, oil, and gas sectors

nomic policies, and institutional impediments. The identification of barriers and design strategies to promote nationwide implementation of energy-saving measures could be one of the most useful kinds of cooperation.

Finally, assistance in securing project financing is very important. We would like to get more effective and helpful technical support from the International Institute of Energy Conservation, the National Renewable Energy Laboratory (USA), Hagler Bailly Services, Inc., and other organizations that could provide technical assistance with the identification, preparation, and submission of bankable energy-efficiency projects for financial assistance from international lending institutions and the private sector.

There are also many opportunities for international cooperation on adaptation issues. The country needs support to continue adaptation studies of livestock, grasslands, water, and other sectors. We need technical and financial support for adaptation assessments of forests and mountains, which together cover about 400,000 square kilometers in Kazakhstan. We would like to continue our cooperation on adaptation technology and cost-effectiveness assessments with the contractors and cooperators of the USCSP and SNAP, particularly from Hagler Bailly Services Inc. We would also appreciate having an opportunity to learn more from the experiences of other countries attending international conferences and workshops and from visits to sites by experts.

In the meantime, Kazakhstan's team has gained some experience in conducting adaptation assessments in agriculture, which could be useful for other countries and teams that are beginning their own studies. Sharing the lessons learned in Kazakhstan with other countries could be another way to encourage future international cooperation.

Cooperation in other capacity-building activities might include increasing public awareness of, and education about, climate change and energy efficiency issues; sponsorship and coordination of seminars, exhibitions, training courses, and other measures in the sphere of energy savings; and editing and publication of informational materials.

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MEXICO

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Summary

The overall objectives of Mexico's climate change action plan are to meet Mexico's commitments to the United Nations Framework Convention on Climate Change (UNFCCC) by the end of 1997; help current efforts to develop criteria for Joint Implementation; and help strengthen Mexico's contribution to mitigating climate change by raising domestic awareness of the possible impacts of climate change, developing the country's related technical capabilities, and gaining support for the implementation of the national action plan (NAP) and related climate change policies.

Introduction

Mexico has tried to lead other developing countries in environmental policy. Mexico began relatively early discussions on transboundary air pollution in 1973 and was the first to sign the Montreal Protocol in 1987. The country's sciéntific community has a strong record of research on climate change, and overall environmental awareness and political commitment has grown rapidly in recent years.

Mexico has shown initiative and leadership among non-Annex 1 countries by conducting an ambitious program for the Country Study, with the help of the USCSP. Now, with the necessary additional support and the continuation of the technical exchange and assistance that has been developed between the Mexican and USCSP teams, a very good national plan is emerging.

The National Action Plan on Climate Change was built on the results of the current country study, and reflects a broader and more in-depth analysis of options. We pursued these with expanded participation of experts from other agencies, the private sector, and NGOs.

Results of Past Studies

Vulnerability

The possible effects of climate change on Mexico's ecosystems, economy, and health are expected to be diverse. In some cases, the predicted variations in precipitation and temperature could improve the situation of a certain area, while in others it could have disastrous consequences.

The vulnerability of our country was assessed taking into account the effect of climate change on agriculture, forest ecosystems, sea level in the coasts of the Gulf of Mexico, the 12 hydrological zones of the country, desertification and meteorological drought, the industrial and energy sectors, and human settlements. These results are presented for each of the three broad geographical regions.

Northern Zone. The north of Mexico currently has difficult climatic conditions. Dry and arid climates prevail, with the exception of the mountainous areas where climate is temperate and semicold. As a consequence of the temperature increases given by the General Circulation Models (GCMs), arid and semiarid climates widen their surface, spreading to the south of the country, while semicold climates disappear. Therefore, it can be said that this zone is unlikely to have drastic change. There are, however, likely to be some harmful effects of climate change. Water resources in the region are particularly vulnerable, as are coastal communities. Large areas of pasture and temperate forests will face warmer climates, and there is reason to believe that zones with tropical dry and very dry forests and desert scrubs would increase.

Central Zone. This zone has the greatest population (especially in the Estado de Mexico and the Distrito Federal) and also the industrial centers of Mexico, having therefore great water, energy, and food needs. Sixty percent of urban population is found in this region, and the population is growing rapidly, placing even greater demands on water and food resources in the future.

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Proposed Measures
Mitigation	
Energy: *Power Generation*	■ Use renewable energy sources, especially large-scale wind plants ■ Fuel substitution
Energy: *Industrial*	■ Industrial cogeneration ■ Efficient electric motors ■ Improved industrial boilers ■ Atmospheric circulating fluidized bed combustion ■ Potable water pumping
Energy: *Transportation*	■ Expansion of public transportation and increased use of electric vehicles in the Mexico City Metropolitan Area
Energy: *Commerical and Residential*	■ Introduce energy-efficient lighting
Forestry	■ Implement forest management options for carbon sequestration
Agriculture and Livestock	■ Implement options to mitigate methane and other GHGs
Adaptation	
Agriculture and Livestock	■ Use of Climate Forecasts in Agricultural Activities in Tlaxcala (January–November 1997)
Forests	■ To be established in second phase of the country study

Competition for land use, mainly for urban and industrial uses, to the detriment of agriculture and forestry, is also characteristic of this region. Because this is the region of the country where environmental modifications by anthropogenic actions is most evident, climate change consequences here are extremely severe.

The region already experiences water shortages, a situation that is likely to worsen with climate change. This will affect the industrial areas, especially the petrochemical and chemical complexes of Guanajuato, Oaxaca, and Puebla; the mining centers of Colima; and the iron and steel industries of Puebla. The food, textile, and paper industries will also be adversely affected. Rain-fed corn production fields in Jalisco, Nayarit, Guanajuato, Aguascalientes, México, Colima, and northern Michoacán would go from suitable and fairly suitable to unsuitable, diminishing the agricultural potential of these states. The most affected forest ecosystems of this region are temperate forests on the eastern side of Michoacán, the northern portion of Morelos, and humid and temperate forests of the Sierra Zongolica in Veracruz.

Southern Zone. In this region, most of Chiapas is likely to experience more frequent droughts, as are Quintana Roo and the eastern part of the Yucatán peninsula, where drought severity increases from low to high. Water resources in this zone display almost no modifications in current vulnerability rates for the GCMs. The coasts of the Gulf of Mexico and the Caribbean Sea are susceptible regions to sea-level rise, especially the delta of the Grijalva-Usumascinta rivers in Tabasco, and the northeastern coasts of Campeche and the Sian Ka'an region, which is a biosphere reserve. For industrial activities, the most dramatic differences are observed in the states of Tabasco and Chiapas, where chemical and petrochemical industries are located. In the energy sector, oil production zones, and extraction platforms located in the Gulf of Mexico are the most vulnerable. Most of the region is likely to become unsuitable for agricultural production. Humid temperate and cold forests found in the mountainous zones of the states of Oaxaca and Chiapas would be threatened, and could even disappear.

Emissions Inventory

Table 2 shows the results of a GHG emissions inventory for 1990. For carbon dioxide, the most important source of emissions is the energy sector (296,900.341 Gg bottom-up; 311,800 Gg top-down). Together, all combustion-related energy sources represent the largest source (69%). However on its own, the category of land use change and forestry emissions represents 31% of national CO_2 emissions. For methane, agriculture and cattle-raising are the largest source 49.22% (1793.297 Gg), followed by fugitive emissions from the oil industry and a small portion from coal mining, which contribute 28.53% (1,039.58 Gg), and waste 14.44% (526 Gg).

Mitigation Assessment

There are a variety of methodologies to analyze the costs and feasibility of limiting GHG emissions at a national level, including a number of software packages that make forecasts in the energy sector (MEDEE, LEAP, etc.).

Mexico utilized a model developed in the Energy and Environmental Studies Group at the Engineering Institute at UNAM. This model is similar to the DEFENDOUS model developed in India, and it is based on the STAIR model developed at the Lawrence Berkeley National Laboratory.

The model was able to develop optimal results by combining the various options in such a way as to pro-

Table 2. GHG Emissions in Mexico in 1990 (Gigagrams)

GHG Sources and Sinks	CO_2 top/down	CO_2 bottom/up	CH_4	N_2O	NO_x	CO	NMVOC
Total Emissions and Removals	459,278.333	444,378.674	3,641.275	15.788	1,013.055	11,034.675	800.770
All Energy (Fuel Combustion and Fugitive)	311,800.000	296,900.341	1,080.978	7.971	962.973	8,727.564	800.770
1. Fuel Combustion	311,800.000	296,900.341	41.398	7.971	962.973	8,727.564	800.770
Energy & Transformation Industries		108,475.773	3.442	2.323	298.358	281.484	
Industry (ISIC)		64,971.198	1.540	0.061	111.547	20.716	
Transport		95,944.448	35.934	3.916	521.849	8,420.336	800.770
Small Combustion		23,554.988	0.459	0.090	20.918	3.944	
Other		3,953.934	0.023	1.581	10.301	1.084	
2. Fugitive Emissions from Fuels			1,039.580				
Solid Fuels			70.270				
Oil and Natural Gas			969.310				
Industrial Processes	11,621.000	11,621.000					
Agriculture			1,793.297	5.817	11.082	195.111	
Enteric Fermentation			1,700.905				
Manure Management			48.101				
Rice Cultivation			35.000				
Agricultural Soils				5.510			
Prescribed Burning of Savannas							
Field Burning of Agricultural Residues			9.291	0.307	11.082	195.111	
Land Use Change & Forestry	135,857.333	135,857.333	241.000	2.000	39.000	2,112.000	
Uptake by managed forests	−31,551.667	−31,551.667					
Forest clearing	217,734.000	217,734.000	241.000	2.000	39.000	2,112.000	
Uptake abandoned lands	−50,325.000	−50,325.000					
Waste			526.000				
Solid Waste Disposal on Land			468.000				
Wastewater Treatment (urban)			58.000				
Waste Incineration							

vide a progressive decrease in each of greenhouse gases considered. Results were drawn in a figure that showed, for each scenario, the cumulative greenhouse gas emissions avoided and the incremental costs of adding, one by one, the different mitigation scenarios. These curves enable the determination of the cheapest mix of energy and non-energy options that will meet the energy and non-energy requirements for the different scenarios.

Objectives

Specific objectives of Mexico's national action plan include:

- In-depth evaluation of high priority adaptation measures and review of mitigation technologies and identification of opportunities to promote technology diffusion.
- Outreach and education activities to increase understanding of the possible impacts of climate change on Mexico, and to gain support for implementation of the national climate change action plan.
- Continued development of technical and policy analysis capabilities of key personnel and processes in Mexico.

Methods

Establishing the Planning Team

The National Institute of Ecology (Instituto Nacional de Ecología, INE), from the Ministry of Environment, Natural Resource and Fisheries (Secretaría de Medio Ambiente, Recursos Natuturales y Pesca, SEMARNAP) is in charge of addressing climate change issues and of establishing national policies in regard to those issues. It has the capability of convening different governmental agencies, industry, academia and NGOs to analyze the implications of global change. The INE uses a multidisciplinary approach in its work on climate change. The technology assessments, conducted as part of the SNAP program, were developed by the Engineering Institute at the National Autonomous University of Mexico (Instituto de Ingeniería, UNAM). The program that Mexico conducted during 1996 and part of 1997 was based mostly on technology assessments. The first step taken by INE was the creation of a working group with experts from the Engineering Institute at UNAM and representatives from other ministries.

Establishing Priorities

Based on the results of the Country Studies Program, the experience of different experts on technology assessments, and the different opportunities that the Mexican economic restructuring reforms are providing for new investments, the working group proposed to the Steering Committee that it place an emphasis on technological options for mitigation, and recommended the analysis of 12 technologies in both the energy and non-energy sectors. These technology assessments are under way at the time of this writing (September 1997).

The national GHG inventory indicated that energy production and consumption represent the largest contribution to Mexican GHG emissions. Nevertheless, land use changes and deforestation are also key contributors to the country's GHG emissions. Most of the technology assessment is being developed for energy technologies, but also includes land use changes and livestock emissions.

Technology Assessment

Mexico's technology assessment uses the following two analytical procedures.

- *Rough cut technology assessments*. The rough cut assessments for 12 technologies are based on generic costs and applicability information. The initial assessments rely as much as possible on data gathered or known through the country studies process. The assessments examine the likely technical, market, institutional, and social factors and the economic costs or benefits that would influence the acceptability and penetration of technology. The brief assessments also identify specific likely partners (such as business or industry associations, municipalities, and others) and allies that could assist in implementing the option.
- *In-depth analysis of marginal but promising options*. Of the rough cut assessments, 3 to 4 highly promising but marginal options will be identified for more in-depth analysis. These analyses include consultation with pertinent possible partners and allies in adopting the technologies, including representatives from the relevant sectors, researchers, and government officials. The most appropriate mechanisms for promoting technology

implementation, including voluntary programs, regulation and codes, public promotions, joint implementation, and others will be evaluated.

The 12 technologies identified for rough-cut assessments are:

- Efficient industrial electric motors
- Efficient industrial boilers
- Industrial cogeneration
- Commercial and residential efficient lighting
- Residual and potable efficient water pumping
- Passenger transportation in the Mexico City Metropolitan Area (MCMA): Electric and hybrid vehicles
- Passenger transportation in the MCMA: Intermodal substitution
- Retail logistic operation for freight transportation in the MCMA
- Power generation: fluidized bed combustion
- Wind power generation
- Land use change
- Efficient large-scale cattle farms.

The in-depth assessments involve:

- Development of a baseline scenario, according to national plans, including the following greenhouse gases: carbon dioxide, carbon monoxide, nitrogen oxides, and methane
- Evaluation of the economic feasibility of the implementation of different mitigation technologies
- Development of mitigation scenarios for years 2000, 2005, and 2010, integrating the mitigation technologies
- Determination of a least-cost mix of energy demand and supply technology options
- Suggestion of policies that promote the implementation of mitigation options

Specific products of the technology assessment include:

- Estimation of GHG emissions for base year and baseline scenarios
- Synthesis of the state of the art of different technologies
- Energy saving and GHG mitigation potential for different energy technologies
- Carbon sequestration potential for land use systems
- Estimation of the potential for mitigating methane with efficient large-scale cattle production systems
- Estimation of associated costs of mitigation and carbon sequestration
- Incremental cost curve (mitigation potential vs. unit carbon cost) of different technologies
- Main barriers for technology implementation
- Identification of users, partners, and allies for technology implementation
- Suggestion of mitigation policies
- Impacts on current environmental and non-environmental policies

Criteria for Screening and Evaluating Measures

Although the criteria to screen and evaluate measures have not been established, the technology assessment process will help in giving a long-term mitigation target for different technologies. The long-term mitigation target acts as a goal and allows questions to be asked about how proposed activities of the steering committee will actually help progress towards the goal. In addition, progress towards this goal needs to be measured and the effectiveness of individual activities needs to be assessed. As with the technology assessment process, all members of the steering committee will need to be involved in this process.

