# Policy Studies on Greenhouse Gas Mitigation and Economic Development

# Synergies and Challenges

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*The report can be downloaded at:* ***http://www.iadb.org/sds/env***

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# Introduction

The twin objectives of economic development and the mitigation of greenhouse gases (GHGs) present both opportunities and challenges for the countries of Latin America and the Caribbean. Economic development and poverty alleviation, as well as local environmental protection, can be major catalysts for GHG reductions. Many economic and social reforms, even if not adopted under the name of climate protection, can also contribute to GHG mitigation. At the same time, some mitigation activities can be expensive and may, therefore, compete with critical immediate development priorities.

In recognition of the importance of these issues, the Inter-American Development Bank issued a Climate Change Action Plan[1] in 2000 that called for the Latin American and Caribbean region to support country policies and increased knowledge building of both GHG mitigation and adaptation to the prospective impacts of climate change. Since 2000, the Bank has pursued a number of individual analyses and technical assistance measures in an attempt to strengthen energy policies and investments in ways conducive to clean energy development, as well as, to reduce vulnerability to natural disasters, which may eventually pose an increased threat as a result of climate change. Furthermore, the Bank is engaging in a regional level assessment of GHG mitigation opportunities and challenges, including gaps in institutional capacities.

As part of this suite of efforts, the Bank commissioned three case studies of the potential for links between GHG mitigation and sustainable development. The case studies examined innovative options for GHG abatement. These included the reform of the urban transport system (Santiago, Chile); the capture and combustion of methane (one of the most potent GHGs) through more efficient management of solid household waste (Chile); and sustainable forestry development and increased carbon sequestration to soak up atmospheric carbon in growing trees in order to create so-called carbon sinks (Argentina). These three studies were selected through a competitive process from larger set of proposals submitted by research centers throughout Latin America and the Caribbean. The three selected studies were deemed to have a strong potential in regards to their ability to illustrate the links between GHG mitigation and broader development objectives. An assessment of these links is essential given the high priority of economic and social development for the countries of the region, as well as, the frequently limited economic returns from GHG mitigation alone (a topic that will be discussed in this report).

In different ways, each study sought to examine the range of potential opportunities and obstacles that may exist in the future pursuit of more climate-friendly economic development. Furthermore, the linkage of these climate-friendly development opportunities to emerging international opportunities for the financing of GHG mitigation, including the fledgling private "carbon finance" markets for GHG credits and GEF projects, might accelerate economic and social development in the region.

In addition, each of the studies addressed a set of specific issues that related to the sector or country in question. In the case of sustainable forestry development and GHG abatement in Argentina, for example, questions arose concerning the particular species to be grown, the impacts on soil quality, and the potential competition among local industries, such forest development and cattle ranching. GHG reduction and capture potential through more efficient

[1] The document can be downloaded at: http://www.iadb.org/sds/doc/Clima_inside.pdf

management of solid household waste in Chile, focused primarily upon the new and pending regulations on landfills and the manner in which those regulations would affect the baseline for calculating creditable reductions under evolving international mechanisms for trading GHG reduction credits. Regarding the options for GHG abatement from urban transport in Santiago, Chile, the focus was on both the novelty and complexity of developing creditable reductions from a large-scale urban transport system.

This monograph reviews the findings of the three case studies and provides an assessment of the opportunities and challenges posed by the twin objectives of economic development and GHG mitigation in Latin America and the Caribbean. Section II presents background information on international climate policies and institutions under the United Nations Framework Convention for Climate Change (UNFCCC) and the Kyoto Protocol, as well as the Latin American and Caribbean context for policy studies, including summary data on GHG emissions and abatement possibilities in the region. Also included in this background section is a brief summary of relevant trends in GHG emissions and economic development in other major regions of the world.

Section III of the monograph presents summary material for each of the three case studies. In this section, references are made to the complete individual studies, in order to facilitate more in-depth review by interested readers. Section IV provides a comparative analysis of the aforementioned cases, centering on ten issues common to the three individual cases. Section V concludes with a series of crosscutting observations that focus on the broad nexus between GHG abatement and economic development in Latin America and the Caribbean, as well as the needs and opportunities for improved policy coordination and institutional strengthening.

# 1. Background

This section discusses the international climate policy and institutions and the situation in the region. It then compares Latin America and the Caribbean to other regions of the world.

