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GREENHOUSE GAS OFFSETS: A CASE STUDY IN THE SIERRA GORDA BIOSPHERE RESERVE, MEXICO

by

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ABSTRACT

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This Master's Degree Project explores the challenges and incentives of participation in Clean Development Mechanism (CDM) land use change and forestry projects that sequester carbon from the atmosphere. This topic was investigated through a literature review, interviews, conferences, a case study, and analysis of information. The Sierra Gorda Biosphere Reserve in East Central Mexico (Reserve) was used to identify the incentives and barriers to development and successful implementation of CDM projects from the host country perspective, and to examine the co-benefits in addition to carbon sequestration. The Reserve is managed by the non-profit organization Grupo Ecológico Sierra Gorda (Grupo). Feasibility studies on the potential for the Reserve as a CDM carbon sequestration project have already begun.

As the issue of global warming achieves greater political recognition, the CDM, created under Article 12 of the Kyoto Protocol, is gaining popularity in the international arena. A CDM project, in simplest terms, can be defined as an international project that results in a real, measurable and long-term decrease in net greenhouse gas emissions in a non-Annex I, or host, country. Although the host country does not receive credit for the emission reduction, it may receive many other benefits, including technology, expertise and funding. Many incentives for participating in a CDM project exist; however, currently numerous obstacles must be overcome before CDM can be considered a successful and effective tool to manage GHG emissions.

Key recommendations include: Parties to the Kyoto Protocol must ensure inclusion of land-use change and forestry projects under the CDM, and must ensure the goals of the CDM are more inclusive of host country participants. Key recommendations specific to the case study include: the Mexican government should identify multiple CDM projects and pool carbon resources, Grupo Ecologico Sierra Gorda should partner with a local university to conduct a comprehensive gap analysis of forest ecosystems in the Sierra Gorda, Grupo should consider CDM projects in addition to afforestation and deforestation, and Grupo must ensure local residents of the Sierra Gorda are provided with training and education opportunities.

Key Words: **Kyoto Protocol, Clean Development Mechanism, greenhouse gas offsets, climate change, global warming, carbon sequestration, Sierra Gorda Biosphere Reserve, Mexico, developing country, biodiversity**

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CHAPTER 1

INTRODUCTION

"Without a much stronger commitment to solving climate change and biodiversity loss, we will bequeath to our children and grandchildren an irretrievably impoverished world. Such a fate can be avoided, but it requires a strong international commitment and concerted action."

Paige Brown 1998 p. 1

1.1 BACKGROUND

The impending threat of global warming from increasing greenhouse gas emissions has convinced the international community to start developing initiatives to reduce and sequester greenhouse gases (IPCC 1995b). International agreements such as the 1992 United Nations Framework Convention on Climate Change and the 1997 Kyoto Protocol have brought the concept of binding greenhouse gas emissions reduction targets closer to reality (UNFCCC 1999). As countries sign agreements to reduce their emissions, they are faced with the formidable task of implementing the conditions of these contracts (UNFCCC 1999). Countries must now do what they have promised, which invariably will require the support of the organizations and corporations within each country (Zollinger and Dower 1996; United Nations 1998). These entities are choosing to voluntarily reduce their GHG emissions, thereby avoiding the imposition of governmental command and control measures (UNFCCC 1999; Thompson 1997).

Acutely aware of the financial bottom line, organizations and corporations are searching for cost effective opportunities to reduce their emissions (Zollinger and Dower 1996; Michaelowa and Dutschke 1998). In addition to domestic technology or infrastructure changes that may be cost-prohibitive, the international community has created three flexibility mechanisms under the Kyoto Protocol to help with reaching emission reduction targets: Joint Implementation, emissions trading, and the Clean Development Mechanism (Articles 6, 12, and 17 under the Kyoto Protocol). These flexibility mechanisms will be market-based, cost-effective tools that provide alternatives to domestic emissions reduction projects (Trexler and Kosloff 1998). In theory, the use of these tools is less expensive per tonne of carbon reduced or sequestered than domestic projects (Sedjo 1998; Janssen 1997). The flexibility mechanisms are further defined in Chapter 2, and in Appendix I.

The Clean Development Mechanism (CDM) is one flexibility mechanism that has the potential to provide benefits far beyond climate change mitigation (Trexler and Kosloff 1998; Brown 1998; Jannsen 1997; Imaz et al. 1998; Trines 1998). The CDM allows governments or private institutions in Annex I, or industrialized, countries to receive 'certified emission reductions' by financing projects that reduce net greenhouse gas emissions in a developing, non-Annex I country (IISD 1998a). A portion of the emission reduction can then be applied against the investor's own emissions.

CDM projects are also referred to as greenhouse gas offsets because they are used to offset emissions in one part of the world by reducing emissions in another. For example, emissions from a gas plant in Alberta can be offset by projects that reduce vehicle emissions, capture landfill methane, or plant trees to sequester carbon elsewhere in the world. Even though emissions are coming from the gas plant, less greenhouse gas is being emitted to, or is being sequestered from, the atmosphere elsewhere. Because climate change is a global phenomenon and reducing greenhouse gases anywhere in the world will have global consequences, offsets have become viable options for reducing these gases and meeting international commitments (Janssen 1997).

Land use change and forestry CDM projects involve the creation or protection of forest to maintain and increase carbon sequestration, whereby carbon is removed from the atmosphere and stored in plant biomass (Brown 1998; Frumhoff et al. 1998). In addition to carbon sequestration, these projects have the potential to offer significant co-benefits to the non-Annex I country, such as reduced air pollution, increased technology and capacity, ecological restoration, biodiversity conservation and the promotion of sustainable land use practices (Brown 1998; Frumhoff et al. 1998; Trexler and Kosloff 1998). However, CDM projects also have the negative potential to promote land conversion and the introduction of monoculture plantations and exotic species, as well as the inappropriate use of forests (World Bank 1998; Frumhoff et al 1998). Furthermore, landowners in the developing country may be left without a source of income if their land is used for a CDM project (D. Thompson pers. comm.).

The purpose of this Master's Degree Project (MDP) is to explore the challenges and benefits of participation in Clean Development Mechanism forestry projects. The Sierra Gorda Biosphere Reserve in East Central Mexico is used to assess the incentives and barriers to CDM projects from the host country perspective, and to examine the co-benefits and costs in addition to carbon sequestration. The Reserve is managed by the non-profit organization Grupo Ecológico Sierra Gorda (Grupo), and feasibility studies on the potential for the Reserve as a CDM carbon sequestration project have already begun. This study provides recommendations for the international community with regard to CDM development, and recommendations specific to the host country stakeholders in the Sierra Gorda Biosphere Reserve case study to address their needs for successful CDM projects.

1.2 OBJECTIVES

To achieve the purpose of this MDP, six objectives were met:

- to review literature pertaining to the Clean Development Mechanism and to identify and evaluate the necessary and sufficient conditions required for CDM projects;
- to review literature and available information on the Sierra Gorda Biosphere Reserve to become familiar with the region, with particular emphasis on the environmental conditions;
- to consult with Grupo Ecológico Sierra Gorda to gather information with regard to expectations for the Reserve, and the potential CDM projects;
- to better understand non-Annex I countries' perspectives on CDM, focussing on land use control issues and necessary and sufficient conditions for successful CDM projects;
- to identify current challenges and benefits to the proposed CDM projects in the Sierra Gorda; and
- to develop recommendations that address the opportunities and limitations to successful and sensitive implementation of CDM forestry projects in a host country.

1.3 METHODOLOGY

The following research methods were followed to satisfy the above objectives:

- a literature review;
- conferences;

- a case study and site visit to a carbon sequestration project in the Sierra Gorda Biosphere Reserve;
- informal interviews with Grupo Ecológico Sierra Gorda and practitioners; and
- analysis of the collected information.

1.3.1 Literature Review

The literature review was divided into two major subject areas. The first review focused on the issue of climate change and, in particular, the concept of the Clean Development Mechanism to gain a better understanding of the initiative. This review explored the international political initiatives behind the CDM, and identified different types of projects. Forestry-based carbon sequestration projects, and the challenges facing such projects, were researched more thoroughly than energy projects. The literature helped clarify the theoretical aspects of climate change and the Clean Development Mechanism, and provided a macro and holistic view of the concepts.

The first literature review included a large variety of sources. It utilized University of Calgary resources such as CD Rom and CLAVIS on-line catalogue systems. However, the information available from these resources was insufficient to comprehensively explore the subject of interest. Much of the literature, therefore, came from sources in the international negotiating arena for the Kyoto Protocol, such as countries' submissions and discussion documents with regard to their positions on the Clean Development Mechanism. Given the popularity of the climate change debate, newspaper and magazine articles were reviewed to ensure current information was included. Other information sources included literature from business, research organizations, and consulting firms specializing in climate change, such as Woodrising Consulting Inc. and Trexler and Associates Inc.

The Internet proved an invaluable tool for gathering information. The Clean Development Mechanism is in its nascent stages, and the Internet provided current updates of new developments. Search terms included Kyoto Protocol, Clean Development Mechanism, Joint Implementation, Activities Implemented Jointly, climate change, global warming, carbon sequestration, and biodiversity. These terms will be defined later in the document, and in Appendix I. The websites of several organizations were visited repeatedly throughout the research, including the United Nations Framework Convention on Climate Change (www.unfccc.de), the International Institute for Sustainable Development (www.iisd1.iisd.ca), the World Resources Institute (www.wri.org), and Resources for the Future (www.rff.org). In addition, climate-related newsgroups and on-line newsletters were subscribed to, such as the *Linkages* newsletter at www.iisd.ca/linkages/journal, and the Climate-L newsgroup.

The second literature review focused on the Sierra Gorda Biosphere Reserve in East Central Mexico. Available data on the environmental and socio-economic conditions on the Reserve were obtained from Grupo Ecológico Sierra Gorda and Woodrising Consulting Inc. The primary document obtained was the management plan for the Reserve entitled *Programa de Manejo Reserva de la Biosfera Sierra Gorda de Querétaro.* In addition to literature received from Grupo and Woodrising, the library at the Instituto Nacional de Ecología (INE) in Mexico City, D.F was searched for publications relating to Mexico, the state of Querétaro, and the Sierra Gorda Biosphere Reserve. The Instituto Nacional de Estadistica, Geografia e Informatic (INEGI) in Mexico City, D.F. was also visited to obtain maps of the region.

1.3.2 Conferences and Presentations

The researcher attended three conferences in 1998 to further her knowledge on climate change, offsets, and Mexican perspectives on climate change mitigation and the Clean Development Mechanism. In addition, one presentation by delegates from Central America in the University of Calgary OLADE program was attended. This presentation was specific to the host country perspective on the Clean Development Mechanism. Information gathered from presentations and informal discussions during these conferences was used to supplement the literature review. Table 1.1 explains the purpose of attending each conference and presentation, and its relevance to the research.

TABLE 1.1 Conferences and Presentations

CONFERENCE OR PRESENTATION	DATE	DESCRIPTION
Canadian Energy Research Institute Alberta Offset Development Workshop, Calgary, Alberta	February 2-3, 1998.	Focused on development of an overall strategy to reduce Alberta's greenhouse gas emissions. In particular, the role of credits for early action and its role in a Canadian negotiating position. Obtained information on offsets, and met government and industry stakeholders involved in climate change initiatives.
Canadian Energy Research Institute Climate Change Conference, Calgary, Alberta	May 4-5, 1998.	As a member of a group of graduate students, researched and developed a prototype for evaluation of greenhouse gas reduction measures outlined in the federal action plan on climate change. Developed criteria to rank measures based on political, economic and social feasibility. Organized workshop for the conference.
Sexto Congreso Internacional de CONIECO, Enviro-Pro Expo México Conference, Mexico City.	September 23- 24, 1998.	Attended several climate change sessions, and heard from both Canadian and Mexican stakeholders. Of note, a presentation on Mexican National Action Plan by INE, and presentation on carbon sequestration by Mexican Ministry of the Environment, Natural Resources and Fisheries (SEMARNAP).
Sustainable Development in Energy and Environmental Management in the Americas Seminar. University of Calgary-OLADE program.	June 18, 1999.	Attended presentation entitled *Clean Development Mechanism: A Sustainable Development Approach for Central America: Case Study Panama.* Presented by delegates from Honduras, Panama, and Costa Rica, and represented one developing world perspective on the CDM.

1.3.3 Case Study

The CDM is an evolving environmental management tool, therefore the research for this Master's Degree Project was exploratory, and focused on gaining insight into CDM projects and the issues that impede or support their successful implementation. To complement the theoretical knowledge gained from the literature review and conferences, a case study was deemed the best way to observe the practical challenges facing forestry CDM projects in the developing world. The Sierra Gorda Biosphere Reserve in East Central Mexico was chosen as the case study for numerous reasons:

- positive relationship of graduate supervisory committee member, Mr. Neil Bird, to Grupo Ecológico Sierra Gorda;
- researcher's personal interest in land use change and forestry CDM projects;

- high biodiversity and endemism on the Reserve;
- presence of local communities relying on the land for subsistence on the Reserve;
- geographical proximity of Mexico to Canada as a non-Annex I country; and
- willingness of Grupo to be the subject of the case study.

While researching a paper on Joint Implementation, the precursor to the CDM, for Environmental Design 747 (Environmental Management), Woodrising Consulting Inc., a company that specializes in climate change mitigation was contacted. Mr. Neil Bird of Woodrising provided an introduction to their efforts to promote the Sierra Gorda Biosphere Reserve as a forestry CDM project. Through discussions with Mr. Bird, the researcher determined that the issues facing the Sierra Gorda could be common to other projects of a similar nature. Therefore, the Sierra Gorda was chosen as a case study to illustrate the complexities involved in CDM projects with the intent of applying the findings to CDM projects in other regions.

Case studies are typically multi-method, involving analysis of documents and records, observation, and interviewing (Robson 1993). Available documents and records were obtained during the literature review, discussed above. A site reconnaissance was conducted in September, 1998 for three weeks to allow for observation of the case study: two weeks were spent in the Sierra Gorda, and one week was spent in Mexico City, D.F.. During the site visit to the Sierra Gorda, the ecological and socio-economic conditions on the Reserve were observed and noted, the Reserve and the state to the north, San Luis Potosi, were toured, and conversations with members of Grupo were conducted. Research notes were compiled based on discussions and observations, and site conditions were documented in photographs. The visit to Mexico City included attending a conference, and conducting brief meetings with Ms. Julia Martinez and Mr. Roberto G. de la Maza E of Instituto Nacional de Ecologia, and Mr. Liviu Amariei of Secretaria de Medio Ambiente, Recursos Naturales y Pesca. These meetings provided insight into the Mexican government's perspective on the CDM.

Data gathered in the field were summarized into legible notes for future reference.

1.3.4 Informal Interviews

The case study in the Sierra Gorda was exploratory, and standardized, structured interviews would have been inappropriate. Instead, a combination of open-ended and focused interviews were conducted. Typically, open-ended interviews do not have pre-specified interview questions, and their goal is to gain insight into a person's perception (Robson 1993). Alternatively, focused interviews include key topics that the interviewer wishes to discuss (Robson 1993). Both of these methods were employed when interviewing members of Grupo and INE. Given the cultural differences and the role as an outsider, open-ended interviews were chosen at the onset of the site reconnaissance primarily to become familiar with the Reserve and with members of Grupo, and to gain an understanding of Grupo's perceptions of greenhouse gas mitigation efforts. As knowledge of the situation increased, more focused and detailed questions were asked pertaining to the Reserve. Interviews sought to find answers to the following questions, which were formulated based on the literature review and discussions with graduate supervisory committee members:

- how is the Clean Development Mechanism perceived?
- what are the practical ecological and social challenges facing the successful implementation of forestry CDM projects on the Reserve?
- how do CDM projects fit with the overall ecological management of the Reserve?
- how does the issue of land ownership affect the successful outcome of CDM projects?
- where should appropriate land use CDM projects be located on the Reserve?
- what benefits other than carbon sequestration can CDM projects offer for the Reserve?
- what concerns are there regarding the CDM in Mexico?
- what does Mexico require for acceptance of CDM projects?

The interviews furthered the researcher's understanding of the host country perspective. Through the interview process, practical concerns with regard to CDM project acceptance and success were identified.

1.3.5 Data Analysis

The data and information collected from the literature review, conferences, case study and interviews were analyzed to determine the requirements for a successful forestry-based CDM project. From this analysis, recommendations were produced. The recommendations were directed at the international community negotiating the implementation of the Kyoto Protocol, and the host country stakeholders in the case study, including the Mexican government, and Grupo Ecológico Sierra Gorda. These recommendations address the issues arising from both the theoretical research and the case study.

1.4 RESEARCH LIMITATIONS

This research was limited by several factors. The Clean Development Mechanism is a relatively dynamic and evolving concept. Specifics of its use and methodologies are still under debate in the international community, making it difficult to access current and accurate data. Peer reviewed papers on climate change, while not abundant, are increasing in number as the issue of climate change reaches centre stage in the media. Current information on climate mitigation was obtained through subscription to several internet newsgroups, including the *Linkages* newsletter, and the Climate-L newsgroup.

The case study was bounded by financial and temporal constraints. The duration of the site reconnaissance to the Sierra Gorda was limited to three weeks due to financial constraints. This subsequently limited the amount and quality of data collected. During that time, the majority of the Reserve was toured, and members of Grupo Ecológico Sierra Gorda were interviewed. It was not possible, however, to collect intrusive baseline data. Further time and expertise would have been required to conduct a complete environmental baseline study of the area.

There were also significant language and cultural barriers encountered during the site reconnaissance. These barriers limited the quality and quantity of information collected. The majority of the reconnaissance was conducted with Mr. Neil Bird, who has a good working relationship with Grupo and provided translation when necessary. However, personal biases and cultural differences affected the researcher's perceptions and ability to gather accurate data.

Comprehensive field studies have not been completed in the Sierra Gorda due to limitations in funding and expertise. Thus, it was not possible to exclusively gather published, highly reliable sources for the environmental and social setting of the Reserve. Information obtained through the interview process was highly relied upon. As a result of differences in perceptions and individual recollections, conflicting data between published documents and interviews were occasionally encountered. To improve accuracy and ensure defensibility, data from cited sources were used, where possible. For example, the existence of the tropical evergreen vegetation community on the Reserve is in question. Information published by the Mexican government denied the existence of the community, while information gathered from interviews suggested that it was present in the Sierra Gorda. In this case, the researcher determined that this community would not be included in the study. When published information was not available, the extensive field and biological knowledge of Roberto Pedraza Ruiz and Francisco Javier Garcia Meléndaz of Grupo Ecológico Sierra Gorda was used.

1.5 DOCUMENT LAYOUT

This MDP is organized into five chapters as follows:

Chapter 1 Introduction

Chapter 1 discusses the background and rationale for studying the Clean Development Mechanism. It explains the potential for land use CDM projects to fulfil various objectives for developing countries in addition to carbon sequestration. The purpose, objectives, research methods, and limitations to this research are discussed. Brief chapter summaries are provided.

Chapter 2 Greenhouse Gas Offsets; the Clean Development Mechanism

Chapter 2 consists of a literature review that explains the history of global warming, and international and Canadian climate change initiatives. It discusses types of greenhouse gas offsets, and focuses on land use change and forestry projects under the CDM. Standards and criteria for CDM projects are explained, and incentives and barriers to participating in CDM projects are explored from an industrialized and non-industrialized country perspective.

Chapter 3 A Case Study in the Sierra Gorda Biosphere Reserve, Mexico

This chapter summarizes the literature review and site reconnaissance data to describe the Mexican institutions and capacity for managing CDM projects. The potential for forestry CDM projects in Mexico is highlighted, and project acceptance criteria and concerns are discussed. A case study on the Sierra Gorda Biosphere Reserve in East Central Mexico illustrates issues facing the successful implementation of the Clean Development Mechanism. The environmental and social settings of the Biosphere Reserve are described to provide an understanding of the current ecological and socio-economic conditions in the region.

Chapter 4 The Potential for Greenhouse Gas Offsets in the Sierra Gorda Biosphere Reserve

Chapter 4 explores the history of CDM proposals in the Sierra Gorda and describes the current carbon sequestration proposal. The stakeholders involved in the project are discussed, and the proposal's compatibility with existing national and local objectives is assessed. The benefits of this project to the Sierra Gorda are evaluated, with emphasis on the possible co-benefits. The barriers and challenges facing the success of this project are also assessed. Finally, various forestry options and their compatibility with the Sierra Gorda's needs are discussed.

Chapter 5 Conclusions and Recommendations

Conclusions reached throughout the document are summarized and recommendations are provided. The recommendations are divided into two sections. First, general recommendations are provided to the international community regarding the implementation of the Clean Development Mechanism. Second, recommendations specific to the Sierra Gorda Biosphere Reserve case study are provided and aimed at host country stakeholders.

Appendix I provides a glossary of the numerous terms that have accompanied the rise in popularity and political awareness of the climate change issue. It is provided in hopes of reducing the inevitable confusion that results from the introduction of so many new terms.

CHAPTER 2

GREENHOUSE GAS OFFSETS:

THE CLEAN DEVELOPMENT MECHANISM

"If designed on the basis of sound technical guidelines, supported by strong national and regional...policies, and pursued on the basis of mutual benefit and voluntary cooperation between industrialized and developing countries, CDM projects can contribute substantially to the conservation and restoration of...forests and their biological diversity", while combating climate change.

Bill Freedman 1998 p.9

During the past decade, the issue of global warming has achieved international political recognition and has become a priority on national and corporate agendas throughout the world. Scientific reports have concluded that human-induced climate change could seriously impact our global environment, economy, and society (IPCC 1995). Recognizing the threat that climate change poses, Canada and many other countries have entered into international agreements to reduce their greenhouse gas emissions and combat global warming (Environment Canada 1995). These agreements have spurred an attempt within Canada to find solutions to the growing greenhouse gas (GHG) emissions portfolio.

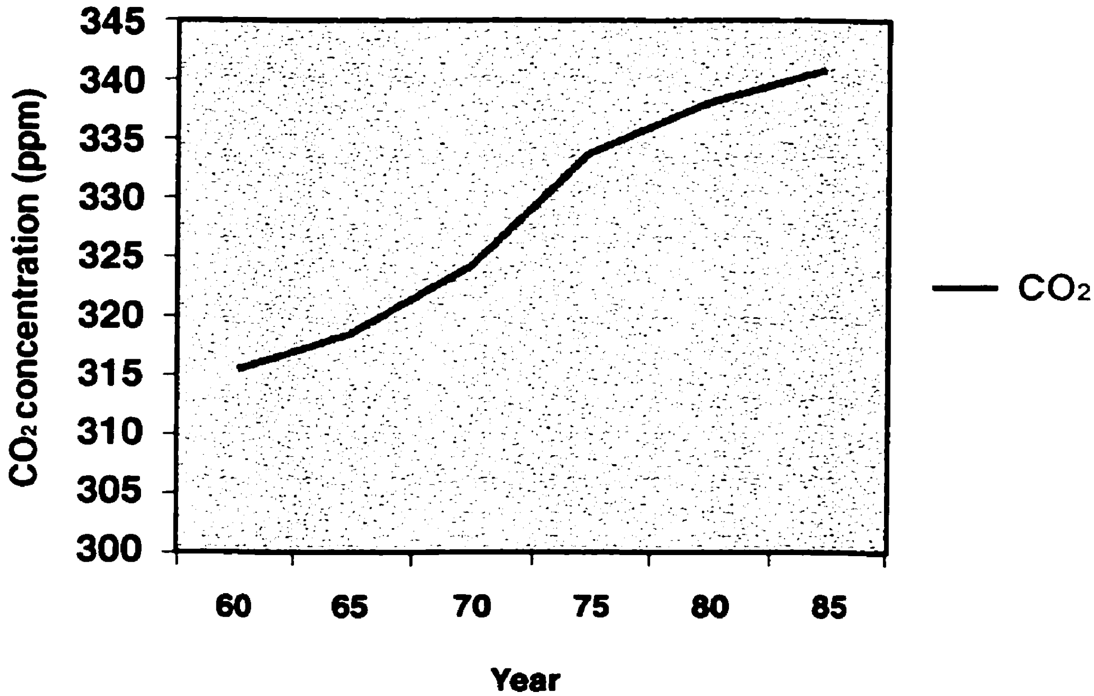
This chapter focuses primarily on the Clean Development Mechanism as an emerging environmental management tool to address the issue of GHG emissions, and explores the unique benefits and barriers to using such a tool. In particular, carbon sequestration through forestry projects will be emphasized.

2.1 HISTORY

2.1.1 Global Warming

Four billion years ago, before the dawn of life, the Earth's atmosphere was mainly composed of the greenhouse gas carbon dioxide (CO_2). Billions of years and thousands of natural processes have transformed the atmosphere into one that is oxygen rich (21%) and carbon dioxide poor (0.035%) (Raven et al. 1986; Manahan 1991). Carbon dioxide is still an important factor in ensuring the Earth remains habitable, however. Its presence in the atmosphere contributes to the greenhouse effect and the warming of the Earth (Hirsch 1994). The greenhouse effect is caused when gases, such as carbon dioxide, methane and nitrous oxides, accumulate in the atmosphere. These gases trap solar heat, increasing the temperature of the earth's surface (Hirsch 1994). This is an important natural process; without this effect, the average air temperature would be as low as -18°C (Campbell 1990).

The 20th century has changed the balance of the natural processes that cause the greenhouse effect. Since 1850, CO_2 concentrations in the atmosphere have been increasing (Raven et. al. 1986). The Industrial Revolution introduced greenhouse gases to the atmosphere through deforestation and burning of fossil fuels at a rate that is unprecedented (Figure 2.1; Hirsch 1994). Since the Industrial Revolution, the concentration of CO_2 in the atmosphere has increased 30%; a significant percentage considering prior to that, levels remained relatively stable for 10,000 years (Denton 1997).



Source: Campbell (1990)

FIGURE 2.1 Increase in Atmospheric CO_2 since 1958

Scientists predict that this increase in atmospheric CO_2 may result in increased global temperatures, or global warming (Figure 2.2) (IPCC 1995). While there are still some unresolved scientific questions concerning the impacts associated with global warming, the science behind this phenomenon is gaining both credibility and popularity (IPCC 1995). There is a general consensus among the international scientific community that an increase in anthropogenic GHGs in the atmosphere could significantly impact global weather patterns, ecosystems, and economic activity (IPCC 1995). The 1992 United Nations Framework on Climate Change (UNFCCC or FCCC) has defined climate change as:

> "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods."

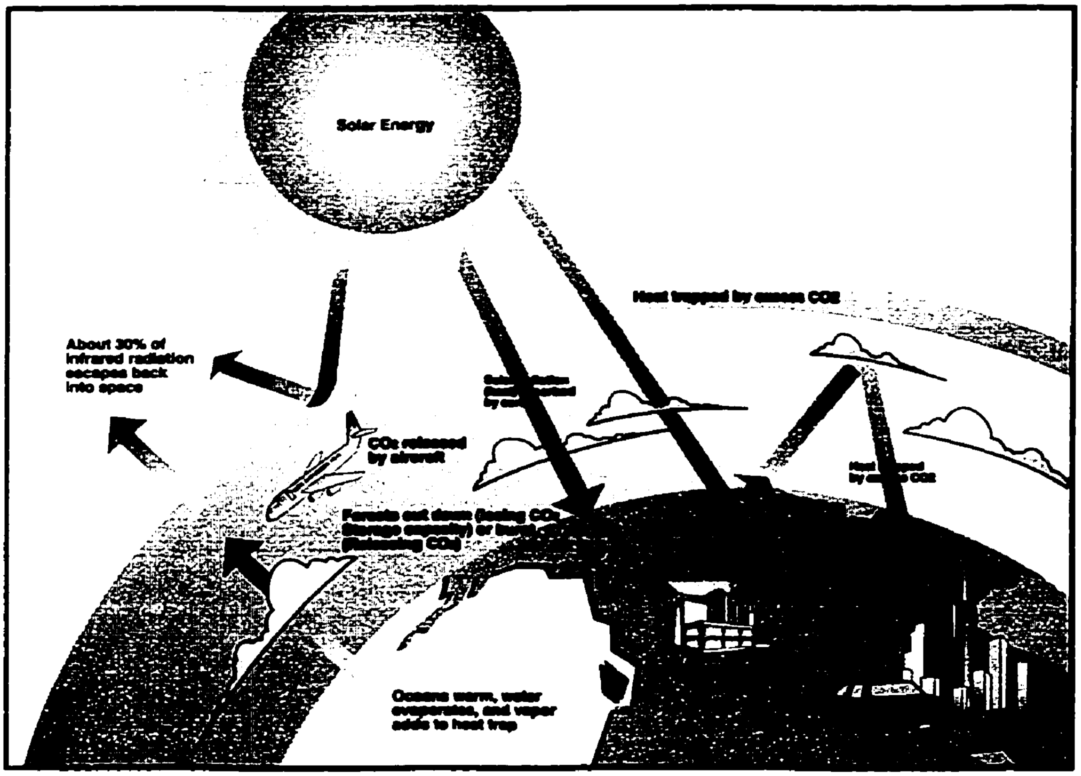


FIGURE 2.2 Global Warming

CO_2 is the most abundant human emission of greenhouse gas (Figure 2.3), and it is also the primary greenhouse gas that contributes to global warming. As such, it is often the main target when discussing GHG reductions. Water vapour makes up about 98% of the GHGs, and 2% is made up of other gases (Hirsch 1994). Figure 2.3 illustrates the relative contributions of various GHGs in the atmosphere to global warming, excluding water vapour.

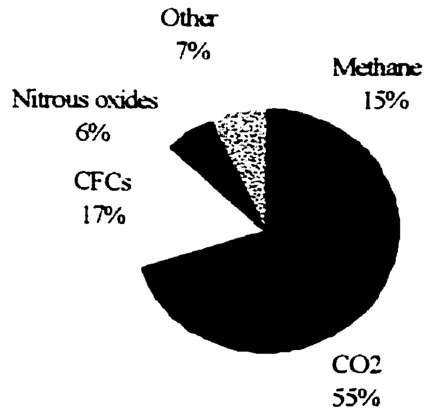


FIGURE 2.3 Contribution of Greenhouse Gases to Global Warming

Source: Intergovernmental Panel on Climate Change 1990

There is growing evidence of increasing temperature extremes around the globe. Data suggests that nine of the past eleven years have been the warmest on record, and reports confirm that the average surface air temperature has increased 0.3°C to 0.6°C over the past 100 years (Standing Committee on Environment and Sustainable Development 1997). Assuming that emission trends continue and no abatement actions are taken, climate models predict that the global temperature will rise by 1°C to 3.5°C by the year 2100 (United Nations 1998).

Climate change is likely to have a significant impact on the global environment. Global warming will cause sea levels to rise, resulting in flooding of low-lying areas, increased shoreline erosion, and the disappearance of many coastal cities (United Nations 1998). In the mid-latitude regions, climatic zones are expected to shift towards the poles by 150 to 550 km (United Nations 1998). This means that forests, agricultural land, deserts and many other biotic regions will eventually shift as well. As a result, some species will be unable to adapt, ecosystem fragmentation will occur, and individual species will face extinction, reducing biodiversity. According to Recer (1999), the ecological balance can be disrupted by a temperature change of just a few degrees. If a key species in a community is sensitive to temperature fluctuations, higher temperatures could initiate a chain of events that affects the entire ecosystem. For example, in a study of starfish in the tidal waters of Oregon, a five-degree increase in temperature dramatically changed the feeding habits of the starfish. They increased their rate of feeding to such an extent that the prey population of mussels was nearly eradicated (Recer 1999). Temperature changes in other ecosystems could have similar results, affecting one or two species and consequently affecting the entire ecosystem.

A global warming computer model at Britain's Hadley Centre for Climate Prediction and Research has calculated that by 2050, global warming will have disastrous results. The model predicts the following impacts from climate change:

- 170 million people will face shortages of clean drinking water;
- 30 million people in Africa will face starvation due to drought;
- 100 million people will be forced from their coastal homes;
- portions of the Amazon rainforest will become desert; and
- decreased precipitation on the North American prairies will cut wheat and corn production by 10 % (IISD 1998a).

These are only predictions. Climate change forecasts are difficult to make because of the uncertainty involved. Once climate change begins, the resulting changes may feed back on the original warming. There is not yet a clear understanding of these feedback mechanisms, and the predictions arising from the climate change debate are often contradictory (Raven et al. 1986; Campbell 1990). Although there is still some controversy as to the validity of some of the climate change predictions, however, politically this debate has become moot. The international community is slowly adopting the precautionary principle, under which "activities that threaten serious or irreversible damage can be restricted or even prohibited before there is absolute certainty about their effects" (Bainbridge 1998 p.1). Politically, they are moving forward with initiatives to combat global warming. This MDP accepts this fact, and therefore will not enter into an exhaustive discussion regarding the merits of the science supporting climate change. Please see Hecht (1997), Stevenson (1997), Ellsaesser (1997), or Ray (1993) to further examine the argument against climate change.

2.1.2 International Political Initiatives

Serious political initiatives to address emission reduction began only a decade ago, and have included funding programs for scientific research, international negotiations for establishing a framework for achieving global emissions reductions, and the creation of binding international commitments to implement strategies and monitor CO_2 reduction compliance. Table 2.1 summarizes the history of international political events dealing with greenhouse gases and the creation of the CDM. A discussion of these initiatives follows.

TABLE 2.1 Summary of Greenhouse Gas Initiatives

INITIATIVE	DATE	DESCRIPTION
Intergovernmental Panel on Climate Change (IPCC) two assessment reports	1990, 1995	Confirmed that human activities impact climate and contribute to global warming.
Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change	In session between 1990 to 1995	Committee that negotiated the FCCC for the Earth summit. The INC had a total of 11 sessions after which the COP (see below) became the presiding body of the FCCC.
United Nations Framework Convention on Climate Change (UNFCCC or Convention)	Came into force March 21, 1994	Set up by the INC; signed by 170 countries at the Earth Summit in Rio de Janeiro in 1992. A general treaty that sets the framework for GHG reductions, but doesn't address strict targets.
Conference of the Parties (COP)	1995-present	The supreme body of the FCCC. Has met four times—1995 (Berlin), 1996 (Geneva), 1997 (Kyoto), 1998 (Buenos Aires).
Berlin Mandate	1995	Outcome of COP1. Began a negotiating process that researched and elaborated policies and set quantifiable emission reduction objectives for discussion at COP3 in Kyoto, Japan.
Kyoto Protocol	December, 1997	Protocol to the FCCC; signed at COP3 in Kyoto. Requires Canada to reduce greenhouse gas emissions to 6% below 1990 levels by the period 2008-2012. Created the Clean Development Mechanism.
Buenos Aires Plan of Action	November, 1998	Created at COP4 in Buenos Aires. Includes a work program with priority on determining modalities and procedures for the Clean Development Mechanism.

Intergovernmental Panel on Climate Change

In 1988, the Intergovernmental Panel on Climate Change (IPCC) was established in response to growing international concern about the possibility of global warming. The IPCC is an international scientific panel dedicated solely to GHG research. It is charged specifically with the following three tasks:

- to assess scientific information related to the various aspects of climate change;
- to evaluate environmental and socioeconomic impacts arising from climate change; and
- to formulate realistic response strategies for the management of the greenhouse issue (Earth Council 1994).

The IPCC assessment reports in 1990 and 1995 confirmed the scientific basis for climate change. The IPCC's second report in 1995 concluded that there is a "discernible human influence on the global climate" which destabilizes the globe's ecosystem (IPCC 1995b).

United Nations Framework Convention on Climate Change

The first IPCC report in 1990, and the confirmation of a human impact on climate, spurred the formation of the Intergovernmental Negotiating Committee (INC) (United Nations 1997). The purpose of the INC was to establish an effective international treaty that set an overall framework for GHG mitigation. The result of the INC negotiations was the United Nations Framework Convention on Climate Change, a general treaty that does not discuss strict reduction targets, binding commitments, or financial mechanisms (United Nations 1997). This treaty, referred to as the FCCC or the Convention, is the backbone of all subsequent climate change initiatives.

The key philosophy of the United Nations Framework Convention on Climate Change is the use of the precautionary principle. Its ultimate objective is the "stabilization of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a certain timeframe sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" (Article 2). The FCCC encourages Parties, of which Canada is one, to implement projects both domestically and internationally that will reduce GHG emissions, and enhance sinks and reservoirs. It also encourages signatories to pursue international offset projects, and implement policies and measures jointly with other parties (Watt and Sathaye 1995).

The Convention gained widespread international recognition in 1992 when it was signed by 170 countries at the United Nations Conference on the Environment and Development in Rio de Janeiro. Canada ratified the FCCC in December 1992, and it entered into force in 1994. There are two notable non-signees of the convention, China and India. They are two of the five largest emitters of GHGs.

COP1 and the Berlin Mandate

In response to widespread skepticism regarding the lack of concrete targets in the FCCC, Canada and many other countries made a voluntary commitment to reduce GHGs to 1990 levels by the year 2000. This commitment was discussed at the first Conference of the Parties (COP1) in Berlin in 1995. The outcome of COP1 was the establishment of the Berlin Mandate, and the formation of an international pilot phase for joint implementation (JI), referred to as Activities Implemented Jointly (UNFCCC Secretariat 1997). COP2 was convened in 1996 in Geneva to discuss the results of the second IPCC report, but no significant agreements were reached.

COP3 and the Kyoto Protocol

The Berlin Mandate at COP1 began a negotiating process that developed policies and set quantifiable emission reduction objectives to be discussed at COP3 in Kyoto, Japan. Negotiations in Kyoto lead to the signing of the Kyoto Protocol on December 11, 1997. Appendix II provides a copy of sections of the Protocol. It has been heralded as the most significant advance in reducing greenhouse gases. Supporters view it as a positive and concrete step towards the reduction of anthropogenic GHGs in the atmosphere. Critics, on the other hand, believe that the Protocol was created simply because today's political leaders want to flex their environmental credentials. It has been criticized as unrealistic and economically unfeasible (Crncich 1998; Cornford 1997). In fact, some believe that ratification of the Protocol will cripple the economies of rich nations for decades (Jacoby et al. 1998). This assessment, however, fails to consider the economic benefits gained from avoiding global warming and from energy efficiency improvements (IPCC 1995a).

The Kyoto Protocol has been signed by 160 countries and, if and when it is ratified, will be legally binding. It divides countries into Annex I (industrialized) and non-Annex I (less industrialized) countries. Only Annex I countries are committed to emission reduction under the Kyoto Protocol. Non-Annex I countries must take action against climate change, but will not be legally bound to reduce their emissions. As an Annex I country, Canada is committed to a greenhouse gas emissions reduction of 6% below 1990 levels by the 2008-2012 commitment period. Collectively, the industrialized nations have agreed to reduce their emissions by 5.2%, and demonstrate significant progress by 2005. In reality, the agreement represents a 30% reduction when compared to the total GHG emissions expected in 2010 (Cornford 1997). To come into force, the Protocol must be ratified by at least six countries representing more than 55% of the total 1990 emissions from industrialized countries (Cornford 1997). The Alberta Government and the Canadian Chamber of Commerce stated in *Business in Calgary* in December, 1998 that Canadian ratification will depend on the United States, which cannot ratify the Protocol without the Republican-controlled Senate approval (Crncich 1998; Cornford 1997). As of August 29, 1999, 84 countries had officially signed the Protocol, and 14 countries had ratified it (UNFCCC 1999).

The agreement reached in Kyoto includes six GHGs: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. To achieve the collective 5.2% reduction of these gases as promised in the Protocol, individual national reductions will vary. Not all countries have to reduce their emissions. Some have to stabilize their current emissions, and some are allowed to emit more than they did in 1990. If participating countries meet their targets, total greenhouse gases will be reduced 16% by 2100 (Jacoby et al. 1998). Table 2.2 illustrates national commitments made in the Kyoto Protocol, as compared with 1990 emission levels (Socci 1997).