Ensuring Integration with Other Plans

Various programs for mitigating greenhouse gas emissions already exist in the Mexican Secretariat of Environment, Natural Resources, and Fishing. In addition, the mitigation technologies under assessment were chosen considering other Mexican development goals, such as mitigation of urban pollutants, and the emissions standards that will be mandatory for industries in 1998. Also, the energy sector technologies are being assessed considering the goals of the Energy Saving National Commission (Comision Nacional para el Ahorro de Energia), and the forestry sector mitigation alternatives consider the national forestry program.

Mexico developed a National Development Plan for the period from 1995 to 2000. This plan is the first step toward subsequent policy decisions that will undoubtedly influence future greenhouse gas emissions and sequestration in Mexico. The Mexican country study has contributed already to this process, because some technical studies are completed and published. Individual researchers involved in the country study have given their own recommendations. In addition, the Mexican team is compiling a list of final findings and recommendations to add to the decision-making process by late November 1997.

Following the release of the NAP in November, the country studies team plans to pursue further integration of climate considerations into implementation

of the National Development Plan by participating in discussions leading to the inclusion of climate change issues in Mexican environmental law. In this aspect, the Mexican team is very well situated, because its coordination belongs to the National Institute of Ecology.

Measures

Summary of Plan Measures

Mitigation

The mitigation measures listed in Table 3 are described in more detail in the Energy section.

Adaptation

The specific adaptation measures and technologies or classes of technologies that Mexico is examining in greater detail were decided following completion of the mitigation and scenarios portions of the climate country study, and after expert, intergovernmental, and public review of the study. These reviews occurred in the first half of 1996.

The National Institute of Ecology is currently coordinating both of the following adaptation activities:

- Climate forecasts are being used to coordinate agricultural activities in Tlaxcala during the period January to November 1997. This project includes making assessments of the potential agricultural production of the zone, and the implementation of production programs. This is the first attempt to plan productive activities taking into account the climate variability factor.
- Selection of additional adaptation measures to be implemented in the northern and central regions of the country will be carried out as part of the second phase of the country study.

Energy Sector

The energy sector is the most important anthropogenic source of greenhouse gas emissions in Mexico. About 85% of final energy use, and 61% (1995) of power generation, is produced through the consumption of fossil fuels. The remaining energy supply comes from hydro, geothermal, and nuclear power production, fuelwood, and bagasse.

Specific Mitigation Measures

The following discussion relates to the specific measures listed in Table 3.

Industrial Cogeneration. To meet projected electricity demand in Mexico, and to reduce associated carbon dioxide emissions for the year 2005, new cogeneration plants could be constructed in each of the five major industrial branches: petrochemicals, chemical, sugar, paper and pulp, and fertilizers.

Electric Motors in the Industrial Sector. The energy saving potential for year 2010 due to penetration of high-efficiency motors makes the following assumptions:

- The industrial sector represents 80% of the potential market for high-efficiency motors
- The 28 million three-phase inductive motors in the industrial sector consume 30,850 GWh, nearly 70% of the total electricity consumption in the industrial sector
- High-efficiency motors provide 10% more energy savings compared to conventional ones.

The emissions avoided, shown in Table 3, consider the maximum penetration scenario, which assumes that total motors sales from 1997 to 2010 will be high-efficiency motors. Under this scenario, in the year 2010, high-efficiency motors would represent 20% of the motors installed in 1994.

Atmospheric Circulating Fluidized Bed Combustion. The installed capacity of coal power plants in Mexico is 1200 MW, with another 700 MW to be installed by the year 2004. The emissions reductions shown in the table are calculated assuming that all of these plants applied fluidized bed combustion instead of conventional systems.

Potable Water Pumping. Large pumping systems require less maintenance than deep water well pumps. For this reason, the energy saving potential is bigger in the latter than the foremost. For deep water well pumps, it is estimated that corrective and maintenance measures can save around 35% of the national water pumping electricity consumption. In comparison, the large water-pumping systems energy saving potential is around 1%.

Calculating the energy saving potential according to CFE energy sales for year 1993, we obtained around 903.8 GWh per year, for pumping systems and 14 GWh

Table 3. Summary of Mitigation Measures, Impacts, and Resources

Measure	Lead Agency	CO_2 Reductions in 2000* (tonnes)	CH_4 Reductions in 2000 (tonnes)	Other Environmental Benefits
Energy				
Industrial cogeneration	National Institute of Ecology	1,971,190.9 (1990–2005)		
Electric motors in the industrial sector	National Institute of Ecology	61,183.620 (1997–2010)	.227	CO: 170.925 NO_x: 829.491
Industrial boilers				
Atmospheric circulating fluidized bed combustion	National Institute of Ecology			NO_x: 66,000 CO: 920,000
Potable water pumping	National Institute of Ecology	512,000/yr		
Fuel substitution				
Renewable energy: Wind generation	National Institute of Ecology	15,042,000 (2000–2010)		
Electric vehicles in Mexico City	National Institute of Ecology	861,331/yr		CO p.a.: 9,234.9–30,008 NO_x p.a.: 91.8–1,096.3
Public transportation in Mexico City	National Institute of Ecology		(See Table 6)	
Commercial and residential efficient lighting	National Institute of Ecology	1,038,700-3,319.730 (2000–2010)	20 652	NO_x: 3,680–11,880 CO: 240–771
Forest management mitigation options	National Institute of Ecology	15,272,727/yr		
AIJ ILUMEX Project	Federal Commission of Electricity (Mexico) Norwegian Government World Bank	726,675 (1995–2006)	18.57	SO_x: 10,986 NO_x: 1,982 HC: 746 CO: 188 Particulates: 5,363
Forestry				
AIJ project for salicornia cultivation in Sonora	GENESIS Salt River Project Halophyte Enterprises EIC Corporation	1,080 (equivalent)		
AIJ Scolel-Té project	ECOSUR National Institute of Ecology Union de Crédito Pajal University of Edinburgh IEA GHG R&D Program Federation Internationale de l´Automobile EIC Corporation	230,000 (over 30 years)		

* Annual emission reductions expected in the year 2005
p.a. = per annum
Note: Start date and funding requirements for each measure are yet to be determined.

per year for deep wells. The total energy saving potential is 917.8 GWh per year, equivalent to an installed capacity of 106.2 MW.

Large-Scale Wind Generation of Electricity. Wind power generation is an alternative for both old fuel oil steam power plants and new combined cycle plants currently under development. Because there is not enough information regarding the final useful life for several fuel oil steam plants currently in operation, in the GHG mitigation calculations it is assumed that wind power generation will be substituted for the combined cycle plants. Wind power generation has to represent at least 10% of the electricity generation, increasing its participation from 300 MW of installed capacity in year 2000, to 5000 MW in 2010. According to this penetration scenario, and considering a load factor of 0.3, the generating capacity of wind power will be 1,314 GWh for each installed capacity of 500 MW.

Electric Vehicles in Mexico City. The difference in fuel intensity and unit emissions of internal combustion engines and electric vehicles is provided in the tables below. It is assumed that 10% of the Mexico City Metropolitan Area private car fleet in 2010 will consist of electric vehicles.

Public Transportation in Mexico City. Mitigation scenarios assume that, by year 2000, 70% of the Program to Improve Air Quality will be accomplished. Assumptions for the reference scenario are: 1994 modal share, unit emissions evolution for the period from 1989 to 1994, and a decrease of 3km/hr for all the transportation modes.

Commercial and Residential Efficient Lighting. The estimation of energy savings and GHG mitigation potential of commercial and residential efficient lighting was made taking into account the implementation of compact fluorescent lamps and efficient arrangements (ballast, tubes, and fixtures).

Forest Management Mitigation Options. Three mitigation options were assessed: natural forests management, reforestation, and agroforestry systems. The penetration of natural forest management is based on the expected demand for wood products for year 2010 (based on population and economic growth). The penetration of reforested areas is estimated considering the governmental policies and goals for year 2000, corrected with the efficiency of reforestation (living trees/planted trees). The penetration of agroforestry is considered to be moderate. Total carbon capture is simply the product of the unit capture by the penetration, and is calculated indepen-

Table 4. Fuel Intensity

	Electric Vehicles	Gasoline Internal Combustion
Average fuel intensity	5km/kWh	9.5–12 km/lt. (0.97–1.28 km/kWh)
Average distance traveled	35km/day	35 km/day

Table 5. Comparative Unit Emissions

GHG	Electric Vehicles* (g/km)	Gasoline Internal Combustion Vehicles (g/km)**
CO_2	38.59	55.3
CO	0.03	2.1
NO_x	0.52	0.6

* Source: Calculations use Mexican installed capacity by fuel and electricity generation.
** Source: FED91

Table 6. Potentially Avoided Emissions in Public Transportation (thousands of tonnes per year)

GHG	2000 Reference	2000 Mitigation	2010 Reference	2010 Mitigation
CO	2545	1504	2635	1269
HC	645	431	635	316
NO_x	100	74	109	66

dently for the three mitigation options. It is estimated that, by the year 2010, it will be possible to have 6.6 million hectares devoted to mitigation projects, with an estimated total capture of 1,129 megatonnes of carbon. Nearly 90% of the total capture comes from natural forest management, 9% from reforestation, and 1% from agroforestry. These values are still low if compared with the total carbon sequestration potential.

Implementation Strategies

The National Institute of Ecology will coordinate the overall (cross-sectoral) implementation of the plan. With the support of SEMARNAP's Chief Advisor Office, the Institute will have the authority to present the plan to other agencies that will be involved. The National Institute of Ecology plans to hold regular meetings, workshops, conferences, etc., to coordinate activities among sectors. The effectiveness of this plan will be monitored through the annual reports from the agencies. SEMARNAP has restructured the coordination of the interinstitutional participation in the discussions on climate change, having set up a formal forum, led by the Chief Advisor to the Secretary. INE is the technical arm of these negotiations and is in charge of initial contacts. The establishment of the Mexican Office for mitigation of emissions of GHG in 1997 represents a new outreach effort through which contact with the industrial sector is carried out.

The current international discussions around the negotiation for a Protocol to be agreed to by December have added momentum to the internal consideration of the possible implications for Mexico. In addition, there is growing recognition among the public and private sectors of the acute nature of several of Mexico's environmental problems. As momentum builds to tackle these problems, including air pollution, water quality and supply, and waste management, the country studies team will have opportunities to promote mitigation options that curtail greenhouse gas emissions as well as other contaminants. Mexico is currently undergoing economic restructuring, privatization, and reforms that will provide opportunities for new investments. The country studies team could work with a number of different sectors to help them incorporate low GHG emissions into their other environmental planning priorities.

RUSSIAN FEDERATION

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U.S. Country Study Initiatives

Summary

The Russian Federation ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 and accepted obligations as an Annex I Party to the Convention. Russia then became an active participant in the U.S. Country Studies Program, and we now have three years of successful experience with collecting and analyzing data on GHG emissions, conducting a vulnerability assessment, and developing potential adaptation and mitigation measures. In 1996, we created the official Federal Target Program titled "Prevention of Dangerous Climate Changes and Their Negative Consequences," as a general structure for future Action Plan implementation. This program, and Russia's Joint Implementation (JI) activities, are briefly described in this chapter in the section on Measures. Development of supporting legislation is currently extremely important for Russia, and the Introduction describes two new federal laws relating to climate change. Thus, all of the components required for the preparation and future implementation of the Russian Federation's Action Plan are already in place; however, funding for this work is frozen and actual progress is very slow at present. We had anticipated funding from the Russian Government through the Federal Target Program, and from the U.S. Government through the SNAP Program. SNAP funding is expected in November 1997, at which time work on the Action Plan will recommence.

Introduction

The Russian Federation is an Annex I Party to the UNFCCC, a category that includes developed countries and countries with economies in transition (Interagency Commission, 1995). Article 4 of the Convention directs developed countries to take practical steps to facilitate other countries' fulfillment of their obligations under the Convention.

Past Studies

The United States initiated a special Country Studies Program to provide relevant assistance to countries in their efforts to create an information base for future activity under the Convention. The Russian Federation became an active participant in this Program, and the U.S. Department of Energy signed a cooperative agreement with the Russian Federal Service for Hydrometeorology and Environmental Monitoring (RosHydroMet), the agency nominated by the Government of the Russian Federation as the official lead organization on climate change issues. We have had three years of very fruitful and effective work collecting and analyzing data on greenhouse gas (GHG) emissions, performing a vulnerability assessment, and developing potential adaptation and mitigation measures (Smith et al., 1996; Izrael et al., 1997).

Current Programs

Energy Conservation

The energy efficiency of existing and new equipment and buildings, and process improvements in industry, have been identified as the priority targets for energy conservation. A Federal Energy Conservation Act has been passed, delineating a general conservation strategy. This strategy includes greater use of energy meters, energy auditing, differential energy pricing, and increased reliance on local resources for heat and power generation. However, consumers have not shown any interest in energy

conservation, and regulatory incentives are currently lacking. Regional energy conservation agencies have also been established, by local governments, in more than a dozen large cities.

Forest Preservation and Expansion

In 1997, a new Forest Code was adopted that includes measures to protect existing forests and provisions to expand forest cover. All forests that are not within municipal borders are now Federal property, and changes in land use within forests are now forbidden. Areas of unforested land that are potentially suitable for tree-planting have also been brought under the management of the Federal Forestry Service, making it possible to use forests to sequester a large amount of additional carbon in the future.

The Action Plan Report is expected to:

- Provide a detailed analysis of the carbon sequestration effects of the new Forest Code
- Support related measures to integrate the new code into usual business practices
- Develop additional measures to enhance the positive effects of the code on carbon sequestration

Methods

The Government of the Russian Federation established a special Interagency Commission on Climate Change Problems, which currently includes decision makers from all relevant ministries and agencies, as well as leading scientists. The Head of RosHydroMet, A. Bedritsky, is Chairman of the Commission. The Commission stays in contact with all organizations of the Russian Federation that play a part in Russia's obligations under the UNFCCC. A group of technical experts provides expertise and technical reports to the Commission. Additional assistance is provided by the Institute of Global Climate and Ecology (IGCE), the lead organization within RosHydroMet on climate change issues.