### International Climate Policy and Institutions

The risk of climate change has been the focus of international efforts to limit GHGs for over a decade. In 1992, the UNFCCC was overwhelmingly approved by the world community in a first step towards reducing global emissions of GHGs. Under the Convention, the industrial, or "Annex B," countries agreed to mitigate their emissions, while all nations agreed to conduct an inventory of their contributions to global warming and an initial assessment of domestic policy options. The Convention established an ongoing process for developing and updating international commitments through regular Conference of the Parties assemblies. Additionally, Latin American and Caribbean nations have been active participants in this process since its inception.

At the third meeting of the Conference of the Parties (COP3), held in Kyoto, Japan in December 1997, a protocol bearing the name of the host city was signed by more than 150 nations. The Kyoto Protocol establishes legally binding national emission targets for developed country signatories, and mechanisms for international cooperation to promote cost-effective GHG abatement and sustainable development in both developed and developing nations. Overall, the Protocol requires industrial nations to, between the years 2008 and 2012, reduce their GHG emissions to a level 5.2 percent below those of 1990. In order to enter into force, the treaty must be formally ratified by at least 55 nations, including industrialized countries representing at least 55 percent of the GHG emissions of Annex B nations in 1990. That process is already far along. Despite the announced withdrawal by several Annex B nations, including the United States, a substantial majority of countries have ratified the Protocol. At this point, ratification by Russia is the remaining stumbling block for the Protocol to legally enter into force. When, or if, Russia will ratify the agreement is, at best, uncertain.

The Clean Development Mechanism (CDM), an important policy instrument embodied in the Kyoto Protocol, is of particular interest to the Latin American and Caribbean nations. , The CDM is designed to generate both cost-effective GHG control and sustainable development benefits for host developing countries (see box 1 for general principles and procedures of the CDM). Through the CDM, environmental gains, such as cleaner air and water, soil conservation, reduced deforestation, and biodiversity protection, are likely occur, in addition to such potential social benefits as poverty alleviation, employment, and rural development. It is anticipated that, in most cases, these benefits will overlap with a number of the formal, as well as informal, goals of developing countries. Thus, rather than conflicting with existing development priorities, the CDM has the potential to achieve gains on climate change and to, generally, support economic development and local environmental goals.

**Box 1: General Principles and Procedures for Access to the CDM**

1) *Sustainable development*: The projects will have to fulfill the objectives of sustainable development in the host country, including the conservation of biodiversity and the sustainable use of natural resources.

2) *Beginning of the projects*: Only projects that begin during or after the year 2000 will be eligible.

3) *Additionality*: The projects must generate a reduction of real, measurable, and long-term emissions, in addition to those which would have occurred in the absence of the project. To this end, the flows and stocks of carbon resulting from project activities will be compared with those that would have occurred in the project's absence (the "baseline").

4) *Certification*: The reduction of emissions must be certified by an independent third party (the "Operational Entity"), who is officially accredited by the Executive Board of the CDM. The operational organizations will be responsible for validating proposed CDM projects and verifying, as well as certifying, reductions in the anthropogenic emissions of GHG sources.

5) *The parties*: The parties will voluntarily participate in the CDM. All participating nations must be signatories to the Kyoto Protocol and must designate a national authority for the CDM.

6) *Period of credit*: The period of validity provides an individual CDM project with two time allowance options during which the project may generate credits. The project may receive either a maximum, yet twice renewable, time span of seven years, or a nonrenewable maximum of ten years during which it may complete the previously mentioned credit activity. Nevertheless, these periods solely correspond to energy projects, as the decision concerning the rule's application to forest projects remains unclear.

7) *Forest activities and changes in land use (LULUCF)*: Based on decisions made at COP9 (Milan, Italy), the activities included in the CDM for the first commitment period will be limited to forestation and reforestation. Thus, soil conservation and related activities are not creditable during the first budget period.

The CDM allows project-based GHG reductions in developing nations to be transformed into Certified Emission Reductions (CERs). In turn, these CERs become available to countries or companies as credits that may be used as a means of evading individual Kyoto emission control commitments. Because many abatement opportunities are less expensive in developing nations, the CDM can help reduce the overall cost of achieving global GHG reductions. Since GHG emissions contribute equally to climate change irrespective of their geographic location, the impact on the global environment is the same. CERs can be generated through the joint activities of developed and developing nations. Similarly, developing countries, through their unilateral efforts, may generate credits and make them available for sale on an open market in return for carbon dioxide credits. Such an open credit-based market is expected to develop when the Kyoto agreement formally enters into force.