TABLE 2.2 National Emission Reduction Commitments

COUNTRY	NATIONAL COMMITMENT (COMPARED TO 1990 LEVELS)
Canada	-6%
United States	-7%
Switzerland, European Union, many Central and East European states	-8%
Hungary, Poland and Japan	Stabilize emissions
Norway	+1%
Australia	+8%
Iceland	+10 %

Kyoto Mechanisms

While the Protocol provides strict reduction targets for each country, it also provides the tools and flexibility mechanisms to reach those targets. Specifically, three flexibility mechanisms, or Kyoto mechanisms, are discussed (Appendix II):

- emissions trading (Article 17 of the Kyoto Protocol);
- the CDM (Article 12 of the Kyoto Protocol); and
- JI (Article 6 of the Kyoto Protocol).

Emissions trading is an international initiative whereby Annex I countries that reduce emissions below their target can sell excess carbon credits to others directly or through a trading market (United Nations 1998).

The CDM was created as a successor to what was previously referred to as JI and Activities Implemented Jointly. That is, investment by Annex I countries in emission reduction or avoidance projects in non-Annex I countries is now under the CDM. CDM projects generate emission credits, or certified emissions reductions (CERs), that can be traded and applied against emission reduction targets beginning in the year 2000 (IISD 1998a). Box 1 provides a standard definition of the CDM.

Box 1 Definition of the CDM
A flexibility mechanism created in the Kyoto Protocol that allows governments or private entities in Annex I countries to fund GHG emissions reduction or avoidance projects in non-Annex I countries, and receive credit in the form of 'certified emissions reductions' (IISD 1998a).

Joint Implementation, on the other hand, is now a process that helps industrialized countries meet their international GHG commitments by working together. An Annex I country, or an organization within that country, can finance a project that reduces net emissions in another Annex I country, and receive 'emissions reduction units' (United Nations 1998). Joint Implementation and the Clean Development Mechanism will be market-based mechanisms for the transfer of technology and resources from one country to another. This chapter explores the CDM in further detail.

According to Article 12 of the Protocol, the CDM has the following three goals:

- To encourage the achievement of sustainable development in non-Annex I countries;
- To contribute to greenhouse gas reduction and other environmental goals of the FCCC; and
- To assist Annex I countries with complying with international emission reduction targets.

These goals appear to address both Annex I and non-Annex I country needs. Non-Annex I countries can participate meaningfully in greenhouse gas reduction while achieving sustainable development objectives, and Annex I countries can achieve their emissions reductions at least cost. It is the Annex I country, however, that currently has the most to gain through the CDM by having flexibility in meeting its targets (TERI 1998). The CDM must also be designed in such a way as to maximize the benefits to the host countries.

Article 12 also establishes independent auditors to verify project activities: an act that is essential for any useful environmental management tool. Further, it states that any certified emissions reductions must be real, measurable and long-lasting to ensure credibility.

2.1.3 Canadian Political Initiatives

The Kyoto Protocol has generated mass media coverage and public attention, essentially guaranteeing that private industries will be facing pressure to help Canada meet its target of 6% below 1990 levels by the commitment period. If the Protocol is ratified and becomes legally binding, the pressure will escalate as corporations and organizations within Canada are expected to accept their share of the burden (Zollinger and Dower 1996; United Nations 1998).

To ensure that Canada meets its international commitments, the federal government has allocated $150 million over three years to the climate change issue (Environment Canada 1995). In 1995, the government developed a National Action Plan (NAP) on Climate Change that stated the pre-Kyoto strategy and outlined ways to achieve the international commitment (Environment Canada 1995). The intent of NAP is to set the strategic direction to stabilize GHG emissions. The following principles formed the foundation of the plan:

- precautionary principle;
- shared responsibility between sectors and regions;
- effectiveness with sustained results;
- competitiveness i.e., cost-effective, enhance employment opportunities and improve international competitiveness;
- transparency and accountability;
- flexibility;
- international cooperation; and
- science.

The effectiveness of this plan has yet to be determined.

The Climate Change Voluntary Challenge and Registry (VCR) was created as a key element of the action plan (VCR Inc. 1998). CDM projects should be registered with the VCR. The main purpose of the VCR is to encourage public and private sector organizations to voluntarily limit their net greenhouse gas emissions. Specifically, its mandate is "to provide the means for promoting, assessing and recognizing the effectiveness of the voluntary approach in addressing climate change" (VCR Inc. 1998). The VCR includes two steps for organizations to follow. The first involves filing an action plan outlining greenhouse gas emission reduction strategies, and the second involves reporting achievements (VCR Inc. 1998). Prior to 1999, a letter of intent was also required. Since its inception, over 700 organizations have joined the VCR, representing 70% of Canada's business and industrial potential for GHG reductions. Of these 700 organizations, however, only 364 submitted action plans, and only 35 received a passing grade in an independent review conducted by the Pembina Institute for Appropriate Development (Pembina Institute 1998). The many critics of the VCR claim that it has failed to motivate corporations and organizations to meaningfully reduce greenhouse gases.

The Government of Canada has also created a federal Secretariat to oversee the climate change initiatives (Environment Canada 1998). The Secretariat will endorse the work of federal Ministers and confer with the provinces and stakeholders to develop a Canadian National Climate Change Process to address Kyoto commitments (Environment Canada 1998). The process, developed in consultation with the provincial and territorial governments, will include the following areas:

- consultation with provinces, territories, municipalities, industries and communities;
- initiation of public education and engagement activities;
- research and design work on mechanisms such as emissions trading and joint implementation;
- support of quick start initiatives on a leveraged and cost shared basis; and
- engagement of developing countries in climate change initiatives (Environment Canada 1998).

The Canadian National Climate Change Process includes the formation of 16 Issues Tables that are charged with providing expert and detailed input to the identification and analysis of greenhouse gas reduction opportunities. The Tables are to identify the challenges and benefits of the various options open to Canada (National Climate Change Secretariat 1998). Table members include government, industry, environmental non-governmental organizations, and other representatives (National Climate Change Secretariat 1998). If constructive and effective, the results of the discussions from three of these Tables, the Forestry Table, the Sinks Table, and the

Flexibility Mechanisms Table, may be relevant to the success of the CDM in Canada in the future.

As illustrated by the components of the national strategy, the federal government supports the use of the Kyoto mechanisms, and the engagement of developing countries. It has publicly supported using the CDM in addition to taking domestic action, maintaining that it makes sense to choose the most cost-effective way of reducing the amount of carbon dioxide in the atmosphere, regardless of where on the globe the reduction takes place (Environment Canada 1998). International agreements, the federal government's support of the initiative, self regulation, and the possibility of receiving carbon credit for early action (prior to the 2008-2012 commitment period) all act as driving forces that open the door for organizations to start using the CDM as a tool to reduce their emissions.

Box 2 illustrates a Canadian example of a company that has already started using the CDM.

Box 2 Canadian Initiatives

There are Canadian companies that are already investing in CDM projects as part of their corporate greenhouse gas action plans. Suncor Energy Inc., for example, is a Canada-based international energy company. Under the VCR, Suncor has completed a greenhouse gas action plan that details how it will decrease and avoid emissions, domestically and internationally. Suncor has invested in an international offset project in Belize under the CDM. The project is a carbon sequestration project in the Rio Bravo that is expected to remove at least 400,000 tons of CO_2 from the atmosphere, which is the equivalent to the annual greenhouse gas emissions from about 80,000 cars.

2.2 TYPES OF GREENHOUSE GAS OFFSET PROJECTS

2.2.1 Source Projects

There are two classifications of CDM projects: sources and sinks. Source CDM projects refer primarily to energy projects that decrease CO_2 emissions arising from the use of carbon-based fuels (a source of emissions) (Cutright 1996). Projects of this nature commonly include the transfer of technology or the improvement of infrastructure. For example, a German corporation could invest money in the construction and operation of a wind energy project in Central

America. The renewable wind energy might replace coal as the source of electricity in the area, thereby lowering carbon emissions. The corporation, in turn, would receive credit for a portion of the carbon emissions that were avoided. This credit can then be applied to their own operations in Germany, and used to meet their national and international targets (IISD 1998a). While sources are important emission reduction projects, this MDP will focus primarily on the second type of project: a sink.

2.2.2 Sink Projects

In contrast to source projects, sinks are land use change and forestry (LUCF) initiatives that sequester or incorporate carbon into plant biomass. This classification is based on the carbon cycle, whereby carbon dioxide is incorporated into living systems through photosynthesis (assimilation), and released back into the atmosphere through respiration (Figure 2.4; Campbell 1990). The living systems, such as plants, soils, and oceans are sinks when they absorb CO_2, and sources when they release it (Campbell 1990).

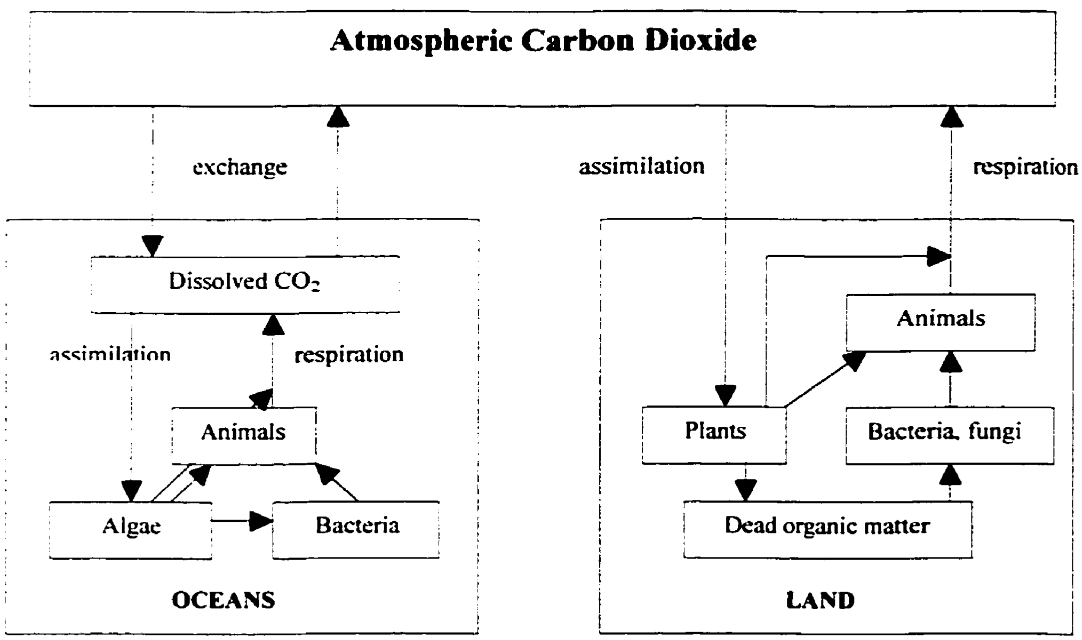


FIGURE 2.4 The Carbon Cycle

Adapted from Ricklefs (1990)

A sink CDM project includes carbon sequestration in plants and soils in land use and forestry activities. For example, a Canadian corporation could invest in protecting a threatened mature rainforest in Costa Rica as a CDM project. In return, they will receive credit for a portion of the carbon that is sequestered in that forest. By absorbing CO_2 from the atmosphere, trees become natural storehouses of carbon. In fact, studies have indicated that sinks could remove up to 30% of carbon from the burning of fossil fuels from the atmosphere (IPCC 1995a). This carbon can be stored for decades or centuries, until the tree is burnt or decomposes. At that time, the carbon is returned to the atmosphere. When trees are logged, the end product of the lumber determines if the carbon remains stored within the wood (Sedjo et al. 1998). If the lumber is used to make furniture, for example, the carbon will remain in the wood and will not be released back into the atmosphere unless the furniture is burned, or the wood eventually decomposes (Muller 1991; Brown 1998). If the lumber is burned for fuel for heating homes or cooking, however, the carbon will be immediately released and will contribute to the greenhouse effect.

Forestry projects are considered viable options for CDM projects because of the forest's ability to store carbon in its biomass. There is some controversy over what portions of the forest should be included in this biomass calculation, whether it should include aboveground biomass (leaves, stems, branches, bark), above-ground litter, below ground biomass (roots, soil), or all three. Carbon sequestration has been defined as:

> "The process whereby forested areas retain a revolving but stable store of organic carbon in their biomass" (Asian Development Bank 1995).

Conversion of old growth forests to fuel, young forests, or other land uses such as agriculture increases the CO_2 in the atmosphere and contributes to global warming. Forest conversion contributes between 1-2 GT of carbon annually to the atmosphere, and has contributed approximately 30% of the atmospheric build up of CO_2 in the past 150 years (Trexler and Kosloff 1998; Brown 1998). If all tropical forests were removed, CO_2 would increase in the atmosphere by 10-17% (IPCC 1990). Biomass burning for land clearing in non-Annex I countries, including tropical deforestation and the burning of savanna, contributes a significant amount of GHGs to the atmosphere (Lopez 1999).

Since forestry practices have contributed to the global warming phenomenon through deforestation, it makes sense that forestry projects can play a role in curbing climate change. In Canada, for example, the Council of Forest Industries believes afforestation efforts could sequester up to 10% more of Canada's emissions than currently sequestered in Canadian forests (Cornford 1998). In fact, the build up of CO_2 during the 1980's from land use change and deforestation accounts for almost 20% of *anthropogenic* radiative forcing of GHGs (Figure 2.5). Radiative forcing describes a change in the energy balance of the Earth's atmospheric system in response to changes in the concentration of GHGs. This energy balance controls our climate system (Brown 1998).

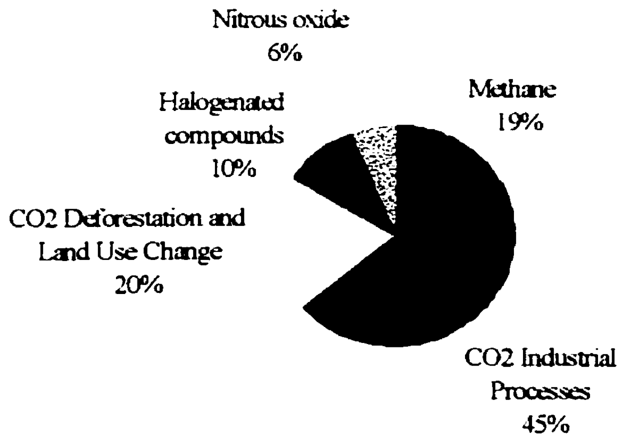


FIGURE 2.5 Greenhouse Gas Share of Radiative Forcing

Source: Brown 1998 p. 9

The FCCC and the Kyoto Protocol promote the use of sinks in reducing atmospheric carbon. Article 4 of the FCCC states that each industrialized country shall "adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases and protecting and enhancing its greenhouse gas sinks and reservoirs" (Article 4.2a). In addition, it affirms that Parties shall "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoir...including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems" (Article 4.1d). During the Kyoto negotiations, Canada fought for, and won, the right to include forest sinks, and the removal of CO_2 from the atmosphere by these sinks, in calculations of greenhouse gas emissions (Cornford 1997). Verifiable sink accumulations during 2008-2012 will now be counted in meeting international targets. The Kyoto Protocol includes several references to land use change and forestry projects (Table 2.3).

Article 2 (ii) states that each Party included in Annex I, in order to promote sustainable development, shall protect and enhance sinks and reservoirs of greenhouse gases, taking into account the promotion of sustainable forest management practices, afforestation, and reforestation. Article 3.3 of the Protocol requires industrialized country's to submit an inventory of greenhouse gases during the 2008-2012 commitment period. The inventory must include "the net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period" (Article 3.3).

The Kyoto Protocol limits the reporting and inventory of land use change and forestry to afforestation, reforestation, and deforestation. Afforestation typically occurs when forest is created on land that has not been previously forested or land that has not been forested for a very long time (Sedjo et al. 1998). It may include both natural processes and tree planting, and always results in a carbon sink. Reforestation refers to the re-establishment of a forest on recently harvested land, or land that has been cleared for "awhile" (Sedjo et al. 1998). It also results in a carbon sink, because the new forest adds plant biomass that sequesters carbon from the atmosphere. Deforestation, on the other hand, occurs when forests are cleared and not replanted (Sedjo et al. 1998).

Article 12 of the Protocol, which addresses the CDM, does not explicitly mention forestry projects. Regardless, proactive organizations are seeking to make their own rules with regard to these projects, in hopes of influencing which projects will eventually be allowed under the CDM (Stewart 1997; Trexler and Kosloff 1998). The IPCC is scheduled to release a Special Report on Land Use, Land use Change, and Forestry and Carbon Emissions in 2000 (Brown 1998). Until this report is released or guidelines are created that specify which land use change and forestry projects are recognized under the CDM, it can be assumed that all projects are acceptable.

TABLE 2.3 Summary of Land Use Change and Forestry under the Kyoto Protocol

ARTICLE	RELEVANCE TO LAND USE CHANGE AND FORESTRY
2	Promotes the protection and enhancement of sinks and reservoirs of greenhouse gases by Annex I countries, taking into account the promotion of sustainable forest management practices, afforestation and reforestation, in order to promote sustainable development.
3.3	Defines which domestic emissions industrialized countries should inventory during the 2008-2012 commitment period. GHG removals and emissions from human-induced afforestation, reforestation, and deforestation that have occurred since 1990.
3.4	States that later Conferences of the Parties may include additional activities such as forest harvest management, or remove activities that must be inventoried.
6 and 17	Defines joint implementation and carbon trading. Refers to enhancing carbon storage and reducing emissions, but does not specify which kinds of projects are allowed.
12	No explicit mention of land use change and forestry projects, making it unclear which kind of endeavors will be allowed under the CDM.

Source: Brown (1998) page 6

2.3 ACTORS AND PARTICIPANTS

Many players are involved in the establishment, development, and implementation of the CDM, including the international community, federal governments, organizations within countries, employees within the governments or organizations, and local communities (Trexler and Kosloff 1998; Thompson 1997). Article 12.9 of the Kyoto Protocol clearly states that private and/or public entities may be involved in CDM projects, and will be subject to whatever guidance is provided by the Conference of the Parties executive board. Ultimately, COP, as part of the international community, is the driving force behind the creation and implementation of the CDM (Article 12.4, Kyoto Protocol). It is responsible for determining how the methodologies and standards for the CDM are established, and who can participate.

Federal governments are external participants (Thompson 1997). They must decide how to proceed with the Kyoto Protocol. In Annex I countries, it is the federal government's responsibility to ensure that any private sector participation is consistent with the Protocol, and any rules or guidelines that will be developed. They must also promote a climate that is amenable to investing in offset projects by ensuring the necessary institutions are in place for the CDM, honoring their commitment to reward credit for early actions, and establishing national regulations, if necessary (Zollinger and Dower 1996). Governments within non-Annex I, or host, countries will be responsible for determining which CDM projects are eligible for certification within their borders (Article 12, Kyoto Protocol). They must also determine which projects are consistent with their own national objectives.

Organizations or other private entities may also be participants in the CDM (Article 12, Kyoto Protocol). The CDM is a complex initiative, and private entities and organizations, and professionals involved in projects or trading will have to develop the necessary expertise. Internal participants should include both environmental and financial employees of organizations who have a strong understanding of the international intricacies of the CDM, as well as the organization's own goals (Thompson 1997). Because it is an emerging environmental management tool and there are few case studies from which to learn, organizations and decision-makers will have to be proactive when searching for and investing in potential projects, and will have to use lessons learned from AIJ projects (Trexler and Kosloff 1998). They must also be sensitive to the needs of the host country and organization whether that is another corporation, a non-governmental organization, or a government. Local communities in the host countries are often passive participants, positively (reduced pollution) or negatively (loss of land) affected by CDM projects (Thompson 1997). CDM partnerships may occur with little public input from such communities.

2.4 Standards and Criteria

Because the CDM is a relatively new tool, several logistical issues still require further clarification, including the issue of methodologies and standards. AIJ, the pilot phase of JI, has caused many national AIJ offices to open and has spawned discussions on project acceptance criteria and standard reporting formats. While the results from the pilot phase will probably be ambiguous at best, any methodologies could be refined and applied to the CDM, where applicable (Kosloff 1997).

According to Trines (1998), the process for setting an international standard is well defined. The International Organization for Standardization (ISO) defines standard as "...a documented agreement containing technical specifications or other precise criteria to be used consistently as rules, guidelines or definitions or characteristics...". At the time of this writing, the CDM is lacking an official standard to guide the process. ISO's Technical Committee on Environment Management (TC 207), however, passed a resolution in June, 1999 stating their interest in developing internationally accepted standards for the Clean Development Mechanism (Cutter Information Corp. 1999). There are several principles that can be adopted from the FCCC and the Kyoto Protocol that will help define the scope of the standard. These include criteria for project eligibility and principles for certification (Trines 1998).

2.4.1 Project eligibility

Criteria to determine which projects should be accepted under the CDM are still under negotiation. Several organizations and governments are currently discussing and developing criteria and principles for project eligibility (IISD 1998a; Toman and Cazorla 1998; Trexler and Kosloff 1998). The following criteria can be summarized from these discussions and international agreements:

- measurability;
- additionality;
- acceptability;
- co-benefits; and
- capacity (Trines 1998).

Measurability

Article 12.5 (b) of the Kyoto Protocol stipulates that CDM projects must be real, measurable, and have long-term benefits related to the mitigation of climate change. This ensures that the project is combating climate change, and that the carbon credits can be verified and certified. This is discussed further below in Section 2.4.2.

Additionality

Article 12.5(c) of the Protocol states that CDM projects shall provide emission reductions that are additional to any that would otherwise have occurred. That is, the emission reductions must be a result of the CDM project, and must not have eventually occurred, regardless of the project. The emissions without the project are termed the baseline scenario. The certified emission reduction (CER) credit, then, should be the difference between the baseline scenario and the CDM project emission levels (Trines 1998). The Protocol also promotes financial additionality, whereby the project must be funded outside of the Official Development Assistance (ODA).

Acceptability

CDM projects must be acceptable to both the host country and the investor. Article 12.5(a) declares that participation in CDM projects is voluntary. Each participant, then, should have an opportunity to decide if the project meets national and corporate objectives. Projects should be tested against what is internationally or nationally acceptable to ensure they are consistent with environmental and development priorities, including sustainable development (Trines 1998).

Co-benefits

The CDM is being promoted as a win-win scenario (Trexler and Kosloff 1998; Frumhoff et al. 1998). In addition to emissions reduction or sequestration, CDM projects should benefit the host country in other areas, such as maintaining biodiversity, decreasing local pollution, or job creation (Imaz et al. 1998). Social and environmental indicators can be used to ensure that projects comply with local legislation, and do not cause detrimental impacts (Trines 1998). Assessing co-benefits also guarantees that emissions are not simply being displaced to another area, thereby resulting in no net decrease of carbon. For example, logging stopped in one location can result in deforestation of another area: a phenomenon known as leakage (Watt and Sathaye 1995; Brown 1998).

Capacity

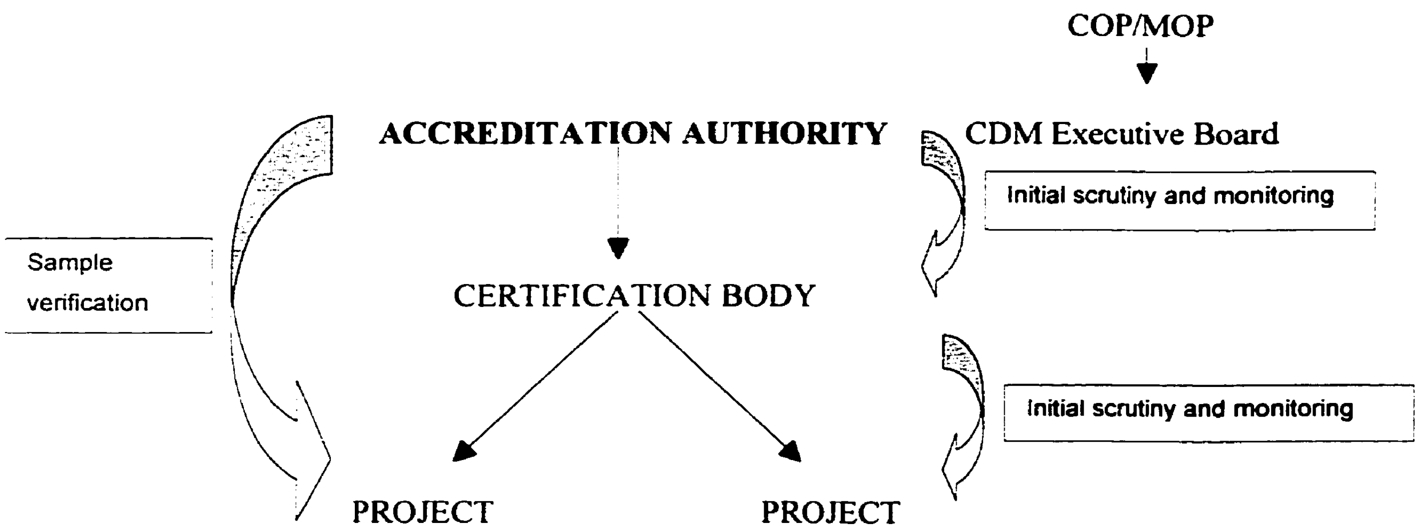
The capacity of a CDM project indicates the level of capabilities the stakeholders have to complete the project (Trines 1998). Ascertaining the management skills of those who will undertake the project, the financial resources, the level of infrastructure and technology available, and the ability to demonstrate emission reductions can determine if the project will succeed in its goal (Trines 1998). This criterion provides a holistic perspective of the project.

2.4.2 Certification

Certification of CDM projects involves two steps: certifying the projects prior to inception, and certifying the emissions reduction, thereby creating CERs (Trines 1998). With regard to project certification, Article 12.7 of the Protocol promotes "ensuring transparency, efficiency and accountability through independent auditing and verification of project activities". Methodologies and standards for certification still need to be established, as do the bodies that will perform these services (IISD 1998b). These certification bodies are beginning to form (Trines 1998; Cutter Information Corp 1999). In July, 1999, the first officially recognized independent verification and certification of greenhouse gas emission reductions was conducted by a Norwegian certification foundation, Det Norske Veritas (Cutter Information Corp 1999). For the CDM to be an effective environmental management tool, certification of emission reductions should be both standardized and harmonized (Thompson 1997). To maintain credibility, progress reports based on monitoring programs should be submitted annually to COP that include the quantification of emissions as well as the environmental, social and economic effects of the project (Trines 1998). Certification of emissions reductions guards against project failure and liability (Toman and Cazorla 1998). Stringent certification, monitoring and verification will ensure limited liability for the investor in a CDM project.

The Kyoto Protocol establishes an executive board to provide guidance to COP on the CDM (Article 12). Not only should COP and the executive board develop clear procedures and guidelines to follow for certification and acceptance, they must also develop certification entities to assess the CDM projects before they can proceed (Trines 1998). Using existing bodies like ISO that have the relevant expertise and experience would be preferable to creating new organizations (Trines 1998). The certification bodies can be intergovernmental or private, but should remain independent of acceptance and implementation of projects (Toman and Cazorla 1998). The certification body and the CDM executive board should have equitable North-South representation (Frumhoff et al. 1998; TERI 1998). An accreditation authority should be responsible for initially accrediting the certification body before it can officially certify projects on its own, and then monitoring its progress (Trines 1998). This further adds credibility to the process and reduces risk for the investor and the host country. Forestry CDM projects, for example, could use the Forest Stewardship Council, which already accredits organizations that certify timber products, as a potential accreditor (Frumhoff et al. 1998).

There are many standard certification frameworks from which COP can draw to determine the appropriate process for the CDM. Figure 2.6 illustrates one certification framework that could work for the CDM.



Source: Trines (1998)

FIGURE 2.6 Standard Certification Framework

Article 12.5 states that emission reductions must lead to real, measurable and long-term benefits to the mitigation of climate change. This implies that verification of emissions reduction is required. Verification of the emissions reduction involves quantifying the amount of carbon reduced or sequestered, and certifying this reduction so that it can apply as a credit (Trines 1998). As with certification of CDM projects, methodologies for this process should be standardized to increase credibility (Thompson 1997). The jury is still out as to how this should be accomplished. The U.S. Environmental Defense Fund suggests that:

> "Verification that reductions are being achieved by the host country should be done by an objective, third party source. One approach would be for the Conference of the Parties to develop specifications for verification and allow investors in joint implementation [or CDM] hosts to hire accredited private companies to verify the hosts according to the specifications...Another approach would be to have verification carried out by a body established by the Conference

of the Parties. Verified reductions would have a greater level of certainty and therefore value. As a result, not all JI [or CDM] investments need to be verified, but all need to be subject to verification on demand" (Dudek et. al 1994 p.7).

2.4.3 Emissions Trading

Many organizations are addressing the issue of standards and methodologies for trading of CERs (National Climate Change Secretariat 1998). For example, GERT, the Greenhouse Gas Emissions Trading Pilot, is currently developing standards and methodologies for emissions trading that will likely be used for CDM projects in the future. GERT is a Canadian program spearheaded in British Columbia, and has since been joined by Alberta, Saskatchewan, and Nova Scotia (B.C. Ministry of Employment and Investment 1997). These provinces have signed a Memorandum of Understanding with Environment Canada and Natural Resources Canada (B.C. Ministry of Employment and Investment 1997). Currently, tradable emission reductions can be generated by projects that reduce emissions, avoid increases in emissions that would otherwise have occurred, or absorb or sequester emissions. Whether these emission reductions are traded on a project-by-project basis between parties, or whether there will be a clearinghouse where certified reductions can be held for placement on the market must still be established (Toman and Cazorla 1998).

2.5 Incentives and Benefits

2.5.1 Incentives for Annex I Countries

Why choose the CDM as a tool for reducing greenhouse gas emissions? There are many reasons for organizations or governments in both the investing country and the host country to participate in the initiative, ranging from environmental stewardship to the prospect of capital gain. Annex I countries, or organizations within those countries, may choose to invest in the CDM for many reasons, including (Cutright 1996; Michaelowa and Greiner 1996; Michaelowa and Dutschke 1998; Trexler and Kosloff 1998; D. Thompson pers. comm.):

- to fulfil a moral obligation;
- to prevent the predicted environmental impacts from global warming;
- to prevent potential negative economic consequences of global warming;
- to receive early credit against carbon emissions;

- to demonstrate that voluntary programs to reduce GHG emissions are viable;
- to reduce a greater volume of CO_2 per dollar invested than domestic projects could achieve; and
- to gain access to new markets in developing countries.

Fulfil a moral obligation

Article 3.1 of the FCCC states that Parties should "protect the climate system for the benefit of present and future generations of humankind..." and that "the developed country Parties should take the lead in combating climate change and the adverse effects thereof." This suggests that developed countries, being responsible for the majority of anthropogenic emissions in the atmosphere, must also take responsibility for fixing the problem they created. Developing countries should not face limits to their economic growth because of the historical actions of industrialized countries (TERI 1998). From an environmental perspective, investing in GHG reduction strategies or projects like CDM may represent the 'right thing to do'. While economic growth is essential to improving the conditions of millions of people in developing nations, the result of industrialization under the current development model is usually increased GHG emissions (Global Climate Coalition 1997). Annex I Parties, then, are obligated to help non-Annex I countries achieve industrialization, if that is their goal, by providing efficient technology to help keep emissions to a minimum (TERI 1998).

Prevent predicted negative environmental and economic impacts

Environmentally, curbing emission growth could also avoid predicted global impacts such as rising sea levels, increased shoreline erosion, ecosystem fragmentation and loss of biodiversity in the future (United Nations 1998; Denton 1997). The CDM could also provide a cost-effective solution to the potential negative economic consequences of global warming. Although economic analyses of reducing carbon emissions is difficult, some studies have predicted that a doubling of atmospheric carbon dioxide could result in damages of 1 to 1.5% GDP for industrialized countries, and 2 to 9% per year for developing countries (IPCC 1995a). In this light, avoiding these damages by investing in greenhouse gas emission reduction projects is economically prudent.

Credit for early action

While doing the right thing sounds like a good idea, it alone is not a strong enough incentive for organizations to invest dollars into offset projects (Lile et al. 1998). The CDM has provided a large incentive for private organizations to invest dollars in offset projects by allowing early credit. Article 12.9 of the Protocol states that certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period (2008-2012). Although no concrete action has been taken, the Canadian government supports awarding credit for early action, which ensures that Canadian organizations may have a significant incentive to invest in CDM projects (Ross 1998). Credit for early action is a key issue, and is essential to prove to stakeholders that delaying action to reduce emissions is not advantageous.

Demonstrate that voluntary programs to reduce GHG emissions are viable

As mentioned earlier, another primary incentive for Annex I countries to use the CDM is the opportunity to demonstrate that voluntary programs for GHG emission reductions are viable, and that the private sector does not require a mandatory command and control approach to experience positive results (Cutright 1996; Thompson 1997). In other words, if industry does not want to be faced with a carbon tax or other similar measures, they need their attempt at self-regulation to be successful. The CDM can demonstrate that voluntary programs can be effective in reducing GHG emissions.

Reduce a greater volume of CO_2 per dollar invested

Although CDM projects may involve both public and private entities, their market-based and potentially cost-effective approach makes them especially appealing to corporations (Curtis and Aslam 1998). The stable and global nature of greenhouse gases lends itself well to the economic characteristics of a market-based trading scheme. The disproportional cost of carbon credits throughout the world (between $1 per tonne and $100 per tonne of carbon) provides an economic incentive to trade (Curtis and Aslam 1998). The CDM is cost-effective in that, if energy efficiencies are already high in industrialized countries, further reductions can be expensive and inefficient (Thompson 1997). In many cases, it would be more cost-effective to provide the necessary resources to developing countries to achieve emissions reductions than to endeavor to produce emission reductions domestically. For example, afforestation of low cost lands in developing nations is one of the least expensive greenhouse gas reduction options (Sedjo 1998).

It would be less expensive in the short-term to invest in afforestation in a developing country than to improve fossil fuel energy efficiency domestically. The CDM may also lead to new and innovative developments in emission reduction that encourage future market-based approaches to environmental issues.

Gain access to new markets

The private sector in Annex I countries should also view the CDM as an opportunity to enter new markets in developing countries. As the economies in these countries grow, investors that have a presence in the country already will have an advantage (Michaelowa and Greiner 1996).

2.5.2 Incentives for Non-Annex I countries

Without binding targets, non-Annex I countries may find less incentive than Annex I countries to participate in CDM projects. Some countries, such as those that may be most adversely affected by global warming (e.g. small island states) have a large direct incentive to participate in climate change initiatives (United Nations 1998). Most developing countries, however, are more concerned with "feeding their children, than with protecting their grandchildren from potential global warming" (Jacoby et al. 1998 p. 4; E. Sempris pers. comm.). Sensitive, properly planned and implemented CDM projects offer benefits in addition to climate change mitigation that may be appealing to the host country (Imaz et al. 1998). Through the CDM, technology, expertise and funding can be provided to the host country. This, in turn, can contribute to community, social and economic development, and support the host country's goals (Bird and Munoz 1997). Costa Rica, for example, insists that CDM projects must meet the government's goals of "biodiversity conservation, reforestation and forest preservation, sustainable land use, watershed protection, air and water pollution reduction, reduction of fossil fuel consumption, increased utilization of renewable resources, and enhanced energy efficiency" (Andrasko et al. 1996 p.33). These criteria ensure that CDM projects are compatible with national objectives.

Potential co-benefits are perhaps the greatest incentive for host countries to participate in the CDM (Imaz et al. 1998). The concept of the CDM focuses on no-regrets policies. In addition to reducing the amount of GHG in the atmosphere, it also has the potential to reduce air pollution through improved energy sources, stimulate the economy, reduce soil erosion, improve watershed quality, and restore biodiversity (Imaz et al. 1998; Trexler and Kosloff 1998). Table 2.4 illustrates some general benefits that could arise from CDM projects.

TABLE 2.4 CDM Potential Co-Benefits for Developing Countries

Environmental

- reduced air pollution caused by old technologies;
- transfer of clean technologies that leapfrog over inefficient phase of industrialization;
- reduced water pollution and soil erosion caused by deforestation and unsustainable forestry or agriculture practices;
- restoration of productivity of degraded lands;
- biodiversity conservation;
- improved waste management practices;
- support for country's goals of sustainable development;

Economic

- attract foreign direct investment in priority sectors of host country economy;
- transfer of clean, cost-effective, state-of-the-art technologies and know-how;
- energy efficiency improvements;
- creation of additional jobs and areas of expertise (capacity building);

Social

- improved access to more efficient technologies;
- partial support for community based livelihoods through CDM power and forestry projects;
- health improvements from cleaner air;

Political

- opportunity to meaningfully participate in emissions reductions;
- advancement of national goals;
- improve trade opportunities;
- satisfy international commitments.

Adapted from International Flexibility Mechanisms Table (1998); Trexler and Kosloff (1998); D. Thompson (pers. comm.)

2.5.3 Incentives for Participating in Forestry Projects

According to Freedman (1997), the most important means of decreasing CO_2 emissions would involve reducing the use of fossil fuels as energy. Given this fact, why would forestry projects be considered as viable options? Because fossil fuels are so economically important to Canada and other industrialized nations, it is currently cost prohibitive to rely solely on fossil fuel reduction to meet international greenhouse gas reduction commitments (Freedman 1997). Forestry projects, through deferring emissions by avoiding deforestation, or increasing the amount of organic carbon stored in trees by afforestation, offer an attractive and inexpensive alternative to be used in addition to energy projects (Bird 1998; Freedman 1997). Tree planting and conservation can buy time by delaying global warming during the slow transition to non-fossil fuel sources of energy (Freedman 1997; Muller 1991). Forestry-based carbon offset projects can also complement the reduction on fossil fuel emissions while helping developing countries finance ecologically and socially sustainable alternatives to damaging land use practices (Frumhoff et al. 1998). The United States Initiative on Joint Implementation (USIJI) currently screens potential offset projects to determine if they are acceptable, given certain criteria. Of the 110 project proposals submitted to USIJI, 49 were carbon sequestration projects (Lile et al. 1998). While there is a Canadian Joint Implementation Initiative (CJII) office, the USIJI is more established.

Deforestation usually results in private short-term economic gains. The CDM offers a chance to balance these local gains with potentially greater global benefits by financially rewarding those who create these benefits (World Bank 1998). Some developing countries may be better off financially with less land clearing and more carbon sequestration. One study suggests that developing countries can receive more capital for their forests through conservation than through conversion to agricultural land (Schneider 1994). Schneider (1994) studied the market value of forest land for agriculture in Brazil, and found that values ranged between \$2 to \$300 per hectare. By combining figures on the amount of carbon stored in these forests with potential carbon taxes in Brazil, one reaches values of \$700 and \$5000 per hectare (Schneider 1994). This is the value that the forests could be worth to potential northern investors, were they not converted for agricultural purposes.

There are numerous reasons to reduce deforestation and restore forest ecosystems, many of which are more pressing than the threat of global warming. Environmentally, "emissions from the conservation and degradation of forest and grassland ecosystems is not only a contributor to climate change but is also a significant driving force behind species extinction and the loss of critical ecosystem functions and services such as regenerating watersheds, purifying water, slowing soil erosion, and providing food, fiber and medicines" (Brown 1998, page 6). Conserving and restoring forests and their ecological functions, then, could protect and restore these services. As well, forestry-based offset projects can conserve and maintain biological diversity (Brown 1998; Frumhoff et al. 1998). As these services benefit the world, not just the country within which the forest resides, industrialized countries should share in the responsibilities of ensuring their continuation. The CDM provides a tool to do just that.

Socially, it is the local community that relies upon the forest that would be the most affected from a forestry-based project (TERI 1998). Why would they choose to give up their land use control of a forest? If the CDM project includes a long-term sustainable forestry component, they would still have an income from the land and their concerns may be alleviated (Brown 1998). If the project requires conservation of large tracts of forest, however, forestry-based communities would have greater reason to be concerned about their livelihoods. In these cases, communities would have to be given other opportunities to earn a living as part of the CDM project.

2.6 Barriers Facing the CDM

2.6.1 General CDM barriers

Although the CDM bandwagon is filling up and gaining speed, there are still barriers to its success that must be addressed, including (Brown 1998; Greenpeace 1997; Jacoby et al. 1998; Rolfe 1998; TERI 1998; N. Bird pers. comm.; D. Thompson pers. comm.):

- political uncertainty;
- moral and ethical opposition;
- reduced pressure for research and development;
- lack of binding targets;
- technical issues such as the calculation of baseline;

- lack of clarity regarding sustainable development objectives; and
- poor portrayal and description of CDM to non-Annex I countries.