Russia adopted its SNAP Workplan in March 1996. The overall objective of the work is to facilitate the implementation of commitments arising from the UNFCCC. Specific objectives are to:

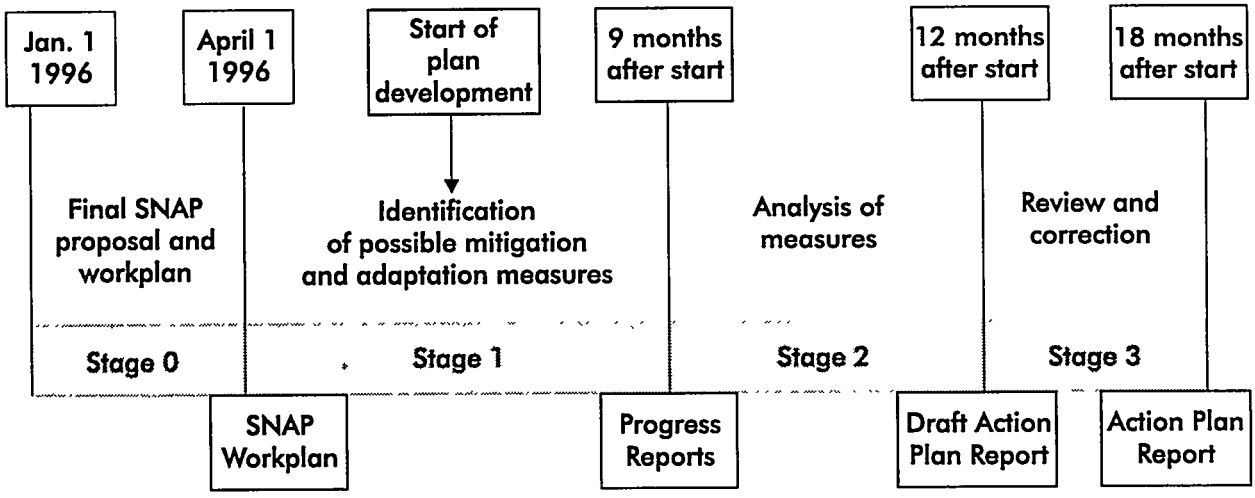
- Support preparation of the Action Plan and related materials for the National Communication (NC)
- Conduct an in-depth evaluation of priority mitigation and adaptation technologies in all main branches of the national economy, including the determination of opportunities to promote technology diffusion
- Support the initial stages of Action Plan implementation.

The Action Plan activity schedule and products are presented in Figure 1.

Two Progress Reports have been issued. This chapter is a brief compilation of these progress reports, prepared by the IGCE (Y. Izrael, Principal Investigator; S. Avdjushin, Project Director).

Our work in 1996 led to the creation of the official Federal Target Program entitled "Prevention of Danger-

Figure 1. Schedule of Action Plan Activities and Products



ous Climate Changes and their Negative Consequences," which is a regulatory framework and general structure for future Action Plan implementation. On October 19, 1996, the Program was adopted by the Russian Government, and the applicable order was signed by Prime Minister V. Chernomyrdin. RosHydroMet is the lead agency for the Program. The Program is described briefly in the Measures section.

In July 1996, V. Chernomyrdin, Prime Minister of the Russian Federation, and A. Gore, Vice-President of the United States of America, signed a statement of intent between the two governments on joint implementation (JI) of measures to reduce emissions of greenhouse gases. This step stimulated further development, not only in JI activities but in all work related to climate change. The JI activity is also described briefly in the Measures section.

Measures

The Russian Federation has identified a number of measures that merit further consideration and elaboration in the national action plan. The process of developing the action plan will establish which of these measures are the highest priorities for implementation. As mentioned above, the measures were identified through two different initiatives: the Federal Target Program on climate change and the international JI process. Because JI projects are so important, they will be included among the measures implemented through the Federal Target Program.

Federal Target Program on Climate Change

In the fourth quarter of 1996, the Federal Target Program titled "Prevention of Dangerous Climate Changes and Their Negative Consequences" was adopted by the Russian Government, and the applicable order was signed by V. Chernomyrdin, Prime Minister (Russian Federation, 1996). A brief description of the Program is presented here.

Program Summary

The time frame of the Program is 1997–2000. The total approved budget is 239.4 billion rubles, which is equivalent to US$40 million using an approximate exchange rate of US$1:6000 rubles. (This exchange rate is used for all calculations in this chapter.) The Federal budget will cover 72% of all expenses. The non-Federal budget sources suggested cover 28% of expenses, and are considered additional funds for implementation of the Mitigation subprogram. Distribution of the total budget by year has not yet been determined. The 1997 budget will be

Table 1. Overview of the Federal Target Program on Climate Change

State Customer of the Program	Russian Federal Service for Hydrometeorology and Environmental Monitoring (RosHydroMet)*
Main developers of the Program	Scientific organizations of the following ministries and agencies: ■ RosHydroMet ■ Ministry of Fuel and Energy (MinFuelEnerg) ■ Russian Federal Forestry Service (FedForestServ)
Goals and purposes	■ Reduce damage from dangerous climate change ■ Manage international obligations of the Russian Federation under the UNFCCC ■ Provide Russian decision makers with information about current and future climate change and its consequences ■ Create the technological, scientific, and legal basis for preventing dangerous climate change and facilitate sustainable economic development of Russia under climate change conditions
Implementation management	RosHydroMet is responsible for control of program implementation

*All translations of titles of ministries and agencies and all abbreviations are unofficial.

extremely modest, and probably no funds will be available at all.

There are three general categories in the Federal Budget:

- Expenses for relevant construction and equipment are planned at 94.631 billion rubles (55.2%) or about US$15 million
- Expenses for project design, research, and scientific applications are planned at 24.643 billion rubles (14.4%) or US$4 million
- Other expenses are 52.163 billion rubles (30.4%) or US$8.5 million

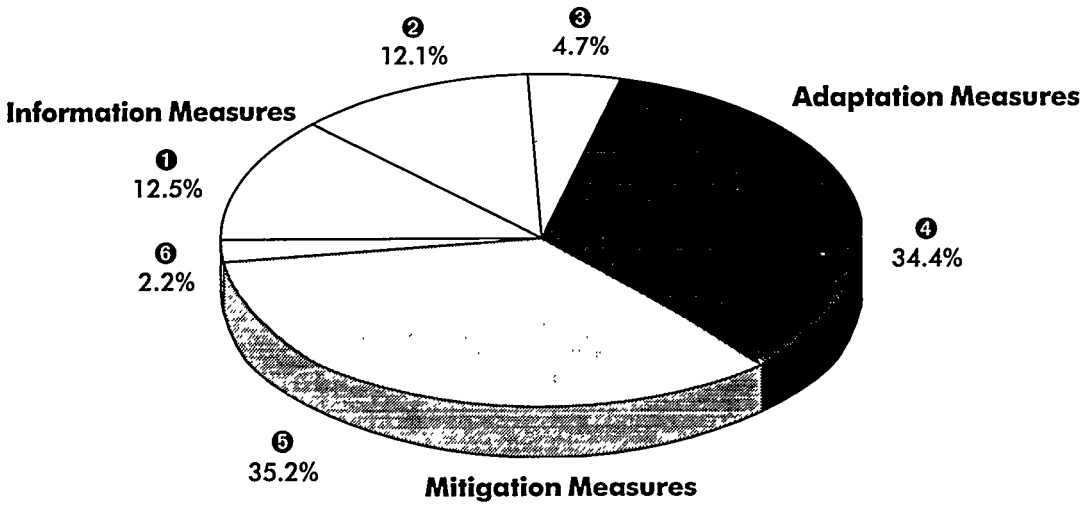
These budget areas are divided among six subprograms. There are two main fields of activity: adaptation and mitigation. If some urgent adaptation measures become necessary, then adaptation will take priority over mitigation. In Russia, there are currently no urgent adaptation issues, so similar funds were allocated to both activities. In addition to these two thrusts, the information base is very weak in Russia, and the creation of three information systems was considered to be essential underpinning for the rest of the work. The minimum cost of these information systems was calculated and appropriate funds were reserved. It is also necessary to have funds for future development of the Program and to develop an applicable methodology for complex assessment, reporting (e.g., National Communications), and general management of the activities. These expenses were estimated to be no more than 3% of the total budget.

Subprograms

Subprograms 1–3 have a service function, and each is a relatively small portion of the budget.

The tables that follow provide details of all of the subprograms, listing activities, lead agencies, and percentage funding allocations; the tables are numbered 2–1 through 2–6, and the second number is the same as the segment of the pie chart (Figure 2) that it describes. The distribution of funds is presented by percentage because these proportions will not change; absolute values

Figure 2. Distribution of Federal Budget Among Subprograms



Information Measures	❶ System for gathering and disseminating information on climate change and the role of anthropogenic factors ❷ Analytical system for collection and statistical accounting of data on GHG emission sources and carbon sinks, and their influence on global warming ❸ Observation system for measuring GHGs and aerosols, and standardizing methodology ❻ Strategies and measures for the period before 2020 to prevent dangerous climate changes and their consequences
Adaptation Measures	❹ Preventive measures to adapt the Russian economy to climate change
Mitigation Measures	❺ Measures to limit anthropogenic emissions and enhance sinks

Information Measures

Table 2–1. Subprogram: Information Gathering and Dissemination

Activities	Lead Agencies	Funding (%)
Observation system on climate change, including climatic data collection and analysis, and developing an appropriate telecommunication system for collection and dissemination of information	RosHydroMet, Russian Academy of Science (RusAcadScience)	70.1
System of observation and data collection on response of ecosystems to climate change (fenological, dendrochronological data, etc.)	RosHydroMet, FedForestServ, RusAcadScience, State Committee on Ecology (StateComEcol)	17.3
System of observation, data collection, and analysis of changes in permafrost caused by climate change	RosHydroMet, RusAcadScience	12.6
Total for subprogram		100

Table 2–2. Subprogram: Analysis of GHG Sources and Sinks

Activities	Lead Agencies	Funding (%)
Create and operate a system for estimation of GHG emissions and sinks (inventory system), based on collected data on GHG sources and removals	RosHydroMet, State Committee on Statistics (StateComStatistics)	30.1
Create and operate a system for collection of data on sources of GHG emissions in energy and industry sectors that use fossil fuels	RosHydroMet, StateComStatistics, MinFuelEnerg	20.3
Create and operate a system for collection of data on deforestation, soil degradation, and carbon stocks in forests and soils	RosHydroMet, StateComStatistics, FedForestServ, State Committee on Land Resources (StateComLandRes)	12.4
Create and operate a system for collection of data on agriculture production and technologies related to GHG emissions	RosHydroMet, StateComStatistics, Ministry of Agricultural Production (MinAgrProd)	12.4
Create and operate a system for collection of data on municipal and industry wastes, which is necessary for estimating GHG emissions	RosHydroMet, StateComStatistics, StateComEcol	12.4
Operate a system for collection of data on emissions of gases (CO, NOx, nonmethane hydrocarbons) with indirect greenhouse effects and other anthropogenic effects, including aerosols	RosHydroMet, StateComEcol	12.4
Total for subprogram		100

Table 2–3. Subprogram: Development and Standardization of Observation Systems

Activities	Lead Agencies	Funding (%)
Create an analytical base for station measurements. Metrological support for developing measures and standardizing methodologies and equipment. Development of standards for monitoring station measurements. Study of regions to determine siting of stations	RosHydroMet, RusAcadScience, State Committee on Standards (StateComStand)	35.2
Provide stations and analytical laboratories with equipment and instruments for sampling, measurement, data transfer and maintaining standards	RosHydroMet, RusAcadScience, StateComStand	47.5
Train personnel; develop a database service; intercalibrate standards; provide methodological guidance and international data exchange; identify trends; produce annual publications	RosHydroMet, RusAcadScience, StateComStand	17.3
Total for subprogram		100

Table 2–6. Subprogram: Strategies and Measures for the Period Before 2020

Activities	Lead Agencies	Funding (%)
Develop a strategy and measures to prevent dangerous climate change and its negative consequences for the period before 2020 in three stages: 2001–2005, 2006–2010, and 2011–2020	RosHydroMet, RusAcadScience	12.2
Develop a Federal Target Program for the period 2001–2005	RosHydroMet, RusAcadScience, MinFuelEnerg, FedForestServ, MinNaturResources, StateComEcol	27.2
Prepare National Communications and other Russian Federation documents for the UNFCCC	RosHydroMet	12.3
Develop a methodological basis for complex assessment of the consequences of climate change for different branches of the economy, health protection, and other human impacts under the various scenarios and prognoses	RosHydroMet, RusAcadScience	48.3
Total for subprogram		100

Adaptation Measures

Table 2–4. Subprogram: Preventive Measures to Adapt Russian Economy to Climate Change

Activities	Lead Agencies	Funding (%)
Develop a system of data collection and analysis on the dangerous impacts of climate change on managed and natural ecosystems, and various branches of economy. Improve and unify methodologies based on domestic studies and official documents of the UNFCCC	RosHydroMet, StateComEcol, MinAgrProd, FedForestServ, Ministry of Natural Resources (MinNaturResorces)	23.7
Develop preventive measures for adaptation in agriculture, water management, and forestry, including assessment and forecasting of possible positive consequences	RosHydroMet, MinAgrProd, FedForestServ, MinNaturResources	28.6
Develop preventive measures in health protection (e.g., sanitary epidemiological environments; temperature regimes in large cities)	Ministry of Health Protection (MinHealthProtection), RosHydroMet	6.7
Develop measures in permafrost regions to adapt to the negative consequences of climate change (e.g., energy production facilities, buildings, pipelines, and roads)	RusAcadScience, RosHydroMet, MinFuelEnerg, Ministry of Transportation (MinTransportation), Ministry of Railroads (MinRailroad), Ministry of Construction (MinConstruction)	23.7
Develop a system of measures to prevent or reduce negative consequences in the most vulnerable regions of the country	RosHydroMet, Ministry of Extraordinary Situations (MinExtraordSituations), MinNaturResorces, RusAcadScience	4.9
Prepare and publish legal instruments for assessment, prognosis, and prevention of the impacts of dangerous climate change on managed and natural ecosystems and branches of the economy	RosHydroMet, StateComEcol	12.4
Total for subprogram		100

Mitigation Measures

Table 2–5. Subprogram: Measures to Limit Anthropogenic Emissions and Enhance Sinks

Activities and Target Sectors	Lead Agencies	Funding (%)
Develop, create, and improve the regulatory framework and legal instruments for economic and administrative management of GHG emissions	Ministry of Economy (MinEconomy), StateComEcol	9.5
Develop and improve a system of mitigation measures to reduce GHG emissions and enhance sinks; establish a centralized database to determine cross-sectoral and interregional interactions	RosHydroMet	9.5
Improve the State standards system; develop new standards to reduce GHG emissions and enhance sinks through efficient production and operation of equipment, fossil fuel use, transportation, agriculture, forestry, municipal management, etc.	StateComStatistics	5.0
Measures to improve energy efficiency, conserve fuel and raw materials, and use new energy sources to reduce GHG emissions		
Fuel and energy sectors	MinFuelEnerg, Ministry of Nuclear Industry (MinNuclearIndustry)	10.7
Transportation sector	MinTransportation, MinRailroad, Ministry of Industry (MinIndustry), MinConstruction	12.0
Chemical and petrochemical industry	MinIndustry	8.3
Metallurgy	MinIndustry	8.3
Machine production sectors	MinIndustry	7.4
Defense industry	Ministry of Defense Industry (MinDefenseIndustry),	6.6
Construction industry	MinConstruction	6.6
Agriculture	MinAgrProd	6.6
Measures to enhance CO_2 sinks in forests	FedForestServ	9.5
Bilateral international projects on activities implemented jointly to reduce GHG emissions and enhance GHG sinks	RosHydroMet and other relevant ministries and agencies	Financing from non-Federal budget sources. Estimated cost: 68 billion rubles for three years
Total for subprogram		100

will be determined when funds become available. All funding levels are from the Federal Budget, unless otherwise noted. Further elaboration of these subprograms will be carried out as part of the work on the Action Plan.