The operational framework for the CDM was agreed upon during the seventh meeting of the Conference of the Parties (COP 7), which took place in Marrakesh, Morocco, in October 2001. COP 7 also authorized the establishment of the CDM Executive Board, the process for developing detailed rules and guidelines, and the methodologies for certain necessary tasks, such as: reporting, validating, monitoring, registering, and certifying emission reductions (see boxes 2 and 3).

### Box 2: Participants in CDM Projects

**Executive Board:**

- Approve methodologies for baselines, monitoring plans and project boundaries
- Accept operational entities
- Develop and maintain CDM registry

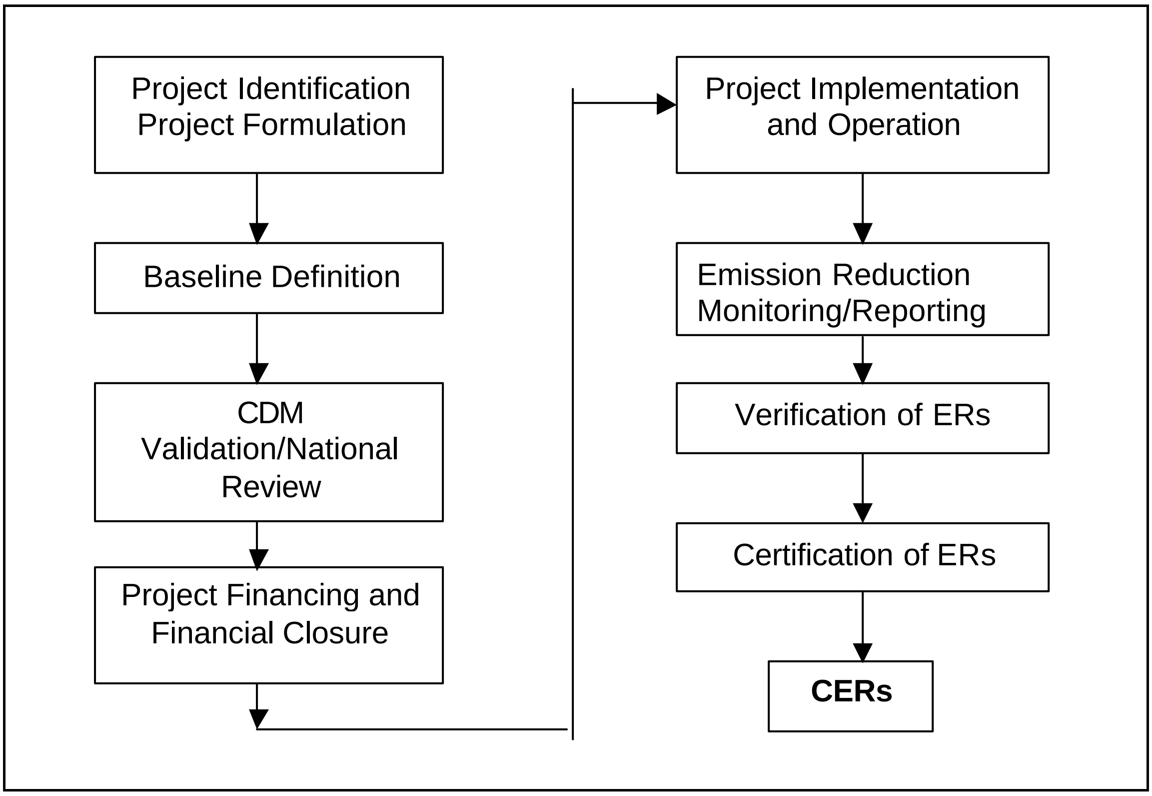
**Designated National Authority:** Provides government approval for individual projects to be submitted to the Operational Entities for validation.

**Operational Entities:** Independent institutions accredited by the Executive Board to carry out validation, verification, and certification functions.

**Investor/Developer:** Private or public sector, or another entity, providing financing and sponsorship for the project.

**Consultants/Brokers:** Financial, engineering, and legal support for project development and implementation.

**Box 3: Key Steps for a CDM Project**




Major decisions regarding land use and forestry were made at COP 9, which was held in Milan, Italy, in December 2003. The COP 9 decisions forged a compromise between those countries primarily concerned about the quality of the CERs, and those seeking to avoid high transaction costs in the form of excessively stringent criteria for environmental and social impact statements, non-permanence of carbon sequestration, and "leakage" from newly developed sinks to other areas. Furthermore, an agreement was made on the issuance of temporary credits that would help address the challenges and potential threats posed by pests and other natural (and manmade) factors that could jeopardize long-term forest projects. Due to earlier decisions to restrict the amount of credit claimed by individual Annex I nations on the basis of forest-based CDM (COP 7), the stage is set for limited use, at least, of sequestration-based CDM credits in the first Kyoto budget period.