Political uncertainty

Like any new international initiative, the CDM is not without its uncertainty and opposition. Despite the progress that has been made and the popularity it has gained, there is still political uncertainty about its future. There are many unanswered questions under Article 12 of the Kyoto Protocol, such as which types of projects will be allowed, and what methodologies will be used. There is also the uncertainty as to whether or not the Kyoto Protocol will be ratified. Without ratification, there is no Clean Development Mechanism. This has not, however, stopped Parties from being proactive and investing in CDM projects in anticipation of receiving credit towards their emission reduction targets.

Moral and ethical opposition

Philosophically, there is the concern that the CDM could become a tool for maintaining the unsustainable lifestyles of affluent societies at the expense of the developing countries (Bernstein and Chasek 1993). According to Greenpeace (1997), offset projects will "enable the North to continue using three times its share of the atmosphere". The CDM could allow industrialized countries to "buy their way out" of their responsibilities for emissions reduction by exploiting the cheap resources of developing countries (TERI 1998; Kuik 1994). The CDM is viewed by critics to be an excuse to turn attention away from the environmentally unfriendly industrialized countries, and put the burden of GHG reductions on the shoulders of the developing nations (IISD 1998a; E. Sempris pers. comm.). Many developing nations are proposing that a cap be placed on the amount of emissions reductions that can be accrued through offsets (TERI 1998). In fact, Article 12 of the Kyoto Protocol states that carbon credits may be used by Annex I countries to meet 'part' of their GHG reduction targets. The level at which this cap should be placed remains undetermined and controversial.

Reduced pressure for research and development

If no limit is imposed on what percentage of emission reductions can be gained through CDM projects, there is a concern that the CDM could stop the adoption of needed domestic improvements in the energy efficiency of industrialized countries. That is, it could possibly reduce pressure to invest in research and development domestically when fast and inexpensive offsets are available in other countries (D. Thompson pers. comm.). IISD (1998a), on the other hand, believes that the CDM will stimulate research and development in industrialized countries. This remains the subject of debate, and will only be resolved with time and experience in the CDM.

Lack of binding targets

The lack of binding emission reduction targets for non-Annex I countries imposes another barrier on the success of the CDM, both as a management tool and as an effective initiative to reduce global greenhouse gas emissions. Annex I countries that have binding targets could be at an economic disadvantage in the long-term (Jacoby et al. 1998). Industries that rely heavily on carbon-emitting technology or substantial energy will become more expensive and less competitive in Annex I countries. As developing countries advance, develop and invest in these industries, they have a competitive advantage with lower costs. In addition, as these facilities are constructed, non-Annex I countries will be more reluctant to threaten these industries by accepting emission reduction targets in the future (Jacoby et al. 1998).

Non-Annex I countries do not have binding targets because many still require periods of industrial growth. Could this change? There were two events at COP4 in Buenos Aires that suggest this might be a possibility. First, two non-Annex I countries made significant announcements. Argentina's President Menem announced that Argentina would voluntarily comply with a future emissions target, and Kazakhstan announced it would take on obligations to reduce GHG emissions. Second, the United States signed the Kyoto Protocol, declaring that the announcements from Argentina and Kazakhstan illustrated "meaningful participation" from non-Annex I countries (IISD 1998a). If developing countries will have binding emissions targets in the future, then they would be remiss to sell off all of the least-cost carbon projects at such an early date. They may need to claim the carbon sequestration capabilities of their forests for themselves in the future.

Technical issues

Technical issues currently plague all CDM projects, although they are slowly getting resolved (Trexler and Kosloff 1998; Brown 1998). How to quantify the baseline scenario (the emissions without the project) is a controversial and complicated issue (Brown 1998). Baseline emissions may potentially be established using two methods:

- use of a standardized baseline for specific project categories; or
- project-by-project (Japanese Delegation 1998).

There are pros and cons for both methods. Using a standardized baseline for each project category (tropical forestry, coal to fossil fuel technology transfer) would simplify administrative tasks, reduce transaction costs, and subsequently lower project costs (Japanese Delegation 1998). The formulation of these standardized baselines, however, requires a significant amount of expertise on the quantification of emission reductions that currently does not exist. More projects would have to be undertaken before enough data is collected with which to determine these baselines. Because of the widely diverse projects within each sector, a sectoral or standardized baseline could also result in a gross over or under estimation of emission reductions (Japanese Delegation 1998). Determining baselines on a project-by-project basis may be necessary until more research has been completed. Given that methodologies for quantifying emission reductions are established, calculating baselines on a project-by-project basis would ensure that accurate and verifiable estimates of emission reductions are made. Transaction costs, however, would increase substantially (Japanese Delegation 1998). Regardless of which method is used to calculate baselines, the process must be transparent and stringent because once the project begins, the baseline situation no longer exists.

The issue of whether baselines should be adjusted periodically over the project's lifetime is another controversial barrier to the smooth implementation of the CDM (N. Bird pers. comm.). For example, the baseline scenario for a retrofitted utility boiler should not only include pre-retrofit emission levels, it should also reflect the extent to which retrofitting is good practice, and would have eventually been completed (Rolfe 1998). The baseline emissions will decrease at each periodic review of the project, because the boiler would have been improved upon anyway. The difference between the baseline and the current emissions equals the emission reduction. The emission reduction, then, will decrease as the baseline scenario improves.

Lack of clarity regarding sustainable development objectives

One of the goals in Article 12 of the Kyoto Protocol stipulates that CDM projects shall assist developing countries in achieving sustainable development. This is a vague objective, and one that is open to interpretation.

Poor portrayal of CDM to non-Annex I countries

Host countries need clarification of the benefits CDM projects for developing countries, and in particular, they require clarity regarding the promise of sustainable development. The Chair of G-77/China, Ambassador Arizal Effendi, has stated that sustainable development needs to be spelled out in dollars and cents, in terms of "poverty alleviation and job creation" (IISD 1998b p. 2). In addition, the goals of the CDM should reflect the requirements of the host country, and create an incentive to participate. Clarification of Article 12 of the Protocol could reduce the concerns of host countries and aid in the success of the CDM.

2.6.2 Barriers to Successful Forestry Projects

Although forestry CDM projects have the potential to be effective in mitigating climate change and in providing co-benefits to host countries, there are still numerous barriers and unanswered questions that impede their path to success. Among these are (Trexler and Kosloff 1998; Brown 1998; Frumhoff et al. 1998; TERI 1998; D. Thompson pers. comm.):

- fear that forestry projects may impede progress on achieving emissions reduction in the energy sector;
- fear that forestry projects could become a political loophole and not result in real reductions;
- perception that forestry offsets have too many unsolved analytical issues, including quantification of sequestered carbon;
- uncertainty surrounding forestry projects in the Kyoto Protocol;
- difficulty in quantifying and attaching value to ecological services and secondary benefits;
- loss of land use control in host country and other negative local impacts; and
- risk of leakage and liability (lack of permanence).

Impede emissions reduction in energy sector

Early forestry offset projects have focused primarily on Latin America where land values and labor rates are inexpensive (Trexler and Kosloff 1998). The popularity of forestry projects has caused critics to fear that Parties will focus their attention and resources on these relatively inexpensive options, thereby ignoring or delaying research into more expensive but effective energy projects.

Fear of political loopholes

There is also the fear that forestry options could become a political loophole in GHG reduction efforts. This is based on the concepts of additionality and baseline, discussed above in Sections 2.4.1 and 2.6.1 respectively. In short, the loophole could be created if Parties try to claim carbon credits for projects that would have occurred anyway. For example, a Party may claim that a forested area would have been converted for agricultural use were it not for the CDM investment, when in fact it wasn't in danger of conversion (Brown 1998).

Unresolved analytical issues

Quantification of emissions reductions is difficult for any offset project, whether it involves technology transfer or land use change (Trexler and Kosloff 1998). CDM forestry projects, however, have unique analytical issues that need to be addressed. One of the perceived greatest obstacles to investing in forestry projects is the difficulty experienced in quantification of the GHG sequestered within the forest biomass (Brown 1998). Any effective tool requires standardized, practical, and repeatable methodologies that produce specific and measurable results (D. Thompson pers. comm.). The inability to satisfactorily quantify GHG reductions acts as a deterrent to Parties that expect concrete gains from their investment, as well as challenges the Kyoto Protocol's stipulation for "real" and "measurable" reductions.

The quantification of carbon sequestration on land use and forestry projects is especially onerous for many reasons. First, trees must be on the land for many years to ensure that carbon does not escape into the atmosphere. The Center for Clean Air Policy in the United States has concluded that forestry projects must be at least 50 years in length to be considered equivalent to emissions reductions (Center for Clean Air Policy 1993). It is questionable if the integrity of the forests as carbon stores can be guaranteed for long periods of time, especially in countries with questionable and shifting land use control (Greenpeace 1997). Solutions to this dilemma have included not selling all the potential carbon credits from a project. Instead, the host country keeps a percentage of the credits, thereby providing a cushion in the case of carbon release (Imaz at al. 1998). Second, the mechanisms involved in carbon uptake and storage are complex and have to be further researched, especially in tropical ecosystems (Odingo 1997). Decisions must be made on what biological components of the trees will be counted in the quantification of the carbon sequestration. Should roots and soil be included as well as above-ground biomass? Monoculture plantations appear to be easier to quantify than natural ecosystems, which could result in higher costs for forest protection projects (Sedjo et al. 1998). If these monoculture crops grow quickly and sequester high amounts of carbon, they could conceivably replace diverse old growth forests unless the issue of quantification is simplified. Third, if the forest is not protected, the end-use of the lumber further clouds the issue of quantification (D. Thompson pers. comm.). As previously discussed, harvested trees may or may not count for carbon sequestration. If the tree is harvested for firewood, for example, the carbon will be released into the atmosphere. If the tree is made into furniture, the carbon remains stored for the lifetime of the furniture. Fourth, measuring carbon before and after modifications in land use has also not been perfected (N. Bird pers. comm.). For example, the impact on emissions from displacing agriculture for afforestation projects involves not only a measurement of the carbon that can be sequestered by the new trees, but also a subtraction of the carbon sequestration potential from the agricultural land. It should be noted that current research is addressing and solving these analytical issues, and proving that quantification of sequestration may not be as difficult as once thought (Trexler and Kosloff 1998; Frumhoff et al. 1998; Hamburg et al. 1997; IGBP Terrestrial Carbon Working Group 1998).

Uncertainty in Kyoto Protocol

Because of the investment risks and the complexities inherent in the quantification of carbon sequestration of forestry projects, there is not as much investment in land use projects as there could be, even though they deliver high non-financial, secondary benefits (N. Bird pers. comm.). Unresolved issues regarding forestry projects in the Kyoto Protocol exacerbates the uncertainties surrounding such projects. Investing in forest protection projects, for example, while proactive, is risky because these types of projects may not be allowed in the future under the Protocol. Investors also believe sequestration projects to be risky because of their complicated nature and long timespan (N. Bird pers. com.).

Lack of valuation of ecological services

According to Frumhoff et al. (1998), "markets generally fail to capture the values of biodiversity, carbon storage and other ecosystem services." The CDM creates a new opportunity to "correct this market failure by motivating payments for the carbon storage and sequestration values of tropical forests" (Frumhoff et al. 1998 p.1). During cost-benefit analysis of potential projects, value should be assigned to secondary benefits and ecological services such as biodiversity conservation (Baskin et al. 1997; Daily et al. 1996; Barrett 1988; Johansson 1987). This could increase the attractiveness of the project and decrease the perceived risk.

Loss of land use control and other local negative impacts

In the host country, there are also concerns that must be overcome before CDM forestry projects will be successful. First and foremost, there is concern regarding the loss of land use control (D. Thompson pers. comm.). Developing communities may rely on a particular land use practice for their income. Planting or conserving trees as carbon sinks on land that is currently farmed as agriculture may not be a viable economic option for that community, unless other lands are then used more efficiently. The host country may also be concerned about the threat to national sovereignty that CDM forestry projects may pose (TERI 1998; Brown 1998). The Kyoto Protocol is an international agreement, and the investors in CDM are from northern, industrialized countries. Entering into CDM projects may entail giving up land use control to a developed country, and could preclude using the land for purposes other than carbon sequestration (Brown 1998). In fact, there is a concern from critics of forestry projects that entire countries may be turned into carbon sequestration reserves, thereby hindering economic development (Trexler and Kosloff 1998). To ensure this does not happen, projects should be screened to ensure that property rights and the needs of local users are addressed, and that national development priorities are respected (Brown 1998).

Risk of leakage and liability

The issue of land use control is inextricably linked to the issues of leakage and binding targets. Leakage occurs in forestry projects when protecting one area simply results in the deforestation of another (Watt and Sathaye 1995; Brown 1998). This concern is magnified when the project is between an Annex I country that has agreed to binding reductions and a non-Annex I country that has no such commitment. A country without binding reduction targets could easily permit deforestation without penalty after the project GHG reductions have been calculated. Many developing countries have poorly defined property rights, and large populations with high growth rates that depend on the land for subsistence (Sedjo et al. 1998; Brown 1998). In these instances, industries such as agriculture and livestock grazing provide food and shelter to communities. Converting this land back to protected forest without providing for alternative means of substinence essentially deprives these communities of their livelihood while offering little disincentive for future deforestation (Brown 1998).

The risk of leakage increases the liability to the investor when they enter into a CDM agreement (Toman and Cazorla 1998). While certification and verification will reduce liability to the investor, there is still the chance that the project will not deliver the certified emissions reductions. Organizations like the Greenhouse Gas Management Consortium (GEMCO) in Canada want guarantees of permanence for investors. They suggest that a contingency be added to the investment, or only partial carbon credits be sold so that the carbon amount is guaranteed in the case of fire, pests, or drought (N. Bird pers. comm.). A contingency of carbon credits can cover the loss to the investor if the project is not successful. Capping the percentage of carbon credits that a foreign investor can receive from an offset project may account for future risks and reduce liability.

2.7 SUMMARY OF ISSUES

Despite the barriers and challenges, the CDM is still viewed by many as a new and exciting environmental tool to manage the threat of climate change. There are discrepancies between Annex I and non-Annex I expectations and driving forces for participation in the CDM. The CDM must be promoted and designed so developing countries have an equitable share in benefits, understand the CDM clearly, and receive benefits that are sensitive and appropriate to their specific circumstances. With more research, proper planning and implementation of projects, the obstacles and barriers to successful projects may be overcome

Chapter 3 will discuss the institutional, socio-economic and environmental setting of the case study in the Sierra Gorda Biosphere Reserve.

CHAPTER 3

A CASE STUDY IN THE SIERRA GORDA BIOSPHERE RESERVE

"Properly designed and implemented, forestry-based CDM projects could support climate, biodiversity conservation and sustainable development objectives by paying the incremental costs of protecting parks and watersheds, reducing the impacts of logging restoring forests on degraded lands, and other measures."

Peter Frumhoff et al. 1998 p. 1

Forestry-based CDM projects cannot be planned or implemented in isolation of the communities they will impact, nor can they focus purely on carbon sequestration benefits. Issues such as carbon sequestration potential, endangered forest regions and biodiversity hot spots often overlap in developing countries, offering opportunities for positive synergies (Brown 1998). The Sierra Gorda case study was chosen as an example of a forestry-based CDM project that could illustrate these synergies. Through exploring the issues pertinent to this area, the case study will focus on the benefits and challenges facing a host country when they enter a CDM partnership. It is anticipated that the issues that arise will allow broader interpretations to be made to CDM forestry projects as a whole.

Chapter 1 included the methods and limitations in this case study, and the rationale behind choosing this area. This chapter makes use of a combination of the literature review and site reconnaissance data to describe Mexican institutions and their capacity for managing CDM projects, and the environmental and social setting of the Sierra Gorda Biosphere Reserve. This discussion is not intended to be an exhaustive description of the ecological conditions present in the Sierra Gorda. Rather, it will provide a cursory overview to illustrate the importance of the Reserve from an ecological perspective.

3.1 CDM IN MEXICO

As a non-Annex I country, Mexico does not have binding emissions reduction targets under the Kyoto Protocol. Regardless, they have embarked on several initiatives to reduce and/or sequester greenhouse gases and combat climate change. For example, an inventory of greenhouse gas emissions was conducted in 1996, and the Kyoto Protocol was signed on June 9, 1998 (J. Martinez, pers. comm.). The inventory showed that the energy sector is the most significant source of CO_2 emissions in Mexico (67%), and that forestry and land use change contribute 30.57% of total anthropogenic CO_2 emissions. Burning forests to make room for agriculture is a common land use conversion practice in Latin America, and a large cause of CO_2 emissions. In fact, land use conversion is the primary cause of emissions in the forestry and agriculture sectors (J. R. Ardavin, pers. comm). Investment in CDM projects in the forestry sector can help both Mexico and other countries acquire the time necessary to develop renewable energy sources and increased energy efficiency. Figure 3.1 provides a summary of land use in Mexico.

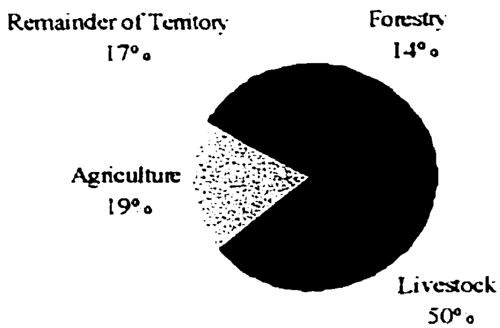


FIGURE 3.1 Land use in Mexico

Source: INE 1997

Mexico produced approximately 2% of global emissions in 1990. It is currently in the top 15 countries in terms of total volume of GHG emissions (J. Martinez pers. comm.). When compared with other non-Annex I countries, Mexico is the fifth largest emitter, behind China, India, Brazil and Indonesia (INE 1998). They have been involved in several projects under the pilot phase of JI (AIJ): projects that would now be considered CDM projects under the Kyoto Protocol. They have developed the institutions and procedures to address AIJ project proposals, and are well equipped to enter the CDM market. Further, they are willing and able to meaningfully participate in emissions reductions as a non-Annex I country.

3.1.1 Institutions and Capacity

The Mexican agency currently responsible for accepting, approving and endorsing CDM activities and reporting them to the Conference of the Parties (COP) is the Instituto Nacional de Ecología (INE; National Institute of Ecology). INE is a semi-autonomous institute under the direction of the Secretaria de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP; Ministry of the Environment, Natural Resources and Fisheries). In addition to climate change initiatives, INE is charges with the following tasks:

- to formulate, practice and evaluate the general policy to be followed in ecological matters;
- to establish rules and ecological criteria for the conservation and rational use of natural resources;
- to enforce the rules on rational use of wild and aquatic life to conserve and develop them;
- to manage protected areas not expressly managed by other government bodies; and
- to issue technical rules on hunting seasons (Gallina 1997).

Within INE, there are two separate climate change offices:

- Dirección de Cambio Clima Global (DCCG; Global Climate Change Directorate); and
- Oficina Mexicana para la Mitigación de Gases de Efecto Invernadero (OMMIGEI; Mexican Office for Greenhouse Gas Mitigation).

The DCCG is responsible for Mexico's voluntary registry program and National Action Plan. OMMIGEI is the part-time office specifically charged with developing CDM projects, under the direction of Dr. Carlos Gay Garcia (JIN 1998). This office promotes GHG projects to Mexican companies, identifies potential forestry and energy projects, and organizes methodology workshops for estimating carbon sequestration within forestry projects (N. Bird pers. comm). Ideally, OMMIGEI wants a total of 10 million tonnes of carbon identified in potential projects before the CDM officially starts (N. Bird pers. comm). Potential projects would then advance through what is now the AIJ process. In addition to INE and SEMARNAP, the current AIJ program also includes the Energy Ministry (SE), the Secretariat of Foreign Affairs (SRE) and the Commerce Secretariat (Figure 3.2).

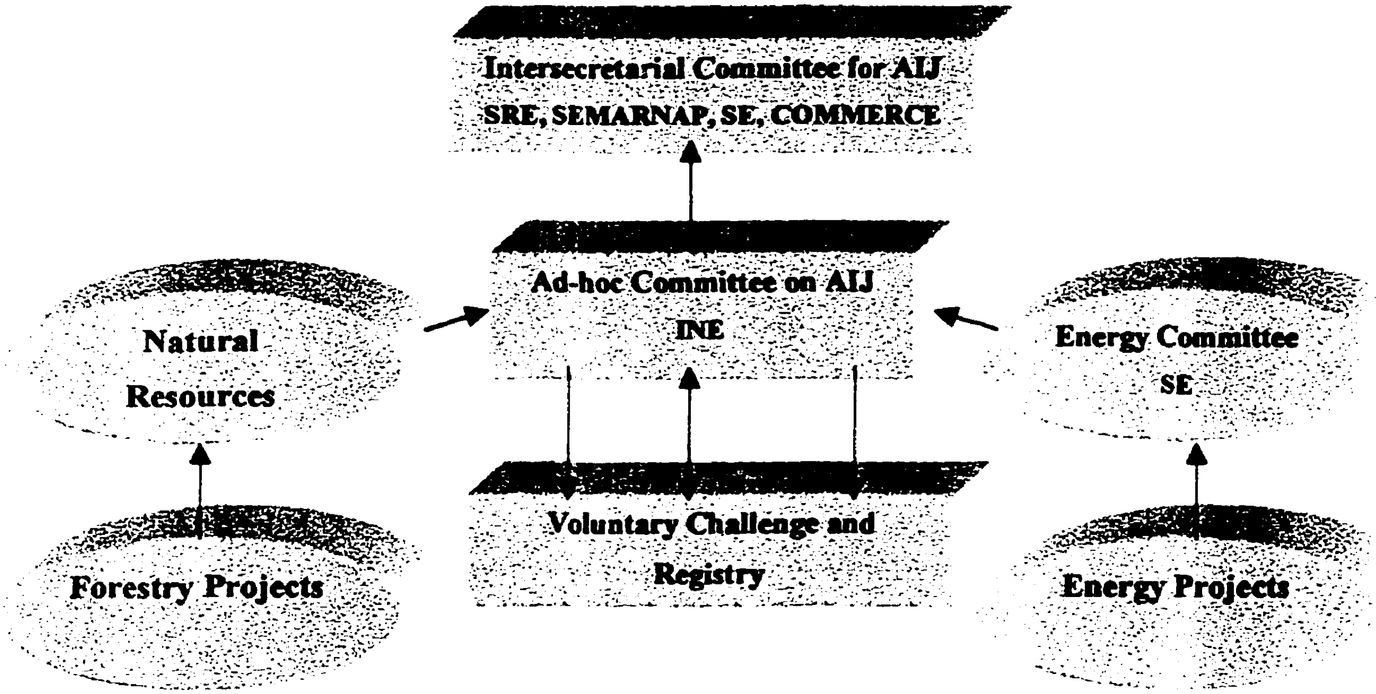


FIGURE 3.2 Mexican Institutional Framework

Source: Imaz et al. 1998

Project proposals are submitted to the Ad-hoc Committee on AIJ/JI, the Energy Committee, or the Natural Resources Committee. These committees review projects and discuss methodological issues such as project approval, criteria and baselines. The final decision to accept projects lies with the Ad-hoc Committee. The Intersecretarial Committee has yet to be formed, but eventually it will provide final approval and letters of acceptance for projects. Projects are then listed in the Voluntary Challenge and Registry (JIN 1998). National institutions to assess, monitor and verify projects are still required (Imaz et al. 1998).

The Natural Resources Committee is responsible for forestry-based projects. The guidelines they adhere to in the area of natural resources seek to:

- respond to the needs of local proprietors of natural resources;
- ensure the most technically appropriate and efficient use of resources;
- optimize the potential productivity of resources, thus increasing economic benefits to be derived;

- promote natural resource conservation and restoration; and
- increase community awareness about global environmental issues, as an incentive to conservation (JIN 1998).

To date, four projects have been officially accepted under this program. There is a sustainable agroforestry project, Scolel Té, in Chiapas, a project to cultivate salicornia on marginal desert land in Sanora, a community forestry project in Oaxaca, and a renewable energy mini-grid project in Baja. These projects have also been accepted by the USIJI program (Imaz et al. 1998; Sathaye et al. 1998).

3.1.2 Forestry Projects in Mexico

Mexican temperate and tropical forest ecosystems cover 50 million hectares of the country and provide habitat for 10% of the world's species diversity (Segura 1996). Table 3.1 provides information on species diversity and endemism in Mexico.

TABLE 3.1 Species Diversity and Endemism in Mexico

SPECIES GROUP	NO. OF SPECIES	ENDEMISM (%)	WORLD RANK
Flowering plants	30,000	40-50	n/a
Pines	55	85	1
Oaks	138	70	1
Reptiles	707	56	1
Mammals	439	33	2
Amphibians	282	62	4
Birds	980	12	7

Source Flores-Villela and Gerez (1988)

Mexico is an important contributor to world biodiversity (McNeely et al. 1990; Gallina 1997). According to McNeely et al. (1990):

> "..this biological richness is due to the great habitat variation and diverse ecological regions, complex topography, heterogeneity of soils and climate, geological history, and geographic location. Like

Indonesia, Mexico bridges two major biogeographic realms in the world – the Neartic and the Neotropical – that facilitates the exchange between elements of northern boreal and tropical origins. This great array of interacting species and organisms creates unique ecosystems of international importance".

Productivity of commercial forests in Mexico varies by region and type of forest. The national average of productivity is 1.3 m^3/ha/yr, which is 2.3 times less than that of Canada (Segura 1996). In addition to timber products, Mexican forest ecosystems produce 2.77 million tonnes of plants used for food, medicine, grazing and industrial purposes (World Bank 1995). If formal markets existed, ecological services such as watershed protection, tourism, recreation and potential pharmaceutical products could be provided by the forest ecosystems. The World Bank (1995) estimates that ecotourism, for example, could generate an annual income of more than US$30 million for the Mexican economy.

Deforestation estimates in Mexico range from 620 to 680 thousand ha per year, resulting in emissions of 71 MtonC per year (Segura 1996; L. Amariei pers. comm.). Forest conversion to agriculture and livestock is the primary cause of deforestation in temperate and tropical forests (Segura 1996). Between 1970 and 1990, the area covered by agriculture in Mexico increased 39%, and the area used for livestock grazing increased 100%, while forests declined 13% (Segura 1996). In addition to agriculture and grazing, forest fires and insects are the next largest causes of deforestation, although impoverished farmers who wish to increase their agricultural and grazing holdings often cause the forest fires (Segura 1996).

While many Annex I countries are reluctant to invest in forestry projects because of methodological and political uncertainties (see Section 2.6.2), the inclusion of forestry projects is vital if Mexico is to participate in the CDM (J. Martinez pers. comm.). Studies have been undertaken in Mexico to assess the capacity of its forests to capture carbon (INE 1998; Segura 1996). The results of these studies illustrate that the amount of carbon sequestered could be larger than the expected annual growth of emissions from the energy sector- 48.3 MtonC between 1990 and 2010 (INE 1998). In addition, carbon sequestration could represent an estimated value of US$650 to US$3,400 per hectare (Segura 1996). Like INE, the private sector in Mexico is also in favor of forestry projects. According to a private-sector representative, they are interested in CDM project options that maximize secondary benefits, such as biodiversity, and minimize cost (J.R. Ardivin pers. comm.).

3.1.3 Criteria for Project Acceptance

As mentioned in Chapter 2, the host country must accept CDM projects prior to implementation. In general, INE relies on the USIJI criteria to screen projects and determine project eligibility (J. Martinez, pers. comm.). To be approved by the Mexican government, projects must demonstrate that they:

- contribute to the sustainable and economic development of the region (co-benefits);
- represent an advance in the country's technical capacity;
- consider present and future emissions, both with and without the project, using accepted IPCC methodology;
- provide sufficient guarantees that net reductions will not be lost or canceled over time;
- contribute to achieving net global emissions reductions that are scientifically measurable and verifiable;
- in the case of forestry projects, result in a reasonable amount of carbon sequestration while promoting sustainable development; and
- are consistent with other environmental goals (JIN 1998).

Any Mexican citizen, business or government entity is eligible to participate in AIJ projects.

3.1.4 Concerns about CDM projects

The Mexican government's experience with AIJ has identified problems and solutions to international offset initiatives. Some concerns focus on institutional shortcomings, while others indicate the need to evaluate Mexico's ability and capacity to benefit from the CDM as a host country. Table 3.2 summarizes these concerns and offers some proposed solutions.

TABLE 3.2 Mexican Concerns Regarding CDM Projects

CONCERN	PROPOSED SOLUTIONS
Annex I countries will use CDM for most or all of their emissions reductions commitments	Annex I countries must begin significant domestic GHG reduction commitments
Additionality of CDM funding and potential redirecting of current ODA funding	Focus CDM on traditionally non-ODA funded activities
Difficult project evaluation because of unknown value of carbon credits	Allow future carbon market to determine value, or begin with international values being discussed
Mexico is OECD country, and may have binding reduction commitments in the future	Cap maximum share of project's carbon credits for investor. Develop national GHG reduction program
Investors threaten to go elsewhere unless given higher share of carbon credits	Ensure projects are of high quality and verifiable. Develop national standards specifying foreign share of carbon credits
High risks associated with projects (e.g. long life spans, transfer of obsolete technology)	CDM projects must be thoroughly analyzed for risks prior to project acceptance
Loss of land use control	Alternative means of income should be provided, including opportunities for sustainable forestry
Lack of awareness and knowledge of CDM among Mexican participants	Develop national education programs on the concept of global warming and CDM

Adapted from Imaz et al. 1998; and J. Martinez (pers. comm.)

In terms of methodologies, Mexico believes that financial and project additionality is a confusing criterion that needs to be further defined at an international and national level. Financial additionality, in particular, is often hard to determine when CDM funding and official development assistance come from the same agencies. Mexico is also concerned that official development assistance (ODA) could be compromised by CDM funding. Quantifying emissions credits is another methodological concern. OMMIGEI is actively involved in solving this concern through the research and development of acceptable methodologies (J. Martinez pers. comm.).

A major concern of the Mexican government is that Annex I countries will try to use the CDM to comply with the majority of their emissions reduction commitment. As an OECD country, there is always the possibility that Mexico will face binding GHG emissions reduction commitments in the future. They would be remiss to "sell off" the majority of their carbon sequestration capability, or energy efficiency projects to foreign investors when they may require the carbon credits in the near future (Imaz et al. 1998). Annex I countries are interested in investing in the low hanging fruit, or cheapest CDM projects, from non-Annex I countries. Mexico does not want to be left solely with expensive energy and technology projects in the case of legally binding commitments. Another concern related to the anticipation of future commitments is the issue of carbon credit sharing. Mexico wants to cap the percentage of carbon credits that a foreign investor can receive from an offset project. This achieves two purposes. It ensures that Mexico does not sell all of its credits, and it accounts for future risks in the projects (Imaz et al. 1998). If a CDM afforestation project involving a forest burns down, for example, there is a contingency of carbon credits that can cover the loss to the investor. The international community is still debating who accepts the liability in this case, but if it is the host country, then keeping a percentage of the credits from long-term or risky projects will cover future risk. Mexico also prefers to use the CDM for land use projects where other funding is harder to obtain, instead of energy projects.

There are several other risks involved with CDM projects that have been raised as potential concerns by the Mexican government. Macroeconomic risks, new activities risks, long-term project risks and the risk of dumping old technologies all cause concern in Mexico, and must be taken into account and analyzed prior to project acceptance (Imaz et al. 1998). First, macroeconomic issues should be predicted as much as possible. Mexico recently experienced an unexpected depression that could have affected CDM projects that require consumer purchases, such as commercial forestry projects or renewable energy projects. Second, many potential CDM projects also include new activities that have little available experience or infrastructure. Third, Mexico has raised the concern about the risks associated with long-term projects, such as forestry-based projects that have greater uncertainties given their long timespans. Issues such as changing land tenure, for example, could affect the project's permanence, outcome and effectiveness. Fourth, CDM energy projects could result in developed countries transferring inadequate or inappropriate technologies to the developing country (Imaz et al. 1998).

Loss of land use control was specified as a concern by J. Martinez of INE (pers. comm.). In particular, local communities could be displaced through conservation efforts during forestry CDM projects. Mexican citizens, like the majority of the global population, do not have a firm grasp on the concepts of global warming or the CDM. They should not be taken advantage of by industrialized countries' investors because of their lack of knowledge. Rather, education programs should be initiated at the local level to assist communities in making informed decisions with regard to potential CDM projects that may affect them.

3.2 THE SIERRA GORDA BIOSPHERE RESERVE

The Sierra Gorda Biosphere Reserve in East Central Mexico is an example of a sink project that is applying for funding as a CDM initiative. It is located in the northern half of the state of Querétaro, approximately 200 km north of Mexico City (Figure 3.3). The Reserve is comprised of 383,000 hectares, bounded by the state of San Luis Potosi to the northeast, the Estoraz River to the southwest, the Moctezuma River to the southeast and the Santa Maria River to the northwest (Bird and Muñoz 1998). The Sierra Gorda is an extension of the Sierra Madre Oriental mountain range, which is located in the convergence of four climatic regions: humid tropical zone, dry tropical zone, temperate zone, and the arid zone. Within the 383,000 hectares lies a myriad of climates, physical features, altitudes, ecosystems and species. This variation provides the ingredients for great biological diversity. It also provides a justification for preserving and enhancing this biodiversity through CDM projects.

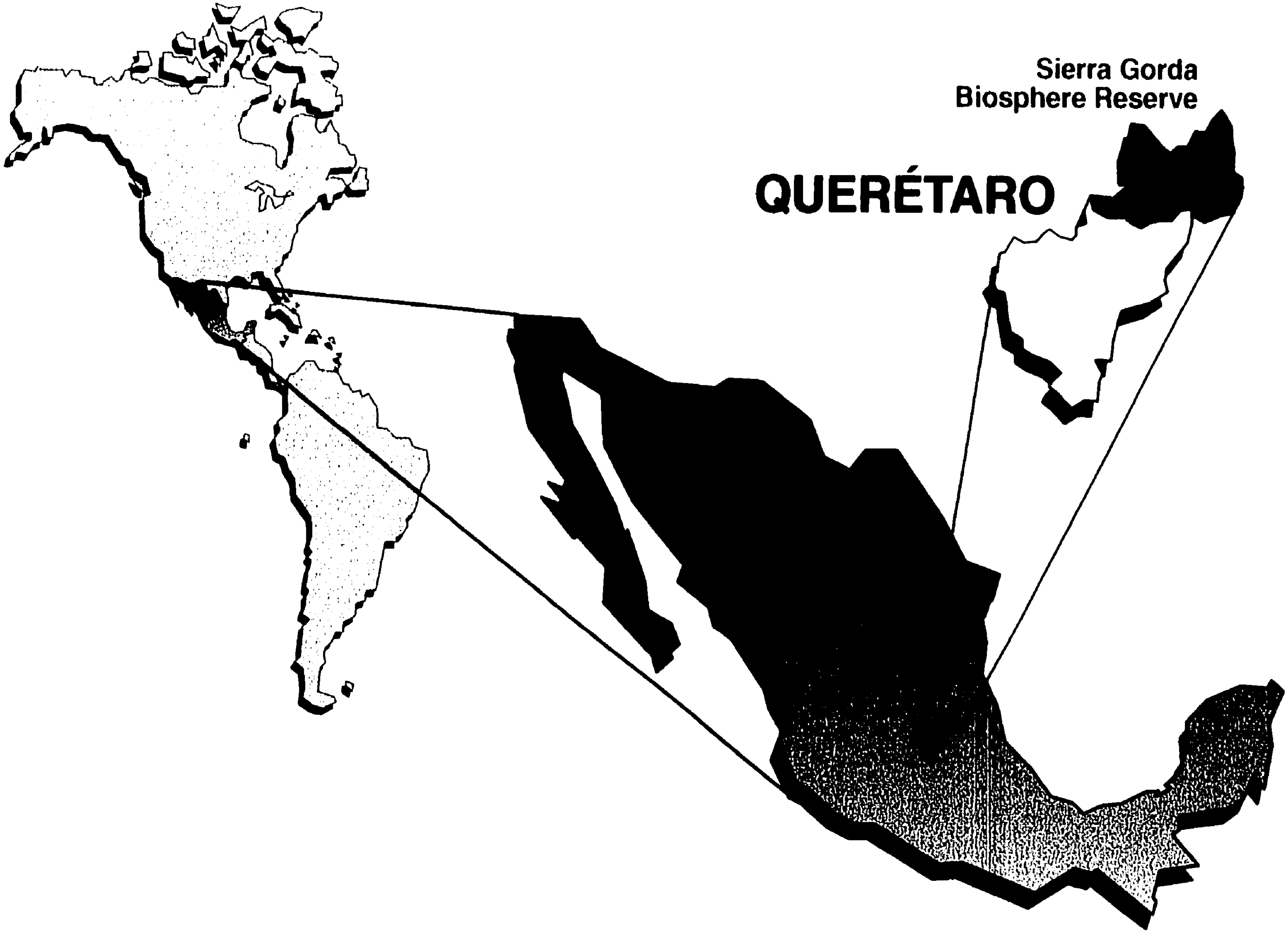


FIGURE 3.3 The Sierra Gorda Biosphere Reserve

3.2.1 Grupo Ecológico Sierra Gorda

For the past decade, a not-for-profit organization Grupo Ecológico Sierra Gorda I.A.P., has been involved in efforts to protect the Sierra Gorda's abundant natural resources (Woodrising 1998a). The core of Grupo consists of one family, and is lead by Martha Isabel Ruiz Corzo (Pati), a dynamic woman with a strong passion for the Sierra Gorda. Her husband, Roberto Pedraza Muñoz, and son, Roberto Pedraza Ruiz are also members of the organization, and are both Serranos (born in the Sierra Gorda). Grupo has established four major goals:

Pati Ruiz Corzo of Grupo and her sons

- the comprehension, respect and care of nature and biodiversity;
- the protection of wild flora and fauna;
- the integral fortification of the natural richness in the ecosystem communities in order to achieve self-sufficiency status; and
- the creation of employment and socio-economic development for the inhabitants of the Sierra Gorda.

In 1997, their efforts were rewarded when the Sierra Gorda was decreed a Biosphere Reserve by the Diario Oficial de la Federacion (R.P. Ruiz pers. comm.). To achieve this designation, Grupo submitted a management plan for the Reserve to the Mexican government, and defined their role as stewards. There are 21 biosphere reserves in Mexico protecting 3.9% of the country, ten of which currently have management plans (INE 1995). It is important to note that this Biosphere Reserve designation is from the Mexican government, and not the United Nations. As such, it has its own rules by which it must abide. A selection of the administrative rules of the Reserve is provided in Appendix III.

In June, 1999, Grupo received the prestigious SEMARNAP 'National Excellence Award for Ecology' from President Zedillo of Mexico. The award recognizes Grupo's efforts in developing and successfully implementing a restoration and conservation program for the Sierra Gorda that also addresses the Reserve's socio-economic problems.

Grupo has a general purpose for the Reserve, as well as several objectives. The primary purpose is to preserve and restore the Reserve's ecosystems, natural resources, biodiversity, and evolutionary processes, promote the sustainable exploitation of natural resources, and let the local inhabitants develop economic and social activities (GESG 1998a). In particular, the objectives of the Reserve are to:

- encourage continuity in natural processes through landscape conservation, ecosystem balance, and biodiversity conservation;
- establish management strategies for ecosystem conservation;
- restore and rehabilitate natural systems, such as the cloud forest;
- identify and complete the current information about natural components and their processes, promote practical research under sustainable use criteria;
- obtain information, parameters and indicators about every process carried out in the Reserve to support an impact assessment;
- establish a rational use and exploitation system of the natural resources in order to generate a sustainable culture;
- integrate urban development, recreation, ecotourism and conservation, and set strategies to buffer or control current impacts;
- establish preventative and strategic planning actions to mitigate and avoid pollution, deterioration and degradation of natural resources;
- generate values, habits and positive attitudes to promote the environment to the local population;
- transmit the Reserve's meaning, importance, objectives, projects and goals to the population, in order that the inhabitants can value the Reserve as a component of their daily life;
- adopt integral exploitation techniques and procedures for natural resources, and implement these strategies and continuously improve them; and
- keep alive the regional culture to regain the Reserve's identity (GESG 1998a).