Projects for Joint Implementation

For the Russian Federation, the JI process has been a successful experience. Creation of the JI framework was completed and officially presented to the UNFCCC Secretariat. Six projects were considered and adopted.

Institutional Measures

In the Russian Federation, the Interagency Commission on Climate Change Problems is a special official body that coordinates JI activity and project evaluation.

The main criteria for evaluating JI project proposals were developed and then used by the Interagency Commission on Climate Change Problems. These criteria were officially presented at the session of the UNFCCC Subsidiary Bodies (Session AGBM–5) in December 1996 in Geneva. The criteria include the following:

- Projects should be new and developed with the specific aim of reducing anthropogenic GHG emissions or increasing their sinks
- Projects should be voluntary for participating parties
- Projects should allow for verification of results, including monitoring by the Interagency Commission
- Projects being implemented should be connected with appropriate investments in the Russian territory
- Participants should undertake measures to encourage private investors to finance projects
- Project documents should be presented to the Interagency Commission in Russian

Joint Implementation Projects

Three JI projects are currently being implemented:

- Russia–USA RUSAFOR project (reforestation measures in the Saratov Region)
- Russia–Netherlands Horticulture project in Tyumen Region (increasing energy efficiency as well as CO_2 utilization in tomato horticulture)
- Russia–Netherlands Sanitary Landfill Methane Utilization in the Moscow Region (methane extraction, burning, and electricity production at two large landfills)

Three projects have been approved by both sides and are waiting for financing:

- Russia–USA RUSAGAS project (reduction of methane leakage in pipeline pumps in the Saratov and Volgograd Regions)
- Russia–USA ZELENOGRAD project (energy efficiency improvements in centralized heating systems in Zelenograd, a city in the Moscow Region)
- Russia–USA VOLOGDA project (forest planting and assistance for natural reforestation in the Vologda Region)

JI activities are considered to be a very important part of the Federal Target Program, and they cover a significant part of the non-Federal Budget measures of the Program. The description of the Federal Target Program in the Action Plan Report should include support for JI activities as an integral element of Russia's climate change activities.

Implementation Strategies

The institutional framework for developing and implementing the Action Plan consists of the infrastructure recommended in the Federal Target Program, the infrastructure used for JI measures, and legislation.

The scientific and technological foundations of the Action Plan are databases of possible projects; research conducted to develop mitigation and adaptation measures; and data on new technologies collected by RosHydroMet, the Ministry of Science and Technology, and other ministries and agencies from 1994–1997. The U.S. Country Studies Program provided effective and essential support for collecting and analyzing GHG inventory data, performing the vulnerability assessment, and developing potential adaptation and mitigation measures (Izrael et al., 1997). The current emphasis is to establish a "bank of new technologies" focused on the practical use of technologies and new installations and devices by domestic and foreign companies in Russia and elsewhere.

An experienced core team of experts will be used to quickly prepare the Action Plan. This team has already worked with the U.S. Country Studies Program and has prepared materials for the first and second national communications of the Russian Federation to the UNFCCC. The number of individuals on the team will need to be expanded to prepare the Action Plan, but the main infrastructure can be the same.

Thus, all of the main components required to prepare the Action Plan are in place except for the financial resources. Two essential funding avenues have been identified: support for the Federal Target Program, "Prevention of Dangerous Climate Changes and Their Negative Consequences," by the Russian Government, and support from the U.S. Government under the SNAP Program.

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TANZANIA

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Summary

This chapter provides an overview of Tanzania's National Action Plan (NAP) on Climate Change. The development of the NAP takes into consideration Tanzania's current economic and social status, as well as the country's obligations under the United Nations Framework Convention on Climate Change (UNFCCC). This chapter describes various climate change initiatives, their cross-sectoral relationships, and the consultative process used to implement the plan.

Tanzania's NAP addresses the following main issues:

- Sector-specific policies, plans, and programs to reduce greenhouse gas (GHG) emissions
- Policies, plans, and programs to preserve existing, and develop new, GHG sinks
- Adaptation measures to respond to the potential impacts of climate change
- Strategies that address the linkages between climate change and social, economic, and environmental policies and programs

Introduction

Tanzania ratified the UNFCCC in April 1996. All Parties to the Convention are required by Article 4.1.(a) to develop, periodically update, publish and make available national inventories of anthropogenic emissions and removal of greenhouse gases that are not controlled by the Montreal Protocol. The Center for Energy, Environment, Science, and Technology (CEEST) has already undertaken various activities to that effect, described under the section on Results of Past Studies. Development of the National Action Plan on Climate Change is being undertaken to complement the efforts that have already been made in Tanzania in the area of climate change studies.

While Article 12 of the Convention calls for Parties to communicate their GHG emissions and removal data to the Conference of the Parties, the Convention allows the least developed countries, such as Tanzania, to make the initial communication at their discretion. However, the work done thus far in Tanzania is a good basis for the development of a national action plan on climate change; the NAP will be an important component of the National Communication to the Conference of Parties.

The main objective in developing Tanzania's action plan is to incorporate climate change issues in the national planning process. Sectoral measures and investments in GHG mitigation will affect general macroeconomic policy and vice versa. For this reason, development of the NAP is being undertaken by a multidisciplinary and multisectoral team, which is coordinated by CEEST. CEEST is a nongovernmental, nonprofit-making organization that has been involved in policy and other studies on energy, the environment and natural resources and management since it was established in 1992.

The team preparing the plan is discussed in the section on Methods. The key members of the team responsible for compilation of this chapter are Prof. M. J. Mwandosya, the team leader; Wilfred D. Kipondya, the technical and administrative coordinator; and Hubert E. Meena, an economist.

Results of Past Studies

This section describes the major climate change studies in Tanzania. CEEST and various other institutions have also conducted other, smaller scale national studies related to climate change. Taken together, all of these past studies have identified the elements to be considered in the preparation of the National Action Plan on Climate Change.

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Proposed Measures
Mitigation	
Energy	■ Switch to combined-cycle power plants from simple gas-cycle turbines ■ Improve transmission and distribution systems ■ Develop renewable energy technologies ■ Emphasize demand-side management ■ Use natural gas
Industry: *Cement Production*	■ Install CO_2 recovery systems
Industry: *Pulp and Paper*	■ Optimize recovery boilers to reduce lime and energy use
Industry: *Other*	■ Implement energy efficiency improvements
Transportation	■ Rehabilitate and expand urban rail systems ■ Improve traffic flow control ■ Use CNG vehicles
Agriculture: *Crops*	■ Change fertilizer application techniques
Agriculture: *Livestock*	■ Improve feeding practices
Forestry	■ Expand carbon sinks through afforestation and reforestation
Adaptation	
Agriculture: *Crops*	■ Use irrigation to boost maize production ■ Grow short-season and drought-resistant crops ■ Change crop rotation practices
Agriculture: *Grasslands/Livestock*	■ Change range management practices ■ Educate farmers
Forests	■ Introduce new tree species ■ Change use of forests and forest products
Water: *Agricultural use*	■ Encourage nighttime irrigation of fields

Vulnerability and Adaptation

An assessment of Tanzania's vulnerability and adaptation to the impacts of climate change has been completed. The study was financed under the U.S. Country Studies Program (USCSP). The study covered the development of climate change scenarios for Tanzania, impacts on agriculture, forestry, grasslands and livestock, water resources, coastal resources, and, to a lesser extent, the impacts on human health, specifically malaria disease.

Tanzania's climate change scenarios are consistent with generally accepted projections of global climate change over the next century, i.e., a temperature increase of 1.5° C–4.5° C and an effective doubling of CO_2 levels. Evaluation of adaptation options involved the identification and assessment of changes in technologies, practices, and policies that could help Tanzania to prepare for climate change by taking advantage of its beneficial impacts and responding to the adverse effects. See the Measures section for a description of the vulnerability and adaptation options identified in the study.

Emissions Inventory

Tanzania has completed a study, coordinated by CEEST, of GHG emissions by sources, and GHG removal by sinks. This study was funded by the Global Environmental Facility (GEF) through the United Nations Environmental Program (UNEP). Tanzania was one of 11 developing countries selected for this GEF/UNEP project, which used the IPCC/OECD methodology. This initiative was also supported by the US Country Studies Program. Table 2 summarizes the results of the GHG inventory study in Tanzania.

Mitigation Assessment

Another study has been completed by CEEST on technological options for abatement of greenhouse gases. This

Table 2. GHG Emissions in Tanzania in 1990 (Gigagrams)

	Emissions of Carbon Dioxide (CO_2)	Removals of Carbon Dioxide (CO_2)	Emissions of Methane (CH_4)	Emissions of Nitrogen Oxide (NO_x)	Emissions of Nitrous Oxide (N_2O)	Emissions of Carbon Monoxide (CO)
Energy Sector						
Fuel combustion	1,938.976	NA	NA	NA	NA	NA
Stationary combustion in industry	NA	NA	0.207	4.021	0.0005	26.434
Thermal power generating plants	NA	NA	0.010	0.916	0.0019	0.634
Mobile combustion activities	NA	NA	0.291	8.719	0.0248	51.805
Others (fossil fuels in households)	NA	NA	0.018	0.189	NA	0.003
Traditional biomass energy	NA	NA	424.481	54.110	1.9086	1,550.000
Coal activities	NA	NA	0.821	NA	NA	NA
Naturally occurring exploited gases	1.260	NA	NA	NA	NA	NA
Subtotal	1,940.236	NA	425.828	67.955	1.9358	1,628.876
Industrial Processes						
Nonmetal processes (cement)	343.634	–	NA	NA	NA	NA
Nonmineral processes (pulp and paper)	5.787	–	NA	NA	NA	NA
Subtotal	349.421	–	NA	NA	NA	NA
Agriculture						
Rice cultivation	NA	NA	84.756	NA	NA	NA
Enteric fermentation	NA	NA	872.275	NA	NA	NA
Manure management	NA	NA	8.057	NA	NA	NA
Nitrogenous fertilizers	NA	NA	NA	NA	0.5673	NA
Burning of agricultural residues	NA	NA	323.002	20.728	0.5730	1,053.477
Burning of savannas	NA	NA	47.825	21.390	0.5920	1,255.396
Subtotal	NA	NA	1,335.915	42.118	1.7323	2,308.873
Land-Use Change and Forestry						
Forest clearing for agricultural lands	727.060	NA	2.483	0.617	0.0170	27.158
Abandonment of managed lands	NA	1,930.500	NA	NA	NA	NA
Forests subject to human activities	55,937.510	1,814.770	NA	NA	NA	NA
Others (shifting cultivation and dams)	NA	NA	0.579	0.139	0.0050	4.173
Subtotal	56,664.570	3,745.270	3.062	0.756	0.0220	31.331
Waste Management						
Municipal solid waste disposal	NA	NA	8.363	NA	NA	NA
Waste water treatment	NA	NA	2.308	NA	NA	NA
Others (industrial waste management)	NA	NA	33.108	NA	NA	NA
Subtotal	NA	NA	43.779	NA	NA	NA
Total	58,954.227	3,745.270	1,809.124	110.829	3.6901	3,969.080
Global Warming Potential (GWP)						
(100 years integration)	1.0	1.0	21		310	
Gg CO_2-equivalent			37,991.604		1,143.931	

NA = Not available

study received financial support from the government of the Federal Republic of Germany through the German Agency for Technical Cooperation, GTZ. The researchers in this study benefited from training provided by the US Country Studies Program as well as methodological backstopping from the UNEP Collaborating Center on Energy and Environment at RISO in Denmark. Table 3, in the Measures section, summarizes the mitigation options analyzed in the study.

Objectives

The main objective of the NAP is to develop climate change measures that take into account, and are complementary to, Tanzania's national economic policies and plans to achieve sustainable development.

Specific objectives of the development of the NAP include:

- Identification of the complementarity between actions on climate change and sectoral policies
- Identification of barriers to decisions that could lead to emission reduction in sectoral program implementation
- Assessment of the viability and feasibility of measures to mitigate climate change
- Development and promotion of options that will lead to successful and measured reductions of GHGs by industries and other enterprises
- Development of a national climate change information service
- Strengthening the human resource and institutional capacity of Tanzania to analyze climate issues

Methods

Establishing the Planning Team

A team of researchers who have participated in the previous climate change studies is participating in the development of the NAP. In addition to these researchers, other experts are co-opted for their input as the need arises. The Division of Environment (DoE) is the responsible authority, and CEEST is the technical coordinator for this work; these two organizations collaborate closely to develop the NAP. Figure 1 is a detailed institutional organization chart, showing the domestic and international interactions of the study team.