The Kyoto Protocol requires CDM investments to be additional to the, otherwise, regular activities. In order to determine "additionality" a baseline must be established. Arguably, the issue of additionality involves the motivation of the project sponsors. However, since it is not practical to evaluate human motivations directly, commonplace procedures must be developed so as to accomplish this task.

Box 4 presents a list of barriers that, according to the CDM Executive Board, are key factors in determining project additionality. The CDM has established a set of streamlined procedures and approved specific methodologies for "small-scale" CDM projects.[2] However, larger projects are governed by a set of general procedures and new case-by-case approved methodologies.

### Box 4: List of Barriers Identified by CDM Executive Board

1. *Investment barrier*: a more viable financial alternative to the project activity would have led to higher emissions.
2. *Technological barrier*: a less technologically advanced alternative to the project activity, or the risks associated with the performance of new technology, would have led to higher emissions.
3. *Barrier due to low penetration*: a technology with higher market penetration (market share) would have led to higher emissions.
4. *Barrier due to prevailing practice*: prevailing practice would have led to higher emissions.
5. *Regulatory barrier*: without the project activity, regulatory barriers would have led to options with higher emissions.
6. *Competitive disadvantage barrier*: without the project activity, competitive disadvantages of non-traditional projects would have led to the adoption of traditional options with higher emissions.
7. *Managerial resources barrier*: without the project activity, limited managerial resources that abide by energy and emission standards would have led to non-compliance and higher emissions.
8. *Other barriers*: without the project activity, for another specific reason identified by the project participant, the capacity to absorb new technologies, as well as informative, organizational, financial, or institutional barriers would have heightened emissions.

In mid-2003 the CDM Executive Board issued fourteen methodology decisions for large-scale projects. Eight of the fourteen projects were based in Latin America and the Caribbean. One of two approved methodologies concerned a landfill gas project in Brazil that was under development by a subsidiary of French utility Suez Environment. The second of the two methodologies was based on an initiative to reduce the amount of hydroflourocarbons (HFCs) – potent GHGs– emitted in South Korea by the Ulsan Chemical Company, which was a cooperative effort of the UK chemicals company Ineos Fluor and Korea's Foosung Group. Decisions on additional methodologies remain pending before the Board. In some cases, the unconfirmed status of these methodologies is due to the need for revision, in light of the first round of comments received from the Executive Board. New methodological issues are certain to arise as the Board, the investor community, and the host countries gain additional experience with CDM projects.

There are various methods by which a baseline can be developed, ranging from national baselines (e.g., national carbon intensity) to sectoral or subsectoral baselines, and even to projects that are developed on an individual basis. In general, very broad baselines impose the least transaction costs to individual projects but may result in relatively large errors in estimating GHG reductions. Project level baselines, while still fraught with uncertainties, have the potential to produce reasonably accurate estimates of GHG reductions. However, there are negative results associated with project level baselines, as well, such as significant project cost increases and detailed government review, which causes a slowing of the approval process.

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[2] Small-scale projects are defined as: Renewable energy projects with a maximum output capacity 15 MW or equivalent; Energy efficiency projects with a maximum reduction in energy consumption on supply and/or demand side of 15 GWh or equivalent; other projects with annual direct emissions of less than 15 kilotons of $CO_2$ or equivalent.

Activities eligible for the CDM include a broad array of emission reduction measures and efforts to expand carbon storage in forest sinks.[3] Various institutions are being developed worldwide as a means of supporting the aforementioned opportunities. These supportive efforts are furthered by the construction of bilateral arrangements, such as the Netherlands Clean Development Facility, as well as a number of multilateral initiatives, including the Prototype Carbon Fund (PCF) and other World Bank programs, as well as an initiative of the Andean Development Bank (CAF in Spanish). The World Bank has recently announced the creation of a new $100 million Community Development Fund to extend carbon financing of small projects in poor, rural communities, as well as a $100 million BioCarbon Fund created to finance agricultural and forestry projects.

The PCF, the largest multilateral initiative, was established in 2000 to mobilize public and private investment in order to serve as a vehicle for creating a market for GHG reductions. The PCF has also helped increase the capacity of developed and developing countries by demonstrating the practicality of project-based activities when used to support global environmental objectives and to promote sustainable development. By mid 2003 the PCF had committed more than $100 million to the support of projects in non-Annex B nations.