The objectives of the Reserve include both environmental and socio-economic goals. Although Grupo is responsible for managing the Sierra Gorda, it is the local communities that will determine if the protection and enhancement efforts are a success through their commitment to conservation. It is therefore both the environmental and social objectives that must be considered and respected during the planning and implementation of CDM projects.

3.2.2 Environmental Setting

The environmental setting for the Sierra Gorda is significant because it illustrates its great biological diversity, provides the justification for looking at the Reserve as a location for CDM projects, and highlights some of the possibilities for planning and locating projects. The high diversity in the Reserve should be protected and enhanced, where possible. The CDM provides a tool where this can be accomplished.

Baseline information is limited for the Reserve. There is not an effective working relationship between the University of Querétaro (Universidad Autonama de Querétaro) and Grupo. This may contribute to the limitations in data, and could be rectified by attempting to establish a working relationship and involving the University in future research, if possible. The following discussion provides a brief overview of ecological conditions on the Reserve, based on information provided in the management plan, personal communications with Grupo, and a limited site reconnaissance. The management plan submitted for the Sierra Gorda, *Programa de Manejo Reserva de la Biosfera Sierra Gorda de Querétaro* was translated from Spanish into English by Sonia Morales, a Mexican graduate student in the Faculty of Environmental Design at the University of Calgary. The information provided in this chapter on the environmental setting of the Sierra Gorda Biosphere Reserve is from this translation, and from information gathered during the site reconnaissance.

Topography

The Reserve's dramatic topography contributes to its diverse ecosystems and species, and varies from 300 to 3,100 meters above sea level (masl). There are three mountain ranges within the Sierra Gorda that trap moisture from predominately easterly winds, and that are aligned in a northwest to southeast direction. They are all part of the Sierra Madre Oriental. In the far southwest of the Reserve, there is a semi-desert zone, 1,300 to 1,700 masl, that ascends to the town of Pinal de Amoles, which is located on the most westerly mountain range at more than

Creosote bush desert in the Sierra Gorda

3,000 masl. The second mountain range can reach 1,600 masl, and the third, most easterly mountain range reaches 2,900 masl. Between each mountain range are valleys that can dip as low as 300 masl. The mountain ranges are geographic barriers that create a rain shadow effect, which determines climatic, biological and social conditions in the Sierra Gorda, resulting in a wide variety of climactic conditions and vegetation zones. Precipitation, for example, ranges from 350 to 2,500 mm per year throughout the Reserve (GESG 1998a).

Vegetation

In 1970, there were approximately 1,000 floral species known to occur in the Sierra Gorda. In the last 25 years, that number has almost doubled through an increase in the intensity of inventories, even though some areas in the Reserve have still not yet been studied. According to Silva (1998), there are 1,725 recorded vascular plant species and 124 fungal species identified on the Reserve today. Many floral species are endemic to the Sierra Madre Oriental mountain ranges. Twenty-seven of the vascular species are under protection by La Comision Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), or the National Commission for the Use and Understanding of Biodiversity (Table 3.3).

TABLE 3.3 Flora with Protected Status

CLASS	FAMILY	GENUS	SPECIES	STATUS*
Coniferopsida	Cupressaceae	*Cupressus*	*benthamii*	PE
		Cupressus	*lusitanica*	PE
	Pinaceae	*Abies*	*guatemalensis*	P
		Pinus	*pinceana*	PE
Cycadopsida	Zamiaceae	*Ceratozamia*	*hildae*	A
		Ceratozamia	*mexicana*	A
		Dioon	*edule*	A
		Zamia	*fischeri*	A
Dicotyledonae	Betulaceae	*Carpinus*	*caroliniana*	A
		Ostrya	*virginiana*	R
	Cactaceae	*Astrophytum*	*ornatum*	A
		Echinocactus	*grusonii*	P
		Lophophora	*difussa*	A
		Diospyros	*xolocotzii*	R
	Fouquieriaceae	*Fouquieria*	*fasciculata*	A
	Gentianaceae	*Gentiana*	*spathacea*	R
	Lauraceae	*Litsea*	*glaucescens*	P
	Magnoliaceae	*Magnolia*	*schiedeana*	A
	Meliaceae	*Cedrela*	*dugesii*	PE
	Tiliaceae	*Tilia*	*mexicana*	P
Monocotyledonae		*Yucca*	*queretaroensis*	R
	Bromeliaceae	*Tillandsia*	*roland-gosselinii*	A
Monocotyledonae	Orchidaceae	*Encyclia*	*mariae*	A
		Laelia	*anceps*	P
Monocotyledonae	Palmae	*Brahea*	*moorei*	R
		Chamaedorea	*sartorii*	A
Taxopsida	Taxaceae	*Taxus*	*globosa*	R

Source: CONABIO and F.J.G. Meléndaz (pers. comm.)

***Protection Status**	**27**
P In danger of extinction	5
A. Threatened	12
R. Rare	6
PE. Subject to special protection	4

Five fungal species are also under special protection. The vegetation consists of 268,250 hectares of forests and jungles, and 61,500 hectares of desert (GESG 1998a). The remaining area in the Reserve is used for agriculture and towns. The vegetation has been classified into fourteen vegetation communities based on dominant species, according to Rzedowski (1978). According to Roberto Pedraza Ruiz of Grupo, there may be a fifteenth vegetation community: tropical evergreen forest. Rzedowski's system was chosen for the purpose of this MDP.

However, further field studies are necessary in the Sierra Gorda to determine which communities are present.

Rzedowski's fourteen vegetation communities are summarized in Table 3.4. Figure 3.4 also provides a map of the vegetation zones in the Sierra Gorda. The tropical semi-evergreen vegetation community is omitted from Figure 3.4.

TABLE 3.4 Vegetation Communities in the Sierra Gorda Biosphere Reserve

VEGETATION COMMUNITY	AREA (ha)	DESCRIPTION
Tropical semi-evergreen forest (bosque tropical subcaducifolio)	5,250	Found in deep gulleys and riparian areas, at low elevations.
Tropical dry forest (bosque tropical caducifolio)	145,250	122,445 ha are more or less protected. Found at elevations of 300 to 1,400 masl. Although abundant on Reserve, this community is endangered in Latin America.
Oak forest (bosque de encinos)	61,500	Grows at 800 to 3,100 masl. Located primarily in Pinal de Amoles. High instances of endemism.
Cloud forest (bosque mesofilo de montana)	10,000	Found in the most humid regions of the Reserve, between 800 to 1,500 masl. Contains endangered species *Magnolia schiedeana.*
Coniferous Forests		
Pine forest (bosque de pino)	19,000	Found in cold, temperate, humid and sub-humid climates. Main species are Pinus sp. Up to 1,600 masl grows P. greggi, between 2,400 and 2,850 masl is P. patula, and in dry zones between 2,750 masl and 3,100 masl grows P. rudis.
Juniper forest (bosque de juniperus)	2,750	Located primarily between 2,400 masl and 2,850 masl.
Cedar forest (bosque de cupressus)	400	Primarily found between 1,600 to 2,600 masl. Dominant species is *Cupressuss Lusitanica*, which is under special protection.
Alpine forest (bosque de abies)	not quantified	Present in small areas, between 2,200 and 3,100 masl. Dominant species is *Abies guatemalensis*, which is endangered.
Mixed oak-pine forest (bosque de pino-encino)	38,250	A mixture of oak and pine species found throughout the Reserve.
Desert Shrubs	56,419	
Cactus scrub (matorral crasicaule)	not quantified	Located in southwest portion of Reserve, between 1,400 and 2,500 masl. Dominated by globular and cylindric cacti.
Submontane scrub (matorral submontano)	not quantified	Found between 800 and 2,200 masl near limestone. Located in riparian canyons and hills.
Creosote bush desert (matorral microfilo)	small quantity	Found between 1,300 and 2,000 masl, in areas with 380-400 mm precipitation.
Cactus desert (matorral rosetofilo)	not quantified	Located in small areas of the Extoraz river basin, between 1,600 to 2,200 masl.
Oak scrub (encinar arbustivo)	small quantity	Found in dry, cold climates, and riparian areas.

The following is a brief discussion on the major forest communities in Mexico and in the Sierra Gorda Biosphere Reserve.

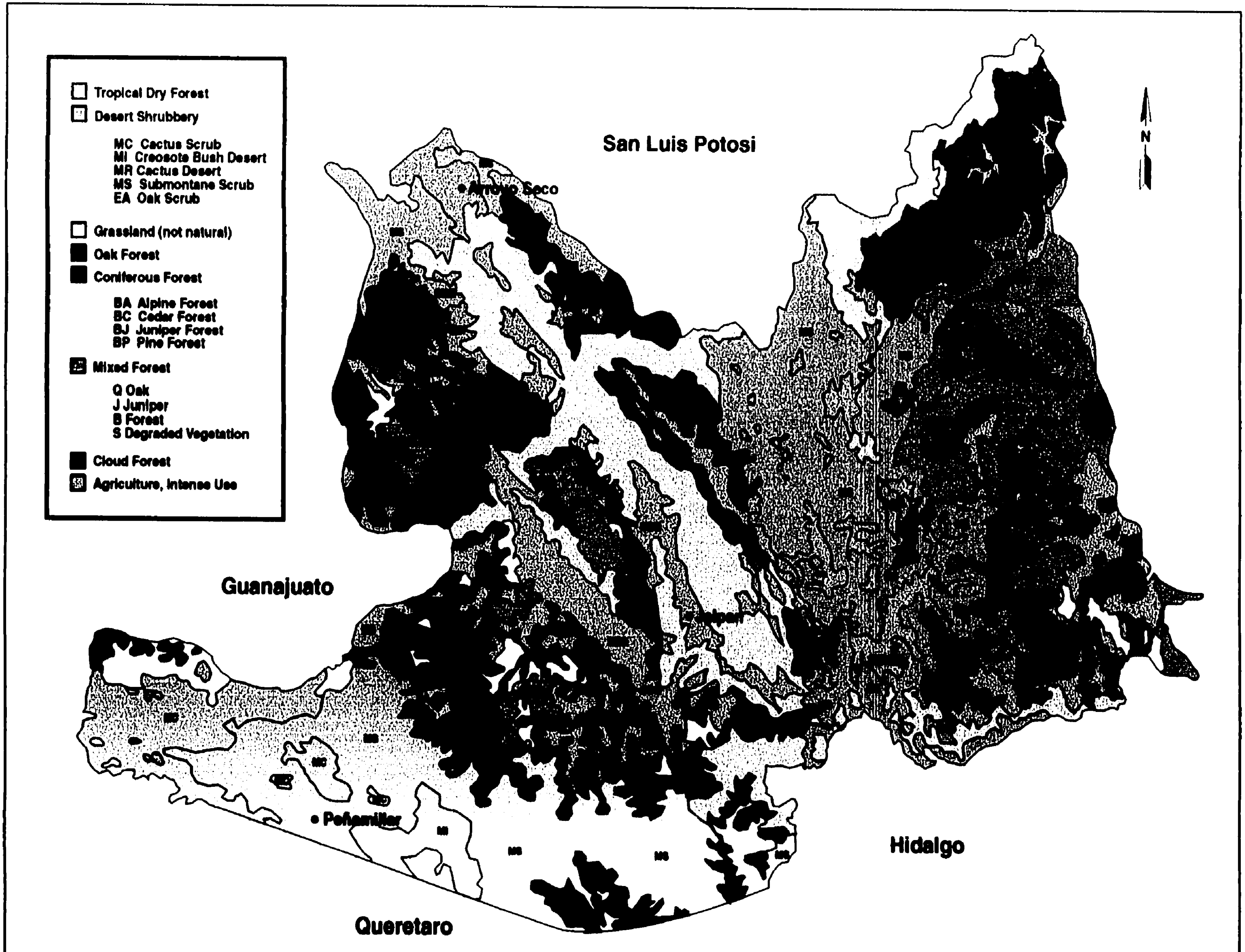
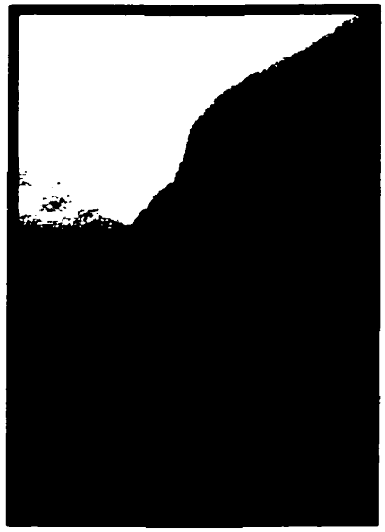


FIGURE 3.4 Vegetation Communities of the Sierra Gorda Biosphere Reserve

Not to scale

Tropical Dry Forest

Tropical dry forest, or tropical deciduous forest, covers approximately 8% of Mexico, and is often located at low elevations and on hill slopes (Rzedowski 1978). It is dominated by tree species that lose their leaves during the six-month dry season (Gallina 1997). Relative to other vegetation communities in Mexico, human impact is low in tropical dry forests due to the unsuitability of the soils for agriculture (Gallina 1997). Of the 229 endemic vertebrate species in MesoAmerica, 34% are restricted to this vegetation community (Flores-Villela and Gerez 1988). This is the largest community on the Reserve.



Tropical dry forest in the Sierra Gorda

Oak Forest

Oak forests with between 150 and 200 species cover 5% of the land surface in Mexico, and pine-oak communities occupy 14% (Gallina 1997). These forests are characteristic of the mountainous areas of Mexico, and, in addition to pine forests, cover almost all areas with temperate semihumid climate. This community is severely impacted by human activity because it is located on soils suitable to agriculture, and in areas with favorable climate (Gallina 1997). On a local scale, oak forests are exploited heavily in Mexico, and often converted for agricultural and grazing purposes. This conversion usually causes the loss of the soil's ability to absorb and retain water, resulting in severe erosion (Rzedowski 1978). The oak forest vegetation community contains 468 species of terrestrial vertebrate, of which 29% are restricted to this type of vegetation (Flores-Villela and Gerez 1988). Six percent of the species are officially listed as endangered (Gallina 1997). The oak forest communities in the Sierra Gorda exhibit high species endemism.

Cloud Forest

Cloud forest in the Sierra Gorda

Cloud forest is typically located in humid temperate climates in mountainous areas (Gallina 1997). Because it requires cool, humid conditions, cloud forest is only found in isolated areas, covering less than 1% of Mexico's land surface (Rzedowski 1978). It is restricted to areas with steep slopes, sheltered valleys, and rough topography and comprises dense vegetation (Gallina 1997). Cloud forest is heavily exploited, and is one of the most diverse and threatened habitats in Mexico (Gallina 1997). Its presence in the Sierra Gorda Biosphere Reserve emphasizes the Reserve's biological importance.

Coniferous Forests

The coniferous vegetation communities include pine, juniper, cedar, pine-oak and alpine forests. These forests are common and widespread in Mexico, located in diverse ecological conditions and covering 15% of the land surface (Rzedowski 1978). More than 90% are pine and pine-oak communities, consisting of 35 species of pine (Gallina 1997). Damaging forestry practices, grazing, agriculture, and the traditional use of fire for pasture management have affected the extent and composition of conifer forests severely (Rzedowski 1978). The effects of the fires on conifer stands may or may not be detrimental, depending on whether pine is considered a climax community. Some authors, for example, state that fire prevents regrowth, and others consider it beneficial because it eliminates less fire resistant non-conifer species (Gallina 1997).

Pine-oak forest in the Sierra Gorda (2900masl)

Coniferous forests in Mexico contain 49 endemic terrestrial vertebrate species and eight endangered species. In the Sierra Madre Oriental, the pine forest is distributed primarily in patches due to the high occurrence of limestone soils (Gallina 1997).

Fauna

The diverse ecosystems and vegetation communities on the Reserve offer equally diverse habitats for a wide variety of wildlife. Mexico is home to 2,400 species of terrestrial vertebrates, 194 of which are officially threatened or endangered (Gallina 1997). This includes 123 bird species, 32 mammals, 35 reptiles, and four amphibians. In the Sierra Gorda, systematic studies of the fauna have not been conducted and estimates of species numbers are considered conservative. Sightings of diverse species on the Reserve are common, and Grupo, in partnership with Woodrising Consulting Inc., is considering offering ecotours to showcase the wide variety of animals and plants in the area (N. Bird, pers. comm.). CONABIO has assigned protective status to a number of faunal species on the Reserve. During the site reconnaissance, it was not possible to gather information on the locations of the habitats of all of these protected species. While there are also numerous endemic species, this information was also not available in a usable format at the time the site visit to the Reserve. Grupo is continuing efforts to compile this information for future reference. CONABIO, for example, has funded studies to determine which of Mexico's 2000 butterfly species may be on the Reserve. Thus far, they have estimated there are 645 species of butterfly in the area (R.G. de la Maza E. pers. comm.).

Table 3.5 provides data on the level of protection for mammals, birds, reptiles and amphibians in the Sierra Gorda. Appendix IV provides a complete list of fauna in the Sierra Gorda that have protected status.

TABLE 3.5 Protected Status of Fauna on the Sierra Gorda Biosphere Reserve

	Protection Status					
Fauna	**In Danger of Extinction**	**Threatened**	**Rare**	**Subject to Special Protection**	**Total Number**	**% of Mexican Total***
Mammals	6	12	8	0	26	56
Birds	10	27	29	8	74	30
Reptiles	0	10	19	5	34	29
Amphibians	0	5	1	1	7	125

* Percentage calculations used the total official threatened and endangered species in Mexico. According to Gallina (1997), there are only 4 protected amphibians. CONABIO's data of the Sierra Gorda includes 5.

Rare and interesting species of fauna are occasionally captured by Sierra Gorda residents because of their perceived value as exotic pets. In the southeast corner of the Reserve, a wild ocelot was captured and displayed in a cage (see photo). After some discussion and negotiation, Grupo purchased the ocelot for 100 pesos, or approximately ten Canadian dollars. While the practice of supplying remuneration for endangered species can potentially create an incentive to make capturing these species into a lucrative career, Grupo felt it was a wise decision in this particular

Caged ocelot near Tancuilin

case because of political issues. The resident was given a stern warning, and the ocelot was released into the wild to fend for itself. Not only does capturing wild animals threaten their existence, it promotes a belief among inhabitants that these unique species are valuable more as pets then as part of their natural ecosystem. Grupo is involved with environmental education programs to deter this type of behaviour.

Habitat fragmentation is also a common occurrence on the Reserve. Pockets of human disturbance, including towns, roads, agricultural lands, and small-scale forestry operations, are scattered throughout the Sierra Gorda. These pockets break up the fauna and flora habitat, and may contribute to habitat fragmentation and loss. Fragmentation and disappearance of habitat because of human activities constitutes the most serious threat to biodiversity and species extinction (WWF 1992; Groombridge 1992; Collinge 1996; Gallina 1997; Fahrig 1997). In addition, it can result in the loss of native plant and animal species, the invasion of exotic species, increased soil erosion, and decreased water quality (Collinge 1996). The valleys and riparian corridors within Sierra Madre Oriental mountain range in the Reserve act as wildlife corridors for many species, especially the larger carnivores such as the puma and jaguar (R.P. Ruiz pers. comm.). Fragmenting these valleys with human activity potentially affects these species. Further studies on wildlife movement and habitat are required on the Reserve to determine the consequences of habitat fragmentation on the diverse number of species.

3.2.3 Management Zoning

The Sierra Gorda Biosphere Reserve has been divided into management zones based on the established concepts of core areas and buffer zones within a protected reserve network (Noss 1995). This zoning was established when the Sierra Gorda was decreed a biosphere reserve by the Mexican government, and forms the basis of the management of the area. In general, the zoning follows a human-dominated model of a reserve network, first established for biosphere reserves by UNESCO (1974), and later elaborated upon and championed by various authors (Noss 1995).

The model includes core areas surrounded by multiple-use or buffer zones with varying levels of protection. Noss (1995) also includes wildlife corridors specifically intended to provide connectivity between core areas and between other reserves (Figure 3.5).

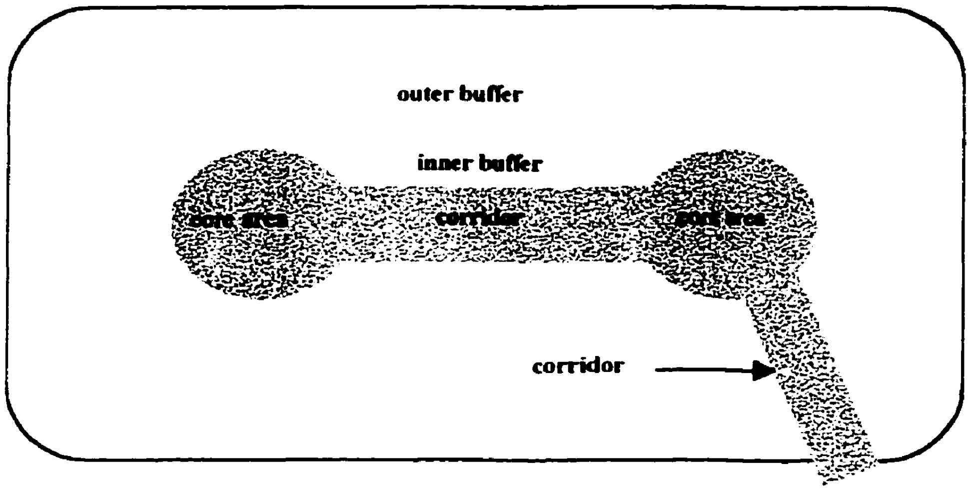


FIGURE 3.5 The Model Reserve Network

The hypothesis behind reserve networks is that if functionally connected, areas within a reserve and a system of reserves will be united into a whole that is greater than the sum of its parts (Noss 1995). While this model is widely accepted and often implemented in protected areas, it is not always practical. Issues surrounding land tenure and land use control can necessitate the establishment of core areas and buffers in regions that are less than ideal ecologically, but that are pragmatic socially and economically. Property rights and the needs of local communities must be taken into account (Brown 1998). This is the case on the Sierra Gorda Biosphere Reserve.

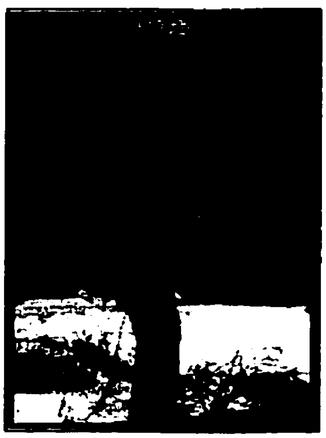
Zonas Nucleos

The core areas of the Reserve are termed the 'zonas nucleos', and are established based on areas that were deemed to have special physical characteristics, or fauna and flora requiring protection. The core areas are an essential part of the model reserve network, and form the backbone upon which all other areas can be managed. They can be defined as any area that is maintained in its natural state, where natural disturbance events are either allowed to proceed without interference or are simulated through management (Noss and Cooperrider 1994). In reality, they "are not usually pristine, they are simply areas where native biodiversity and ecological integrity are the overriding goals (DellaSala et al.1996 p. 210). Optimal core areas, or zonas nucleos, may be identified using the following criteria:

- locations of roadless, undeveloped, or otherwise essentially wild areas of significant size;
- concentrated occurrences of endemic, rare, threatened or endangered species;

- areas of unusually high species richness and biodiversity;
- locations of rare or unusual plant or animal communities, breeding sites, etc;
- resource hotspots such as sites of unusually high primary productivity, sinkholes, outcrops of unusual parent material;
- watersheds of high value for aquatic biodiversity;
- sites sensitive to development, such as steep slopes, unstable soils, or aquifer recharge areas;
- sites recognized as important by indigenous peoples; and
- sites that could be added to adjacent protected areas to form larger reserves (Noss 1995).

According to DellaSala et al. (1996) "most conservation planning efforts worldwide emphasize ecosystem representation rather than single species protection.." (p. 214). To be fully representative and to maintain biodiversity in the region, representation of all habitats, communities and species in core areas is essential. Representation is also the main criterion used to evaluate areas for protection (Noss and Cooperrider 1994). While the zonas nucleos within the Sierra Gorda Biosphere Reserve were established in an attempt to protect those areas of greatest ecological importance such as riparian corridors and the habitat of rare species, they were also chosen based on their availability at the time of the management plan submission. The process involved in selecting these zones was hurried and may not have taken all ecological factors into account, resulting in some important areas being missed (R.P. Ruiz per. comm.). The zones are primarily located on the periphery of the Reserve in less populated areas and areas of difficult access. Because they often abut neighboring states, the presence of a buffer zone around the zonas nucleos cannot be guaranteed outside of the boundaries of the Reserve.



Signage outside of Zonas Nucleos II, Ayutla Canyon

Within the zonas nucleos, conservation, scientific research, and environmental education are priorities. Ecotourism is also encouraged, although it must be low impact and not disturb the ecosystem. Roads, hunting, the introduction of exotic species, and any other disruptive activities are prohibited by Grupo. Where possible, signage is placed at the boundaries of the zones, identifying the areas as protected (see photo). There are eleven zonas nucleos on the Reserve that protect approximately 24,839 ha (Figure 3.6, Table 3.6).

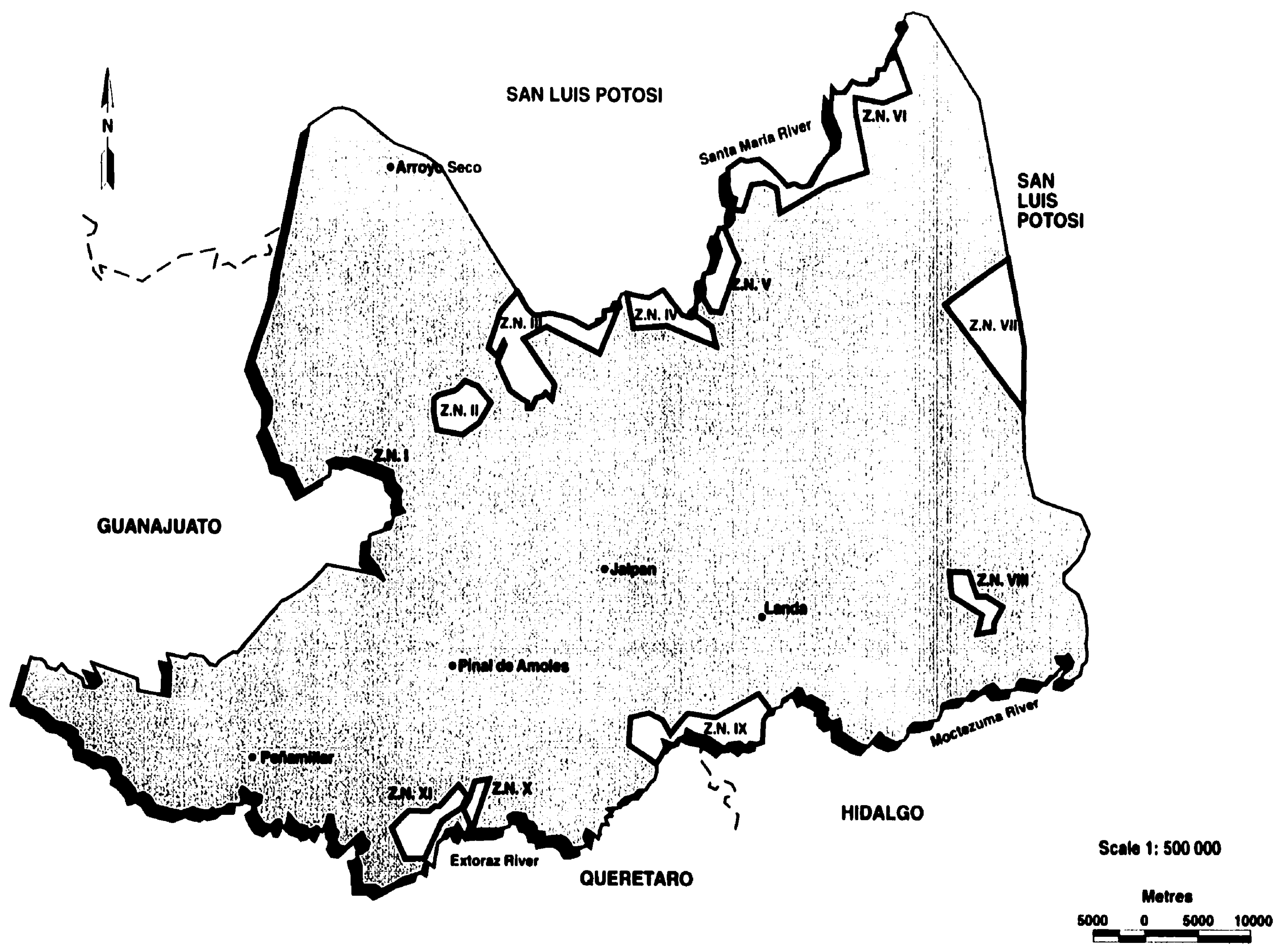


FIGURE 3.6 Zonas Nucleos in the Sierra Gorda Biosphere Reserve

Source: Grupo Ecológico Sierra Gorda

TABLE 3.6 Zonas Nucleos on the Sierra Gorda Biosphere Reserve

ZONE	NAME	AREA* (ha)	SIGNIFICANCE FOR PROTECTION
I	Sótano del Barro	1.5	Smallest zone on the Reserve. Protects one of the deepest sinkholes in the world, 500 m in diameter, and 410 m deep. Habitat of the endangered species *Ara militaris*, or Military mackaw.
II	Ayutla Canyon	1,684	Protects tropical dry forest, and is located along the Santa Maria River. One of the representative animals of the region is the *Puma condcolor*, or puma.
III	Puente de Santa Maria	4,104	Protects riparian zone and tropical dry forest. Located on both sides of the Santa Maria river. Habitat of the *Panthera onca*, or jaguar, which is an endangered species.
IV	Raudel del Buey	1,794	Along with Zones V and VI, is located in sequence along the Santa Maria river, and forms a corridor often used by wildlife such as the endangered jaguar and *Lutra longicaudis*. Protects tropical dry forest.
V	Chacas	1,267	Protects riparian zones, tropical dry forest and submontane scrub.
VI	Barranca de Paguas	4,829	Largest zone on the Reserve, protecting riparian zone, tropical dry forest and tropical semi-evergreen forest. The habitat of the endemic species *Crax rubra* is also protected. Rich in diversity of wildlife.
VII	Cañada de las Avispas	4,664	Located on the east side of the Reserve. Protects hectares of oak forest, pine forest, juniper forest, cloud forest, alpine forest, cedar forest, oak-pine forest, and oak scrub. Habitats of the endangered bearded wood partridge (*Dondrortyx barbatus*), and yew (*Taxus globosa)* also protected.
VIII	Joya de Hielo	1,092	Contains the largest area of cloud forest on the Reserve. Protects endangered flora such as *Magnolia schiedena*, and endangered fauna such as *Ursus americanus*.
IX	Cañon de Moctezuma	3,270	Located on the southern edge of the Reserve, in a riparian corridor. Protects tropical dry forest and submontane scrub.
X	Cerro Grande	400	Protects creosote bush desert and cactus desert.
XI	Mazatiapan	1,734	Protects creosote bush desert and cactus desert.

*With the exception of Sótano del Barro, values have been rounded up to the nearest hectare.

Table 3.7 summarizes the vegetation communities that are represented and protected within the various zonas nucleos.

TABLE 3.7 Vegetation Communities Protected by the Zonas Nucleos

VEGETATION COMMUNITIES	ZONAS NUCLEOS
Tropical semi-evergreen forest	VI
Tropical dry forest	I-VI, IX
Oak forest	VII
Cloud forest	VII and VIII
Pine forest	VII
Juniper forest	VII
Cedar forest	VII
Alpine forest	VII
Mixed oak-pine forest	VII
Cactus scrub	Not protected
Submontane scrub	V and IX
Creosote bush desert	X and XI
Cactus desert	X and XI
Oak scrub	VII

While the majority of vegetation communities on the Reserve are protected to some degree within the zonas nucleos, some communities are inadequately represented. Zone VII, for example, contains many different vegetation communities, but does not contain large tracts of land for each. An ecosystem may be represented by only a limited number of hectares within the zone. According to Roberto Pedraza Ruiz (pers. comm.), for example, the cloud forest is very important for diversity, and more of it should be under protection than what is currently protected under Zones VII and VIII. The biologist working for Grupo at the time of the site reconnaissance also determined that the tropical semi-evergreen forest has high diversity in the Sierra Gorda, and more of it should be protected (F.J.G. Melendaz pers. comm.). The vegetation communities protected in Zones X and XI, on the other hand, are adequately

Tropical semi-evergreen forest (585masl) represented and are generally present in areas of low population density. Grupo does not feel that these ecosystems require further protection. Further studies are required to determine in a comprehensive manner which vegetation communities contain habitat for protected or endemic fauna or flora.

Grupo was responsible for selecting the zones, and approached the communities to ask if they would donate their land for conservation. For the most part, maintaining these areas as protected zones has been successful because there is little opportunity for forestry on the land, and there are no access roads (C.M.I. Ruiz Corzo pers. comm.). Zone VIII, however, has both access roads and commercial forestry potential. Each parcel of land in Zone VIII is also owned separately, as opposed to the community ownership that occurs in the other zones. Because of these factors, the landowners who originally donated their land for protection have changed their minds, and have begun logging the forest. There is a clause in the agreement that the landowners signed to donate their land for conservation that allows them to renege on their commitment, although it involves an onerous legal procedure (C.M.I. Ruiz Corzo pers. comm.). In response to this dilemma, Grupo has offered to pay them for the land in hopes of deterring further logging of the area. These zones are already protected, and cannot be used for CDM projects because they would fail the additionality criteria. That is, they have been protected regardless of the carbon sequestration potential of the land. That said, Zone VIII still offers an interesting perspective of what can happen when land use control is donated to conservation by local landowners. Perhaps the only way to truly protect the land is to buy it outright, although that may ignore the realities of humans in the ecosystem, and still does not fully address the concerns about leakage in other areas. Section 3.2.4 will further discuss the issues of human use pressure and land tenure in the Sierra Gorda.

Multiple Use Buffer Zones

Buffer zones provide an opportunity to integrate human development and activity with conservation (Noss and Cooperrider 1994). The buffer zones on the Reserve occupy most of the area: 358,764 hectares. In a variation and adaptation of the traditional model reserve network, the buffer is divided into six zones according to the level of management required, and activities that will be permitted (Figure 3.7):

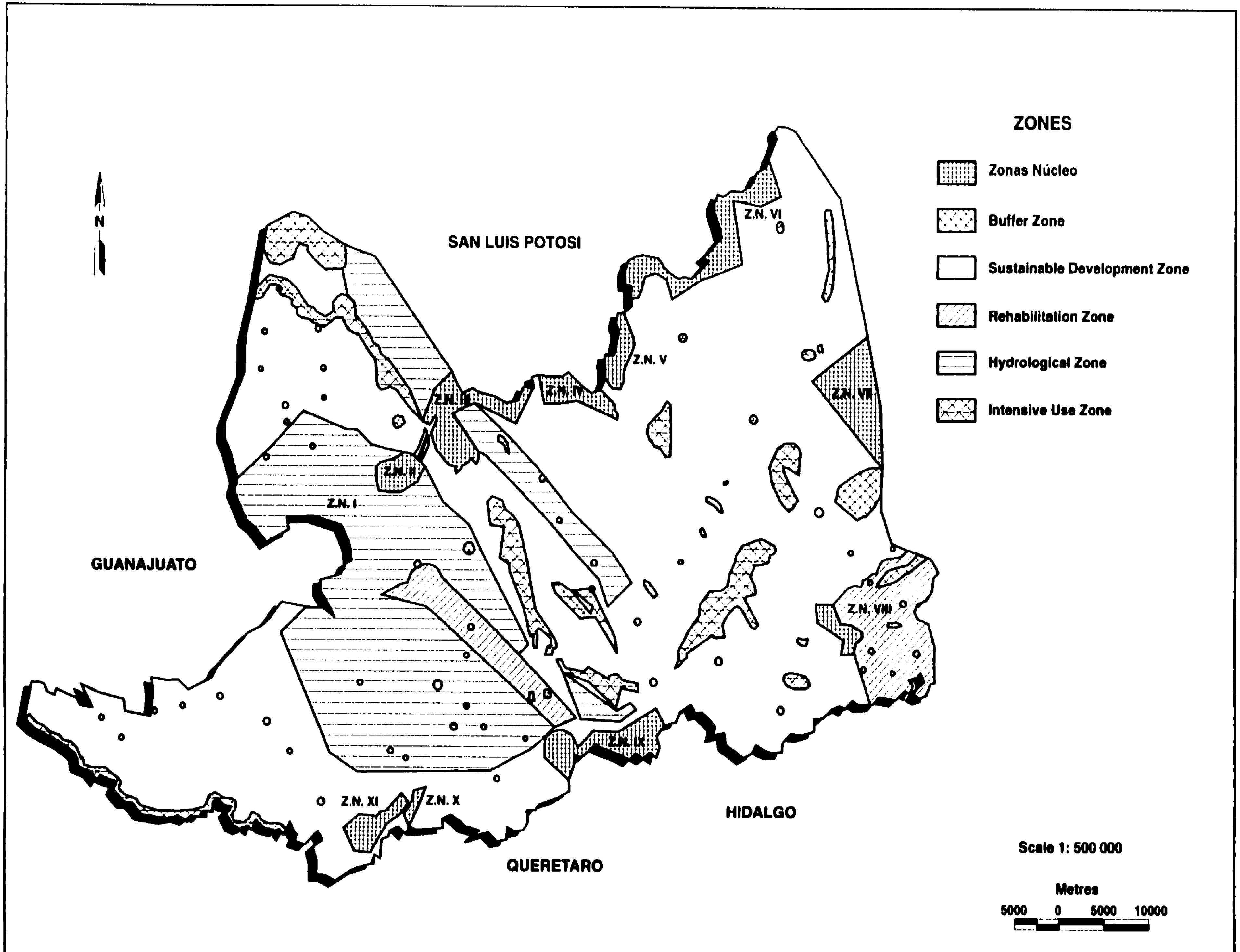


FIGURE 3.7 Management Zones in the Sierra Gorda Biosphere Reserve

Source: Grupo Ecológico Sierra Gorda

- buffer zone;
- hydrological load zone;
- rehabilitation zone;
- sustainable development zone;
- intensive use zone; and
- urban zones.

Strategic buffer zones were chosen for the purpose of protecting rivers, corridors and biodiversity. The areas are dedicated to conservation, rehabilitation, restoration and sustainable exploitation of natural resources. Activities that are allowed in the buffer zones include research, ecosystem preservation, environmental education, low impact ecotourism, use of waterbodies, and low impact exploitation projects. Pollutants such as agrochemicals are not permitted.

Hydrological zones are the watershed priority zones for water reloading into the Reserve's springs, streams and rivers. Within these areas, forested areas should be protected, and land use change is not allowed. In deforested areas, reforestation is promoted, as is soil and water protection. Permitted activities include research, restoration, conservation, environmental education, tourism, low impact exploitation of natural resources, low impact exploitation of mineral resources, and forestry exploitation based on sustainable forestry principles. Activities related to livestock grazing are discouraged.

The rehabilitation zones were chosen because of the need for soil protection efforts. Programs for reforestation, soil protection and water protection are encouraged, and landowners will be educated on the proper use of the land. Permissible activities include research, environmental education, tourism, low impact exploitation projects, reforestation and agroforestry-grazing systems, horticulture, and rational exploitation of wild fauna.

The sustainable development zones are located between the all other buffer zones, and form the greatest part of the Sierra Gorda Biosphere Reserve. All above activities are permitted, in addition to the exploitation of fauna and flora for commercial purposes under controlled conditions and given approval.

Intensive use zones are close to urban centres. In these zones, the medium and long term exploitation of natural resources will be promoted, as well as current planning programs for local and urban development.