The Division of Environment

The Division of Environment, under the office of the Vice President, is a focal point for all matters related to environment. The Division of Environment also provides a link between the government of the United Republic of Tanzania and the United States of America on NAP development.

The National Climate Change Committee

The National Climate Change Committee (NCCC) comprises members from government ministries and institutions, nongovernmental organizations (NGOs), and academic and research institutions. The main function of the committee is to oversee climate-change-related studies and issues in the country. The committee receives periodic reports from CEEST for review. It gives advice on the study implementation process and provides guidance to researchers. The NCCC is made up of the following twelve members:

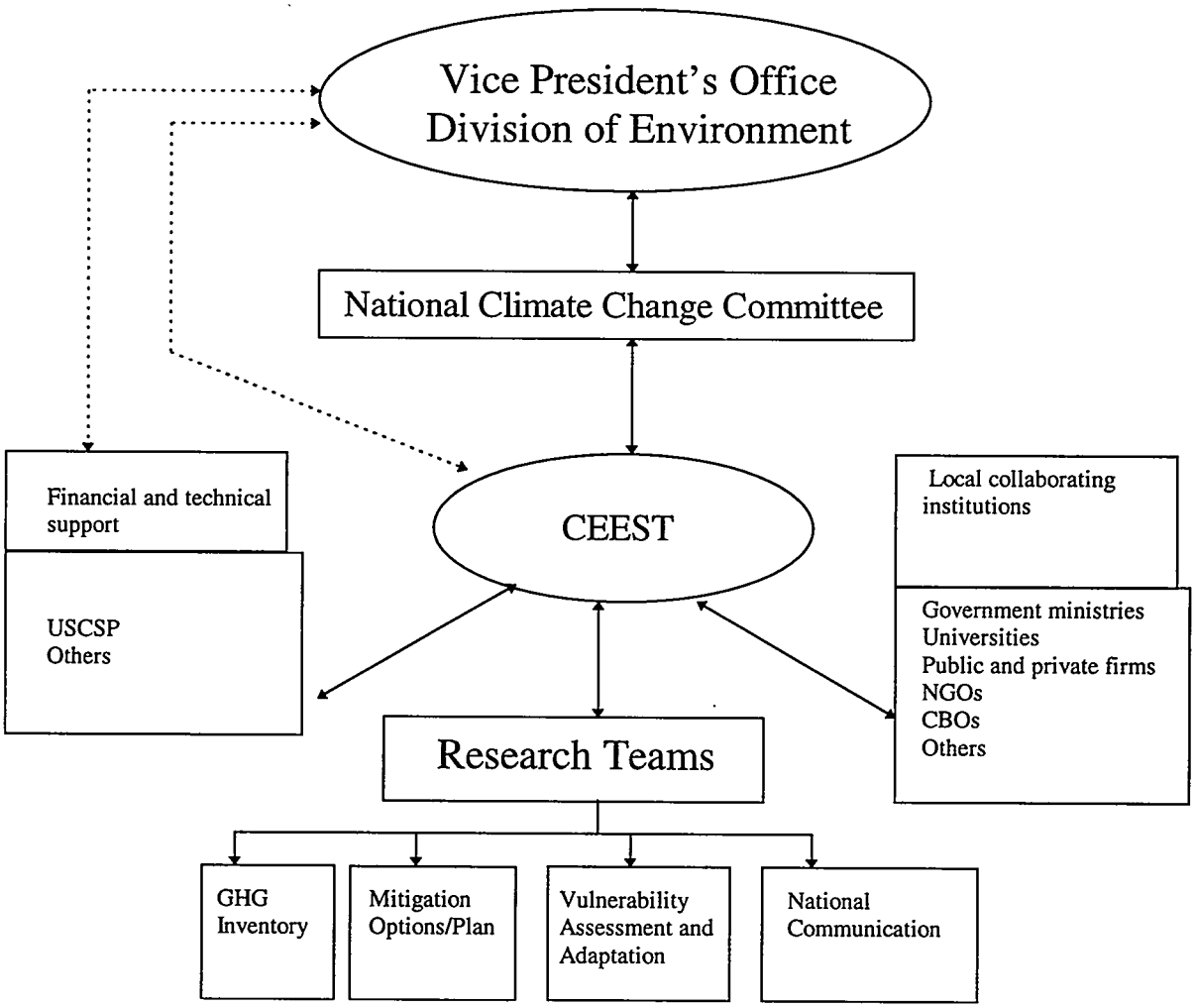
- Director for Environment (NCCC Chairman)
- Director General of Meteorology (NCCC Co-Chairman)
- Director General of National Environment Management Council
- Commissioner for Energy and Petroleum Affairs
- Representative from Planning Commission
- Representative from Foreign Affairs
- Representative from Attorney General Chambers
- Director for Fisheries
- Director for Forestry
- Commissioner for Agriculture
- Representative from University of Dar es Salaam
- Chairman/Director of CEEST

The Center for Energy, Environment, Science, and Technology

Since its establishment in 1992, CEEST has been able to develop the expertise and facilities necessary for research and coordination of climate change work. It has an extensive network of researchers and associates. CEEST is responsible for the coordination of climate change studies in Tanzania, including development of the NAP.

For this particular project, CEEST is fully engaged in the provision of technical and administrative arrangements throughout the project duration, and reports regularly to the DoE and the NCCC. The study team meets regularly to review the progress of the study and exchange ideas and information in order to ensure quality and timely output.

Figure 1. Organization of Climate Change Activities in Tanzania



CEEST Study Team Personnel. To ensure that different aspects of climate change are integrated in the development of the plan, a wide range of experts from different sectors are included in the study team. Individual members of the study team have the following responsibilities and sectoral focuses, among others:

- Overall guidance on both technical and administrative aspects of the study (Team Leader)
- Technical coordination of the study and responsibility for work on the environmental aspects of the plan (Assistant to the Team Leader)
- Management of project finances and guidance on preparation of the energy sector of the plan (Financial Coordinator)
- Preparation of the agricultural sector of the plan
- Preparation of water resources sector of the plan
- Preparation of the coastal resources sector of the plan
- Preparation of the forestry sector of the plan
- Preparation of the economic and industrial sectors of the plan

The team receives technical inputs from various institutions including the Planning Commission, Ministry of Finance, Central Statistics Bureau, and other agencies involved in the planning of the national economy.

Steps in Plan Preparation

1. **Determine plan objectives and sectors of interest.** The objectives of the plan are determined in accordance with national interests and priorities. These objectives should be in agreement with those of other national activities and policy measures. Sectors with activities of interest are being identified and included in the preparation of the plan.
2. **Design a participatory process.** Preparation of a multisectoral plan like this requires the participation of many different players. One of the main processes will be to design the participatory process so that it clearly indicates how each of these participating bodies will be involved in the plan and how they will implement it.
3. **Evaluate and develop sectoral and multisectoral measures.** Sectoral and multisectoral measures will be developed and evaluated to see how they meet the objectives of the plan. The sectoral leaders will work together to ensure that measures defined in the plan are implementable and in agreement with national interests.
4. **Comparative analysis and refinement of measures across sectors.** Analysis will be made of measures that have been identified for implementation, for different sectors, under the plan.
5. **Preparation of implementation strategies.** Implementation strategies will be prepared using sectoral and multisectoral information as evaluated and developed in steps 3 and 4 above. The strategies will have to conform with other national developmental plans.
6. **Preparation and adoption of national plan.** Sectoral policy reviews will be made and discussion forums undertaken with different stakeholders, including government ministries and institutions. Discussion papers on the transportation, industrial, residential and commercial, agriculture, and forestry sectors; and energy efficiency and renewable energy opportunities shall be prepared by researchers as an input into the consultative process. As part of the project initiation activities, a team of researchers/planners will attend a training workshop based on lessons and experiences leaned from other countries, especially the U.S.A.

   Forums will be convened to discuss sectoral policies, plans, and activities to see the extent to which they reflect, in part, opportunities for emission reductions. The aim of these forums will be to outline short- and long-term benefits and costs that the response to climate change can have on the environment and the economy. One key feature of the exercise will be to secure the active involvement of all stakeholders, especially private enterprise. A major national workshop to discuss issues related to Tanzania, climate, and development will also be convened.
7. **Incorporation of NAP measures into other development plans and programs.** The process to incorporate the plan measures into other development plans and programs is an important step in the preparation of the action plan. This would be achieved by ensuring that the plan measures are incorporated in the national planning mechanism through an integrated approach to climate change. The Directorate of Environment, through its parent ministry, will have to ensure that the plan is accepted for inclusion into other development plans and programs. This will be facilitated by holding workshops for senior government officials to explain the benefits of integrating the NAP with other programs.

Expected Products

The products of the project will include the following:

- *Reports.* National sectoral reports on different plan measures will be prepared and presented at national and international forums. These reports will also be submitted to international bodies as demonstration of the country's implementation of the UNFCCC.
- *Journal articles.* Articles about NAP activities and measures will be published, contributing to global understanding of climate change issues.
- *Workshops.* A number of workshops will be held during the development of the plan. These workshops will enhance the national capability to prepare, interpret, and implement the plan. They will also be the best forum for exchanging information on different aspects of the plan.

Measures

The NAP will address three main sectors: energy, forestry and land use, and agriculture. Some aspects of industry and transportation will also be considered, primarily as they relate to energy use. Because resources are limited, other important sectors such as water, coastal resources, and health will not be covered. Sectoral policies that will be integrated into the NAP are listed in Table 1 and outlined in this section. Tables 3 and 4, following, show the mitigation and adaptation strategies that are currently being given the most serious consideration.

Table 3. Some GHG Mitigation Options

Sector	Option	Description
Energy Supply	■ Advanced electricity generation technologies	■ Install 230 MW of combined-cycle power plants instead of simple cycle gas turbines
	■ Efficiency improvements	■ Increase the efficiency of existing power generation systems by repowering and improving transmission and distribution systems
	■ Charcoal production	■ Improve the conversion efficiency of charcoal kilns
	■ Coal mining	■ Optimize methane release from coal mines
	■ Renewable Technologies	■ Use solar collectors, photovoltaics, wind turbines, and biomass
Industry	*Cement Production*	
	■ Production management	■ Install automatic control systems for reducing the amount of fuel used and improving production efficiency
	■ CO_2 recovery system	■ Install CO_2 recovery systems. Recovered CO_2 can be used for other industrial applications
	■ Fuel switching	■ Substitute natural gas for fuel oil in two production plants
	■ Production mix	■ Produce blended cements such as pozzolanic cements, blast furnace slag cement, and Portland cements in order to reduce the amount of fuel used for calcination and the amount of lime used per unit of cement produced
	Pulp and Paper	
	■ Efficiency improvements	■ Optimize the recovery boiler in order to reduce both the amount of lime and energy used
	■ Recovery of CO_2	■ Recover CO_2 from calcination by absorption of CO_2
	Other Industries	
	■ Energy efficiency improvements	■ Improve efficiency in existing plants through maintenance, improved steam production and management, improvements to motor drive systems, cogeneration, and power factor correction
Transportation	■ Vehicle efficiency	■ Improve technical efficiency of vehicles
	■ Improve system efficiency	■ Improve traffic flow, increase vehicle load factors, improve vehicle maintenance, traffic operation, training and management
	■ Modal split	■ Rehabilitate and expand the rail system
	■ Urban transport	■ Implement city trains in Dar es Salaam
Household and Service	■ Electrical appliances	■ Improve efficiency of electrical appliances
	■ Cookstoves	■ Increase efficiency of biomass cookstoves
	■ Waste management	■ Waste management including landfills and waste water treatment
Agriculture and Livestock	■ Agricultural practices	■ Reduce methane and carbon emissions through better practices related to fertilizer application, rice cultivation, and loss of organic carbon from cultivated soils
	■ Livestock husbandry	■ Better husbandry, including better breeding and feeding practices
Land Use and Forestry	■ Forest management	■ Maintaining existing stocks through forest protection and conservation; and expanding carbon sinks by means of afforestation, reforestation, and enhanced regeneration and agroforestry practices
	■ Grasslands and rangelands	■ Maintaining or increasing carbon sequestration through better soil management and sustainable agricultural practices

Table 4. Summary of Vulnerability and Adaptation Options by Sector

Vulnerability	Adaptation Measures
Agriculture Sector	
Maize Integrating the CERES-Maize model and GCMs indicated that maize yields would likely be lower with a doubling of carbon dioxide than under baseline climate in all scenarios, as a result of both decreasing rainfall and increasing temperature.	■ Increase irrigation to boost maize production in all areas ■ Grow short-season and drought-resistant crops ■ Adjust farmed areas ■ Change crop rotation practices ■ Increase use of manure and fertilizer ■ Control pests, weeds, and diseases ■ Make better use of climate and weather data, weather forecasts, and other management tools
Coffee Simple linear regression models showed that coffee production yields are likely to increase as long as standard agronomic practices are followed.	■ Follow standard agronomic practices
Cotton Cotton yields are likely to increase by 17%–169% as long as standard agronomic practices are followed. Yields could decrease by 10%–20% depending on the impact of pests and diseases.	■ Follow standard agronomic practices
Grasslands/Livestock Sector	
Increased temperature and rainfall could result in: ■ Changes in plant species associations ■ A general increase in yields ■ Favorable condition for ticks, snails, blood-sucking insects and pests; increased likelihood of infection with encephalitis, trypanosomiasis, liverflukes, bluetongue; increased likelihood of locust and armyworm outbreaks	**Reactive adaptation measures:** ■ Alter management practices to change land use patterns: – Management for proper range use – Range management for livestock production – Manipulation of range vegetation **Anticipatory adaptive measures:** ■ Infrastructural development ■ Research and development ■ Education of farmers ■ Input costs and product pricing
Forestry Sector	
Most of Tanzania's land is projected to shift from subtropical dry forest and subtropical moist forests to tropical very dry forests, tropical dry forests, and small areas of tropical moist forest.	■ Reduce rate of deforestation ■ Protect existing forests ■ Introduce new tree species or strengthen existing species ■ Change or improve use of forests and forest products

Table 4. Summary of Vulnerability and Adaptation Options by Sector (continued)

Vulnerability	Adaptation Measures
Water Sector	
With higher mean temperatures, runoff is likely to decrease in two basins, the Ruvu and Pangani basins; runoff is likely to increase in other basins.	**Supply management:** ■ Increase capital investment in reservoirs and infrastructure **Demand management:** ■ Reduce water demand by investigating new water-saving technologies and changing patterns of use **Conservation in the domestic sector:** ■ Reduce use of water for bathing and toilet flushing ■ Reuse cooking water ■ Repair leaks ■ Reduce use of water for washing cars ■ Harvest rainwater **Conservation in the agricultural sector:** ■ Encourage nighttime irrigation ■ Introduce closed conduits ■ Reuse drainage water ■ Use waste water effluents **Conservation in the industrial sector:** ■ Encourage recycling of water
Coastal Areas	
Almost all of Tanzania's coastline is vulnerable to either 0.5 m or 1.0 m of sea-level rise. Land losses are estimated to be 2090 km² for 0.5 m and 2117 km² for 1.0 m sea-level rise Structures at risk in Dar es Salaam are valued at about TSh 50 billion and TSh 86 billion for sea-level rises of 0.5 m and 1.0 m, respectively	■ Protect important areas ■ Construct sea walls ■ Implement building regulations ■ Regulate urban growth ■ Protecting the coastline of Dar es Salaam would cost TSh 270 billion; protecting the whole coastline of Tanzania would require TSh 9 trillion.