The urban zones contain the 638 towns inhabited by the local communities. Urban activities such as residential development, industry, tourism, and education are encouraged, and urban growth is permitted in accordance with urban development plans.

As illustrated in Figure 3.7, the buffer zones do not necessarily border the zonas nucleos, as would be the case in the traditional model reserve network. In fact, only Zone I is completely buffered by a rehabilitation zone. Zones II, III and VIII are partially surrounded by rehabilitation zones and hydrological load zones, while the other zonas nucleos are bordered by neighboring states and sustainable development zones which permit high levels of human activity. It would be difficult to rectify this situation without cooperation from neighboring states and the local communities.

3.2.4 Human Use Pressure

Mexico is home to 91.6 million people, 23 million of these live in rural areas, and 10 million live in forested areas (CONAPO 1996). The growing population has a substantial impact on the natural environment, causing habitat fragmentation, loss of animal and plant species, hydrological cycle modifications, and contamination (Gallina 1997). The Sierra Gorda, in addition to containing diverse ecosystems and species, is home to 100,000 inhabitants who, for the most part, depend on these ecosystems for their livelihood. Eighty percent of the population lives below the poverty line and does not have sanitary services, and 23% are illiterate (R.P. Ruiz pers. comm.). Including emigration to cities, the growth rate is 2.3%. The water quality is poor due to deforestation, pollution from detergents and automobile fuel from outside the Reserve, and negligible sanitary systems inside. Garbage dumps are common, and pollutants from these often flow directly into the sources of drinking water (GESG 1998b). The state of Querétaro, within which the Biosphere Reserve resides, is facing a cholera epidemic due to unsanitary conditions and contaminated drinking water. While emergency actions are being taken, no long-term solutions are readily apparent, and the inhabitants of the Sierra Gorda are at risk (GESG 1998b).

The Reserve's population is distributed among 638 small towns. The distribution, according to the size of the town, is as follows:

- 382 towns 1 to 99 inhabitants
- 223 towns 100 to 499 inhabitants
- 25 towns 500 to 999 inhabitants
- 7 towns 1000 to 2499 inhabitants
- 1 town (Jalpan de Serra) more than 5000 inhabitants

Small community near Tancuilin

All of the land within the Reserve is privately owned, which is common in developing countries. This adds a new social dimension to potential CDM projects, because local communities are currently using the property. Most of Mexico's forested land is either owned by ejidatarios, which is a community of peasants, or communally, based on the historic pre-Hispanic communal property structure (Segura 1996). Until constitutional reforms in 1992, ejido land could not legally be sold. The lack of clear tenure allocation over forested land, and the historical inability to sell this land has created serious problems involving an underestimation of its value. This situation has caused incentives for deforestation and conversion to agriculture both in Mexico and in the Reserve (Segura 1996).

Deforestation

Like much of the developing world, deforestation and the burning of fuel wood causes a large portion of carbon emissions in the Sierra Gorda. Individuals have been exploiting the Sierra Gorda forests since 1850, resulting in little existing old growth today (R.P. Ruiz pers. comm.). The rate of deforestation on the Reserve is 550 ha per year, which includes both forestry operations and clearing for agriculture. The main causes of deforestation are forest fires, land use changes, pests, and unlicensed forestry practices. Between 1993 and 1997, the average annual deforestation rate on the Reserve was as follows:

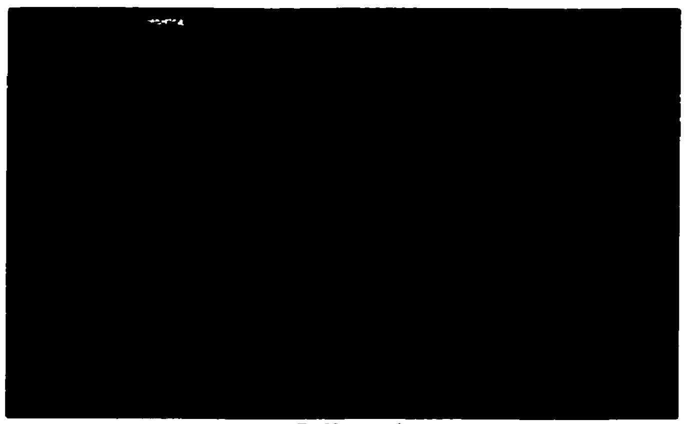
- 370 ha were caused by forest fires;
- 50 ha were caused by pests and illnesses;
- 90 ha were caused by clearing for grazing; and
- 40 ha were caused by the building of rural roads (F.J.G Meléndaz, pers. comm.)

To address the deforestation problem on the Reserve, Grupo has been involved with commercial and domestic reforestation programs using predominantly fast growing pine species such as *Pinus patula*, *Pinus greggi* and *Pinus pseudostrobus*. White cedar and oak have also been planted on the Reserve, but experience has proven that pine grows the quickest, and is most resistant to drought and pests (R.P. Ruiz pers. comm.). Over 1000 ha have been planted thus far. Difficulty arises because the rate of deforestation is greater than the pace of reforestation, and the fact that there is currently little incentive for small landowners to change the use of their land into forest. CDM projects have the potential to offer that incentive.

Six year old pine-cedar plantation on Reserve

Agriculture and grazing

Between 1980 and 1995, 200 million hectares of natural forests were converted to agricultural land and pasture in Latin America, Africa and Asia (FAO 1997). In Mexico, 19 million hectares of the country's available 30 million hectares suitable for agriculture is under cultivation (Gallina 1997). These statistics are mirrored in the Sierra Gorda, where, like the rest of Mexico, the largest industries are agriculture and grazing. Agriculture, primarily corn and beans, is the main industry within the Reserve, but it does not generate enough earnings nor does it adequately feed the population of the region. Uncontrolled agrochemical use, the lack of technical consultation, and serious soil erosion on steep slopes compound the problems caused by land conversion, and increase the



Soil erosion

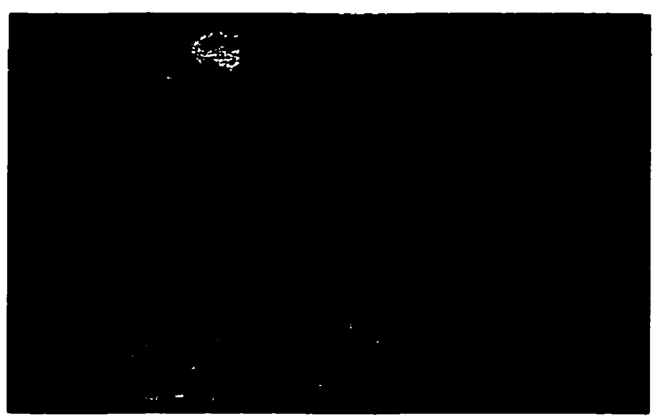
environmental concerns associated with the agricultural industry in the region (see photo). The cattle industry is gaining popularity in the Sierra Gorda. 213,345 hectares were used for farming purposes during 1995 and 1996 (GESG 1998a). Cattle can be found even in the most remote locations of the Reserve and on the most challenging landscapes. In addition to deforestation, environmental concerns of the grazing industry include invading grass species, and water contamination from cattle feces. There is presently not a facility that supports research programs into the low genetic quality of livestock, the lack of technology, and the environmental impacts from agricultural and grazing activities. The popularity of the cattle industry may be due a combination of the following factors:

- cattle require large tracts of land but little financial or manpower investment;
- demand for export of cattle to the United States has increased;
- Mexican law supports the industry (Gallina 1997).

In 1998, 16,000 ha of the forested land on the Reserve were burnt down intentionally and replaced with agriculture (R.P. Ruiz pers. comm.). At that time, there was only one fire-fighting brigade on the Reserve, consisting of twelve people, whereas now there are five brigades, three of which are run by Grupo. Drought has also exacerbated the fires. In 1997 and 1998, fire destroyed 1.5 million hectares of forest in Mexico and Central America (Interpress Service 1999). Prior to 1998, the average area affected by fire in the Sierra Gorda was 370 ha per year (F.J.G Meléndaz, pers. comm.).

Forestry

Compared to agricultural activities, the forestry industry in the Sierra Gorda is not substantial. There are six sawmills on the Reserve that are very small by Canadian standards (see photo). Boards are sold locally at 180 pesos per square metre, necessitating more wood be cut to make a living. Workers have not received training in forestry practices, and large quantities of waste are usually generated. While Grupo is



Sawmill on Reserve

encouraging the workers to learn carpentry and other trades, they have not yet been successful in their efforts. A Forest Management Program is required before commercial exploitation of the forest, but few follow procedures. Grupo and community vigilante groups police illegal activities on the Reserve, such as unlicensed forest exploitation, burnings, theft of floral or faunal species, and unlicensed hunting, but unfortunately cannot always cover the vast area.

Other industries and pressures

Aquaculture, handicrafts and tourism are relatively minor industries in the Sierra Gorda that support a small percentage of the population. Mineral extraction, and in particular mercury mining, was popular in the 1960s and 1970s, but is not active in the area today. There is some interest in reopening abandoned mines, although discussions regarding exploiting the mineral resources has also flagged concerns with respect to pollution and contamination (GESG 1998a).

Additional human-use pressure is exerted from outside the borders of the Sierra Gorda Biosphere Reserve. The Reserve is landlocked and surrounded by four states. Protection ends at its borders, and deforestation and increasing populations on the other side of those borders often impact Querétaro. San Luis Potosi, for example, abuts the Reserve to the north and northeast. The indigenous community within that state, the Huasteco Indians, suffers from extreme poverty, large families, high teenage pregnancy rates, and poor agricultural practices (R.P. Ruiz pers. comm.). They cross the border into the Reserve to take advantage of its natural resources as the soils in San Luis Potosi are eroded and depleted. These populations exert pressure on zonas nucleos VI, as well as other areas in the Reserve as they attempt to clear land for agriculture. Unfortunately, because protection ends at the border of the Sierra Gorda, the destruction that occurs on the other side of that political line cannot be stopped.

Deforestation in San Lois Potosi

Grupo's efforts

Grupo's link to the community is vital to potential CDM projects if they are to succeed. Grupo is operated by a group of local individuals, who are dedicated to preserving the land and beauty that they treasure. They have a very good relationship with the communities in the Sierra Gorda.

This relationship is paramount in ensuring the acceptance and success of Grupo's initiatives throughout the Reserve. Grupo's mission is the integral rescue of the Sierra Gorda, including creating job opportunities for people in the region and maintaining and enhancing the protection of the natural resources. In addition to championing efforts to protect the Reserve's natural resources, they have initiated school awareness programs which have reached 15,000 children in 167 schools, organized community consciousness sessions in 122 communities, and reforested 1000 ha annually for commercial purposes (GESG 1998b). Their outreach program includes environmental education, community improvement, and protection and regeneration of forest resources. Unlike many environmental education programs in industrialized countries, Grupo's program is not preaching to the converted. Rather, it is seeking to educate primarily the children of the Sierra Gorda on the value and importance of natural resources, in hopes of altering land use practices and embracing sustainability in the future.

With regard to the protection and regeneration of forest resources, Grupo's program includes:

- construction of 31,900 linear meters of terraces for prevention of erosion in the mountainous region near the town of Pinal de Amoles;
- reforestation of more than 1,000 hectares in 100 communities in the municipalities of Arroyo. Seco, Jalpan de Serra, Landa de Matamoros, Pinal de Amoles, Peñamiller, and San Joaquin. This work will include the effort of the 800 small producers of forest products;
- maintenance and cultivation of 1,000 ha of previously reforested areas;
- operation and formation of three fire brigades working towards the prevention and control forest fires within the Reserve;
- the creation of fire breaks and the cleaning of the region near the zonas nucleos of Joya del Hielo (Zone VIII);
- coordination of the surveillance program to operate in 60 communities for the report of violations within the Reserve;
- initiation of programs to begin the reintroduction of native wildlife species; and
- continue the work of controlling the destruction of the forests (GESG 1998b).

Grupo recently received funding from the Commission for Environmental Cooperation for a program entitled 'Training for Sustainability in the Sierra Gorda Biosphere Reserve'. The program addresses the need for a well-coordinated campaign to change the actions and attitudes of the communities within the Reserve. It includes an environmental education program to instill the values of sustainability, clean-up campaigns, recycling programs, plant nurseries, reforestation, festivals, and many other initiatives (CEC 1999). If this program is successful in the Sierra Gorda, other community-based programs in other regions and countries will attempt to replicate their efforts.

3.3 SUMMARY OF ISSUES

Mexico is willing and able to participate in the CDM and in forestry projects. Through the AIJ process, they have begun to develop the necessary institutions to evaluate potential projects to ensure compatibility with Mexican objectives, and they have acknowledged the potential challenges facing participation in the CDM as a host country.

The Sierra Gorda Biosphere Reserve is one area in Mexico where the potential for CDM forestry projects exists. Conflicts arise between human-use pressure and conservation efforts within the Sierra Gorda, because those areas most diverse in species and in need of protection are often the same areas that offer optimum agricultural opportunities, such as cloud forest and tropical semi-evergreen forests (R.P. Ruiz pers. comm.). Landowners do not have any incentive to leave their land as forest, and social and economic conditions on the Reserve are such that the land is usually the sole means of income for a community. The Clean Development Mechanism offers an alternative to damaging land practices, while compensating landowners and offering alternative means of income. Attaching value to forested areas through carbon sequestration projects can provide the needed incentive to embrace conservation practices.

Chapter 4 will discuss potential CDM projects in the Sierra Gorda, and their implications.

CHAPTER 4

THE POTENTIAL FOR GREENHOUSE GAS OFFSETS IN THE SIERRA GORDA BIOSPHERE RESERVE

"Developing countries see [CDM] as a source of additional private foreign investment funds that may otherwise be unavailable and may provide benefits in addition to preventing global climate change. To the degree that the non-GHG benefits are significant, the project will have greater chances of permanence. For example, if a forestry project conserves a biosphere, it can lead to an increase in eco-tourism, providing further incentive for locals to guard the welfare of the forest."

Mireya Imaz et. al 1998 p.22

The Sierra Gorda Biosphere Reserve has been identified as a potential site for CDM forestry projects because of its large carbon pools, rich biodiversity, and significant local support. This chapter will discuss the potential for CDM forestry projects in the Sierra Gorda Biosphere Reserve. It will describe the past and current CDM proposals, identify stakeholders, analyze the benefits of such projects to the region, explain some of the barriers and challenges to their success, and discuss other potential CDM forestry projects for the Reserve.

4.1 First CDM Proposal in the Sierra Gorda

The Sierra Gorda was identified as a site for CDM projects in 1997 by Woodrising Consulting Inc. (Woodrising), a Canadian consulting firm, and Grupo Ecológico Sierra Gorda. Grupo is seeking to advance their objectives and further their protection efforts in the Sierra Gorda Biosphere Reserve through CDM projects. With the help of Woodrising, Grupo has been marketing portions of the Reserve as carbon sequestration projects for potential Annex I investors. To date, there have been two proposals. The following sections analyze these proposals, and discuss their weaknesses and strengths.

The first proposal, tabled before the Kyoto Protocol, included planting native tree species on the Reserve, and executing a regime to sustainably harvest the trees. This proposal was submitted to USIJI by Grupo in February 1997. USIJI was concerned about the following:

- it failed the project additionality criteria;
- the carbon sequestration values were not verified;
- there was no investor; and
- there were questions of permanency (N. Bird pers. comm.).

Failed additionality criteria

The proposal failed the project additionality criteria because the sustainable harvesting component would have made money for the residents in the Sierra Gorda. In other words, if the project makes money, it is assumed that it would have occurred eventually, even without CDM funding. The issue of monetary gain is still unresolved in the CDM, and may change as the CDM evolves and international negotiations continue.

No verification of carbon values, and no investor

The other deficiencies demonstrated in the proposal were that there was little proof of the quantification of the carbon sequestration, and there was not an Annex I investor for the project (N. Bird pers. comm.). These issues illustrate the frustrations that can face a non-Annex I country or organization as it attempts to market a CDM proposal. To get an investor for a project, the carbon sequestration values must be verified to prove their accuracy. On the other hand, to verify the values, the organization requires funding to do the monitoring (N. Bird pers. comm.). As a result, Grupo is put in a no-win situation. They can only hope that an investor will absorb the risk of unknown carbon values, or that they will receive funding from another source to complete the monitoring and therefore attract investors. The difficulty with the latter option, however, is that existing funding sources cannot be redirected to CDM projects, as per the Kyoto Protocol.

Permanency

There was a question of permanency with the first proposal. In particular, potential investors raised concerns about Grupo's role as stewards of the project. Although Grupo was established in 1987 and is recognized as a private assistance institution in Mexico, investors doubted the organization's reliability. To satisfy investors, Grupo must demonstrate that they are able to manage 100-year forestry projects. This concern was addressed in the second CDM proposal, discussed below.

4.2 SECOND CDM PROPOSAL IN THE SIERRA GORDA

A second proposal was drafted in light of the concerns raised regarding the first proposal by USIJI and the wording of the Kyoto Protocol. It includes an afforestation and protection initiative that has the potential to increase the size of the zonas nucleos, as well as protect new areas. A summary of the proposal is presented in Table 4.1.

TABLE 4.1 Summary of Second CDM Proposal in the Sierra Gorda Biosphere Reserve

PROJECT CATEGORY	Land Use Change and Forestry		
DELIVERY MECHANISM	Sequestration and Emission Reduction through Protection		
START DATE	Fall, 1999		
CUMULATIVE AMOUNT	**YEAR**	**CO_2 (tonnes)**	**C (tonnes)**
	2010	25,681	7,004
	2020	106,629	29,081
	2050	545,392	148,743
	2100	645,400	176,018
INVESTMENT TYPE	Partnership		
INVESTMENT AMOUNT	U.S.$ 558,000 (Cdn. $ 781,000)		
COST/ TONNE CO_2	U.S.$ 0.86 (Cdn. $1.21)		
COST/ TONNE C	U.S.$ 3.17 (Cdn. $4.44)		
LOCATION	Sierra Gorda Biosphere Reserve, Mexico		

Source: Woodrising Consulting (1998b)

After 100 years, the investor will receive a percentage of the 176,018 tonnes of carbon sequestered in the trees and roots of the forest, at a cost of US$3.17 per tonne of carbon (Woodrising 1998b). The values for carbon presented in the above table were calculated by Neil Bird of Woodrising Consulting Inc. The amount of carbon sequestered is modeled using GORCAM, an algorithm developed to track carbon storage in various pools of a forest stand. Only carbon stored in trees and roots was included in the calculation. It is important to note that the quantification of carbon pools is extremely complex, and is beyond the scope of this document. For further discussions regarding carbon sequestration models, see Schlamadinger et.

al (1998) and Schlamadinger and Marland (1996). The complete proposal for this initiative can be found in Appendix V

The second proposal attempts to address the weaknesses in the first proposal, as summarized in Table 4.2.

TABLE 4.2 Second CDM Proposal in the Sierra Gorda

WEAKNESS OF FIRST PROPOSAL	SECOND PROPOSAL
• Failed project additionality criteria because of sustainable harvesting component	• No sustainable harvesting, or profit-making component
• Carbon sequestration values not verified	• Carbon sequestration values still not verified
• No investor	• Still no investor
• Questions of permanency	• Grupo created the Joya de Hielo Land Trust, a conservation trust that is based on the model of the Nature Conservancy (Woodrising Consulting Inc. 1998b). Trust ensures land is protected under Mexican law, and cannot be converted to non-forest ecosystems.

This proposal has not yet been sent to USIJI by Grupo for three reasons. First, USIJI already has numerous forestry projects in their portfolio, some of which are in Mexico (N. Bird pers. comm.). Second, the unresolved issues surrounding forestry in the Kyoto Protocol have made Grupo and Woodrising wary of proceeding with the proposal (N. Bird pers. comm). International negotiations on land use change and forestry projects will decide outstanding issues such as which types of forestry projects will be allowed under the CDM. As mentioned in Chapter 2, the IPCC will be completing a report on land use change and forestry issues in the year 2000 that should clarify some of these outstanding concerns (Brown 1998). Third, there is no Annex I investor (N. Bird pers. comm.). At the time of the site reconnaissance to the Reserve in September 1998, a German investor expressed interest in the project. Until an investor makes a concrete commitment to the project, however, it is unlikely that Grupo will submit this proposal to USIJI (N. Bird pers. comm.).

The second proposal is ongoing, and is being refined in anticipation of attracting an Annex I investor. It targets lands in or surrounding areas of particular importance for biodiversity or other ecological reasons, and seeks to permanently afforest agricultural land, as well as protect currently forested land (Woodrising 1998b). The proposal consists of 600 ha of agricultural land that will be permanently afforested through natural regeneration and 600 ha of forested land that will be permanently protected, resulting in an increase of protected land (5%) in the Sierra Gorda (Woodrising 1998b). It is assumed that colonizing propagules are already there, and that natural regeneration is possible. If this is not the case, then planting may have to be considered as an alternative. While a total of 1,200 ha is being marketed, Grupo has identified 1,920 ha of land that is suitable for protection (R.P. Ruiz pers. comm.). They still require additional agricultural areas to meet the 600 ha quoted in the proposal, but have ample locations from which to choose the 600 ha of forested land. Table 4.3 summarizes these areas, and the vegetation communities they would protect. Figure 4.1 illustrates the location of these projects within the Reserve.

In addition to the areas identified by Grupo for the proposal, Roberto Pedraza Ruiz of Grupo selected two supplementary regions of forest for protection. These include 400 ha of cloud forest in El Pilón (number 15 on Figure 4.1) and 300 ha of tropical semi-evergreen and tropical dry forest near Tancuilín (number 16 on Figure 4.1). The area around Tancuilín is home to 380 known butterfly species (R.G. de la Maza E. pers. comm.). While lands of particular ecological value were preferred for CDM projects, the decision to choose areas for afforestation and protection was often based on the landowner's interest and willingness to sell (R.P. Ruiz pers. comm.). Grupo has tried to choose areas known to house endangered, endemic or otherwise protected species, or areas representing a vegetation community needing further conservation, such as the cloud forest (R.P. Ruiz pers. comm.). The political reality for CDM projects in the region is that the practical concerns surrounding such decisions often outweigh the ecological ideals.

TABLE 4.3 Potential Carbon Sequestration Projects in the Sierra Gorda

	LOCATION	SIZE (HA)	VEGETATION COMMUNITY*
Agricultural land that will naturally regenerate (320 hectares)			
1	El Carmen	50	Oak forest
2	Arquitos	30	Pine-oak forest
3	El Llano	100	Oak forest
4	Agua Fria	40	Oak-elm forest
5	El Ranchito	50	Oak forest
6	Tonatico	50	Oak forest
Protection of forested land (1600 possible hectares)			
7	Hornitos	100	Pine-oak forest
8	Pinal de Amoles	200	Pine forest
9	Joya Verde	600	Pine-oak forest/cloud forest, habitat of endangered black bear (*Ursus americanus)*
10	Valle Verde	200	Pine-oak forest, habitat of endangered bear (*Ursus americanus)*
11	Malpais	100	Juniper-oak forest
12	El Madroño	100	Pine-oak forest
13	Media Luna	200	Juniper-oak forest
14	La Yesca	100	Cloud forest, habitat of rare flying squirrel (*Sciurus oculatus*)

*For lands that are currently supporting agriculture, vegetation communities represent what was supported on the land prior to deforestation.

Source: Roberto Pedraza Ruiz pers. comm.

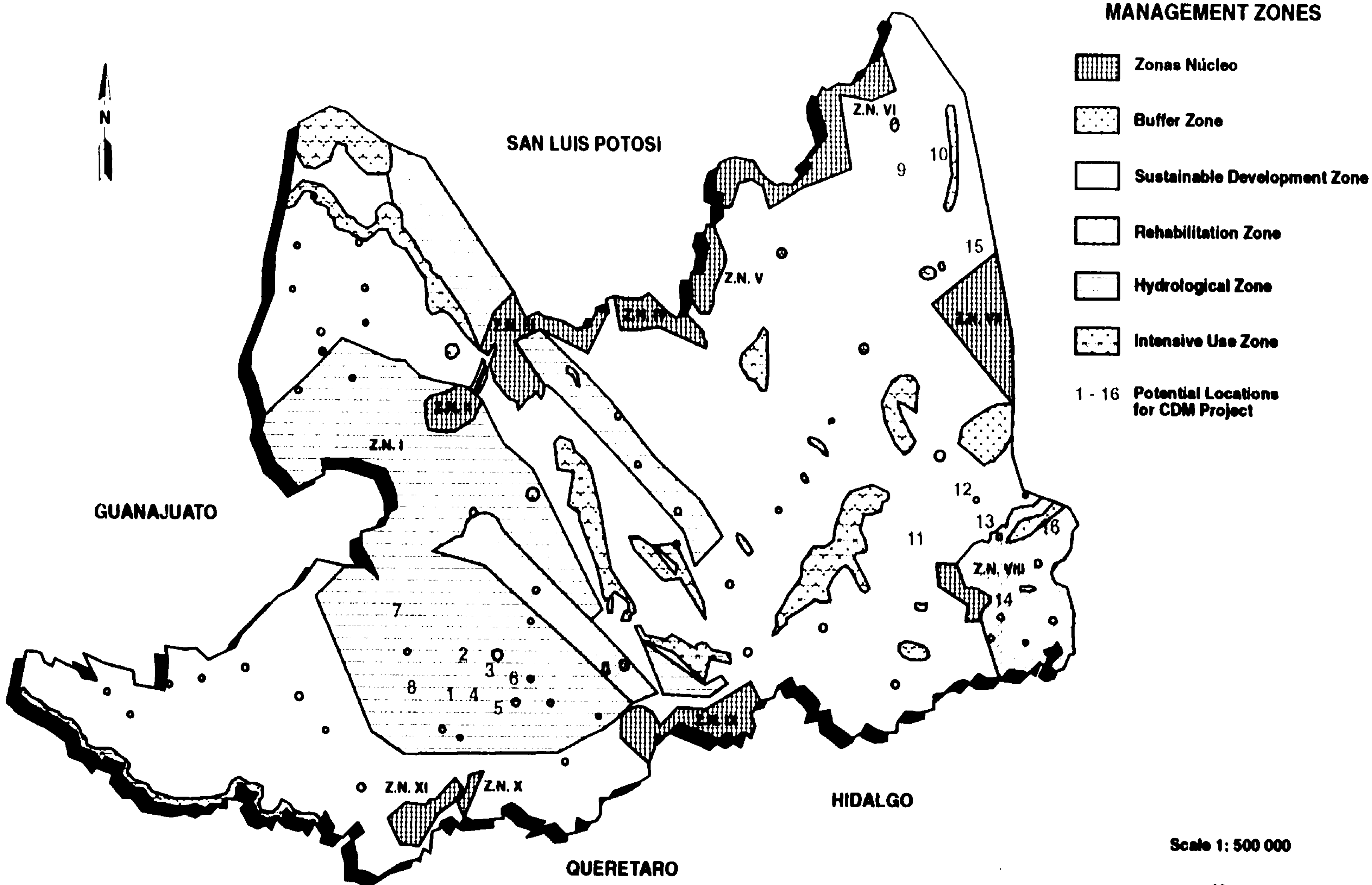


FIGURE 4.1 Potential Clean Development Mechanism Projects on the Sierra Gorda Biosphere Reserve

Source: Grupo Ecológico Sierra Gorda

4.3 STAKEHOLDERS

There are several different organizations and institutions that will govern the success of CDM projects in the Sierra Gorda Biosphere Reserve. Figure 4.2 illustrates the stakeholders that are involved.

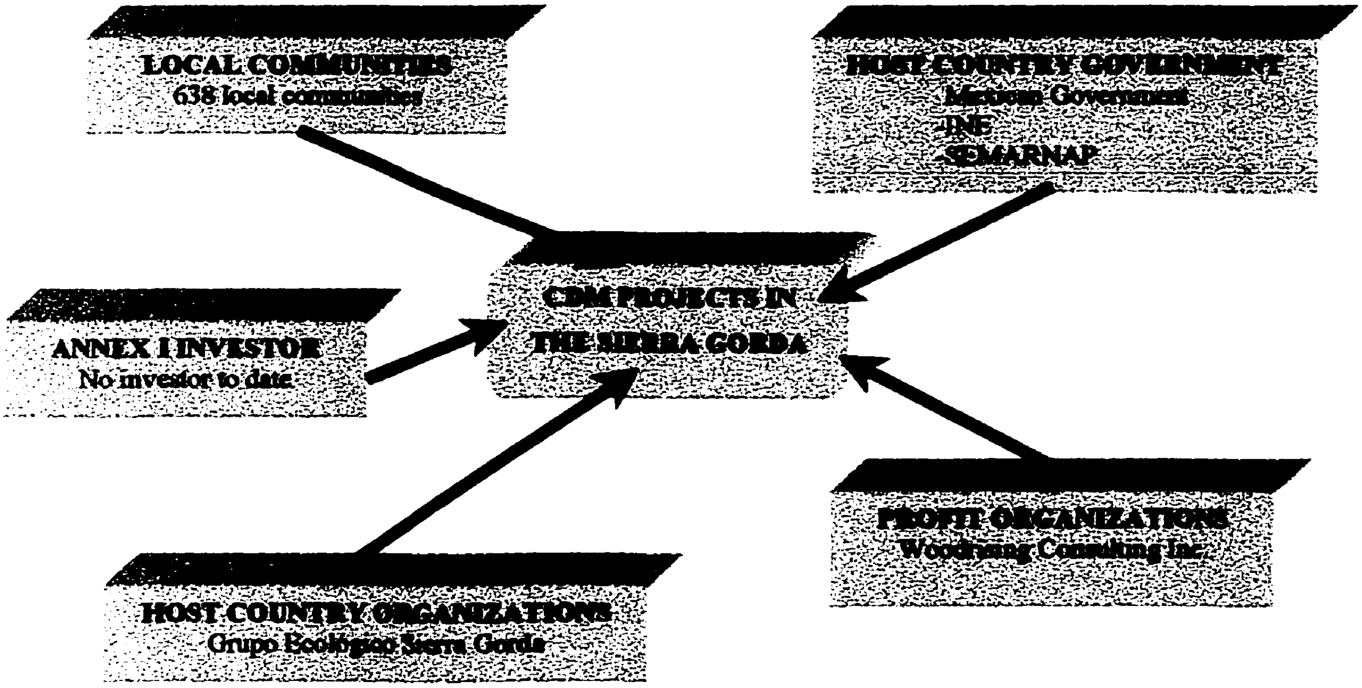


FIGURE 4.2 Stakeholders in Sierra Gorda Biosphere Reserve CDM Projects

4.3.1 The Host Government

In addition to being a climate change initiative, the CDM is also a development mechanism and thus, the role of the developing country government is crucial (TERI 1998). In theory, the host country government is responsible for accepting or rejecting proposed CDM projects prior to implementation. According to Article 12.5(a) of the Kyoto Protocol, participation in the CDM is voluntary, which implies that the host country can refuse to accept a project if it is not consistent with their criteria or national objectives. CDM projects should be beneficial and sensitive to the host country's needs, and not contradict national policies. Any forestry-based CDM project must be submitted to the Natural Resources Committee of SEMARNAP (JIN 1998).

As discussed in Chapter 3, the Mexican government relies primarily on USIJI criteria for project acceptance (J. Martinez pers. comm.). Table 4.4 analyzes if CDM projects in the Sierra Gorda are compatible with Mexican government objectives for forestry projects, using USIJI criteria. The criteria are further discussed below.

TABLE 4.4 Compatibility of CDM Projects in the Sierra Gorda with Mexican Government Objectives

CRITERIA	COMPATIBILITY*
contribute to the sustainable and economic development of the region	P
consider present and future emissions, both with and without the project, using accepted IPCC methodology	Y
contribute to achieving net global emissions reductions that are scientifically measurable and verifiable	Y
provide sufficient guarantees that net reductions will not be lost or canceled over time	P
result in a reasonable amount of carbon sequestration while promoting sustainable development	Y
are consistent with other environmental goals(JIN 1998).	Y

*Y = fully compatible
P = partially compatible. Project can be fully compatible if properly planned with these objectives and criteria in mind.

Contributes to the sustainable and economic development of the region

CDM projects in the Sierra Gorda have the potential to contribute to the sustainable and economic development of the Reserve, especially if alternative land use practices such as ecotourism and agroforestry are encouraged (N. Bird pers. comm.; D. Thompson pers. comm.). The current proposal, while opening up the possibility of ecotourism through increasing conservation, does little to directly advocate sustainable forestry or agroforestry alternatives to current land use practices (Woodrising 1998b). Funds gained from the Joya de Hielo Land Trust, however, can be used to promote sustainable practices in other regions of the forest, which, in turn, could eventually encourage future CDM projects to include a sustainable harvesting component. Sustainable forestry and agroforestry CDM projects in Chiapas and Oaxaca suggest that this is a possibility, although the acceptance of sustainable harvesting proposals ultimately depends on the outcome of ongoing international negotiations on the CDM (Imaz et al. 1998).

Consider present and future emissions using accepted IPCC methodology

The calculations of carbon sequestration that have been presented in the current CDM proposal use standardized and acceptable methodologies. Baseline calculations were made by Woodrising Consulting Inc. to determine carbon values using the GORCAM model.

Contributes to achieving measurable and verifiable emissions reductions

Verification of carbon values is possible through the proposed monitoring program. Ideally, verification will be completed by an independent third party to ensure accuracy and credibility of carbon values and emission credits (Article 12.7 of the Kyoto Protocol). Woodrising has arranged to have these services provided by the experienced Mexican agency El Colegio de la Frontera Sur (Woodrising 1998b).

Provides guarantees that net reductions will not be lost or canceled over time

Permanence of the projects is difficult to guarantee. Article 12.5 (b) of the Kyoto Protocol states that projects under the CDM must provide "long-term benefits related to the mitigation of climate change". People are challenged to understand the time and space of forest landscapes. "Forests operate on cycles of 200 years to 2,000 years. If we are lucky, our lives may last 100 years. If our governments are lucky, they last 4 years. Our corporate institutions function [on quarterly or] one-year profit and loss statements" (Hammond 1998 p.103). Forestry CDM projects that last 100 years are hard for investors and host countries to fathom.

The Joya de Hielo Land Trust attempts to ensure financial and management permanence, but there is still the risk of slash and burn or natural disturbances that could release the carbon back into the atmosphere. Grupo has strengthened its fire protection efforts in the Sierra Gorda, which should alleviate some of the danger of carbon loss through fires (GESG 1998a). Periodic carbon loss through natural disturbance patterns, however, is necessary for a healthy ecosystem and should be considered in the original carbon model calculations (M. Quinn pers. comm.). Carbon loss as a result of social factors, however, cannot be guaranteed. Loss of land use control and failure to provide an alternative means of income could result in deforestation practices simply being shifted to another area in the Reserve (i.e. leakage). If this happens and it is documented, there is no carbon benefit for the investor. Grupo will play an integral role in ensuring this does not occur and enforcing conservation efforts.

Results in carbon sequestration while promoting sustainable development

It is difficult to determine if the CDM project in the Sierra Gorda results in "reasonable amount of carbon sequestration". What is reasonable? Because the project is a market-based initiative requiring private investment, investors are unlikely to participate if they feel the amount of carbon is less than should be expected. The proposal does attempt to promote sustainable development through the allocation of funds from the Joya de Hielo Trust.

Consistent with other environmental goals

Mexico's environmental program supports the promotion of new markets and economic sectors, ecological restoration, the promotion of sustainability, and the protection of natural areas, ecosystems, and biodiversity (INE 1996). If properly planned, CDM projects in the Sierra Gorda will be consistent will all of these objectives. CDM projects also have the potential to advance these objectives through promoting decreased soil erosion and improved water quality.

This initiative does not contradict any of the Mexican government national objectives and criteria for CDM projects.

4.3.2 Host Country Organizations

Environmental non-governmental organizations in developing countries tend to have their roots in the specific region they are charged to protect, and living conditions of the inhabitants often depend on the preservation of nature (Michaelowa and Dutschke 1998). This is the case with Grupo Ecológico Sierra Gorda. Grupo is dedicated to preserving the Sierra Gorda, and improving the standard of living for its residents. It has a large stake in the success of CDM projects, and is in full support of such initiatives in the Sierra Gorda Biosphere Reserve (C.M.I. Ruiz Corzo pers. comm).

Grupo will provide the management and administrative support to the CDM project (Woodrising 1998b). It is responsible for selecting the land, purchasing the land, and enforcing protection efforts. In addition, Grupo will continue their education programs and develop alternative uses for the land dedicated to carbon sequestration. With a budget of just under $US1 million per year, they are financially stable enough to support this initiative (Woodrising 1998b).

CDM projects in the Sierra Gorda must be compatible with Grupo's objectives and vision for the Biosphere Reserve. Table 4.5 summarizes if CDM projects in the Sierra Gorda are compatible with Grupo's objectives. The objectives are further discussed below.

TABLE 4.5 Compatibility of CDM Projects in the Sierra Gorda with Grupo's Objectives

CRITERIA	COMPATIBILITY*
the comprehension, respect and care of nature and biodiversity	Y
the protection of wild flora and fauna	Y
the integral fortification of the natural richness in the ecosystem communities in order to achieve self-sufficiency status	P
the creation of employment and socio-economic development for the inhabitants of the Sierra Gorda	P

*Y = fully compatible
P = partially compatible. Project can be fully compatible if properly planned with these objectives and criteria in mind.

Respect and care of nature and biodiversity and protection of wild flora and fauna

The first two objectives can unequivocally be supported through forestry CDM projects. The current proposal includes the conservation and restoration of ecosystems and habitats within the Reserve that will ensure further protection of flora, fauna, and biodiversity (Woodrising 1998b). The cloud forest, in particular, could be protected through this initiative (R.P. Ruiz pers. comm.). The tropical semi-evergreen vegetation community, which is considered valuable from a biodiversity standpoint according to Grupo's biologist, is not included as one of the proposed areas in Table 4.3. To rectify this and further support Grupo's objectives, future CDM projects could include protection of this community in their priorities and design (F.J.G. Meléndaz pers. comm).

Strengthening natural richness in the ecosystem communities

The protection of more areas within the Reserve from damaging human activity could also help restore the natural processes within the ecosystems (M. Quinn pers. comm.). Carbon sequestration projects, however, rely on the forest remaining standing so that carbon pools are retained to some degree. As discussed above, this ignores important natural disturbance regimes in some ecosystems such as fire, and may make Grupo's third objective and conservation-based forestry CDM projects incompatible in some cases.

Creation of employment and socio-economic development

Grupo's last objective encompasses socio-economic goals within the Reserve. CDM projects can create employment and promote socio-economic development in the Sierra Gorda. Jobs can be created in ecotourism, sustainable harvesting, agroforestry, and eventually monitoring of the initiatives. The funding that could be received from Grupo's CDM proposal provides training opportunities in the ecotourism industry and in sustainable land use practices in regions outside of the CDM project.

This initiative does not contradict any of the Grupo's objectives for the Sierra Gorda Biosphere Reserve. In fact, it supports them.

4.3.3 Local Communities

The 100,000 inhabitants and 638 local communities of the Sierra Gorda are the stakeholders who will be most affected by CDM projects in the region. The vast area within the Reserve, and the limited ability for Grupo to enforce protection of forested areas, suggests that landowners can essentially continue any land degradation practice, if they so desire. They will be ultimately responsible for the success of the projects through their acceptance or rejection of conservation efforts.

In theory, Grupo is representing the interests of the local communities in the Sierra Gorda during the design of the CDM projects. They work and consult directly with the local communities who will be affected by the CDM proposal to ensure their needs are being addressed.

4.3.4 Profit Organizations

Woodrising Consulting Inc. will be responsible for the monitoring and verification aspects of the CDM project. Woodrising has established a positive working relationship with Grupo during previous projects, and has aided in developing and marketing this initiative (Woodrising 1998b). They have extensive experience in climate change projects in developing countries.

4.3.5 Investor from Annex I Country

The investor will supply the financial support for the CDM project in return for a percentage of the sequestered carbon. They will be able to tailor their involvement within the project, ranging from solely purchasing carbon credits to more direct involvement (Woodrising 1998b). To date, there is still no investor for this initiative, although it is being marketed in North America and Europe, and is included on Woodrising's website to ensure access to the global market.

4.4 BENEFITS OF THE CDM PROJECT TO STAKEHOLDERS

As discussed in Section 2.5.2, tangible co-benefits are essential for the acceptance and possibly the success of CDM projects in non-Annex I countries, and Mexico is no exception (Imaz et al. 1998). According to Imaz et al. (1998), secondary benefits of projects are probably the "most compelling reasons for recipient countries to accept these projects" (p.22). For example, a 634,000 hectare extension of Bolivia's Noel Kempff Mercado National Park was financed by US$7 million from three energy companies from the United States (USIJI 1997). Their investment helped expand the protected area of a region of great biological distinctiveness, establish a park endowment, and support ecotourism and other economic development initiatives with local communities (Frumhoff et al. 1998). These co-benefits increased acceptance of the project by local communities.

Project co-benefits tend to be site-specific, however a potential list of co-benefits was presented in Table 2.4 in Chapter 2 and included technology transfer, energy efficiency improvements, advancement of national goals, long-term environmental improvements, restoration of productivity of degraded lands, protection of areas of ecological importance and biodiversity, and sustainable development (Imaz et al. 1998; Trexler and Kosloff 1998). The following sections will discuss potential co-benefits that will arise from CDM projects in the Sierra Gorda.

4.4.1 Host Country Government

From a political perspective, the proposed CDM project provides an opportunity to:

- advance national goals and priorities;
- satisfy commitments to both Kyoto Protocol and the Convention on Biodiversity;
- advance sustainable development objectives;
- advance long-term economic opportunities by providing a new funding source ;and
- meaningfully participate in emissions reductions as a host country.

Advance national objectives

As discussed in Section 4.3.1, the CDM projects are consistent with Mexican goals and priorities. In fact, these projects can advance their objectives by promoting new markets, attracting foreign investment, and protecting natural areas, ecosystems, and biodiversity. CDM investments for only 20% of potential forest conservation and restoration measures would be comparable to the 500 million per year currently provided by grants and loans for tropical forest and biodiversity conservation through the World Bank, Global Environmental Facility, and major bilateral donor agencies (Frumhoff 1998).

Satisfy other international commitments

The proposed CDM project in the Sierra Gorda provides an opportunity for the Mexican government to honor commitments to the Kyoto Protocol, the FCCC, and the Convention on Biological Diversity (CBD). Like the FCCC, the CBD is another international agreement attempting to address a global problem. Its objectives are "...the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.." (Article 1 of the CBD). It was adopted in 1992 during the UN Conference on Environment and Development and ratified by more than 150 countries (Janssen 1997). The Mexican government ratified the CBD on November 3, 1993, and it entered into force on December 29, 1993. Figure 4.3 illustrates the synergies between the CBD, the Kyoto Protocol, and the FCCC.

Host countries and investors would be remiss to only consider climate mitigation benefits when planning for CDM forestry projects. International conventions on climate change and biodiversity should be coordinated to ensure their success and increase their attractiveness to investors (Brown 1998). For example, embarking on CDM projects in areas like the Sierra Gorda that are high in ecosystem and species diversity and are large carbon storehouses would satisfy commitments to all three agreements. That said, there are some instances that CDM forestry projects will threaten or decrease biodiversity in a region. Section 4.7.4 discusses the potential incompatibility of biodiversity protection and carbon sequestration in certain CDM projects. Table 4.6 illustrates the similarities between biodiversity and carbon sequestration potential in developing countries. Mexico is ranked 8th in biodiversity and 6th in carbon sequestration potential (Brown 1998).

TABLE 4.6 Biodiversity and Carbon Sequestration Rankings for Developing Countries

PLANT BIODIVERSITY RANK	COUNTRY	CARBON SEQUESTRATION RANK
1	Brazil	1
2	Colombia	8
3	Indonesia	2
4	Venezuela	16
5	Peru	15
6	Ecuador	19
7	Bolivia	Unranked
8	**Mexico**	**6**
9	Malaysia	5
10	Papua New Guinea	10

Source Brown 1998 p. 7

Opportunity to advance sustainable development objectives

The FCCC and the Kyoto Protocol both recognize the concept of sustainable development. In fact, the criterion for sustainable development mentioned in Article 12 of the Kyoto Protocol is the only goal for CDM explicitly directed at the host country. Host countries see one of the main goals of the CDM as funding the progress towards sustainable development (TERI 1998; Curtis and Islam 1998; E. Sempris pers. comm.). Development funding is required in these countries to fund economic growth, social development and environmental protection (TERI 1998). The goals of emissions reduction in industrialized countries and sustainable development in developing countries need not be in conflict (Velasquez et al. 1999). CDM could provide funding for social programs, increase capacity and training, improve the economy, and help conserve the forests in developing countries, while reducing and sequestering emissions.

Figure 4.3 illustrates the political relationships between biodiversity, climate mitigation, and sustainable development.

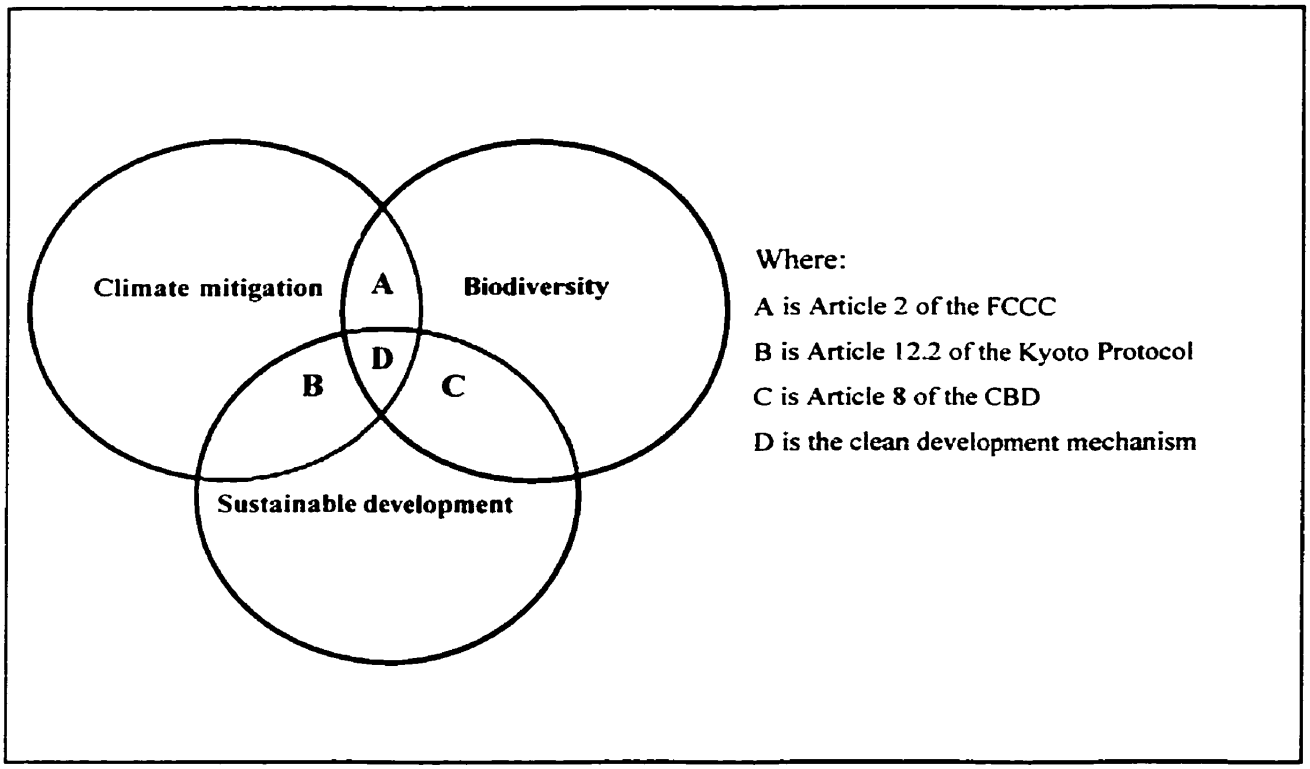


FIGURE 4.3 Political Links Between Climate Mitigation, Biodiversity Conservation, and Sustainable Development

Advance long-term economic objectives

The CDM projects could advance long-term economic opportunities as a new funding source into the national economy. Properly directed funding from CDM protection and afforestation projects can be used to ensure that economic development is a priority (Frumhoff et al. 1998). Funds directed by Grupo into training and new industries would contribute to rural economic development.

Meaningful participation

Since they will not have legally binding commitments under the Kyoto Protocol, many Annex I countries are demanding other types of meaningful participation from non-Annex I countries (IISD 1998a). This includes participation in the CDM. Greenhouse gas offsets allow Mexico, as a non-Annex I country, to meaningfully participate in emissions reductions, thereby proving that they are not in need of enforced commitments.

4.4.2 Host Country Organizations

The benefits that can be gained by Grupo through participation in CDM projects are substantial and can be divided into two groups, socio-economic benefits and ecological benefits.

Socio-economic benefits

- funding for environmental education and outreach programs; and
- financing for ecologically sustainable alternatives to damaging land use practices.

The financial resources provided by CDM projects will fund the objectives of Grupo, including their outreach programs and their efforts to promote environmental awareness and respect. In addition, the funds will be used to promote new, less damaging land practices to the dominant slash and burn agriculture and grazing, such as sustainable harvesting and agroforestry (C.M.I. Ruiz Corzo pers. comm.).

Ecological benefits

- increased network of core areas within the Sierra Gorda;
- improved biodiversity conservation through protection of species habitat and vegetation communities;
- restoration of marginal lands;
- reduced deforestation; and
- reduced soil erosion.

As shown in Chapter 3, a diversity of ecosystems and a wide array of endemic and rare species of plants and animals are found within the Sierra Gorda boundaries (GESG 1998a). Grupo's objectives and mandate include the protection of the diversity within the Sierra Gorda. They have begun efforts to protect the Sierra Gorda's abundant and diverse natural resources through the creation of the Biosphere Reserve, and the establishment of the zonas nucleos. The protected zones, however, tend to be narrow and within river valleys, and do not appear to adequately represent ecosystem biodiversity. CDM offers the opportunity to extend the core areas on the Reserve while maintaining biodiversity by protecting representative ecosystems. Protection of these areas, in turn, will protect habitats, restore marginal lands, reduce deforestation, and reduce soil erosion caused by deforestation and improper agriculture practices.

4.4.3 Local Communities

The proposed CDM project will undeniably affect the local communities and influence their livelihood within the Sierra Gorda. Potential benefits to local communities include:

- positive income for social initiatives such as environmental education and community outreach within the Sierra Gorda;
- training in new land practices;
- new opportunities and industries to generate economic returns;
- reduced sedimentation of waterbodies and improved water quality through watershed protection; and
- improved waste management practices and health benefits.

Positive income and training

Many of the benefits to Grupo, such as funding for outreach programs, will ultimately filter to the local communities. Clean-up campaigns, plant nurseries and community improvement programs will benefit the residents of the Sierra Gorda (GESG 1998a). In addition, training in new land practices, such as sustainable harvesting and agroforestry, can provide an alternative means of income. Current land use practices are not sustainable, and, as the population of the Reserve grows, may not meet the increased demand on resources. Training in more sustainable practices will diversify income, and benefit the residents in the long-term.

New industries

The CDM project could provide new opportunities and new industries to generate economic returns. Low productivity agriculture and grazing within the Reserve does not provide high economic gains (GESG 1998a). New markets could include ecotourism, and monitoring and verification of carbon credits. Ecotourism, in particular, is an industry that is currently being investigated for the region (N. Bird pers. comm.). The local communities would have to be consulted and involved in ecotourism efforts. The interests of the residents of the Sierra Gorda must be coupled with conservation efforts (Borrini-Feyerabend 1997). Ecotourism can provide revenue that is contingent on the state of the environmental surroundings. If marketed correctly, the beauty of the Sierra Gorda, in addition to its unique flora and fauna, should appeal to a wide range of tourists from industrialized countries, if this beauty is protected from degradation.

Watershed protection

The Sierra Gorda is bounded by rivers and contains several watercourses. Most of the area has an annual precipitation no higher than 850mm (GESG 1998a). The karst topography in the northern portions of the Reserve does not retain water, and there are few surficial waterbodies from which to receive a drinking water supply (R.P. Ruiz pers. comm.). However, a quantity of the filtered water comes to the surface through springs and deep pools which are the main water supplies for the region. Difficulty arises because there are not structures for storing and supplying water to the whole population. Only 50% of the houses in 300 towns have drinking water supplied by a pipe system (GESG 1998a). Deforestation surrounding the springs and hydrologic basins has increased the difficulties in harnessing the water for the region. Reducing this deforestation through CDM projects would benefit the Reserve's inhabitants greatly.

Increasing protected forested areas and afforesting deforested land can also reduce sedimentation of the Sierra Gorda's rivers and streams by decreasing soil erosion, thereby improving aquatic habitats. Many of the zonas nucleos currently protect important riparian areas. These areas can be extended through CDM projects. In fact, many of the areas selected for protection and afforestation are within the hydrological loading zones and in or near riparian areas (see Figure 4.1). Protecting these areas will improve the water quality for the inhabitants of the Reserve.

Improved waste management practices and health benefits

In addition to deforestation, water quality is poor in the Reserve due to wastewater discharges and garbage. Only 21% of the houses on the Reserve have any type of wastewater drainage service (GESG 1998a). The rest discharge waste directly into the rivers that supply the drinking water for the Reserve, causing problems with illness and odor. For example, in the municipality of Pinal de Amoles, the residents discharge their wastewater directly into the Jalpan River. Downstream is the Jalpan Dam, which provides the water supply for the largest town in the Reserve, Jalpan de la Serra. The river then receives the waste from Jalpan de la Serra (GESG 1998a). The Sierra Gorda does not have any water treatment plants (GESG 1998a).

Solid waste management on the Reserve is less than ideal. Five municipalities of the Reserve produce 45 tonnes of solid waste daily which is dumped in outdoor landfills that do not work properly (GESG 1998a). In addition, the waste collecting service in those five municipalities does not cover all the urban and semi-urban areas, and garbage that isn't collected is burned or discharged into the rivers. Grupo's efforts include building new composting toilets for remote communities in the Sierra Gorda, and educating the residents on the importance of hygienic practices. In addition to environmental education, funding from CDM projects would further finance improved waste management practices and would decrease health risks in the local communities.

4.4.4 Profit Organizations

The benefits that CDM projects in the Sierra Gorda will provide to Woodrising include financial gain, experience, and personal satisfaction. As consultants, Woodrising will be responsible for several aspects of the projects, and will thereby receive financial remuneration, as well as further experience in their field of expertise. In addition, however, Woodrising has a personal relationship with members of Grupo and their efforts to protect the beauty of the Sierra Gorda. Furthering protection efforts and helping Grupo meet their objectives may fulfil personal goals.

4.4.5 Annex I Investor

While co-benefits are important to the host country and may ultimately determine the success of a CDM project, they are not the main incentive for Annex I participation in CDM projects (see Section 2.5.1). Annex I countries are looking for cost-effective certified emissions reductions. The investor will benefit from the certified emissions reductions gained from the carbon sequestration, as well as cost savings from avoiding domestic emissions reductions. The investor will require assurance that the project will be permanent, and that the requirements in Article 12 of the Kyoto Protocol are fulfilled (i.e. certification, additionality, and measurability).

4.5 Barriers and Challenges

4.5.1 Host Country

CDM forestry projects bring together the need for conservation, the need for carbon sequestration opportunities, and the need for income for communities, but they only work if properly planned to consider all of these factors (Frumhoff et al. 1998). The risks, barriers and challenges to their success must be recognized during the planning stages so that they can be mitigated and overcome, if possible. Barriers and challenges to the host country stakeholders include:

- inappropriate protection;
- the wrong ecosystems may be selected for protection and afforestation;
- numerous landowners involved;
- confusion regarding carbon sequestration and global warming;
- possible rural job loss;
- loss of land use control;
- high population growth; and
- lack of enforcement.

Inappropriate protection and inappropriate ecosystems chosen for protection

Grupo advocates protection of the Sierra Gorda's natural resources and processes. Inappropriate protection, while not considered a barrier by the host government or local communities, would be counter to Grupo's ultimate objectives for the Reserve, as well as detrimental to the floral and faunal species within the Sierra Gorda.

The issue of protecting forested areas for carbon sequestration without considering ecological consequences is a controversial one. The requirement for permanency of carbon pools within forested areas begs the question of what happens with ecosystems that require fires as part of their natural disturbance regimes, or when wind causes tree blowdowns and light gaps to form (M. Quinn pers. comm.)? Disturbance is defined as "any relatively discrete event in time that disrupts ecosystems, community, or population structure and changes resources, substrate availability, or the physical environment (Rogers 1996 p. 1). Natural disturbances are common. Does the need for carbon sequestration become more important than conserving the forests' own natural cycles? In some cases, fire suppression can harm vegetation communities by increasing fuel loadings, altering forest structure, and changing species compositions and age classes (Kilgore 1973). Raging forest fires such as those in Yellowstone National Park in 1988 remind us of what can happen when fire regimes are ignored for extended periods of time. Healthy functioning forest ecosystems require the preservation of natural disturbances, and management of these ecosystems must recognize this fact (Grumbine 1994; Rogers 1996; Pfister 1993).

Managing forests purely for carbon sets a dangerous precedent. The U.S. House of Representatives, for example, recently passed a nonbinding resolution to manage national forests in the United States to reduce GHGs. The measure states that CO_2 may remain sequestered by harvesting the forest before it begins to decompose or burn, thus storing the carbon in wood products (U.S. House of Representatives 1997). This also disregards the importance of fire regimes in forest ecosystems, and suggests that forests should be managed solely for their carbon sequestration potential.

Selection of areas by Grupo for potential CDM projects was based on ecological, socio-economic and political factors within the Reserve (R.P. Ruiz pers. comm.). It is difficult to determine if the right areas are being chosen for protection. Given the fluctuations in natural communities, it has been suggested that one way to represent biodiversity at the ecosystem level is to maintain "a full array of physical habitats and environmental gradients in an interconnected network of reserves" (Christensen et al. 1996 p. 689). The proposed areas for CDM projects do not appear to provide complete representation of ecosystems within the Sierra Gorda (e.g. tropical semi-evergreen forest is still underrepresented), but they are a step in that direction. It was beyond the scope of this MDP to determine which areas should be protected within the Sierra Gorda.

Numerous landowners involved

It cannot be stressed enough that the socio-economic issues can make or break land use change and forestry projects in developing countries (Imaz et al. 1998). The buy-in from local organizations and communities is crucial to the success of these projects. The problems surrounding zonas nucleos VIII in the Sierra Gorda Biosphere Reserve can be repeated in CDM projects. Landowners in that zone reneged on their conservation agreement, and began logging the forest (C.M.I Ruiz Corzo pers. comm.). This is the only zone in the Reserve that has multiple landowners. The areas selected for protection and afforestation also involve numerous landowners. Negotiations to buy the land for a CDM project could prove difficult, although Grupo's positive working relationship with the inhabitants of the Reserve will facilitate the process.

Confusion regarding carbon sequestration and global warming

The rationale and procedures for CDM projects are complex and involve investment from a country that is far removed from the everyday life of the inhabitants of the Sierra Gorda. The residents cannot be expected to fully comprehend the concept of CDM when the international community does not yet understand all of the facets and implications. Residents should, however, be given the opportunity to learn all of the ramifications of their decision to sell or donate their land. Willingness on behalf of the landowners to allocate their land for carbon sequestration and conservation is essential to the success of the project. Without it, the ecological significance of the land is moot.

Possible rural job loss and loss of land use control

Job loss and loss of land use control have been identified by INE as a concern with CDM projects (J. Martinez pers. comm.). Afforestation and protection projects without a capacity-building component do not provide obvious means of income for local residents affected by such projects. As discussed earlier, allocation of funds from CDM projects into rural development and training is essential.

High population growth

The population of 100,000 residents of the Sierra Gorda, as well as those populations that live adjacent to its borders, is growing. Within the Sierra Gorda, the growth rate is 2.3%, including emigration (GESG 1998a). High population growth rates in non-Annex I countries exert continuing pressure on the natural resources. This growth could prove a barrier when identifying lands for protection and enforcing CDM projects.

Lack of enforcement

In addition to Grupo's efforts, there is a 60-community vigilante group that polices the Sierra Gorda area and informs the authorities about environmental impacts (GESG 1998a). Unfortunately, their efforts cannot cover the vast area within the Reserve. Enforcing CDM projects may prove difficult.

4.5.2 Annex I Investor

The potential Annex I investor will have different barriers than the host country. For the proposed CDM projects in the Sierra Gorda, the following barriers may apply:

- no assurance of permanency;
- the carbon has not been certified; and
- uncertainty surrounding forestry projects in the Kyoto Protocol.

No assurance of permanency

While projects must be 'long-term' under the Kyoto Protocol, the time frame for successful CDM forestry projects has yet to be determined. The investor needs some reasonable assurance that the CERs they receive will not be null and void in the future because of carbon release from fire or deforestation. Grupo has made every possible effort to ensure this through communication with landowners and fire protection efforts. Poverty, reliance on agricultural practices, unclear land tenure, and lack of enforcement, however, still make the permanency of forestry projects tenuous and subsequently these projects are higher risk.

No certification

Certification and verification methods are still being resolved by the international community (Trines 1998). In addition, without funding, Woodrising cannot verify the carbon values. No verification of the carbon and no certification increases the risk for the investor.

Uncertainty surrounding forestry projects in the Kyoto Protocol

As discussed in Chapter 2, unresolved issues regarding forestry projects in the Kyoto Protocol exacerbates the uncertainties surrounding such projects. Investors are cautious while the international community attempts to resolve these uncertainties.

4.6 SUCCESSFUL CDM PROJECTS FOR THE HOST COUNTRY AND ANNEX I INVESTOR

As demonstrated above, the needs of the host country and the investor are quite different in CDM projects. Annex I countries are looking for certified emissions reductions. To be certified, the CDM project must satisfy Article 12 of the Kyoto Protocol. Article 12.5 (b) of the Kyoto Protocol stipulates that CDM projects must be real, measurable, and have long-term benefits related to the mitigation of climate change. Article 12.5(c) of the Protocol states that CDM projects shall provide emission reductions that are additional to any that would otherwise have occurred. In addition, investors want low risk, cost-effective projects with some degree of permanency. Figure 4.4 illustrates what an ideal CDM project might look like from an Annex I perspective.

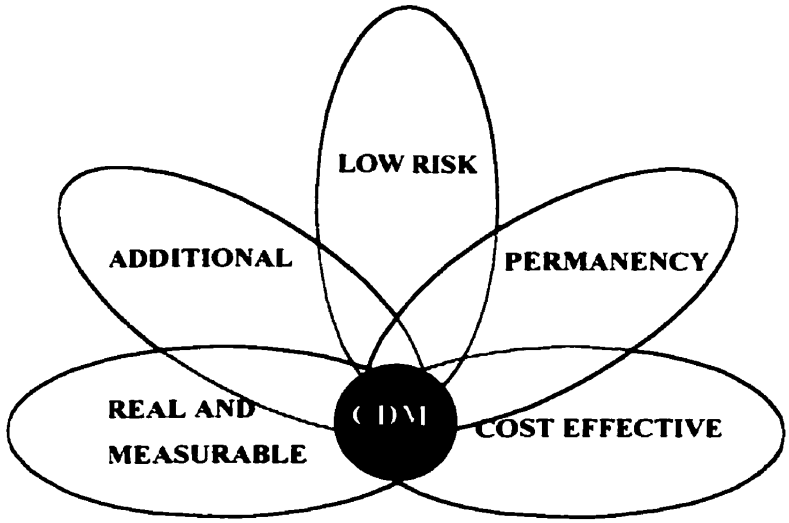


FIGURE 4.4 Good Carbon Offset Opportunities for Annex I Countries

Adapted from Trexler and Kosloff 1998

Host countries do not have the same needs as the investor, and subsequently require different criteria for successful projects. Figure 4.5 illustrates what an ideal CDM project might look like from a host country perspective.

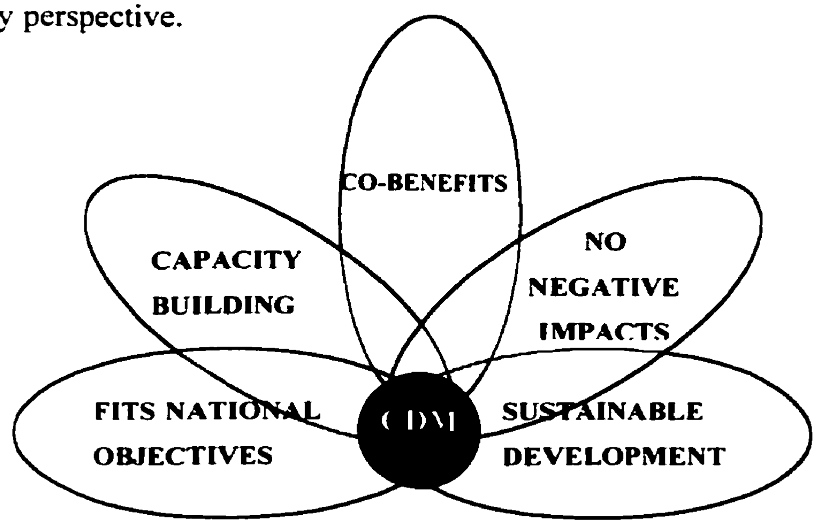


FIGURE 4.5 Good Carbon Offset Opportunities for non-Annex I Countries

The proposed project in the Sierra Gorda Biosphere Reserve has the potential to satisfy most of the criteria of the host country and the Annex I investor. Table 4.7 summarizes whether the projects in the Sierra Gorda satisfy the stakeholders' criteria for successful CDM projects.

TABLE 4.7 Criteria for Successful CDM Projects in the Sierra Gorda

CRITERIA	ACCEPTABILITY OF SIERRA GORDA CDM PROJECTS
Host Country Government	
Consistent with national objectives	✓
Helps fulfil international commitments	✓
Advances sustainable development	✓
No negative economic or environmental impacts	P (may be negative ecological consequences if not properly planned)
Host Country Organization	
Consistent with organization's objectives	P (may be negative ecological consequences if not properly planned)
Provides significant co-benefits (environmental protection and restoration)	✓
Local Community	
Provides significant co-benefits (capacity, training, improved standard of living)	✓
Provides potential alternative sources of income	P (only if funding is targeted to training)
Profit Organization	
Provides income and expertise	✓
Annex I Investor	
Permanent	X (risk of leakage)
Additional	P (still undetermined)
Low risk	P (still uncertainty with leakage and forestry projects)
Real and Measurable	X (carbon has not been verified)

✓ Fulfils criteria
X Does not fulfil criteria
P Criteria partially fulfilled.

4.7 FORESTRY PROJECT OPTIONS

The above analysis is based on the CDM proposal currently being considered, which includes only afforestation and protection projects. These make sense socially and politically for the Sierra Gorda right now. Ideally, however, Grupo and the inhabitants of the Sierra Gorda Biosphere Reserve will be able to participate in a diverse portfolio of projects in the future that meet and address their unique needs. For example, in Guatemala there is an agroforestry and carbon sequestration project that includes woodlots to provide fuel and lumber, agroforestry plantings to provide income, fodder, fruit and nuts, and measures to protect existing forest with fire control and fencing (Muller 1991). The myriad of benefits provided by this unique selection of projects can also attract additional funding from other sources and development agencies.

This section will discuss the available opportunities for CDM forestry projects in the Sierra Gorda Biosphere Reserve, and will analyze the merits of each option.

4.7.1 Protection of Forested Areas

Protection of currently forested areas is one of the options being considered by Grupo in the Sierra Gorda. These are areas that are under threat of deforestation within the Reserve. Protection-based projects should be relatively simple to administer. They require a landbase, which Grupo has already identified, quantification of carbon credits, which Woodrising could provide, and management to prevent the loss of the carbon storage. As aforementioned, ecosystems that rely on natural disturbance regimes that are contrary to long-term carbon storage should either be excluded from CDM protection initiatives, or carbon models should take these natural disturbances into consideration.

Slowing deforestation can have a large effect on increasing carbon sequestration (Trexler and Kosloff 1998; Brown 1998; Muller 1991). Protection of existing forests is essential if global warming is to be curbed. "On average, deforestation releases around 100 tonnes of carbon per hectare through burning and, over time, decomposition. However, newly forested areas sequester only 5-10 tonnes per hectare a year. It therefore takes decades to refix the carbon released into the atmosphere after forests are removed. Conserving existing 'high carbon' forests is therefore important if we are to slow the buildup of atmospheric carbon dioxide over coming decades" (Muller 1991 p. 8). Even when the carbon stored in mature forests is released through oxidation or fire, natural regeneration will fill the gap eventually and ensure that carbon pool remain high (Cairns and Meganck 1994). In addition, not only do natural forests store greater amounts of carbon than tree plantations, they also provide greater biodiversity benefits (Brown 1998; Cairns and Meganck 1994). Carbon credits from protection projects can be used to fund the conservation and protection of natural ecosystems in developing countries.

According to Frumhoff et al. (1998), "projects that successfully conserve standing forests can yield substantially higher near-term carbon credits than many alternative LUCF measures, leading some observers to suggest that they will be highly attractive to investors" (Frumhoff et al. 1998 p. 5). However, protection initiatives face a greater risk of leakage. Forest loss could be redirected elsewhere when social, economic, and policy drivers of land use change are not addressed (Sathaye et al. 1998). The projects must address and counter threats to land use change by providing alternative means of income and land use, as Grupo seeks to achieve through their various initiatives.

The uncertainty surrounding forestry projects under CDM in the Kyoto Protocol exacerbates the risks associated with these projects. Article 3.3 of the Protocol limits the activities that are to be included in national inventories of Annex I countries to afforestation, reforestation, and deforestation. It is unclear if this limit applies to the CDM as well. The international community would be remiss to exclude these types of projects from the CDM. A large percentage of GHG emissions from non-Annex I countries comes from deforestation. Excluding options to address deforestation will weaken the ability of non-Annex I countries to limit current and future emissions, and will ignore cost-effective mitigation options that offer great co-benefits (Brown 1998).

4.7.2 Afforestation and Reforestation

Afforestation and reforestation are included under the Kyoto Protocol in national GHG inventories, although they are not recognized specifically under the CDM. In addition to protection, Grupo has chosen afforestation as a CDM initiative. The areas chosen by Grupo for afforestation are primarily agricultural and marginal lands, and will be protected from harvesting. In general, carbon storage is maximized when the afforestation of agricultural land results in old-growth forests, which is then protected from deforestation and fires, if appropriate (Freedman 1997). Returning these lands back to forest will greatly increase the quantity of organic carbon stored in the ecosystem, and result in a net withdrawal of CO_2 from the atmosphere. The subsequent protection of the forest will maximize the carbon storage.

According to Freedman (1998), afforestation projects should include an ecological design of the reserve. "If an attempt is made to restore a forest natural to a region, then appropriate design of tree species composition and spatial configuration of plantings will be an important consideration" (Freedman 1998 p. 411). Grupo has begun efforts in this direction, but further work and research is still required.

Planting can be expensive, thereby increasing the cost of the carbon credit and deterring investors. Grupo had chosen to allow natural regeneration of these areas. While this can decrease the cost, it also disregards the possibility of providing work and income to local residents who could be hired to do the planting. If the final end land use is conservation, then the same concerns regarding leakage as discussed above apply. Taking away agricultural land begs the question of what the community, that depended on that agriculture, will now do for substinence and income. To address this, Grupo has chosen to invest in other initiatives on the Reserve to provide alternative means of income for the local communities.

4.7.3 Sustainable Harvesting and Agroforestry

Sustainable harvesting projects were not included in the currently proposed CDM projects for the Sierra Gorda. This is primarily because there were concerns regarding the project additionality criteria in past proposals. That is, if the project makes money for the local communities, it would have occurred in the absence of the project. This issue is still unresolved, but the existence of sustainable forestry and agroforestry CDM projects in Chiapas and Oaxaca, as well as six AIJ pilot-phase projects that include a sustainable forest management component suggests that sustainable harvesting projects are a viable option (Brown 1998). Profitability would greatly increase the appeal of projects to both non-Annex I participants and Annex I investors. In addition, government financial incentives may exist for private sector investors from Annex I countries. For example, Canadian companies involved in profit generating reforestation efforts may be able to deduct costs associated with the project, subject to the requirements found in Canadian tax legislation.

"Projects involving sustainable forest management or reduced impact logging in place of an intensive harvest regime have been shown to result in quantifiable carbon emission reductions" (Brown 1998 p. 21). To ensure that degrading land use practices are not rewarded by paying for improvements over poor management activities, the minimum reference case should be at least equal to the existing laws of the host country (Brown 1998). Minimum standards could include basic standards for harvesting. It may prove difficult to track the end product of any harvested wood to determine if the carbon has remained stored. If it is intended for wooden structures, furniture or other long-lived timber products, the carbon sequestration is longer lasting (Muller 1991). If it is used as an alternative to fossil fuels, the carbon benefits are also easier to calculate. On the other hand, if the harvested wood is burned as a fuel but does not replace a fossil fuel, the carbon storage is lost to the atmosphere. If this is the case, sustainable harvesting can provide a means of slowing global warming and buying time for a transition to other renewable sources of energy (Muller 1991).

While there is uncertainty surrounding sustainable harvesting in the Kyoto Protocol, Article 2 of the Protocol promotes sustainable forest management practices. As well, Article 6 of the Kyoto Protocol mentions that projects can be developed in "any sector of the economy", suggesting that forest management can be included. If sustainable forest management were allowed under the CDM, it could become more profitable in host countries than slash and burn agricultural practices (Brown 1998). The greatest benefit of sustainable harvesting, however, is that it provides a direct alternative means of income for local communities, unlike protection or afforestation initiatives. Providing carefully managed lands upon which to practice profitable sustainable forestry could significantly reduce leakage, and alleviate some of the pressure on areas that have been conserved because of their ecological importance. These benefits make this forestry option especially attractive to local communities in host countries.

In the Sierra Gorda, there is not a large timber market in the close vicinity. Combining the financial incentive of timber harvesting with the financial incentive of carbon sequestration could, however, make sustainable forestry a feasible option for the region. Sustainable harvesting and agroforestry should be considered as cost-effective, socially sensitive options for CDM projects in addition to the protection and afforestation initiatives already proposed.

4.7.4 Plantations

Like sustainable harvesting, plantations were not considered for CDM projects in the Sierra Gorda. Many of the same issues apply, including the question of additionality, the end-use of the timber, and the potential for income for the local communities.

In terms of carbon sequestration, "[t]he total amount of carbon that accumulates per hectare in plantation biomass is typically far less than that in the biomass of natural forests" (Frumhoff et al. 1998 p. 8). At the outset, plantations contain insignificant amounts of biomass, and then they accumulate carbon relatively slowly (Schroeder 1992). Because of this, carbon credits from plantations will be delayed relative to protection or afforestation projects. This may discourage investment from Annex I countries, but the reduced risk in other areas such as leakage may compensate for that deficiency. Plantations established on degraded land can increase the carbon pool, and are useful for temporarily storing carbon while alternatives to fossil fuels are investigated (Cairns and Meganck 1994). Monoculture plantations also offer straightforward carbon measurement options at lower costs (Sedjo et al. 1998).

"The role of plantation forests as sustainable and environmentally sound sources of renewable energy and industrial raw material must be recognized" (ADB 1995 p. 14). They can offset pressure on older forests and provide regional employment and development with adequate involvement of local inhabitants. (ADB 1995). Between 1980 and 1995, the area dedicated to plantations more than doubled in Latin America, Africa and Asia (FAO 1997). Managed plantations can be attractive investments for the host country, especially when carbon sequestration value and timber value are combined (Sedjo 1999). They can often offset the costs of land acquisition, tree planting, and management, and provide revenue for the host country (Frumhoff et al. 1998).

Ecologically, there is little evidence that plantations provide significant habitat for native species. Potentially, measures supported by CDM plantation projects could include draining wetlands and "planting permanent monocultures of exotic species in sites where natural or assisted restoration of indigenous forests is feasible" (Frumhoff et al 1998 p. 5). Host countries are concerned about local ecological damage from plantation projects (World Bank 1998). Monoculture plantations are an impediment to preserving biodiversity, and care must be taken to ensure that they do not replace critical habitats or areas of high ecological value. High-yielding monoculture plantations can also permanently degrade soil and water resources, and succumb to pests and diseases quickly (ADB 1995). Mixed plantations can be more productive and less damaging than single species plantations (Montagnini and Porras 1998). In fact, carbon sequestration rates are higher in mixed plantations than in pure plantations. Experiments to determine optimum design and management options for plantations that diminish their negative environmental effects while maximizing carbon storage are ongoing (Montagnini and Porras 1998; Sedjo 1999; Muller 1991).

Like sustainable harvesting, plantations provide the opportunity for direct employment. The social issues surrounding the Sierra Gorda, and the risks associated with leakage, may encourage the use of plantations in appropriate areas and circumstances, and as a component of an overall ecological design for the Reserve.

Table 4.8 provides a comparison of land use change and forestry project options under the CDM for the Sierra Gorda.

TABLE 4.8 Land Use Change and Forestry Options for the Sierra Gorda Biosphere Reserve

OPTION	CARBON	ECOLOGICAL	SOCIAL	ECONOMIC	POLITICAL
Protection of forested areas	High immediate carbon benefits.	High value.	Risk of leakage.	Rural job loss and loss of land use control.	Not yet specifically allowed under Kyoto Protocol.
Afforestation/ Reforestation	Slower accumulation of carbon.	Can help restore degraded or marginal lands. Must ensure appropriate species planted, and ecological design considered.	If final land use is protection, risk of leakage.	Relatively inexpensive. Can be cost prohibitive to plant tree species.	Allowed under Kyoto.
Sustainable Forestry/ Agroforestry	Significant carbon. Difficult to track wood products.	Can protect habitat. Can replace damaging forestry practices.	Positive benefit. Provides income and jobs to locals.	Potential to be profitable to investor.	May fail project additionality criteria.
Plantations	Slower accumulation of carbon and less carbon. May be difficult to track wood products.	Little ecological value. Decreases biodiversity. May help stabilize soils. Must ensure they don't displace critical habitats.	Provide alternative income, little risk of leakage.	Potential to be profitable to investor.	May fail additionality criteria.

4.8 SUMMARY OF ISSUES

Carbon sequestration projects must be designed appropriately so that ecological and socio-economic objectives are addressed, while still satisfying international criteria for the clean development mechanism. The proposed CDM project in the Sierra Gorda is compatible with the host country's objectives and criteria, as well as Grupo's own goals for the Reserve. The co-benefits arising from the project will ultimately determine its acceptance by the local communities and success. Each stakeholder has different potential benefits that could arise from this project. The Mexican government will advance national goals, satisfy international commitments, and advance long-term economic objectives. Grupo will receive funding for both social and ecological efforts, including forest restoration and protection efforts. The local communities in the Sierra Gorda will receive improved water quality and waste management, in addition to training opportunities in sustainable land use programs. The Annex I investor will receive cost effective carbon credits to be applied against their own domestic emissions.

Grupo's environmental programs and their relationship with the local communities will help ensure that CDM projects on the Sierra Gorda Biosphere Reserve are viable and appropriate sources of funding for the region. While the current CDM proposal focuses on afforestation and protection, projects in the future could consider other initiatives such as sustainable harvesting and plantations.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

"If climatic change makes our country uninhabitable, we will march with our wet feet into your living rooms."

Atiq Rahman from Bangladesh (Sachs et al 1998 p. 167)

5.1 CONCLUSIONS

One of the most controversial environmental issues today is climate change. As global warming achieves international political recognition, the concept of the Clean Development Mechanism is gaining popularity as a cost-effective, win-win option for reducing or avoiding greenhouse gas emissions. The CDM is defined as a flexibility mechanism created in the Kyoto Protocol that allows governments or private entities in Annex I countries to fund greenhouse gas emission reduction or avoidance projects in non-Annex I countries. The CDM project must result in a real, measurable and long-term decrease in net greenhouse gas emissions. Stakeholders in the CDM include the Annex I investor (private or public entity in an industrialized country), host country government, host country organizations, local communities, and profit organizations.