Energy Sector

The national energy sector is characterized by the dominant role played by biomass as well as imported crude and petroleum products in the country's energy balance. The country's energy consumption pattern is detrimental to the environment. Various policy measures and strategies such as the use of energy efficient technologies and alternative sources of energy will need to be encouraged in the plan. The strategies could include the following:

- Increase efficiency in power generation
- Promote and disseminate affordable technologies
- Encourage the use of efficient electricity systems and demand-side management methods
- Promote renewable energy such as solar, wind, and mini-and micro-hydro
- Promote development and use of natural gas

Forestry and Land Use Sector

Options in the forestry and land-use sector are based on management of existing land-use carbon stocks, and expansion of land-based carbon sinks. Mitigation of GHG

The Takagas Waste-to-Energy Project

One example of a measure to reduce greenhouse gas emissions in Tanzania is a pilot project on energy recovery from municipal waste. Popularly known as *Takagas*, this initiative is to be implemented in Dar es Salaam. *Taka* is a Swahili word for waste, and *Takagas* is therefore gas from waste. The goal of the Takagas project is to reduce emissions of GHGs in Tanzania by substituting bioenergy (methane gas and electricity), produced from anaerobic digestion of industrial and municipal waste in the Dar es Salaam area, for fossil fuels. Additional GHG reduction will be achieved by reducing the uncontrolled release of methane from improperly disposed organic wastes. Organic fertilizer will be produced at the same time. The plant will have a capacity to treat about 57 tonnes of organic waste per day, or about 3% of the daily waste generated in Dar es Salaam. The project combines methane emission reduction for GHG mitigation, with production of electricity, fuel for transportation, and fertilizer production. The installed capacity of the biogas plant will be 1 MW. The project is being funded by the GEF and the Danish Development Assistance (DANIDA). This project is a collaborative effort of the Ministry of Energy and Minerals, the Dar es Salaam City Council, and the University of Dar es Salaam.

emissions from forestry and land-use requires improvement of existing land-use management and enhancement of land-use productivity, and it calls for measures to impose strict regulations on deforestation activities. The aim here is to maintain the existing stands of aboveground biomass by exercising protection and conservation measures, encouraging non-wood bioenergy, and practicing intensive agricultural management. The NAP will have to identify options that are likely to result in the greatest carbon storage in vegetation and soil.

Agriculture and Livestock Sector

Agriculture and livestock are important sectors of the economy for Tanzania. They are also the main source of food supply and raw materials for the industrial sector as well as the major market for industrial goods. The NAP will address policies and strategies geared to promoting the adoption of environmentally friendly technology and methods in these sectors.

Industry Sector

The industrial sector is another important sector of the economy. One of the near-term development strategies in this sector is to increase output by increasing efficiency in existing industries. At the same time, the environment must be protected from industrial pollution. Safe industrial technologies, designs, and sites will ensure the lowest environmental impacts and maximum safety. The NAP has to address these issues in the development of the industrial sector while including GHG emissions-reduction options. It should also address ways of enhancing industrial research and development in technologies that help to preserve the environment. Key industries to be addressed include the cement industry and pulp and paper production.

Transportation Sector

Transportation plays a multipurpose role in the development of the country. It is used to transport goods and services between and within production and market centers. It is also important for the movement of imports and exports. Most of the vehicles bought in Tanzania are imported, either new or reconditioned. There are no set standards or specifications on imported vehicles. Even worse, there are no legal standards on vehicle emissions. This results in high levels of polluting emissions from vehicles. The NAP will have to clearly address the GHG mitigation options and measures in this sector. These options would include improving the road network, introducing vehicles fueled by compressed natural gas (CNG); introducing city (metro) trains in major cities; and controlling the flow of vehicles into the cities, among others.

Implementation Strategies

Tanzania will implement the NAP once it is integrated with the other national development plans and programs. The Division of Environment will ensure that the plan is integrated into other programs by channeling it through normal official procedures. By publicizing the plan through media workshops and seminars for various stakeholders, including the business community, it should be possible to have it understood by a larger community in the country.

An incentives package would be proposed to encourage the various stakeholders to implement the plan.

The plan will be updated regularly based on recommendations from a body that will be reviewing the progress of the implementation process. Updating the plan will depend on the availability of funds.

Relationship to National Communication

It is anticipated that the project to develop the NAP will not address the issue of the National Communication in any depth. However, the plan will address some elements of the National Communication. The issue of preparing a National Communication will be dealt with in detail as a follow-up activity, depending on the availability of resources.

International Cooperation

In January 1997, part of the Tanzania study team attended a training workshop organized by the US Country Studies Program to assist participating countries in the acquisition of relevant methodologies for the development of national action plans. The workshop was held in Borgor, Indonesia.

Additional technical assistance will be needed in some priority areas to facilitate the preparation of the action plan, including identifying and training experts on the appropriate methodologies for analyzing the activities under the plan as well as proper modeling techniques. The following types of assistance will be needed:

- *Training on key steps in plan development and technology assessments.* This assistance will be required at the initial stage of the project so that the key project leaders can attend this training workshop to receive guidance in preparing the work plan for the project. Training on sector-specific needs will be emphasized as part of capacity-building and ensuring a stable base of climate-change expertise in the country.
- *Provision of appropriate technical literature on plans and technology assessments.* Such documents are an essential resource for the researchers on the team. Potentially useful documents include those that give guidance on the various approaches and strategies taken in other countries.
- *Visits by international experts.* Assistance is needed with the planning process, design and interpretation of analyses for alternative policies and programs, the drafting of plans, and technology assessments. The experts would be involved to give guidance at the initial stage of the study and on a consultancy basis during the project period, as resources become available.
- *Exchange of information with other countries preparing national plans.* This could be accomplished through participating in international workshops on national plans, distributing copies of plans prepared by other countries, and supporting the exchange of experts between countries within our region. It is suggested that funding should be provided to enable local experts to participate in workshops on issues related to NAP development, including workshops arranged for countries participating in the NAP preparation process.
- *Provision of analytical tools.* These tools are needed for evaluating alternative policies, programs, and technologies and should include reference manuals for these tools. Assistance will be required to facilitate the acquisition of different models that will be applied to analysis at various stages of the study. The models would include macroeconomic models, multicriteria decision models, etc.

THAILAND

Thailand Environment Institute

Summary

Thailand has made a commitment to stabilize or reduce future carbon emissions at 1994 levels. The National Climate Change Committee of the Ministry of Science, Technology and Environment initiated, and was responsible for, this activity. The United Nations Framework Convention on Climate Change (UNFCCC) was signed on November 15, 1994, ratified on December 28, 1994, and went into effect on March 28, 1995.

Thailand is currently in the early stages of developing its National Action Plan (NAP). The process has been established, and an initial scoping meeting has been held. This chapter outlines the NAP development process, the priority sectors and measures that have already been identified, and some of the lessons learned from earlier studies.

Introduction

Results of Past Studies

Vulnerability and Adaptation

Forests. A study was performed to characterize potential changes in forest cover in Thailand based on simulated climate change scenarios from three General Circulation Models (GCMs), which utilized local weather station and global climate data. The GCMs consistently predict that tropical ecosystems will encroach on or replace subtropical ecosystems in Thailand. Changes in precipitation patterns are also predicted. Additional research will be necessary to improve the models and to better predict changes in local vegetation. There is not yet enough information available to make policy recommendations based on these predictions.

Coastal Regions. A study of the consequences of a rise in sea level, which is a predicted consequence of global warming, identified substantial impacts. Potential responses to these effects include:

- Artificial preservation of coastal ecosystems through the use of weirs
- Artificial introduction of freshwater to counter increased salinity on coastal farmland
- Construction of seawalls to reduce erosion and flooding
- Artificial replenishment of beaches at resorts
- Abandonment of marginal coastal farmland
- Relocation of coastal villages
- Redesign of wastewater treatment plants in areas where wastewater is released to the sea by gravity flow

Agricultural Water Resources. Rice is by far the most important crop in Thailand; rice production is highly dependent on water. Climate change has the potential to affect agricultural output through drought, floods, changes in rainfall patterns, and intrusion of salt water due to rising sea levels. A study was performed to estimate the vulnerability of agriculture to changes in rainfall and sea levels. The study built on the results of UNEP-sponsored research on the socioeconomic effects of climate change.

Over the past decade, Thailand has experienced severe weather extremes. From 1990–1993, rainfall was below normal levels, resulting in water shortages in 1993. Heavy rainfalls in 1994 and 1995 resulted in the worst floods in Thailand's recent history. However, the impacts of the floods were not as severe as might have been anticipated, highlighting the relative versatility of agriculture in Thailand. From observations of rice production during the climate extremes of the past several years, it is possible to predict adaptive responses to longer term climate changes: farmers are likely simply to switch from irrigated rice production to nonirrigated rice production, or begin growing other crops. The construction of dams in the northern part of the country would help to level out the availability of water resources.

Table 1. Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Measures Under Consideration
Mitigation	
Energy: *Industrial Motors*	■ Implement energy auditing program
Energy: *Transportation*	■ Implement tax incentives for alternative fuels
Energy: *Building Efficiency*	■ Change building codes
Energy: *Electricity Generation*	■ Implement utility power purchase agreements to use more renewable energy
Forestry	■ Protect existing forests ■ Reforestation
Agriculture: *Rice Cultivation*	■ Use low-methane rice cultivars ■ Use direct seeding to reduce the period of methane formation ■ Use soil aeration in conjunction with water management ■ Reduce use of organic matter as fertilizer ■ Use mineral fertilizers ■ Use methane production inhibitors
Agriculture: *Livestock*	■ Reduce fecal methane emissions through improved nutrition
Waste Management: *Landfills*	■ Introduce waste management systems to: 1. Encourage recycling 2. Reduce the quantity of organic material in landfill waste ■ Encourage capture and use of methane gas for energy
Adaptation	
Coastal	■ Establish setback requirements ■ Preserve wetlands ■ Introduce flood warning systems
Agricultural Water Resources	■ Improve water resource management

Emissions Inventory

The Intergovernmental Panel on Climate Change (IPCC) recommends that the global warming potential (GWP) of gases be used as a common unit for comparison. Thailand's emissions study developed an inventory of greenhouse gas (GHG) emissions based on both mass and GWP. The three most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Emissions for these gases are presented in Table 2. The other GHGs (nitrogen oxide, carbon monoxide, and nonmethane volatile organic compounds) were emitted in relatively small quantities (0.5, 1.85, and 0.27 million tonnes, respectively). Emissions of GHGs by sector are presented in Table 3. The sectors that emitted the largest quantities of greenhouse gases were agriculture, forestry, and energy.

Mitigation Assessment

In order to facilitate the preparation of Thailand's national greenhouse gas strategy, a sectoral study was performed to identify the major sources of GHG emissions, forecast future emissions trends, and identify potential strategies for mitigating emissions growth. Base case scenarios were identified, and a forecast of sectoral growth and development was made through the year 2030, with 1994 as the base year. Mitigation options were identified and selected for maximum impact and relevance, and mitigation scenarios were developed indicating potential emissions reductions resulting from implementation of mitigation measures. Cross-sectoral linkages were examined to determine potential interactions among these measures when implemented in combination, and a National Scenario, integrating the best mitigation options from all sectors of the economy, was constructed.

Table 2. 1990 Emissions and Warming Effects for Leading GHGs (Thousand tonnes = Gg)

Gas/Source	Emissions		GWP	Emissions (CO_2 equivalent)	
	Gg	%		Gg	%
Net Carbon Dioxide (CO_2)	**170,098.4**	**100.0**	**1**	**170,098.4**	**67.8**
Fuel Combustion					
Transportation	34,476.6	20.3		34,476.6	13.7
Energy transformation industries	28,093.5	16.5		28,093.5	11.2
Industry	12,207.5	7.2		12,207.5	4.9
Small combustion	8,005.7	4.7		8005.7	3.2
Industrial Processes	9,842.0	5.8		9842.0	3.9
Land-Use Changes and Forestry					
Changes in forests and other woody biomass stocks	19,897.4	11.7		19,897.4	7.9
Emissions	20,709.9			20,709.9	
Removals	–812.5			–812.5	
Forest and Grassland Conversion	81,723.7	48.0		81,723.7	32.6
Abandonment of Managed Lands	–24,148.1	–14.2		–24,148.1	–9.6
Methane (CH_4)	**2,890.9**		**24.5**	**70,826.6**	**28.2**
Fuel Combustion					
Transportation	9.4	0.3		230.7	0.1
Energy transformation industries	1.2	0.0		29.6	0.0
Industry	0.4	0.0		10.1	0.0
Small combustion	0.9	0.0		22.2	0.0
Fugitive Emissions from Fuels					
Oil and natural gas	140.8	4.9		3,449.4	1.4
Solid fuel	17.5	0.6		428.8	0.2
Industrial Processes	0.3	0.0		7.7	0.0
Agriculture					
Rice cultivation	1,786.1	61.8		43,758.4	17.4
Enteric fermentation	530.1	18.3		12,988.3	5.2
Manure management	162.8	5.6		3,988.1	1.6
Field burning of agricultural residues	19.5	0.7		476.6	0.2
Land Use Changes and Forestry					
Forest and grassland conversion	28.2	1.0		690.2	0.3
Waste					
Solid waste disposal on land	121.2	4.2		2,968.8	1.2
Wastewater treatment	24.8	0.9		608.0	0.2
Other					
Wetlands	47.8	1.7		1,169.9	0.5
Nitrous Oxide (N_2O)	**31.2**	**100.0**	**320**	**9,990.7**	**4.0**
Fuel Combustion					
Transportation	0.6	1.8		179.2	0.1
Energy transformation industries	0.2	0.6		60.0	0.0
Small combustion	0.1	0.3		26.5	0.0
Agriculture					
Agricultural soils	29.7	95.0		9,495.6	3.8
Field burning of agricultural residues	0.5	1.7		167.4	0.1
Land Use Changes and Forestry					
Forest and grassland conversion	0.2	0.6		62.0	0.0
Total CO_2 equivalent				**250,915.7**	**100.0**

GWP = global warming potential

Table 3. 1990 Greenhouse-Gas Contribution to the Warming Effect, by Sector

Sector	Emissions in CO_2 Equivalents (Million tonnes)	Percentage of Total Emissions
All Energy	87	35
Industrial Processes	10	4
Agriculture	70	28
Land Use Changes and Forestry	78	31
Waste	4	1.6
Wetlands	1	0.4
Total	**250**	**100**

Energy Sector. The energy sector mitigation scenarios focused on the three principal CO_2-emitting sectors:

- Power generation, for which demand-side management (DSM) would have the greatest potential to reduce CO_2 emissions
- Industry, for which biomass-based cogeneration showed the greatest promise
- Transportation, for which the use of rail transport and increased use of public transportation showed the greatest potential.