The CDM is still evolving. It has the potential to be an effective mechanism for managing greenhouse gas emissions, but not in its current form. For CDM to become a practical and mutually-beneficial environmental management tool, several logistical issues need to be resolved, including questions regarding:

- internationally accepted methodologies;
- internationally accepted standards;
- independent verification institutions;
- certification frameworks;
- an effective emissions trading system;
- transparent and cost-effective carbon quantification models; and
- criteria for project acceptance;

Decisions on these issues will largely determine the effectiveness of CDM as a tool to manage greenhouse gas emissions. Conceivably, the CDM could produce a huge bureaucracy and plenty of red tape, but fail to reduce emissions significantly. Not only would the creation of a bureaucracy be costly, it would deter corporations and other organizations from investing in CDM projects. The last issue on the above list, criteria for project acceptance, is of particular importance to the non-Annex I country. In the Sierra Gorda case study, USIJI raised concerns about the profitability of the first CDM proposal. Although projects accepted by USIJI in the interim by other proponents include a profit margin, this issue is still unresolved. If project acceptance criteria include a no-profit component, CDM projects will be unappealing to the non-Annex I country and local communities, as well as Annex I investors.

In addition to the outstanding logistical issues, the most significant barriers that the CDM must overcome include:

- political uncertainty;
- technical issues such as the calculation of baseline;
- poor portrayal and description of CDM to non-Annex I countries;
- difficulty in quantifying and attaching value to ecological services and co-benefits;
- loss of land use control in host country and other negative local impacts; and
- risk of leakage and liability.

Despite the barriers and unanswered questions, there are many reasons for organizations or governments in both the investing country and the host country to participate in the CDM. There are definite discrepancies between Annex I and non-Annex I expectations and driving forces for participation. From an Annex I country perspective, the CDM is a potentially cost-effective approach to reducing emissions, and could assist countries and organizations in meeting international commitments. Incentives for participation in CDM projects for Annex I countries and corporations within these countries include:

- to fulfil a moral obligation;
- to prevent the predicted environmental impacts from global warming;
- to prevent potential negative economic consequences of global warming;

- to receive early credit against carbon emissions;
- to demonstrate that voluntary programs to reduce GHG emissions are viable;
- to reduce a greater volume of CO_2 per dollar invested than domestic projects could achieve; and
- to gain access to new markets in developing countries.

For organizations investing in a CDM project, early credit, cost-effectiveness, and demonstrating the viability of voluntary programs are the greatest incentives. Credit for early action is a key issue, and is essential to prove to stakeholders that delaying action to reduce emissions is not advantageous. As a market-based mechanism, cost-effectiveness is imperative to attract investors to a project. The CDM also provides the opportunity to demonstrate that volunteer programs that address global warming are viable, and to potentially avoid government control measures such as carbon taxes.

Incentives for non-Annex I countries to participate in the CDM are vastly different than those that attract Annex I investors. The CDM is being promoted as a win-win scenario. Potential co-benefits, in addition to greenhouse gas reductions or avoidance, are the greatest incentive for host country governments, organizations and local communities to participate in CDM projects. Principal co-benefits to host countries include:

- reduced air pollution caused by old technologies;
- transfer of clean technologies that leapfrog over inefficient phases of industrialization;
- reduced water pollution and soil erosion caused by deforestation and unsustainable forestry or agriculture practices;
- restoration of productivity of degraded lands;
- biodiversity conservation;
- improved waste management practices;
- attraction of foreign direct investment in priority economic sectors;
- energy efficiency improvements;
- creation of additional jobs and areas of expertise (capacity building);
- health improvements from cleaner air;
- opportunity to meaningfully participate in emissions reductions;

- advancement of national goals; and
- compliance with international commitments.

The Sierra Gorda Biosphere Reserve in East Central Mexico is an example of a carbon sequestration (sink) project that is applying for funding as a CDM initiative. As a host country, Mexico is willing and able to participate in the CDM and in sink projects. They are developing the necessary institutions to evaluate potential projects to ensure compatibility with Mexican objectives, and they acknowledge the challenges facing participation in the CDM. The Mexican government recognizes the importance of forestry projects to Mexico's role in the CDM. Species diversity and endemism are high in Mexico, and deforestation rates and carbon emissions are significant. In fact, Mexico ranks among the top ten in species diversity and endemism in the world, and ranks first for pines, oaks, and reptiles (Flores-Villela and Gerez 1988). Degrading and unsustainable agricultural and grazing land use practices are threatening the forest ecosystems, causing habitat fragmentation, watershed pollution, soil erosion, and species endangerment. Poverty exacerbates the problem. The forests are relied on for subsistence, and habitat conversion is causing loss of biodiversity and increased carbon emissions. As natural resources are depleted, poverty is accelerated, continuing the cycle.

The Sierra Gorda is an appealing locale for CDM projects because of its fast-growing tree species, large carbon pools, significant co-benefits, rich biodiversity, and substantial local organizational support. The Reserve is in need of further protection efforts to save its natural resources, and the CDM can provide a tool to accomplish this goal. Its varied topography (300 to 3,100 masl), and precipitation (350 to 2,500 mm per year) give rise to diverse plant and animal communities, many of which are threatened or endangered. Twenty-seven vascular floral species, and 141 mammals, birds, reptiles and amphibians in the Reserve receive special protection under Mexican law. There are also a diverse number of ecosystems, including 14 vegetation communities. Currently, there are eleven core protected areas, or zonas nucleos, on the Biosphere Reserve, as well as sixteen potential locations for CDM projects in afforestation and protection. The protected zones tend to be narrow and within river valleys. Suggested afforestation programs have the potential to both increase the size of the zones, as well as maintain biodiversity by protecting representative ecosystems. In particular, the cloud forest and the semi-tropical evergreen forest are in need of more protection on the Reserve. Targeting these areas for CDM projects recognizes Grupo's larger conservation and management objectives. Pfister (1993) states that "ecology may provide many of the answers – but only if it is holistic enough to incorporate the human element as part and parcel of the ecosystem" (Pfister 1993 p. 231). To this end, CDM projects on the Reserve can also provide income and learning opportunities for the Sierra Gorda's 100,000 residents through allocation of CDM funds to community outreach and training programs. The goal of CDM projects on the Reserve, then, is advancing conservation and sustainability efforts while improving the quality of life of the Sierra Gorda's residents. Carbon sequestration is secondary.

To achieve these goals, CDM projects in the Sierra Gorda face several barriers to success that must be overcome, as follows:

- no verification of carbon values;
- no investor;
- inappropriate protection;
- the wrong ecosystems may be selected for protection and afforestation;
- numerous landowners involved;
- confusion regarding carbon sequestration and global warming;
- possible rural job loss;
- leakage;
- loss of land use control;
- high population growth; and
- lack of enforcement.

With more research, proper planning and implementation of projects, education and training of local residents, the obstacles and barriers to successful projects may be overcome. In particular, successful forestry-based CDM projects in the Sierra Gorda require the following:

- verification of carbon values;
- education on the concepts of CDM and global warming, and training in sustainable land use practices for local residents;

- promotion of co-benefits such as improved water quality and waste management to the local communities;
- increased enforcement efforts; and
- studies on the ecological baseline of the Sierra Gorda to ensure CDM projects are appropriate and compatible with natural processes and Grupo's own objectives.

Potential Annex I stakeholders are wary of investing in the Sierra Gorda because the carbon values have not been verified or certified. Until this happens, investment is unlikely. Should this obstacle be overcome, investors are still confronted with the relatively high risks associated with forestry CDM projects in developing countries, such as leakage and lack of long-term credits. If Grupo fails to receive adequate funding and disbands, the investor must be satisfied that their investment is still secure. The Joya de Hielo Land Trust, established by Grupo, may help alleviate this risk. However, investors may also lose the carbon credits through deforestation by local residents. To minimize the possibility of leakage, Grupo's link to the community is vital in ensuring the acceptance and success of CDM initiatives. There are three initiatives that Grupo should promote to deter leakage. They must increase education, improve enforcement efforts, and provide training and alternative means of income to the local communities. The issues of global warming and the CDM can supplement education efforts on sustainability and reforestation through the CEC funded 'Training for Sustainability in the Sierra Gorda Biosphere Reserve' education and outreach program. Education and subsequent ownership of environmental objectives can lead to improved enforcement efforts through community vigilante groups.

Grupo must also allocate funds from CDM projects for training in sustainable land use practices for the impoverished inhabitants. Conflicts arise between human-use pressure and conservation efforts within the Sierra Gorda because those areas most diverse in species and in need of protection are often the same areas that offer optimum agricultural opportunities. Landowners do not have any incentive to leave their land as forest, and social and economic conditions on the Reserve are such that the land is usually the sole means of income for a community. The CDM offers an alternative to damaging land use practices, while compensating landowners and offering training and alternative means of income. Attaching value to forested areas through carbon sequestration projects can provide the needed incentive to embrace conservation practices, and deter leakage. Local community acceptance of conservation and afforestation initiatives will reduce the risk of leakage substantially, and increase the permanence of the anticipated carbon pools. Grupo should identify training opportunities in consultation with affected landowners.

While carbon sequestration projects have the potential to reduce international emissions through the promotion of sustainable land use practices, they often fail to address issues such as biodiversity and ecosystem management. Concern has been raised about the appropriateness of planting trees for the sole purpose of gaining carbon credits, while neglecting to consider issues of sustainable development, biological integrity and other biodiversity implications. Managing forests purely for carbon sets a dangerous precedent. Further studies are required in the Sierra Gorda to determine baseline conditions and to ensure that CDM projects are compatible with Grupo's ecological objectives, independent of carbon sequestration goals. Systematic inventories of flora and fauna on the Reserve should be conducted, as well as studies on wildlife movement and habitat requirements to determine the consequences of habitat fragmentation. Field verification of the tropical evergreen vegetation community is also required. Despite their vast knowledge of the Sierra Gorda, Grupo does not have the financial or professional resources to collect comprehensive baseline ecological information for the entire Reserve. Grupo requires external expertise and technology to complement the knowledge of its members, and to aid in conducting comprehensive research on the ecology of the Reserve. Unfortunately, relationships with the Universidad Autonoma de Querétaro (UAQ), the nearest university, are strained due to past competition between the University and Grupo to initially manage the Biosphere Reserve.

The co-benefits arising from the CDM project in the Sierra Gorda will ultimately determine its acceptance and success in Mexico. Co-benefits for the various stakeholders in Sierra Gorda CDM projects comprise the following:

- advance national goals and priorities;
- satisfy commitments to both Kyoto Protocol and the Convention on Biodiversity;
- advance sustainable development objectives;
- advance long-term economic opportunities by providing a new funding source ;
- meaningfully participate in emissions reductions as a host country;

- funding for environmental education and outreach programs;
- financing for ecologically sustainable alternatives to damaging land use practices;
- increased network of core areas within the Sierra Gorda;
- improved biodiversity conservation through protection of species habitat and vegetation communities;
- restoration of marginal lands;
- reduced deforestation;
- reduced soil erosion;
- positive income for social initiatives such as environmental education and community outreach within the Sierra Gorda;
- training in new land use practices;
- new opportunities and industries to generate economic returns;
- reduced sedimentation of waterbodies and improved water quality through watershed protection; and
- improved waste management practices and health benefits.

There are a myriad of social, economic, political and ecological issues that face stakeholders when entering into partnerships for CDM projects. For a CDM project to be successful, stakeholders must be satisfied that their unique needs will be met. In the Sierra Gorda, stakeholders have criteria that determine acceptance and success of projects. First, for the Mexican government, CDM projects must be consistent with national objectives, satisfy international commitments, advance sustainable development, and result in no negative economic or environmental impacts. Second, Grupo requires that the project is consistent with its objectives, and provides significant co-benefits, such as environmental protection and restoration. Third, the local community requires that the CDM projects provide significant co-benefits, such as training, income, and an improved standard of living. Fourth, for any profit organizations involved, like Woodrising Consulting Inc., the project must provide income and expertise. Finally, the Annex I investor requires the project to be long-term, low-risk, additional, real, and measurable. All of these criteria are important in determining if a CDM project is a wise decision for the host community, and if it will be a success.

The potential CDM projects in the Sierra Gorda focus on afforestation and protection. Although the CDM projects do not directly provide alternative means of income, funding from the projects will be directed to training and outreach programs. Other forestry options were not considered in the current CDM proposal because of the potential no-profit precedent from the first proposal. Future CDM proposals should consider a combination of protection, afforestation, plantation, agroforestry and sustainable harvesting, thereby providing a direct income to the community while still advancing conservation objectives. Afforestation with appropriate tree species for each vegetation community could promote conservation and ecotourism while reducing soil erosion and improving water quality. Plantations can be used to alleviate pressure on the protected areas and provide income. To further carbon sequestration, plantation trees could include species suitable for furniture manufacturing to ensure that carbon remains in the wood after harvesting. Agroforestry and sustainable harvesting could replace unsustainable agricultural practices, and could include training in modern farming techniques. A combination of these projects could supply direct value to the Sierra Gorda through new industry, export opportunities, and improved waste management and water quality, while providing carbon sequestration and carbon credit.

5.2 RECOMMENDATIONS

The following recommendations result from analysis of information from the literature review, conferences, site reconnaissance and case study, and informal interviews. Issues surrounding CDM are complex, and this MDP will not make comprehensive recommendations on international negotiations and analytical issues such as the calculation of baseline, the quantification of carbon values, and the design of an effective carbon trading market.

This section includes recommendations for the CDM in general, as well as recommendations that arise from the host country stakeholders in the Sierra Gorda Biosphere Reserve case study. Recommendations are numbered for ease of reference, and not to imply ranking.

5.2.1 General

This section will make general recommendations on the formation and evolution of the Clean Development Mechanism.

Recommendation 1: Parties must ensure inclusion of land use change and forestry projects under Article 12 of the Kyoto Protocol. Protection projects (slowing deforestation) should be explicitly included.

Land use change and forestry projects are currently not explicitly included in the CDM. Deforestation is included in national greenhouse gas inventories as per Article 3 of the Kyoto Protocol, but is not included in Article 12, which discusses the CDM. Slowing and avoiding deforestation is important for many reasons, including:

- primary forests contain large carbon pools;
- deforestation and land use conversion cause a loss of biodiversity; and
- natural areas can provide a sustainable livelihood for communities, and can improve quality of life through improved water quality etc. (Frumhoff et al. 1998; Brown 1998; Cairns and Meganck 1994; Muller 1991).

Slowing deforestation may have a larger impact on the global carbon cycle than reforestation (Goodland et al. 1990; Houghton 1990). Including protection efforts in the CDM, with appropriate monitoring and verification guidelines, is essential if these projects are to proceed.

Recommendation 2: Parties must ensure the goals of the CDM are more inclusive of host country participants.

Non-Annex I countries may be reluctant to participate in the CDM if they perceive that Annex I countries are threatening their national sovereignty, or that CDM financing will substitute Official Development Assistance funding. The purpose of the Clean Development Mechanism, as per the Kyoto Protocol, is threefold:

- to encourage the achievement of sustainable development in non-Annex I countries;
- to contribute to greenhouse gas reduction and other environmental goals of the FCCC; and
- to assist Annex 1 countries with complying with international emission reduction targets.

Of these, only the first goal is definitively directed at non-Annex I countries. To encourage participation in the CDM by developing countries, Annex I countries must ensure that the CDM is designed to emphasize co-benefits, national sovereignty, and the opportunity for funding in addition to official development assistance. In addition, Annex I countries should ensure that the CDM executive board, established in the Kyoto Protocol to provide guidance to the Conference of the Parties, has equitable North-South representation to ensure the needs of the non-Annex I countries are addressed during CDM development.

5.2.2 Sierra Gorda Biosphere Reserve Case Study

The following recommendations are directed at the host country stakeholders in the Sierra Gorda Biosphere Reserve Study. Although they focus on the case study, however, it is anticipated they will be applicable to other similar land use change and forestry CDM projects in the non-industrialized world. The recommendations are divided into three sections: host country government, host country organization, and local communities. Recommendations are only provided to the host country stakeholders because research for the case study focused on host country perceptions, incentives and barriers to the CDM.

The criteria used in Chapter 4 to analyze the components required for successful CDM projects, as well as other research used in this document, were used to formulate the following recommendations. These criteria emphasize the important components of a successful CDM project, as well as highlight some deficiencies in the Sierra Gorda CDM projects.

Host Country Government

Mexican Government Criteria	Acceptability of CDM project
Consistent with national objectives	✓
Helps fulfil international commitments	✓
Advances sustainable development	✓
No negative economic or environmental impacts	May be negative environmental consequences if not properly planned

Recommendation 3: The Mexican government must be proactive in developing CDM project acceptance criteria that address their specific needs.

Currently, Mexico uses USIJI criteria for CDM project acceptance. These criteria include the requirement for projects to contribute to the sustainable and economic development of the region, as well as the requirement to be consistent with Mexican environmental goals. Although

Article 12 of the Kyoto Protocol asserts that CDM projects are voluntary, thereby implying they must be acceptable to host country's goals and objectives, Mexico does not explicitly include this in their project acceptance criteria. Nor do they state that projects cannot result in negative economic or environmental impacts. Mexico should be proactive in developing criteria that are sensitive to their unique needs as a developing country, and should screen potential CDM projects based on these criteria. These criteria should include, but should not be limited to:

- a requirement for consistency with national goals and objectives;
- a requirement for significant co-benefits for local communities; and
- an interpretation of how sustainable development, a requirement of the CDM in the Kyoto Protocol, can be applied to Mexico.

Recommendation 4: The Mexican government should designate institutions for monitoring and verification of carbon, and provide appropriate training.

The political international interest in climate change has spurred the formation of many new industries and services. One of these services is independent third-party monitoring and verification, which is stipulated as a requirement in the Kyoto Protocol. The importance of independent verification of carbon values is emphasized in the Sierra Gorda, where difficulties in attracting investors have resulted from lack of verification. The credibility of the CDM as an emissions reduction tool also stems on its ability to demonstrate real and measurable greenhouse gas reduction and avoidance. Mexico should continue its efforts in developing institutions and capacity to manage the climate change issue, and should focus efforts on developing in-country expertise in greenhouse gas quantification, monitoring and verification, as well as expertise in planning and managing CDM projects.

Recommendation 5: The Mexican government should cap the percentage of carbon credits that a foreign investor can receive from a CDM project to help account for future risks and reduce liability.

As an OECD country, Mexico may have binding greenhouse gas reduction commitments in the future. The Mexican government has identified this as a concern with regard to CDM projects. Capping the maximum share of certified emissions reductions that an investor can receive from a specific project will ensure that Mexico still has carbon credits to apply against its own commitment, if necessary in the future. In addition, capping the percentage of credits will benefit the host country and the investor if the project carbon deliverables are not met. If a CDM afforestation project involving a forest burns down, for example, there is a contingency of carbon credits that can cover the loss to the investor. The international community is still debating who accepts the liability in this case. If it is the investor, they will be responsible for the project failure and subsequent carbon emission if local communities deforest the area. If it is the host country, they will be more likely to enforce the project and ensure carbon remains sequestered. In this case, keeping a percentage of the credits from long-term or risky projects may help account for future risk and liability, as well as provide assurance to the investor.

Recommendation 6: The Oficina Mexicana para la Mitigación de Gases de Efecto Invernadero (OMMIGEI; Mexican Office for Greenhouse Gas Mitigation) should identify multiple CDM projects in Mexico, pool the carbon resources, and market the projects collectively to Annex I investors.

OMMIGEI has already expressed their desire to identify numerous CDM projects in Mexico, which can be accomplished by partnering with local not-for-profit organizations like Grupo and local communities. Pooling the carbon resources from these projects will address several issues, including:

- the Kyoto Protocol states that certified emissions reductions must be 'long-term';
- Annex I investors are wary of investing in forestry-based CDM projects because of their long time frame;
- Annex I investors want guarantees of their investment, and want to minimize risk;
- USIJI criteria state that there must be sufficient guarantees that net reductions will not be lost or canceled over time;

As discussed in Recommendation 5, contingency of carbon credits may cover the loss to the investor if the project is not successful. Alternatively, pooling the carbon from several projects will ensure that, if one project fails, the investor still receives certified emissions reductions from another project. This reduces risk, decreases transaction time, and increases the appeal of CDM projects in Mexico to Annex I investors.

Recommendation 7: OMMIGEI should include the valuation of ecological services during cost-benefits analysis of CDM land use change and forestry projects.

Economic incentives tend to focus on promoting damaging land use practices such as deforestation and grazing. Undervaluing ecological services exacerbates this problem. The CDM creates a new opportunity to "correct this market failure by motivating payments for the carbon storage and sequestration values of tropical forests" (Frumhoff et al. 1998 p.1). Many authors have attempted to assign value to ecological services (Baskin et al. 1997; Daily et al. 1996; Barrett 1988; Johansson 1987). If formal markets existed, ecological services such as watershed protection, tourism, recreation and potential pharmaceutical products could be provided by forest ecosystems. Protecting watersheds, for example, would be less expensive than sophisticated water treatment measures required in the absence of protection. The World Bank (1995) estimates that ecotourism, for example, could generate an annual income of more than US$30 million for the Mexican economy. OMMIGEI is charged with developing potential CDM projects in Mexico. During cost-benefit analysis of potential CDM projects, value should be assigned to co-benefits and ecological services such as biodiversity conservation. From a local perspective, attaching value to forested areas could provide the needed incentive to embrace conservation practices.

Host Country Organization

Host Country Organization Criteria	**Acceptability of CDM projects**
Consistent with organization's objectives	May be negative ecological consequences if not properly planned
Provides significant co-benefits (environmental protection and restoration)	✓

Grupo Ecológico Sierra Gorda's goals and objectives focus on ecological protection and socio-economic development in a sustainable manner. The international community negotiating the CDM is not involved in management of these projects on the ground. Organizations like Grupo must ensure projects are sensitive to their needs and the social and ecological environment within which they are being implemented. To this end, the following are recommended.

Recommendation 8: Grupo Ecológico Sierra Gorda should conduct a comprehensive gap analysis of the forest ecosystems in the Sierra Gorda Biosphere Reserve, in partnership with a local university, or equivalent agency.

Given the need for ecological information in decision-making for CDM forestry projects, this is a core recommendation for Grupo. A gap analysis is defined as "an assessment of the protection status of biodiversity in a specified region which looks for gaps in the representation of species or ecosystems in protected areas" (Iacobelli et al. p. 62). Conservation is a progressive, iterative, and incremental process, and conducting a gap analysis is the first step in conservation planning (Noss 1995). Comprehensive baseline data are required to ensure that CDM projects are compatible with the overall management of the Reserve.

Most protection efforts within the Sierra Gorda can be viewed as positive from a biodiversity standpoint, however those areas most in need of conservation should be targeted first. This ensures that critical habitats and biodiversity hot spots are not lost to development while providing less ecologically desirable land for human activity. Thus far, the areas chosen for afforestation and protection CDM projects by Grupo primarily include oak, pine, and mixed oak-pine communities, in addition to one area of cloud forest. To be truly representative and to ensure protection of biodiversity, Grupo should use its extensive knowledge of the Reserve to identify gaps in their current reserve network of protected zones, and determine which other habitats in the Reserve are in the most critical need of protection. Critical areas could include:

- areas of high endemism;
- areas of high species diversity; and
- habitat of endangered or threatened species.

Many authors have suggested strategies for conducting gap analyses (Noss 1995; Noss and Cooperrider 1994; Iacobelli 1993). Unfortunately, it is beyond the scope of this document to develop a detailed gap analysis methodology for the Sierra Gorda Biosphere Reserve. It is recognized that members of Grupo Ecológico Sierra Gorda will not have sufficient time and financial resources to complete a comprehensive gap analysis of the Sierra Gorda. As such, the following are recommended:

- Grupo should supplement their knowledge of the Sierra Gorda Biosphere Reserve and form a partnership with a local Mexican university to conduct the analysis.
- Regions of the Reserve previously identified as ecologically important should be targeted and inventoried. These include the 400 ha of cloud forest in El Pilón and 300 ha of tropical semi-evergreen and tropical dry forest near Tancuilín that are being considered for CDM projects.
- Grupo should focus studies on areas they deem ecologically important, such as oak forest, cloud forest, and tropical semi-evergreen forest, that are under immediate threat of land conversion because of optimum agricultural opportunities.
- Grupo should identify marginal lands that require restoration.
- The existence of tropical evergreen forest on the Reserve should be field verified and mapped, if possible, using Rzedowski's classification scheme for vegetation communities (Rzedowski 1978).

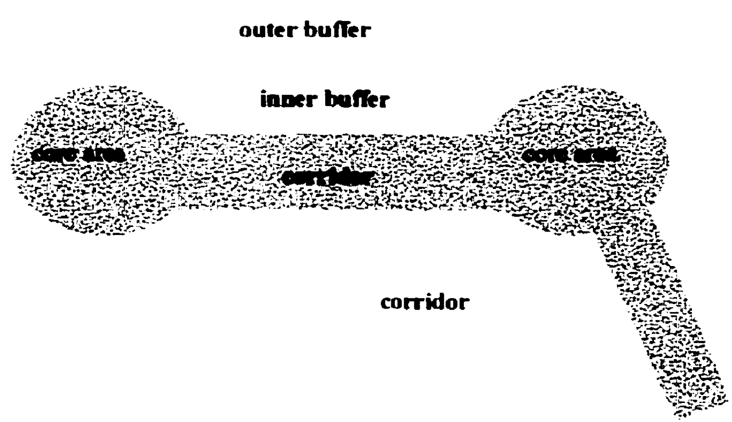
The natural disturbance regimes of the vegetation communities within the Sierra Gorda must be respected during selection of CDM forestry protection projects. Once baseline information is collected, it can be utilized to determine which areas on the Reserve should be targeted for CDM afforestation and protection projects. Without comprehensive baseline data, it is unclear if appropriate areas are being protected, and if critical areas are in need of protection. Baseline data are also essential for calculation of carbon sequestration (see Recommendation 11).

The expertise and technology at the Universidad Autonoma de Querétaro (UAQ) should be used to help develop a gap analysis strategy, collect baseline data, and identify areas for protection. Historically, there has not been an effective working relationship with between Grupo and the UAQ. They have an adversarial relationship stemming from the creation of the Sierra Gorda Biosphere Reserve and the competition to manage it. Political conflicts between Mexican universities and local communities are not uncommon (N. Bird pers. comm.). However, Grupo should strive to develop an effective working relationship with the UAQ that can benefit the Sierra Gorda. If this is not possible due to the political history, Grupo should approach the National University of Mexico (Universidad Nacional Autonoma de Mexico) in Mexico City, another local university with which they are comfortable, or a Canadian or American university that can partner with a local university, such as the University of Calgary. A mutually-beneficial partnership is essential to providing the necessary technology and scientific credibility required for this undertaking, and enhancing the specific ecological expertise of Grupo. In addition, a partnership could provide training opportunities for members of Grupo. In return for training and expertise, Grupo could provide the university with research privileges, possibly exclusive, on the Reserve.

Grupo will need people with skills and expertise to carry out the recommended studies. These studies can be carried out, on an ongoing basis, using a partnership with a university.

Recommendation 9: Grupo Ecológico Sierra Gorda must include CDM projects in a larger ecosystem management framework that includes a reserve network design.

Once a gap analysis is completed and biodiversity hot spots and areas of ecological importance are identified, a system of reserve networks must be designed. To be truly representative, a reserve network must represent all habitats, communities, species and other natural features and processes identified during the gap analysis (Noss 1995). Chapter 3 discussed Grupo's management zoning in the Sierra Gorda, and illustrated an example of a reserve network design as follows.



Efforts should be continued to enlarge the size of zonas nucleos and increase connectivity between the zonas nucleos. In addition to the data gathered during the gap analysis, further studies on wildlife movement and habitat are required on the Reserve to determine the consequences of habitat fragmentation on the diverse number of species, and to aid in the design of movement corridors. While the selection of protected areas is often based on socio-economic factors instead of ecological factors, every effort should be made to ensure that lands chosen for CDM protection or afforestation projects are complimentary to Grupo's overall design of the Sierra Gorda Biosphere Reserve. CDM projects should be considered as a component of the reserve network design, not apart from it. To this end, lands identified by Grupo as in need of conservation should be considered for protection and afforestation CDM projects.

Recommendation 10: Grupo Ecológico Sierra Gorda should consider sustainable harvesting, agroforestry, and plantation CDM projects in addition to the protection and afforestation initiatives currently proposed. If these initiatives are excluded from the CDM in the future, Grupo should still endeavor to implement these projects on the Reserve to replace damaging land use practices.

The Sierra Gorda is in need of conservation efforts to protect its biodiversity and critical habitats. Afforestation projects have the potential to fulfil a portion of this need, in addition to supplying CERs and ecotourism potential. The Sierra Gorda is also in need of long-term employment for the local communities. In areas of less ecological importance, plantation, agroforestry, and sustainable harvesting projects may be more appropriate. These projects should be considered as cost-effective, socially sensitive options for CDM projects in addition to the protection and afforestation initiatives already proposed. The socio-economic conditions of the Reserve are such that land use control plays a vital role in the livelihood of the local communities. Plantations, agroforestry, and sustainable harvesting options provide an income for the inhabitants, alleviate pressure on protected areas, and provide carbon sequestration benefits.

Afforestation and protection projects should be considered for critical areas identified during the gap analysis suggested in Recommendation 8. Potential examples include:

- the habitat of the rare flying squirrel *(Sciurus oculatus)* in the cloud forest in La Yesca;
- the alpine forest where the endangered tree *Abies guatemalensis* is located;
- riparian corridors that are known to be used a wildlife corridors by the puma, jaguar , or black bear; and
- any habitat where endemic or endangered species, such as those listed in Appendix IV and Table 3.3, are found.

Plantations with native tree species are appropriate in areas where:

- there is a need to alleviate pressure on adjacent protected areas;
- fuelwood shortage is common;
- watershed rehabilitation is urgently needed, such as in the Pinal de Amoles region;
- potential for leakage is high, and income for residents is needed; and
- ecological value is low, as determined in the gap analysis and baseline studies.

In addition to those areas suitable for plantations, sustainable harvesting and agroforestry are also appropriate in areas where:

- current land use practices are unsustainable, such as slash and burn agriculture.

CDM projects are site-specific, and the affected communities and organization should determine the projects or combinations of projects that are appropriate for their region. In the Sierra Gorda, Grupo is intimately familiar with the ecological and socio-economic conditions on the Reserve. They should identify areas on the Reserve where projects are viable options, while remaining cognizant of the fact that plantations and harvesting options should not be established in areas of high ecological importance.

Recommendation 11: Grupo Ecológico Sierra Gorda should design a monitoring program, in consultation with Woodrising Consulting Inc. and a local university, to monitor carbon sequestration, as well as carbon management actions and socio-economic and ecological goals to show compatibility.

In addition to monitoring for carbon sequestration values, land use change and forestry CDM projects should also include ecological monitoring components. Monitoring programs in the Sierra Gorda must be designed to determine whether carbon management actions are moving the ecosystems towards the ecological and socio-economic goals and expectations of Grupo (see Chapter 3). A monitoring program includes the identification of indicators of long-term trends, such as biodiversity, to assess the status of these goals. The information provided from the monitoring program is used to reshape management goals in response to changing information and evolving environmental conditions. Some authors have provided information on selecting environmental indicators and developing monitoring programs (Noss 1990; Noss 1995; Woodley et al. 1993).

Partnering with Woodrising Consulting Inc. and a local university would ensure that the monitoring program appropriately addresses carbon sequestration, and that the necessary technology to conduct the program is available. For example, if Geographical Information Systems (GIS) technology is required, the university could supply this. The university could also supply training and expertise to Grupo that could subsequently be passed on to local communities.

Recommendation 12: Woodrising Consulting Inc. should include natural disturbance regimes in carbon sequestration models to ensure that CDM projects are not incompatible with natural ecological processes.

Periodic carbon loss through natural disturbance patterns is necessary for healthy ecosystems. There are two alternatives for addressing the issue of carbon releases from natural disturbance in forest ecosystems. Ecosystems that rely on natural disturbance regimes such as fire that are contrary to long-term carbon storage should either be excluded from CDM protection initiatives, or carbon models should take these natural disturbances into consideration. The long-term effect of fires on the vegetation communities in the Sierra Gorda is not well documented. For example, opinions about the effect of fire in conifer dominated communities vary, depending on which author is consulted (Gallina 1997). Including natural disturbance regimes in carbon modeling would deter negative management practices such as extensive fire suppression in vegetation communities that rely on fire for growth. Unless this occurs, carbon sequestration projects will continue to rely on forests remaining standing so that carbon pools are retained to some degree, and may damage forest ecosystems in the process.

Recommendation 13: Grupo Ecológico Sierra Gorda should consult with local landowners to identify areas for CDM projects, continue education programs to ensure inhabitants fully comprehend the implications of participation, and promote the co-benefits of such initiatives through demonstration projects.

The proposed CDM project will undeniably affect the local communities and influence their livelihood within the Sierra Gorda. The success of CDM projects in the Sierra Gorda is dependent upon the acceptance of such projects by the local communities. Because local communities are so important to the success of forestry-based projects, CDM projects must include a strong community consultation component. Community involvement in the management of land and resources is essential, and early consultation with affected stakeholders can aid in the acceptance of conservation efforts and alternative land use practices.

The interests of the residents of the Sierra Gorda must be coupled with conservation efforts, and co-benefits arising from CDM projects must be stressed. A demonstration forestry-based CDM project should be developed to illustrate the benefits of such projects to local communities, and to improve acceptance of future CDM projects. For example, the region surrounding Pinal de Amoles, which is facing high deforestation rates and poor water quality, could be chosen as a location for a demonstration project. Reforesting the watershed and demonstrating the improvement to water quality to the local residents would allow them to experience first-hand the possible co-benefits of CDM projects.

Grupo's education and outreach programs are extensive. Education programs at a local level should continue to assist communities in decision-making, and presentations to schools should include the issue of climate change. In addition, education programs should highlight the fact that low productivity agriculture and grazing does not provide high economic gains, and that ecological values and services provided by healthy forest ecosystems and sustainable land use practices are numerous. Given the high dependency on the land for substinence and income, ecological and socio-economic co-benefits to the local communities will be the deciding factor in the success of CDM projects in the Sierra Gorda Biosphere Reserve. In fact, for the landowner, co-benefits are the primary benefits arising from CDM projects as climate change mitigation pales behind meeting basic needs. Recognizing, demonstrating, and promoting these benefits is essential.

Local Communities

Local Community Criteria	Acceptability of CDM Projects
Provides significant co-benefits (capacity, training, improved standard of living)	✓
Provides potential alternative sources of income	Only if funding is targeted to training

Recommendation 14: Grupo Ecológico Sierra Gorda should earmark funds from CDM projects to training in sustainable land use practices and strengthening local capacity.

CDM afforestation and protection projects will remove land use control from the local communities in the Sierra Gorda. To reduce the probability of leakage and ensure inhabitants are not without an income, training in new, sustainable land use practices or industries must be provided by Grupo. These could include:

- sustainable agricultural practices;
- agroforestry;
- sustainable harvesting;
- ecotourism;
- composting;
- monitoring and verification of carbon sequestration; and,
- furniture manufacturing and carpentry.

Grupo's relationship with the residents of the Sierra Gorda must be used to identify areas where the training is wanted, and needed.

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APPENDIX I
GLOSSARY

GLOSSARY

Activities Implemented Jointly (AIJ)
The pilot phase of joint implementation, established at the first Conference of the Parties, and ending in 2000 (Brown 1998).

Additionality
Refers to whether the project would have occurred in the absence of a commitment to reduce emissions. Also financial additionality, which refers to whether the project would have occurred in the absence of special funding (International Flexibility Mechanisms Table 1998).

Annex I Countries
The 39 industrialized countries and signees to the Framework Convention on Climate Change that have agreed to adopt measures to return their greenhouse gas emissions to 1990 levels by the year 2000. These countries include the 24 OECD members, eleven former members of the Sovietbloc, and the European Union (Brown 1998).

Anthropogenic
Caused or produced by humans.

Baseline
The carbon emissions level before the project

Berlin Mandate
Outcome of COP1. Began a negotiating process that led to the adoption of the Kyoto Protocol (United Nations 1998).

Biodiversity
The variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Article 2 of the Convention on Biological Diversity).

Carbon Sequestration
The process whereby forested areas retain a revolving but stable store of organic carbon in their biomass (ADB 1995).

Certified Emission Reduction Units (CERs)
Generated by non-Annex I countries through CDM projects (Article 12 of Kyoto Protocol).

Clean Development Mechanism (CDM)
A collaboration between an Annex I country, or a private entity within that country, and a non-Annex I country, or private entity within that country. Allows Annex I countries to receive certified emissions reductions by financing projects that reduce net emissions in a non-Annex I country (IISD 1998a).

Conference of the Parties (COP)
The supreme body of the FCCC. Has met 4 times: 1995 (Berlin), 1996 (Geneva), 1997 (Kyoto), 1998 (Buenos Aires) (United Nations 1998).

Emission Reduction Units (ERUs)
Achieved by Annex I countries through offset projects (Article 6 of Kyoto Protocol).

European Union (EU)
A regional economic integration organization, consisting of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK (United Nations 1998).

Greenhouse Gas
Those natural and anthropogenic gases that comprise the atmosphere and absorb and re-emit infrared radiation (Brown 1998).

Intergovernmental Negotiating Committee (INC)
The committee that negotiated the FCCC before the Earth summit. The INC had a total of 11 sessions after which the COP became the presiding body of the FCCC (United Nations 1997).

Intergovernmental Panel on Climate Change (IPCC)
The international scientific body established in 1988 jointly by the World Meteorological Organization and the United Nations Environment Programme (Article 1.3 of Kyoto Protocol).

Joint Implementation (JI)
A process whereby an Annex I country, or a corporation within that country, can receive "emissions reduction units" when it helps to finance projects that reduce net emissions in another industrialized country, including countries with economies in transition (United Nations 1998)

Kyoto Mechanisms (or flexibility mechanisms)
Mechanisms introduced in the Kyoto Protocol that increase the flexibility and reduce costs of making net emissions reductions, including emissions trading, joint implementation, and the clean development mechanism (Kyoto Protocol).

Kyoto Protocol
Protocol to the FCCC signed at COP3. Requires Canada to reduce greenhouse gas emissions to 6% below 1990 levels by the period 2008-2012.

Leakage
Occurs when an emissions reduction or carbon sequestration project in one area simply results in emissions in another area (Watt and Sathaye 1995).

Meeting of the Parties (MOP)
The supreme body of the Kyoto Protocol. COP will act as the MOP for the Kyoto Protocol.

Natural Disturbance
"Any relatively discrete event in time that disrupts ecosystems, community, or population structure and changes resources, substrate availability, or the physical environment" (Rogers 1996 p. 1).

Non-Annex I countries
Signees to the Framework Convention on Climate Change that do not have legally-binding greenhouse gas emission reduction commitments under the Kyoto Protocol (Brown 1998).

OECD
The Organization for Economic Cooperation and Development, including Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Republic of Korea, Japan, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, the UK and the U.S. (United Nations 1998).

Offset
Any action that reduces or avoids GHG emissions independently of the source of emissions.

Party
A state, or regional organization like the EU, that agrees to be bound by a treaty (United Nations 1998).

Precautionary Principle
The principle whereby activities that threaten serious or irreversible damage can be restricted or even prohibited before there is absolute scientific certainty about their effects (Bainbridge 1998).

Reserve Design Network
A design of protected areas. If functionally connected, areas within a reserve and a system of reserves will be united into a whole that is greater than the sum of its parts (Noss 1995).

Sink
Any process, activity, or mechanism that removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere, including soils, trees and oceans (Brown 1998).

Source
Any process or activity that releases a greenhouse gas, an aerosol, or a precursor of a greenhouse gas into the atmosphere (Brown 1998).

United Nations Framework Convention on Climate Change (FCCC)
A general treaty that sets the framework for GHG reductions, but does not address strict targets. Signed by 170 countries at the Earth Summit in Rio de Janeiro in 1992 (United Nations 1997).

Zonas Nucleos
The core areas of the Sierra Gorda Biosphere Reserve, established based on areas that were deemed to have special physical characteristics, or fauna and flora requiring protection.

APPENDIX II
ARTICLES 6, 12 AND 17 OF THE KYOTO PROTOCOL

KYOTO PROTOCOL TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

FCCC/CP/1997/L.7/Add.1

CONFERENCE OF THE PARTIES

Third session

Kyoto, 1-10 December 1997

Agenda item 5

Article 6

1. For the purpose of meeting its commitments under Article 3, any Party included in Annex I may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:

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

2. The Conference of the Parties serving as the meeting of the Parties to this Protocol may, at its first session or as soon as practicable thereafter, further elaborate guidelines for the implementation of this Article, including for verification and reporting.

3. A Party included in Annex I may authorize legal entities to participate, under its responsibility, in actions leading to the generation, transfer or acquisition under this Article of emission reduction units.

4. If a question of implementation by a Party included in Annex I of the requirements referred to in this Article is identified in accordance with the relevant provisions of Article 8, transfers and acquisitions of emission reduction units may continue to be made after the question has been identified, provided that any such units may not be used by a Party to meet its commitments under Article 3 until any issue of compliance is resolved.

Article 12

1. A clean development mechanism is hereby defined.

2. The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of

the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.

3. Under the clean development mechanism:

(a) Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and
(b) Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

4. The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.

5. Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:

(a) Voluntary participation approved by each Party involved;
(b) Real, measurable, and long-term benefits related to the mitigation of climate change; and
(c) Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.

6. The clean development mechanism shall assist in arranging funding of certified project activities as necessary.

7. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.

8. The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

9. Participation under the clean development mechanism, including in activities mentioned in paragraph 3(a) above and in the acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

10. Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

Article 17

The Conference of the Parties shall define the relevant principles, modalities, rules and guidelines, in particular for verification, reporting and accountability for emissions trading. The Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments under Article 3. Any such trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under that Article.

Annex B

Party Quantified emission limitation or reduction commitment (percentage of base year or period)

Australia 108
Austria 92
Belgium 92
Bulgaria* 92
Canada 94
Croatia* 95
Czech Republic* 92
Denmark 92
Estonia* 92
European Community 92
Finland 92
France 92
Germany 92
Greece 92
Hungary* 94
Iceland 110
Ireland 92
Italy 92
Japan 94
Latvia* 92
Liechtenstein 92
Lithuania* 92
Luxembourg 92
Monaco 92
Netherlands 92
New Zealand 100
Norway 101
Poland* 94
Portugal 92
Romania* 92
Russian Federation* 100
Slovakia* 92
Slovenia* 92
Spain 92
Sweden 92

Switzerland 92
Ukraine* 100
United Kingdom of Great Britain and Northern Ireland 92
United States of America 93

* Countries that are undergoing the process of transition to a market economy.

APPENDIX III
ADMINISTRATIVE RULES OF THE SIERRA GORDA BIOSPHERE RESERVE

PORTIONS OF THE ADMINISTRATIVE RULES OF SIERRA GORDA BIOSPHERE, QUERETARO'S RESERVE*

* translated fr~~ Spanish into English by Sonia Morales, a Mexican graduate student in the Faculty of Environmental Design at the University of Calgary

Nucleus Zone.(*Zona Nucleo*). The best conserved zones, considered habitat of ecosystem or the main important natural phenomena, or flora and fauna species that require particular protection. In the nucleus zone it is allowed to do the following activities: ecosystem and element preservation, scientific research, ecological education, and are prohibited all those activities that can disturb the zone.

Rule 4. The development of new infrastructure in the nucleus zone of the reserve is only allowed if it has the purpose of developing protection activities, sanitation, regeneration, ecological education and research. All the activities must be in accordance with the LGEEPA (*Ley General del Equilibrio Ecologico y Protreccion al Ambiente*; Ecological Balance and Environment Protection Law) in its appendix about Environmental Impact and Management Program.

Rule 5. The reserve must not be disturbed. It is not allowed to modify it physiography deep valleys and springs; it is prohibited to alter the course of water, it is only allowed if it is properly justified by benefiting the community and it must be authorized by the CAN (*Comision Nacional del Agua*; Water National Secretary). A requirement for the authorization is to present a written environmental impact assessment of the zone.

Rule 6. Riverside Vegetation must be conserved considering their natural distribution around water bodies. When the zone deteriorates, the recovery must be through reforest using native species, and soil management treatments to reach the standard balance.

Rule 7. People who get into the area should carry the garbage produced during their stay and throw it away in municipal authorized places.

Rule 8. The sustainable forest exploitation, and land use changes must be in accordance with the forest law of the LGEEPA, and NOM (*Norma Official Mexicana*, Mexican Official Standards).

CHAPTER V
EXPLOITATION OF FOREST WOOD

Rule 36. The technicians uncharged should present the increasing volume rate or movements of the species, and probe that the extraction rate already programmed is lower than increasing resource rate.

Rule 37. Forest management must promote the development and adoption of no chemical pesticides, the methods for controlling pest must be in accordance with the NOM. In addition, the use of the 1A and 1B pesticide methods are not allowed by the OMS (*Organización Mundial de la Salud*), as well as the control pest methods that contain *hydrocarbures* and *cloro*. Tools and training must be offered in order to decrease sanitation and environmental risks, and environmental impact.

Rule 38. The exploitation of forestall wood should be in accordance to the NOM related to this aspect.

CHAPTER VI
EXPLOITATION OF WILD FAUNA AND FLORA

Rule 39. In order to put into effect any flora and /or fauna exploitation project with commercial purposes, it will be required the authorization of the SEMARNAP (*La Secretaria del Medio Ambiente, Recursos Naturales y Pesca*; Environment, Natural Resources and Fishery Secretary), the INE (*Instituto Nacional de Ecologia;* National Institute of Ecology), and the *UCANAP (Unidad Coordinadora de Areas Naturales Protegidas*; Organization of Protected Natural Areas).

Rule 40. In order to obtain the authorization for the exploitation of the flora and fauna with commercial purposes. A request should be submitted to the SEMANARP. The request must have an attachment about the environmental impact assessment of the zone.

Rule 41, The Organizations for the conservation, management and sustainable exploitation of Wild Life (*Unidades para la Conservación, Manejo y Aprovechamiento Sustentable de la Vida Silvestre*), are the only ones that can exploit the flora and fauna with commercial purposes. The request must be submitted to the *Direccion General de la Vida Silvestre* del INE (Wild Life Secretaryof the INE); it must have an attachment about the management program for the interested species.

Rule 43. There is no authorization for wild fauna exploitation for self-consuming purposes.

Rule 44. There is no need of an authorization for exploiting wild flora, unless the Reserve Secretary (*Dirección de la Reserva*) determines that such exploitation can risk other natural species.

CHAPTER VII
SOIL USE

Rule 45. For changing land use, should be submitted a request to the SEMARNAP. The request should have an attachment about the Environmental Impact Assessment and be authorized by the "Balancing Ecological and Environmental Impact Organization" of the INE (Direccion de Ordenamiento Ecologico e Impacto Ambiental), and by the Reserve Secretary.

Rule 46. The following zones are excluded of any land use change*: Outstanding, Hydrologic load, and Rehabilitation zones*, forest and jungles with 15% or bigger slope, mountain forest (*bosques mesófilos de montaña*), middle jungles, and any kind of forest that has been affected by forest fires, in particularly when they are reclaimed for agriculture and livestock activities.

PROHIBITIONS

Rule 47. In the Nucleus Zone (*Zona Núcleo*) it is prohibited the following:

I. Put into effect ecotourism and tourism recreation activities
II. Throw away pollutants to the soil, subsoil, and any water body
III. Put into effect any pollutant activity, such as landfill, dry or change the course of any stream or channel
IV. Put into effect any exploitation of wild native flora and fauna, as well as to introduce new different flora and fauna species into the ecosystems
V. Build roads and any kind of access to the nucleus zone, unless the purpose is vigilance, contingency and Sanitation

Rule 48. In all the reserve it is prohibited the following:

I. Assault any wild fauna species

II. Capture or kill any wild fauna species, unless the purpose is research or reintroduction, an it must be authorized by the UCANP

III. The exploitation and management of the wild flora, fauna, and habitats that are under any protection statement in accordance with the NOM-.059-ECOL-94; unless their purpose is scientific research, reintroduction or through the "Conservation, Management and Sustainable Explotation of Wild life Organization" (*Unidades para la Conservación, Manejo y Aprovechamiento Sustentable de la Vida Silvestre).*

IV. Sale and use of resortera (resortera =hand made tool for killing birds)and rifle *diabolos*

V. Throw away hazard pollute residues

VI. Use explosives for fishing

VII. Generation of noise, vibration, thermical energy and luminous emissions, and visual pollution, when exceeding the maximum limited established by the NOM

VIII. Use of rocks or natural walls with tourism, political, commercial or any type of publicity

IX. Throw away garbage into basements, caves, fissures, gully, rivers, streams, mountains or any natural place, as well as on trails, roads, and any place no authorized

X. The use of residual raw water for irrigation unless the water is treated and meet the currently established standards, as well as the CAN authorization

XI. The establishment of new population (cities, villages, towns)

XII. The use of pesticide or agrochemicals no authorized

XIII. Pour or unload pollutants down in the soil, subsoil, or any water body, unless it has been authorized by the CAN, and has developed treatment and health strategies

XIV. Build public and/or private infrastructure that can significantly affect biologic corridors, forests, and water bodies. The CAN will assess and authorized the projects

XV. Any hydraulic public work must be in accordance with the established by the CAN, and LAN; these organizations will determine the total or partial use and assess the possible impacts

CHAPTER VIII
USE STANDARDS

Rule 49. The use standards for the Nucleus Zone, and the buffer zone of the reserve are:

NUCLEUS ZONE:

a) The allowed activities are: research, contingency, sanitation, ecosystem preservation, vigilance, and ecological education

b) The development of ecoturism activities in the reserve must no exceed the limits for the Nucleus Zone

c) In the Nucleus Zone, any king of activity will be supervised by personnel of the reserve

BUFFER ZONE

The buffer zone is divided into 6 zones:

I. Outstanding sub-zones

a) The activities allowed are: research, contingency, sanitation, ecosystem preservation, environmental education, low impact ecoturism, and low impact exploitation projects

b) It will be allowed the exploitation of water bodies (springs, river beds, channels, etc) to the supplying of population, wild life and production projects

c) It is not allowed the use of agrochemicals, as well as any kind of soil, subsoil and river beds pollutant

II. Hydrologic load sub-zones

a) The activities allowed are: research, contingency, sanitation, restoration, ecosystem preservation, environmental education, low impact ecoturism, recreational tourism, low impact exploitation projects, reforest, low exploitation of mineral resources, fruit plantations, intensive cattle, aquaculture, forest exploitation based on forestry management programs, and rational exploitation of wild flora

b) Activities related with intensive livestock and free grazing will be discourage

III. Rehabilitation Sub-zones

a) The activities allowed are: research, contingency, sanitation, environmental education, recreational tourism, low impact exploitation projects, intensive cattle, reforest, agro-forestry-grazing systems, hortoculture, and rational exploitation of wild flora

b) Reforest and soil protection programs will be encouraged, as well as programs for water infiltration

c) Reforest, rehabilitation, and reintroduction must use wild native species

IV. Sustainable exploitation development sub-zones

a) The activities allowed are: research, contingency, sanitation, ecosystem preservation, environmental education, ecoturism, recreational tourism, agro-forestry-grazing systems, intensive cattle, low exploitation of mineral resources, forest, reforest, hortoculture, aquaculture, forest exploitation based on forestry management programs, and rational exploitation of wild flora

b) The exploitation of exotic fauna and flora with commercial purposes (crop, livestock, horticulture, aquaculture, beekeeping, etc) is allowed under controlled conditions (confined to an specific area, and properly manage strategies)

V. Intensive use sub-zones

a) The activities allowed are: research, contingency, sanitation, ecosystem preservation, environmental education, recreational tourism, agro-forestry-grazing systems, cattle, agriculture, hortoculture, aquaculture, and raw material transformation process

VI. Shanty towns sub-zones

a) The activities allowed are: Housing industry, craft industry, recreational tourism, home plantation, and education

b) The land use change with urban growth purpose is restricted in accordance with the Urban Development Plans (*Planes de Desarrollo Urbano*)

APPENDIX IV
FAUNA WITH PROTECTED STATUS IN THE SIERRA GORDA BIOSPHERE RESERVE

Bird Species with Protected Status in the Sierra Gorda Biosphere Reserve

ORDER	FAMILY	GENUS	SPECIES	STATUS†
Anseriformes	Anatidae	*Anas*	*americana**	PE
Apodiformes	Trochilidae	*Amazilia*	*candida*	R
	Trochilidae	*Atthis*	*heloisa,3*	A
	Trochilidae	*Campylopterus*	*curvipennis*	R
Ciconiiformes	Ardeidae	*Ardea*	*herodias**	R
	Ciconiidae	*Mycteria*	*americana*	A
Columbiformes	Columbidae	*Claravis*	*pretiosa*	R
Coraciiformes	Momotidae	*Momotus*	*momota*	R
Falconiformes	Accipitridae	*Accipiter*	*cooperii*	A
	Accipitridae	*Accipiter*	*striatus*	A
	Accipitridae	*Buteo*	*albicaudatus**	PE
	Accipitridae	*Buteo*	*jamaicensis*	PE
	Accipitridae	*Buteo*	*magnirostris*	PE
	Accipitridae	*Buteogallus*	*anthracinus**	A
	Accipitridae	*Circus*	*cyaneus**	A
	Accipitridae	*Ictinia*	*plumbea*	R
	Accipitridae	*Parabuteo*	*unicinctu**	A
	Falconidae	*Falco*	*sparverius**	A
	Falconidae	*Falco*	*rufigularis*	A
	Falconidae	*Micrastur*	*ruficollis*	R
	Falconidae	*Spizaetus*	*ornatus*	PE
	Cracidae	*Penelope*	*purpurascens**	PE
	Cracidae	*Crax*	*rubra**	P
	Phasianidae	*Colinus*	*virginianus*	P
	Phasianidae	*Dactylortyx*	*thoracicus*	A
	Phasianidae	*Dendrortyx*	*barbatus*	P
Passeriformes	Corvidae	*Cyanolyca*	*nana**	P
	Corvidae	*Cyanolyca*	*cucullata*	A
	Dendrocolaptidae	*Sittasomus*	*griseicapillus*	R
	Dendrocolaptidae	*Xiphorhynchus*	*erythropygius*	R
	Emberizidae	*Basileuterus*	*culicivorus*	R
	Emberizidae	*Dendroica*	*virens*	R
	Emberizidae	*Geothlypis*	*flavovelata*	A
	Emberizidae	*Icterus*	*cucullatus*	A
	Emberizidae	*Icterus*	*graduacauda*	A
	Emberizidae	*Icterus*	*wagleri*	A
	Emberizidae	*Myioborus*	*miniatus*	R
	Emberizidae	*Myioborus*	*pictus*	R
	Emberizidae	*Passerculus*	*sandwichensis beldingi*	A
	Emberizidae	*Passerculus*	*sandwichensis rostratus*	R
	Emberizidae	*Pipilo*	*erythrophthalmus*	P
	Emberizidae	*Seiurus*	*aurocapillus*	R
	Emberizidae	*Seiurus*	*motacilla*	R
	Emberizidae	*Wilsonia*	*citrina*	A
	Mimidae	*Melanotis*	*caerulescens*	A
	Muscicapidae	*Catharus*	*mexicanus*	R
	Muscicapidae	*Myadestes*	*occidentalis*	PE
	Muscicapidae	*Regulus*	*calendula*	A
	Muscicapidae	*Turdus*	*infuscatus*	R

Bird Species with Protected Status in the Sierra Gorda Biosphere Reserve

ORDER	FAMILY	GENUS	SPECIES	STATUS[T]
	Troglodytidae	*Henicorhina*	*leucophrys*	R
	Tyrannidae	*Mionectes*	*oleagineus*	R
	Vireonidae	*Vireo*	*atricapillus**	A
	Vireonidae	*Vireo*	*bellii*	P
	Picidae	*Campephilus*	*guatemalensis*	R
Piciformes	Picidae	*Dryocopus*	*lineatus*	R
	Picidae	*Veniliornis*	*fumigatus*	R
	Ramphastidae	*Aulacorhynchus*	*prasinus*	PE
	Ramphastidae	*Ramphastos*	*sulfuratus**	A
Psittaciformes	Psittacidae	*Rhynchositta*	*terrisi**	P
	Psittacidae	*Amazona*	*viridigenalis**	P
	Psittacidae	*Ara*	*militaris**	P
	Psittacidae	*Aratinga*	*holochlora*	A
	Psittacidae	*Pionus*	*senilis*	A
Strigiformes	Strigidae	*Athene*	*cunicularia**	A
	Strigidae	*Ciccaba*	*virgata*	A
	Strigidae	*Glaucidium*	*brasilianum*	A
	Strigidae	*Glaucidium*	*gnoma*	R
	Strigidae	*Glaucidium*	*minutissimum*	R
	Strigidae	*Micrathene*	*whitneyi*	P
	Strigidae	*Otus*	*guatemalae*	R
	Strigidae	*Otus*	*asio**	A
Tinamiformes	Tinamidae	*Crypturellus*	*cinnamomeus*	R
s/n	Cinclidae	*Cinclus*	*mexicanus**	R
s/n	Icteridae	*Psarocolius*	*montezuma**	R

Source: CONABIO

[T]**Protection Status**	**74**
P.- In danger of extinction	**10**
A.- Threatened	**27**
R.- Rare	**29**
PE.- Subject to special protection	**8**

CONABIO : Especies registradas en el banco de datos de CONABIO obtenida dentro del cuadrante(100°02'LN, 21°41'LW y 99°07'LN,21°07') . 22-Oct-97

Reportes* : Reportes confirmados por población local y que no tiene CONABIO.

Amphibian Species with Protected Status on the Sierra Gorda Biosphere Reserve

ORDER	FAMILY	GENUS	SPECIES	STATUS[T]
Anura		*Rana*	*montezumae**	PE
	Leptodactylidae	*Eleutherodactylus*	*decoratus*	R
	Leptodactylidae	*Eleutherodactylus*	*verrucipes*	R
Caudata	Plethodontidae	*Chiropterotriton*	*chondrostega*	R
	Plethodontidae	*Chiropterotriton*	*magnipes**	R
	Plethodontidae	*Pseudoeurycea*	*cephalica*	A
	Plethodontidae	*Pseudoeurycea*	*scandens*	R

Source: CONABIO

[T]**Protection Status**	**7**
P.-In danger of exitinction	0
R.- Rare	5
A.-Threatened	1
PE.- Subject to special protection	1

CONABIO: Especies registradas en el banco de datos de CONABIO obtenida dentro del cuadrante(100°02´LN. 21°41´LW y 99°07´LN.21°07´) . 22-Oct-97

Reportes*: Reportes confirmados por población local y que no tiene CONABIO.

Reptile Species with Protected Status on the Sierra Gorda Biosphere Reserve

ORDER	FAMILY	GENUS	SPECIES	STATUS[†]
Sauria	Anguidae	*Abronia*	*taeniata*	R
	Anguidae	*Barisia*	*imbricata*	R
	Anguidae	*Gerrhonotus*	*liocephalus*	R
	Dibamidae	*Anelytropsis*	*papillosus*	R
	Phrynosoma	*Phrynosoma*	*cornutum*	A
	Phrynosoma	*Sceloporus*	*grammicus*	R
	Scincidae	*Eumeces*	*lynxe*	R
	Scincidae	*Scincella*	*gemmingeri*	R
	Scincidae	*Scincella*	*silvicola*	R
	Xantusiida	*Lepidophyma*	*gaigeae*	R
	Xantusiida	*Lepidophyma*	*occulor*	R
	Xantusiida	*Lepidophyma*	*smithi*	R
	Xantusiida	*Lepidophyma*	*sylvaticum*	R
Serpentes	Colubridae	*Geophis*	*latifrontalis*	R
	Colubridae	*Geophis*	*mutitorques*	R
	Colubridae	*Nerodia*	*melanogaster*	A
	Colubridae	*Thamnophis*	*cyrtopsis*	A
	Colubridae	*Thamnophis*	*scalaris*	A
	Colubridae	*Thamnophis*	*marcianus*	A
	Colubridae	*Thamnophis*	*sumichrasti*	A
	Elapidae	*Micrurus*	*fulvius*	R
	Viperidae	*Crotalus*	*aquilus*	PE
	Viperidae	*Crotalus*	*atrox*	PE
	Viperidae	*Crotalus*	*durissus*	PE
	Viperidae	*Crotalus*	*molossus*	PE
	Kinosterni	*Kinosternon*	*cruentatum*	PE
		Boa	*constrictor*	A
		Crocodylus	*acutus*	R
		Hypsiglena	*torquata*	R
		Lampropeltis	*triangulum*	R
		Mastocophis	*flagellum*	A
		Pituophis	*deppei*	A
		Rhadinaea	*crassa*	A
		Tropidoddipsas	*sartori*	R

Source: CONABIO

[†]**Protection Status**	**34**
P.- In danger of extinction	0
A.- Threatened	10
R.- Rare	19
PE.- Subject to special protection	5

CONABIO: Especies registradas en el banco de datos de CONABIO obtenida dentro del cuadrante (100°02´LN, 21°41´LW y 99°07´LN,21°07´) . 22-Oct-97

Mammal Species with Protected Status on the Sierra Gorda Biosphere Reserve

ORDER	FAMILY	GENUS	SPECIES	STATUS[T]
Carnivora	Felidae	*Leopardus*	*wiedii*	P
	Felidae	*Leopardus*	*pardalis**	P
	Felidae	*Panthera*	*onca**	P
	Felidae	*Felis*	*yagouaroundi**	A
	Mustelidae	*Galictis*	*vittata*	A
	Mustelidae	*Eira*	*barbara**	P
	Mustelidae	*Lutra*	*longicaudis**	A
	Procyonidae	*Bassariscus*	*astutus*	A
	Procyonidae	*Potos*	*flavus*	R
	Ursidae	*Ursus*	*americanus**	P
Chiroptera	Phyllostomidae	*Choeronycteris*	*mexicana*	A
	Phyllostomidae	*Leptonycteris*	*nivalis*	A
Insectivora	Soricidae	*Cryptotis*	*mexicana*	R
	Soricidae	*Cryptotis*	*mexicana s.*	R
	Soricidae	*Cryptotis*	*parva m.*	R
	Soricidae	*Cryptotis*	*parva*	R
	Soricidae	*Sorex*	*saussurei*	R
Primate		*Ateles*	*geoffroyi*	P
	Erethizontidae	*Coendou*	*mexicanus*	A
	Muridae	*Microtus*	*quasiater*	R
	Muridae	*Neotoma*	*albigula*	A
	Muridae	*Peromyscus*	*boylii*	A
	Muridae	*Peromyscus*	*leucopus*	A
	Muridae	*Peromyscus*	*maniculatus*	A
	Sciuridae	*Glaucomys*	*volans*	A
	Sciuridae	*Sciurus*	*oculatus*	R

Source: CONABIO

[T] **Protection Status**	**26**
P.- In danger of extinction	**6**
A.- Threatened	**12**
R.- Rare	**8**
PE.- Subject to special protection	**0**

CONABIO : Especies registradas en el banco de datos de CONABIO obtenida dentro del cuadrante ***(100°02´LN, 21°41´LW y 99°07´LN,21°07´) . 22-Oct-97***

* *Reportes: Especies reportadas por la población local.*

APPENDIX V
CDM PROPOSAL FOR THE SIERRA GORDA BIOSPHERE RESERVE

Permanent Afforestation and Protection of Forested Land in the Sierra Gorda Biosphere Reserve, Mexico

Woodrising

NG INC.

1. Project Summary

Project Category:	Land-Use Change and Forestry		
Delivery Mechanism:	Sequestration and Emission Reduction (protection)		
Start Date:	Fall, 1999		
Cumulative Amount:	**Year**	**CO_2 (tonnes)**	**C (tonnes)**
	2010	25,681	7,004
	2020	106,629	29,081
	2050	545,392	148,743
	2100	645,400	176,018
Investment Type:	partnership		
Investment Amount:	US$ 558,000 (C$ 781,000)		
Cost / tonne CO2:	US$ 0.86 (C$ 1.21)		
Cost / tonne C:	US$ 3.17 (C$ 4.44)		
Location:	Sierra Gorda Biosphere Reserve, Mexico		

2. Project Description

This initiative involves permanent afforestation of degraded lands (600 ha) through natural regeneration and forest preservation (600 ha). In this manner, the protected lands in the Sierra Gorda Biosphere Reserve will be increased by 5%.

The advantages of Greenhouse Gas (GHG) reductions through a combination of natural afforestation and mature forest protection are many:

- The GHG reduction (sequestration) realized by converting non-timber land to forest is higher per hectare than for reforestation (forested lands returned to forest);
- Over 100 years, afforestation produces larger GHG reductions than does mature forest protection from deforestation;
- The GHG reduction from afforestation is easier to monitor than emission reductions through reduced deforestation as a result of forest protection;
- Natural regeneration is less expensive than planting, has a biodiversity benefit and, in this area of Mexico, results in growth rates that almost equals planted trees, and
- Protecting mature forest results in larger GHG reductions earlier than afforestation.

This initiative uses the Clean Development Mechanism to extend land protection efforts in Mexico's Sierra Gorda Biosphere Reserve. In particular, lands that have already been protected because of their importance for biodiversity or other ecological reasons, are the main target of this project.

The 383,000 hectare Sierra Gorda Biosphere Reserve was created in 1997. Located in the Sierra Madre Oriental some 300 kilometers north of Mexico City, this magnificent area of deep canyons, pine and oak forests, green mountains, deserts and jungle is important because of its rivers and its rich mixture of birds, animals and plants — many of them, unfortunately, in danger of extinction.

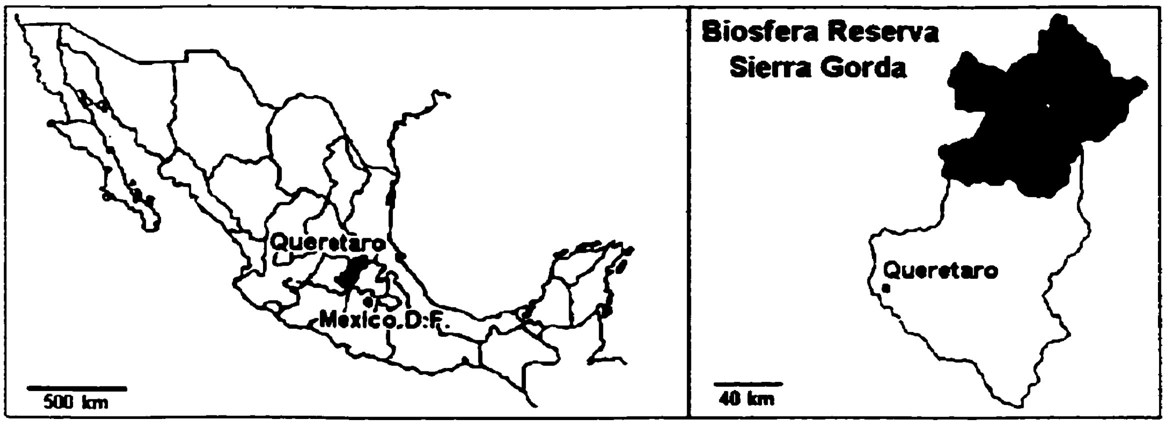
The objective for the Sierra Gorda Biosphere Reserve is to preserve and rehabilitate the region's natural resources for future generations. Realization of this objective falls to the people of the Sierra Gorda — Serranos — and to the agency that is managing the Biosphere Reserve — Grupo Ecológico Sierra Gorda.

Conservation and protection of land is an important goal of the Biosphere Reserve. Some eleven areas of particular ecological importance have already been protected as "Zonas Nucleos" (a total of over 24,000 hectares). This land, while still privately owned, will never be developed as a result of legal agreements made between the land owners and the Biosphere Reserve.

Efforts to increase the amount of land that will be permanently protected from agricultural use, logging, mining or other activities are underway. A land conservation trust — Joya de Hielo — was set up in 1997 to purchase land for permanent protection. It is based on the model of the Nature Conservancy.

Already the owner and steward of some 600 hectares of land in the Sierra Gorda Biosphere Reserve, Joya de Hielo Land Trust, through the Clean Development Mechanism, will advance land protection efforts. While the land will remain the responsibility and property of the Land Trust, the carbon sequestered or protected through this program will become the property of the investor. The initiative will be managed by Grupo Ecológico Sierra Gorda, with technical assistance provided by Woodrising Consulting Inc. and El Colegio de la Frontera Sur.

Figure 1: Project Location



3. Greenhouse Gas Reductions

3.(a). Delivery Method

- Carbon dioxide is sequestered by natural afforestation on 600 hectares of degraded agricultural lands, and
- Carbon dioxide emissions from deforestation are reduced through protection of 600 hectares of mature forest.

Over the next three years, 600 hectares of degraded agricultural lands will be purchased by the Joya del Hielo Land Trust and allowed to naturally regenerate to forest. The carbon sequestered in the trees and roots only on these lands will be the main source of greenhouse gas reduction. Of the 600 hectares 320 have already been selected and are ready for purchase.

As well, 600 hectares of mature forest will be purchased and protected from deforestation and forestry. Again only the carbon stored in the trees and roots will be included in the estimation of GHG reductions. These lands will be chosen from 1600 hectares already identified as suitable for forest protection.

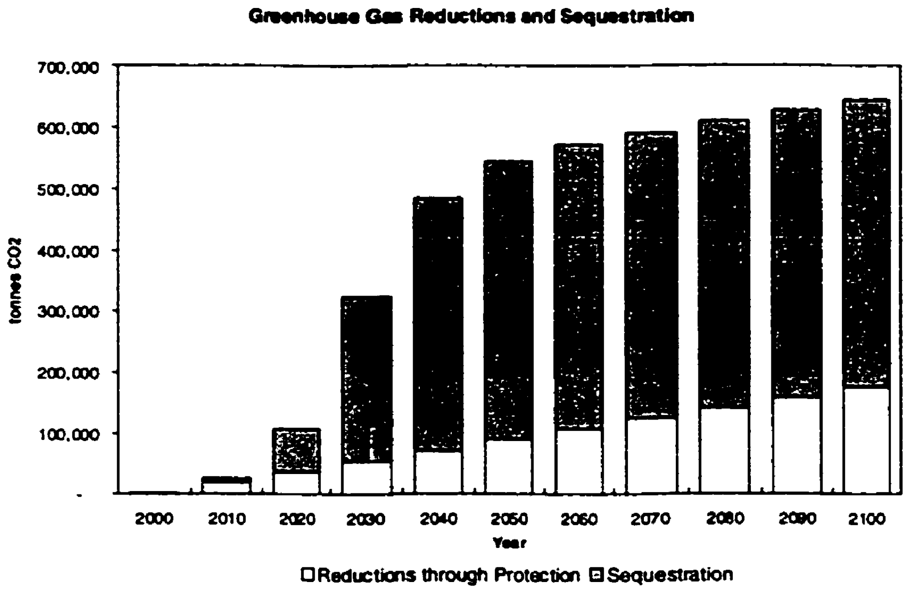
Credits generated will transferred to the investor every ten years.

3.(b). Amount

- 25,681 tonnes of CO_2 by 2010.
- 645,400 tonnes of CO_2 by 2100.

Figure 2 shows the modeled GHG sequestration from afforestation and reductions through protection by this project. GHG credits will be transferred to the investor every ten years coinciding with the monitoring schedule.

Figure 2: Modeled Cumulative GHG Reductions



3.(c). Repeatability

Repeating this project locally may result in leakage and is not recommended. The concept may be repeated in other locations throughout Mexico, and the world.

4. Finances

4.(a). Costs

Capital	US$ 330,000	C$ 462,000
Operating and Maintenance (one-time)	US$ 46,500	C$ 65,100
Transaction (GHG management fee only)	US$ 46,500	C$ 65,100
Monitoring (see schedule)	US$ 135,000	C$ 189,000
Total Costs	**US$ 558,000**	**C$ 781,000**
NPV(discount rate 6.0%)	US$ 464,200	C$ 650,000
$ per tonne CO2eq	**US$ 0.86**	**C$ 1.21**

4.(b). Earnings

none

5. Risks

5.(a). Deliverability — *risk moderate*

There is a risk that the trees may grow less rapidly than expected. The carbon sequestered in Litter and Soil pools may be used to cover any shortfall. They are modeled to be 53% of the total carbon sequestered in the Trees and Roots pools

5.(b). Permanency — *risk low*

The risk of non-permanency has been minimized by the formation of the Joya del Hielo Land Trust. Lands purchased will be permanently placed in a trust.

5.(c). Additionality — *risk negligible*

Without the GHG investment these lands could not be purchased by the Land Trust.

5.(d). Leakage — *risk moderate*

Leakage may occur if the actions (both afforestation and protection) cause other mature forest lands to be deforested.

5.(e). Technology — *not applicable*

5.(f). Credit Ownership — *risk low*

The Land Trust will own the land but transfer the carbon ownership to the investor.

6. Monitoring and Verification

Monitoring of the Trees and Roots pool will be performed every ten years to coincide with the transfer of GHG reductions. Soil and Litter pools will be monitored in the initial monitoring stage but will only be monitored in later years if they are needed to cover a shortfall in carbon in Trees and Roots pool.

7. Other Benefits

7.(a). Public Exposure

For companies actively, or planning to be involved in Mexico, this project has substantial public relations potential.

7.(b). Environmental

The land purchased as a result of this initiative will help to extend the network of protected areas that are home to the Biosphere Reserve's flora and fauna. In this way, this initiative will have a positive effect on local and global biodiversity. Furthermore, expansion of forested areas will contribute to a more robust water supply, reduce soil erosion and help ecotourism efforts.

7.(c). Social / Educational

A goal of Grupo Ecológico Sierra Gorda is to develop alternative uses for the forest. These include ecotourism and agroforestry. Funds obtained by the Joya del Hielo Land Trust will be used to promote activities in these areas.

8. Project Participants

8.(a). Joya de Hielo Land Trust

Joya de Hielo Land Trust was set up in 1997 by individuals from Grupo Ecológico Sierra Gorda and others interested in land protection in the Sierra Gorda. Its purpose is to purchase and preserve or improve lands in order to extend the network of protected space in the Biosphere Reserve. Land purchased by the Joya de Hielo Land Trust is permanently protected under Mexican law. Land protection efforts in the Biosphere Reserve complement other programs managed by Grupo Ecológico.

8.(b). Grupo Ecológico Sierra Gorda

Grupo Ecológico will provide the administrative support to this initiative. It will also select the land, make the purchases and afforest or protect the land as required. It will manage the lands over the duration of the initiative.

Over the last ten years, Grupo Ecológico has planted over 3-million trees on plantations that average 1.5 hectares in size. Its environmental programs reach some 16,000 students in 167 schools. Over 500 dry composting latrines and more than 1,500 efficient cookstoves have been installed. Grupo Ecológico is responsible for the erection of greater than 1,500 signs bearing environmental messages and some 50 murals have been painted on buildings.

More recently, Grupo Ecológico has extended its work to include social as well as environmental programs. Micro-enterprises, many of which use local products and resources, are under development and ecotourism opportunities are being organized. These initiatives will help Serranos and Grupo Ecológico become more self-sustaining while adhering to ecological principles.

Although the majority of Grupo Ecológico's revenue has historically come from government sources within Mexico, it has also received support from the W.K. Kellogg Foundation; the World Bank; the United Nations Development Programme; the U.S. Fish & Wildlife Service; the U.S.D.A. Forest Service; and the Canada Fund. In 1996 it was selected by The Nature Conservancy as an Ecological Leader and in 1997 the Sierra Gorda was given Mexico's highest designation as a Biosphere Reserve. Grupo's status changed from a Sociedad Civil to an Institución de Asistencia Privada in 1997 and Ms. Martha Isabel Ruíz Corzo, manager of the Biosphere Reserve and co-founder of Grupo Ecológico, received a fellowship from Ashoka. Operating on a budget of just under US$1-million per year, Grupo Ecológico has the financial and administrative processes in place to undertake this initiative.

8.(c). Woodrising Consulting Inc.

Canada-based Woodrising Consulting Inc. has worked in conjunction with Grupo Ecológico to develop this initiative. Woodrising will oversee the monitoring and verification aspects of this initiative. Woodrising has arranged to have monitoring and verification services undertaken by El Colegio de la Frontera Sur (Ecosur) — a Mexican agency that is a leader in this discipline.

Woodrising Consulting Inc. has specialized in climate change project development and other aspects of global warming since 1994. Climate change initiatives have been undertaken in Australia, Canada, Chile, Mexico, Peru and Zimbabwe. Clients include the Global Environment Facility in Washington, D.C.; the Canadian International Development Agency; Australia's Greenhouse Challenge Office; TransAlta Corporation; Consumers Gas; and the University of Calgary.

8.(d). The Investor

The nature of an investor's involvement will be tailored to the specific requirements of the investor. It may be limited to a simple purchase of carbon credits through to more direct involvement.

9. Modeling Details

9.(a). Afforestation

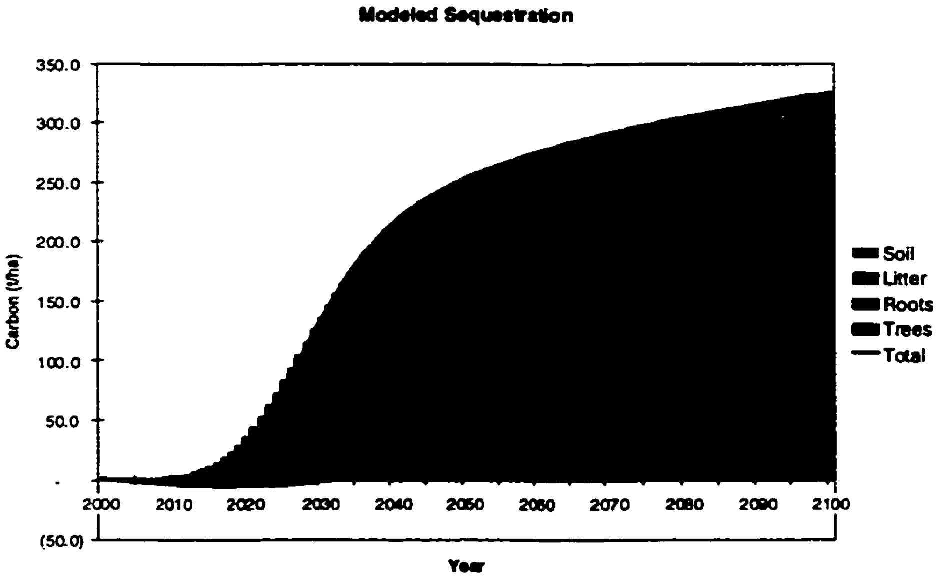
The carbon sequestered through afforestation is modeled using GORCAM, an algorithm developed by Schlamadinger and Marland for tracking carbon storage in various pools of a forest stand.

Important Parameters

Initial carbon (above ground biomass)	10.0 tC / ha
Growth Rate (trees)	4.35 tC / ha / year
Maximum carbon (trees)	185 tC / ha
Richard's parameter	0.243
Roots / Tree	0.21

A full list of parameters and model details will be provided upon request.

Figure 3: Modeled carbon sequestration per hectare



9.(a). Protection

To model the GHG reductions through mature forest protection requires knowledge of the deforestation rate, the amount of land available and the carbon storage per hectare in a mature forest and pasture. The carbon stored in a mature forest has been modeled by running GORCAM until steady-state was achieved.

Important Parameters

Maximum carbon (trees)	185 tC / ha
Current deforestation rate	500 ha / year
Available land for deforestation	133,500 ha
Deforestation rate reduction	0.003745 ha / year / ha protected

A full list of parameters and model details will be provided upon request.

Figure 4: Modeled emission reduction per hectare protected