Forestry Sector. Deforestation in Thailand is causing serious ecological, social, and economic problems, in addition to contributing to global warming. In order to reduce these impacts and control GHG emissions, Thailand is intensifying its efforts to control deforestation and reforest some areas that have already been deforested. These goals have been integrated into the Thai Forestry Sector Master Plan (TFSMP), which was submitted to the Royal Forest Department in 1993.

Agriculture Sector. Rice production is the principal agricultural contributor to GHG emissions in Thailand. Rice grown under irrigation is responsible for as much as 59% of annual emissions, although irrigated rice accounts for only 29% of all rice cultivation. See Table 1 for a list of mitigation options for rice cultivation.

Methane emissions from animals in Thailand are expected to increase at about 4.6% per annum over the next three decades as the number of livestock grows. Currently, livestock are typically raised in small holdings in which the animals receive only the minimum feed

Table 4: CO_2 Emissions in the National Scenario, Compared to the Base Case (million tonnes)

Scenario/Sector	1995	2000	2010	2020	2030
Base Case	148.67	198.3	372.95	583.06	840.45
Power	58.16	77.86	171.89	277.91	413.18
Industrial	29.05	46.77	105.04	186.33	291.41
Transportation	51.69	61.85	82.10	99.01	108.50
Others*	9.77	11.82	13.92	19.81	27.36
National Scenario	119.17	160.77	282.83	426.73	599.96
Power	49.62	66.71	122.54	176.26	243.74
Industrial	26.38	42.19	93.35	167.45	259.75
Transportation	33.40	40.05	53.02	63.21	69.11
Others*	9.77	11.82	13.92	19.81	27.36
Total Reduction	**29.50**	**37.53**	**90.12**	**156.33**	**240.49**

* Includes residential, commercial, and agricultural sectors.

requirements. Widespread nutritional imbalances and insufficient nutrient intake lead to insufficient rumen fermentation and excessive methane production. Improvement of feed utilization efficiency would reduce enteric methane emissions and lower the volume of fecal excretion in the animals, simultaneously mitigating methane emissions while improving yields, particularly for large ruminants.

Waste Sector. Emissions of GHGs from the waste sector in Thailand come from solid waste and wastewater. IPCC methods were used to estimate that waste sector emissions of methane were approximately 146 Gg. The largest emission source is municipal landfill treatment. There is no gas collection system in operation at any of Thailand's landfill sites.

The majority of methane emissions are from the solid waste treatment of landfills and open dumping sites. Although open dumping accounts for 31% of total emissions, this is expected to decline to zero as the government's new solid waste management policy increases landfill usage and terminates the use of open dumping sites. The rate of methane emissions from landfills is predicted to increase by a factor of more than 10 within the next decade. See Table 1 for options to reduce emissions from landfills.

Current Programs

The government is currently implementing several climate change projects. The Thailand Environment Institute (TEI) is the lead agency for these projects, which are financed by the Office of Environmental Policy and Planning (OEPP) and multilateral and bilateral donor agencies. Major projects are listed below:

1. National Strategies on Global Climate Change (US Country Study I)

Funding Source: U.S. Environmental Protection Agency (EPA) through OEPP

The purpose of the Thailand Country Study on Climate Change is the design of a pragmatic action plan for response to climate change, and improvement of the capacity of government institutions to implement a national action plan. The project's objectives are as follows:

- Update estimates and forecasts of GHG emissions using the results of local research, and expand coverage to include GHG emissions from activities such as energy resource extraction, processing, transportation, storage, and distribution
- Assess the vulnerability of tropical forest ecosystems, agriculture, and coastal resources to climate change in all areas of the country; and identify and evaluate potential measures and policies to cope with climate change
- Identify and evaluate the various technologies and policies necessary to reduce Thailand's GHG emissions to a level consistent with its commitment under the UNFCCC
- Identify the constraints for implementation of mitigation options in the energy and forestry sectors, as well as provide recommendations to overcome them
- Prepare an implementation plan that includes strategies for managing the potential impacts of climate change on forestry, agriculture, and coastal resources, as well as for implementing technological and policy options needed to meet specific GHG reduction targets
- Develop a public education program to increase awareness and understanding of climate change issues and facilitate the implementation of adaptation and mitigation strategies

2. Preparation of the National Action Plan on Climate Change (US Country Study II—SNAP)

Funding Source: U.S. EPA

The objective is to increase Thailand's capacity to effectively fulfill its commitment to reduce GHG emissions. Specific tasks are to formulate objectives of the NAP for Thailand and identify sectors for evaluation; to evaluate and design measures for individual sectors; to perform comparative analysis and prepare an implementation strategy; and to prepare the NAP and integrate it into the Government's National Economic and Social Development Plan.

3. National Inventory of Greenhouse Gases Not Covered by the Montreal Protocol (OEPP 1)

Funding Source: OEPP

The National Inventory of Greenhouse Gases (GHGs) Not Covered by the Montreal Protocol serves as a yardstick for Thailand's performance regarding its contribution to GHG emissions abatement and sequestration.

4. National Inventory of Greenhouse Gases Not Covered by the Montreal Protocol : Methane from Rice Fields (OEPP 2)

Funding Source: OEPP

5. Preparation of National Communication for Climate Change (OEPP 3)

Funding Source: OEPP

The objective of this project is to assess and integrate information gathered in all earlier phases of the climate change investigation, discuss policy issues, and recommend mitigation measures based on a national inventory of GHGs not covered by the Montreal Protocol. The National Communication will be submitted to the Conference of the Parties to the UNFCCC. The results will include a recommended policy and both short-term and long-term action plans.

6. Report on Climate Technology Initiative (CTI) Activities in Thailand

Funding Source: International Center for Environmental Technology Transfer (ICETT) and MITI (Japan)

The objective is to develop a report on CTI-related activities in Thailand, and to identify measures to make international CTI-related technology development, transfer, and diffusion more efficient in the energy and industrial sectors.

7. Asia Least-Cost Greenhouse Gas Abatement Strategy Project (ALGAS)

Funding Source: ADB

The objectives are to strengthen the national capacity to develop necessary and reliable information on GHG sources and sinks; to assess, analyze, and verify the information; and to report the results to the Secretariat of the UNFCCC. The project will also identify, formulate, and evaluate viable least-cost GHG abatement strategies using economic models.

Methods

Steps to Prepare the Plan

The process of developing Thailand's NAP includes the following specific tasks:

1. Formulate objectives for the NAP through an initial scoping meeting
2. Identify priority sectors (e.g. energy, forestry, agriculture, and industry)
3. Prepare a work plan
4. Evaluate and design mitigation and adaptation measures for individual sectors; perform a comparative analysis, financial analysis, and technology assessments; select measures
5. Prepare an implementation strategy that is consistent with national circumstances to achieve GHG mitigation and adaptation goals in the energy and non-energy sectors
6. Prepare the NAP, conduct national/regional workshops, undertake outreach and public communication to generate support for implementation, then integrate the NAP into the Royal Thai Government's Eighth National Economic and Social Development Plan (1997–2001) in conjunction with a National Communication

1. Formulate Objectives

A wide variety of country-specific objectives will be analyzed to come up with a well-defined set of objectives that best addresses the country's needs in the climate change planning process. A broad range of sectors (e.g., energy, forestry, and industry) and cross-sectoral modalities (e.g., research and development, and public education) will be considered, and those that are most appropriate for national circumstances will be selected. At the beginning of the project, scoping meetings will be held with key government officials, the country study team, and nongovernmental organizations (NGOs) in order to generate consensus and support among all stakeholders, and to ensure that the government "owns" the ideas generated with their input. Smaller, more specific meetings with certain groups before and after the main scoping meeting may be necessary.

2. Identify Priority Sectors

Establishing priorities involves the development of consensus on the issues or systems that present the greatest need and the most promising opportunities for mitigation and adaptation. Based on the ongoing Thailand GHG inventory study, the most likely priority sectors are the power generation (energy) sector and the land-use sector. In the power sector, the focus will probably be on policy formulation to limit GHGs from independent power producers (IPPs), which the Thai government has begun permitting under a recent deregulation policy. In the land-use sector, the emphasis may be on formulation of an optimum policy for managing rice production and forestry to mitigate release of GHGs. Other sectors will also be examined for identification of cost-effective programs.

3. Prepare a Work Plan

A comprehensive work plan will be prepared to identify the methodologies for screening and evaluation of miti-

gation or adaptation measures. The work plan will also describe how the results of the sectoral and cross-sectoral analysis will be used in preparation of the NAP, the anticipated review process for the national plan, the development of national promotion programs, and the procedure for integrating the climate change plan with other development plans.

4. Evaluate and Design Measures for Individual Sectors, Perform Comparative Analysis, and Select Measures

Once priorities are determined, mitigation and adaptation measures will be identified and designed. A variety of approaches will be used to evaluate these measures, in order to ensure the quality of the selection process. Selection of measures will be performed through an open participatory/consultative process involving all the key stakeholders (government agencies, private industry, NGOs, research institutions, universities, etc.). Measures could include initiatives such as government regulations and standards, voluntary programs, economic and financial incentives, demonstration projects, and educational programs.

5. Prepare an Implementation Strategy and Sectoral Plans

The implementation strategy will describe the roles of lead organizations and supporting and cooperating institutions, the steps necessary to initiate actions, the schedule of activities, the human and financial resources devoted to the measures, outreach activities, and procedures for monitoring performance and refining measures. A plan will be developed for each priority sector, including a detailed description of the mitigation measures, a summary of their impacts, and discussion of the implementation strategy.

6. Prepare the Action Plan, Get Feedback, and Integrate the NAP into the Eighth National Economic and Social Development Plan (1997–2001)

Using the research results, an expert team will draft a national plan. This draft plan will be presented to the general public for evaluation and amendment in a national seminar with the widest possible participation. The amended draft plan will be put before the public throughout the country so that consideration by all regions is assured. The plan will then be examined and improved again in another national seminar.

After an expert review, the plan will be further reviewed by the Ministry of Science, Technology, and Environment (MOSTE); the National Environmental Board (NEB), and the National Committee on Climate Change (NCCC). On approval by these groups, the plan will be presented to the National Economic and Social Development Board (NESDB) for consideration, and then sent to the Cabinet for final approval. The final plan is expected to be integrated into the National Economic and Social Development Plan. It will also be shared through the National Communication channels (and possibly via the Internet), which will also be used for technology assessment, dissemination, and diffusion.

The time frame and level of effort, together with the involved agencies, experts, and consultants, should be clearly defined in the plan, and a monitoring and evaluation system should be included to deal with issues that arise in the actual implementation of the plan. Some of the experts can act as evaluators. Once the plan is approved by the cabinet, branches of the government, by the suggestion and the approval of the NCCC, must design their own specific action plans within the framework of the final national plan.

Organizations and Personnel Participating in NAP Development

The Office of Environmental Policy and Planning (OEPP) will be the coordinating agency throughout the project: contracting a research team, contacting expert groups and government agencies, organizing seminars, preparing the National Communication, etc. Members of the expert team will be nominated by OEPP and approved by the NCCC. It is expected that all researchers involved in national studies on climate change will be included among the nominees, in addition to figures from the private sector. Experts will draft the initial plan, review the draft of the final plan, and serve as consultants for the project.

Given that the most significant amounts of GHGs are emitted by the transportation, power, and forest (and related land-use) sectors, leading agencies in this project will probably come from the Ministry of Communications (which oversees transportation); the Electricity Generation Authority of Thailand (EGAT); the National Energy Policy Office (NEPO); the Department of Energy Development and Promotion (DEDP); and the Department of Forestry. These ministries will actively assist in

the planning process and design of the detailed model, action plans, and strategies, which will be submitted for approval by the NCCC. The NCCC will also encourage and supervise other government agencies to participate on their own initiative.

The NCCC, chaired by the Permanent Secretary of the Ministry of Science, Technology, and Environment, is the sole national body overseeing all matters related to climate change under the FCCC. Its mandate is to supervise formulation and implementation of all national policies, strategies, programs and projects related to climate change. It comprises 26 members representing various government agencies, academic institutions, NGOs, and independent experts. Given Thailand's interest in fulfilling its commitment under the FCCC, funding could be set aside for policy and planning activities without much difficulty. This has been assured by the active involvement of the NESDB and the NEB, chaired by the Prime Minister. As mentioned above, the government has already matched some funding for a climate change project on its own initiative.

Implementation of Work Plan

Table 5 provides a detailed breakdown of the steps to develop the NAP. It also summarizes the schedule for implementing the plan, and indicates the agencies involved, outreach activities, monitoring and evaluation procedures, and the relationship of the plan to the National Communication.

Initial Scoping Meeting

The initial scoping meeting has already been held. This meeting employed the Nominal Group Technique (NGT), a structured workshop process that provides each participant with an equal voice; it is used for generating a list of measures generated and ranked by group consensus. NGT was used to develop a set of potential mitigation options. A list of action priorities was developed from this list by ranking the options according to their responsiveness to a set of agreed-upon criteria. These priorities were then subjected to Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to identify potential problems and benefits. SWOT analysis provides a framework for identifying the most important issues in a complex situation. SWOT analyses were carried out for all of the target sectors, and Table 6 has been included as an example from the transportation sector.

Measures

GHG mitigation options must strike a balance between competing priorities, including GHG emission reductions; consistency with national policies, social, and environmental goals; economic viability; overall energy security; urban air quality; etc. Options selected should be "no regret" options (i.e., have a positive net return).

The following are some of the policy measures proposed for the climate change action plan in the energy sector, which is the focal point of Thailand's climate change work.

Energy Sector

Mitigation measures in the energy sector fall into three categories:

- Measures to reduce demand
- Measures to increase process efficiency
- Measures to use lower-carbon fuels

Reduced sectoral demand and increased process efficiency will result in lower energy demand and, thus, lower fuel consumption and GHG emissions. Use of lower-carbon fuels will result directly in lower GHG emissions. In the near term, or until renewable energy supplies are fully cost-effective, increasing energy efficiency is the most promising area for emissions reduction. To promote these measures, international support may be available from the GEF, World Bank, ADB, CIDA, UNDP, UNIDO, NEDO, JICA, and government agencies from developed countries.

The use of non-fossil energy resources — such as hydropower, geothermal, solar energy, and wind power — is limited by physical considerations and environmental and economic constraints, and it will not contribute significantly to electricity production and CO_2 emission reduction in the near future.

The current program is focused on the three principal CO_2-emitting sources in Thailand: the power, industrial, and transportation subsectors. CO_2 emissions from these three subsectors combined were 93% of total CO_2 emissions from the energy sector in 1994, and their shares are expected to increase to 96.7% of total CO_2 emissions by 2030.

Table 5. NAP Work Plan

Activities	Starting Month (Duration)	Technical Assistance	Agencies	Deliverables	Approach
I. Preparation Stage					
1. Review national inventory and mitigation studies	1(1)	C	TEI	Review report	
2. Review vulnerability and adaptation studies	1(1)	C	TEI	Review report	
3. Set national goals	1(1)	C	TEI, MOSTE	Goals	Interview experts
4. Establish priority sectors	1(1)	C	TEI, MOSTE, NESDB, NEPO, EGAT, MOA	Prioritized sectors	Brainstorming
II. Sectoral Plan Design					
1. Set goals and objectives	2(1)	C	TEI	Goals and objectives	Brainstorming
2. Hold scoping workshops to establish priority areas	2(1)	A	TEI, OEPP, NGOs, MOSTE, NESDB, NEPO, EGAT, MOA	Report on prioritized areas	Brainstorming
3. Conduct technology assessments	3(2)	A	TEI	Ranked technology options	Consultation
4. Evaluate measures and strategies	5(4)	A	TEI	Report	Consultation
5. Review institutional arrangements	5(1)	C	TEI	Report	Qualitative study
6. Conduct financial analysis	6(1)	B	TEI	Report	Quantitative study
7. Hold national workshop	7(1)	C	OEPP, TEI	Proceedings, papers	Public participation
Hold regional workshops (4)	8(1)	C	OEPP, TEI	Proceedings, papers	Public participation
8. Prepare draft NAP	8(1)	B	TEI	Draft NAP	Compilation
9. Hold final national workshop	8(1)	C	OEPP, TEI	Proceedings, papers	Public participation
10. Finalize NAP	8(1)	B	TEI	Final NAP	Compilation
11. Conduct training, buiild capacity	TBD	A	TEI	Report back to office	Training
III. Integration of NAP					
1. Integrate NAP into National Development Plan	10	C	OEPP, NESDB	NAP in NDP	Ministerial communication
2. Integrate NAP into National Communication	10	C	OEPP, NESDB	NAP in NC	Commissioning
IV. Implementation of NAP	11	C	MOSTE, NESDB	Projects	PPB
V. Outreach and Public Communication	2,6,10	C	OEPP	Public participation and awareness	Mass media outreach
VI. Monitoring and Follow-up	TBD	A	OEPP	Report	Consultation

A: International experts dispatched to Thailand

B: International experts consulted remotely or locally based international consultants

C: Local experts

TBD: To be decided

Table 6. Example of SWOT Analysis of Mitigation Options (Transportation Sector)

Option	Strength	Weakness	Opportunity	Threat
Construct mass transit system E = Elevated train U = Underground train	High capacity (E/U) On time (E/U) Convenience (E/U) Less energy consumption (E/U) Reduce air pollution (E) Less congestion (E/U)	Uncomfortable (E/U) High investment cost (E/U) Pollution (noise, air, visual, vibration) (E) Lost commercial opportunities (E)	Business opportunities (E/U) Wider distribution of residential areas (E/U)	Criminals (U) Accidents and fire (E/U)
Create integrated plan for infrastructure and transportation	Less carriage Save budget & time Easy to manage and maintain	Time-consuming process Expensive Difficult to implement	Business opportunities	Political effect
Eliminate vehicles older than 10 years	Reduce pollution Less maintenance Fewer traffic jams Reduce accidents	More scrap, no junk yards (disposal problem) Not affordable for low-income families	Recycle Strengthen auto industry	Objections from used car dealers
Enhance law enforcement	Fewer traffic jams Immediate effects	Some out of regulation Need more resources	Strengthen discipline	Bribery
Improve telecommunications	Time savings Less pollution Energy savings Fewer traffic jams Convenience	High cost to users High investment costs	Business opportunities Technology transfer Work at home	Hazardous to health Telephone tap
Reduce new car prices to increase sales	Less pollution per vehicle Less maintenance Environmentally friendly Fewer accidents Reduce congestion	Problems include increased pollution and more traffic jams, unless road tax, car tax, fuel tax make vehicle use expensive	Stimulate industry Reduce pollution control requirements	N.A.

Power Subsector

Mitigation measures to reduce CO_2 emissions in the power sector include:

- Demand-side management (e.g., energy efficiency and energy conservation)
- Supply-side options such as technology improvement
- Fuel switching

Demand-side management (DSM) is the most cost-effective option for improving energy efficiency in the power subsector. The Electricity Generating Authority of Thailand (EGAT) is currently implementing a DSM program that includes programs on lighting, refrigeration, air conditioners, motors, and load management. A Green Building for Energy and Environment program was introduced in September 1995; projects that have been implemented include Green Department Stores, Green Hotels, Green Hospitals, Green Office Buildings, Green Schools, Green Shops, Green Homes, and Green Minds. In addition, the Department of Energy Development and Promotion (DEDP) is implementing the energy conservation (ENCON) program under the Energy Conservation Promotion Act. The objective of this program is to promote energy efficiency and energy conservation in commercial buildings and factories. The degree of reduction in energy consumption and CO_2 emissions will depend on the degree of success of the programs.

Technological improvements in power plant efficiency may significantly reduce CO_2 emissions. Repowering of existing power plants can increase the efficiency of electricity generation, reducing fuel consumption and extending the lifetime of the facility. However, other environmental factors may take precedence: plant efficiency is lower when pollution control devices are added to the power plant, and CO_2 emissions increase when other gases emitted from the plants are controlled. CO_2 emission reductions due to repowering of existing plants will not be as important as improved emissions forecasts resulting from using lower carbon fuels in power plants planned for future construction.

Fuel switching can also play an important role in reducing GHGs, although it also involves a trade-off among capital costs, operating cost, fuel costs, and supply availability. Increased use of natural gas and combined-cycle technology will lower CO_2 emissions in the

power generation sector in comparison with other technologies. Nuclear power is not considered as an option due to the additional cost, waste disposal problems, and the risks associated with the production process.

As Thailand is not a major energy-producing country, the energy-producing industries contribute less GHG emissions than the end-use sectors. Energy production in Thailand comes mainly from coal mining, oil wells, and natural gas production.

Since most Thai coal is surface lignite, methane does not collect as it does in an underground mine shaft; lignite also releases less methane than other types of coal. It is very expensive to collect gases from surface mining, and there is no safety motivation to do so because there is minimal risk of a gas explosion.

Mitigation options for the oil industry include reducing or eliminating venting and flaring, and optimizing refinery operations. Since oil production is not a major activity in Thailand, the mitigation options in this sector will provide minimal emission reductions.

Some natural gas is released during production, processing, and transmission and distribution to consumers. Options to reduce emissions include changing to high-bleed devices, replacing old pipelines, or improving inspection and maintenance programs. These options are expensive, and would not significantly reduce emissions.

Industrial Subsector

The manufacturing sector is responsible for about 98% of industrial energy consumption in Thailand. The industries that have the greatest potential for energy conservation are the high energy-consuming and/or high energy-intensity industries: the food and beverage industries, nonmetal industries, and basic metal and paper industries.

Technology improvements will provide the major contributions to energy conservation and CO_2 reduction in the industrial sector in the future. These improvements will include:

- Improved steam production (e.g., energy efficiency improvements in boilers through fuel switching, combustion controls, and waste heat recovery
- Increased use of cogeneration systems
- Steam system improvements (such as improved insulation, improved steam traps, and steam pressure and temperature control)
- Improved heat production (e.g., efficiency improvements in furnaces, ceramic kilns, electric arc furnaces, and ovens)
- Improved electromechanical and lighting uses (e.g., variable-speed drives, high-efficiency motors, and high-efficiency lighting)
- Improved energy efficiency in the cement industry (e.g., fuel switching, grinding process improvement, and improvements in pyroprocessing)
- Generic technological improvements (e.g., energy management system and pump modification)
- Recycling

Process changes in industrial production could also conserve energy and lower GHG emissions.

An industrial-sector energy-conservation project already under way includes free energy audits for factories; training courses for their personnel; fiscal incentives such as duty reductions on imported equipment; demonstration funds; and information distribution.

Transportation Subsector

Light-duty vehicles and freight trucks consumed 76.8% of the total energy used in the transportation sector in 1994, and they are thus a major focus for energy conservation and GHG emission reductions. Mitigation options include:

- The use of alternative fuels such as methanol, ethanol, and hydrogen and switching to compressed natural gas, liquefied petroleum gas, and liquefied natural gas
- Improved fuel economy
- Transportation demand management (i.e., switching transport modes from private automobiles to public transportation for passenger transportation, and from trucks to rails or ships for freight transportation; increasing load factors; and urban planning)

Improved fuel economy as a result of changes in vehicle or engine design or improved maintenance can reduce growth in petroleum consumption and emissions from vehicle operations. However, transportation demand is expected to increase as a result of population growth, economic growth, and urban expansion, and thus could offset all of the emission reductions achieved by improving fuel economy or switching to cleaner fuels. A reduction in the anticipated growth in demand for transportation is an important option for reducing GHG emissions.

It is conservatively estimated that passenger demand in Thailand will grow at 10.3% p.a. during 1995 to 2000, and 7.8% p.a. during 2000 to 2010, and freight demand will grow at 5.3% p.a. and 3.6% p.a.,

respectively, during the same periods. Demand management includes options such as switching to more energy-efficient forms of transportation, increasing the load factor in vehicles, and better urban planning. Increasing use of public transportation or use of rail services (instead of trucks) for freight will improve urban air quality and traffic congestion, in addition to lowering GHG emissions. Traffic congestion is a major problem in Thailand, especially in Bangkok. Fuel economy will increase if traffic speeds can be raised to optimal levels.

Urban planning will improve system-wide transportation efficiency in the long term. Better urban planning will minimize travel distances and reduce traffic congestion. Improvements in telecommunications will make it possible for employees to work at home instead of commuting daily to offices, which will reduce fuel consumption, road congestion, and mobile emissions.

Technical Cooperation Projects

In order to develop the required information on program options and implement the GHG mitigation options identified through research, it will be necessary for Thailand to access international support for capacity-building measures and research efforts. A significant amount of work has already been undertaken with international and bilateral support.

Conclusions and Recommendations

Government instruments for reducing GHG emissions are regulations; fiscal incentives; information dissemination; and research, development, and demonstration projects. Since Thailand is not obligated to meet a specific GHG reduction target, the mitigation options implemented should be only the ones that will have no negative effects, and/or will provide other benefits to the economy.

Regulations could include:

- Lighting standards for the commercial sector
- Standards for industrial motors
- Standards requiring the use of high-efficiency technology in new generating capacity
- Performance standards for heat rates to encourage operating and maintenance improvements
- Fuel economy standards for automobiles
- Requirements for periodic vehicle inspection, maintenance, and certification

Fiscal incentives could include:

- Adjustments in electricity prices to reflect real production costs
- A tax reduction on imports of renewable energy equipment
- Tax credits for buying solar hot-water heaters
- Use of carbon taxes to encourage the choice of low- or non-GHG-emitting technologies.

In the industrial sector, incentives could include:

- Investment tax credits for investors in cogeneration
- Subsidies for investments in the manufacture or installation of low- or non-emitting technologies
- Government cost-sharing for fuel switching

Taxes and rebates can be used as an incentive to increase the rate of replacement of existing vehicles, and to promote the sale of high-fuel-economy vehicles. Use of fuels with lower CO_2 emissions can be promoted through tax credits, lower sales taxes, subsidies, or low-interest loans on vehicle conversions for alternative fuels, and subsidizing fuel station construction to improve the availability of alternative fuels. Thailand should incorporate a carbon tax into its national plan. Participation in Joint Implementation (JI) or Activities Implemented Jointly (AIJ) projects should also be encouraged in the future.

Examples of energy efficiency promotion include advertising and labeling of energy-efficient products; a public information program to help commercialize new energy efficiency technologies; and education programs.

Research and development should be promoted to make foreign technologies more suitable for Thailand's tropical environment. Demonstrations of new technologies should be promoted to reduce uncertainties about their benefits and costs, which could delay investment decisions.

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GLOSSARY

ADB	Asian Development Bank
CNG	Compressed natural gas
DANIDA	Danish International Development Agency
GEF	Global Environment Facility
GCM	General Circulation Model, a climate change scenario model that relates to atmospheric circulation
GHG	Greenhouse gas
GWP	Global warming potential
IGCC	Integrated gasification combined cycle
IPCC	Intergovernmental Panel on Climate Change
JICA	Japanese International Cooperation Agency
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
NC	National communication
NGO	Nongovernmental organization
NMVOC	Nonmethane volatile organic compound
NREL	National Renewable Energy Laboratory, a U.S. Department of Energy laboratory
p.a.	Per annum (i.e., per year)
SAR	Second Assessment Report of the IPCC
SNAP	Support for National Action Plans
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNIDO	United Nations Industrial Development Organization
UNFCCC	United Nations Framework Convention on Climate Change
USCSP	U.S. Country Studies Program

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