Despite the high expectations for international support of project-based activities in developing countries, the future of the Kyoto Protocol and mechanisms like the CDM should be regarded with caution. After the initial agreement on the Kyoto Protocol (1997), respected analyses estimated that such project-based activities could make up between one-third and one-half of total GHG reductions, with CER prices in the range of $200 to $500 per ton of $CO_2$ or more during the first budget period of the Protocol (2008-12).[4] More recently, estimates of the demand for CERs, as well as the dollar volume of CDM transactions, have declined dramatically due to the *de facto* softening of the targets that occurred at COP 7, and the subsequent withdrawal of the United States from the Protocol.. The Protocol's formal international approval remains uncertain, raising doubts about the CDM's near-term viability. Though the United States has announced its intentions to reduce domestic emissions on a parallel track to Kyoto via voluntary initiatives, specifics of the U.S. program are still evolving. Similarly, even though the European Union has issued an emissions trading directive and indicated that it intends to meet Kyoto targets regardless of the legal status of the Protocol, questions remain about the nature of such voluntary commitments.[5]

Understandably, these uncertainties have kept the price and demand for credits relatively low. A recent report issued by the World Bank assessing trends in prices of emission reductions credits, indicates some price increases in 2003 compared to the previous several years. However, the 2003 prices are still fairly low and fall within the range of $3.00 to $4.20 per ton of $CO_2$ (weighted average $3.51) when the buyer takes the Kyoto registration risk, and $2.93 to $6.44 per ton of $CO_2$ (weighted average $4.88) when the seller takes the Kyoto registration risk (see table 1). Reportedly, PCF contracts are typically written in order to guarantee that the reductions

[3] See UNFCCC Decision 17/CP.7 for details, available through http://www.unfccc.int.
[4] The original estimates were expressed as $/ton of carbon rather than $/ton of $CO_2$. See Edmonds, J. et.al., 1998. "Unfinished Business: The Economics of the Kyoto Protocol," Pacific Northwest National Laboratory. Report prepared for the U.S. Department of Energy. Also, Ellerman, A.D., H. Jacoby, an A. Decaux. 1998. "The Effects on Developing Countries of the Kyoto Protocol and $CO_2$ Emissions Trading," Joint Program on the Science and Policy of Global Change. Cambridge, Mass: Massachusetts Institute of Technology.
[5] See Kruger, Joseph and William Pizer. 2004. "The EU Emissions Trading Directive: Opportunities and Potential Pitfalls,: Discussion paper 04-24, Resources for the Future, Washington, D.C.

generated during the first several years of project life will be paid for. Thus, Latin American, Caribbean, and other non-Annex B nations have no assurances as to the current or long-term price at which their projects' anticipated CERs may be sold. For many projects this price uncertainty represents a major barrier in securing debt or equity financing.

**Table 1: Reported Prices of Emission Reduction Credits, 2003**

| | Buyer Takes Kyoto Registration Risk (including PCF) | Seller Takes Kyoto Registration Risk |
|---|---|---|
| US$ per tCO2e (2003) | High 4.20<br>Low 3.00<br>Weighted Average 3.51 | High<br>6.44<br>Low<br>2.93<br>Weighted Average 488 |

Source: Derived from *State and Trends of Carbon Market*, 2003, World Bank, Washington, D.C.

Notwithstanding the uncertainties of future international GHG abatement policies, there is a growing interest within developing nations (including the Bank's client countries) in efforts to improve environmental quality and to safeguard important natural resources while also enhancing economic and social progress. It is widely understood that sustainable economic development is a priority that requires attention to the effects of environmental degradation on human health and resource productivity.

Efforts to promote sustainable development may also generate GHG reductions as collateral benefits, in that policy motivation need not be derived solely from GHG abatement activities. GHG abatement may, instead, be an ancillary benefit of other sustainable development initiatives. The modernization of energy systems and improved efficiency in the allocation of energy resources through effective competition and regulatory reform, can reduce local air pollution, increase economic productivity, and reduce GHGs through better thermal efficiency and the use of modern clean fuels. In remote areas, renewable energy can provide social and economic benefits while, at the same time, reducing deforestation and improving local living standards. Similarly, increased forestation can protect cultivated lands and ecologically sensitive buffer zones, while increasing carbon sequestration.

Internal policy discussions have encouraged many nations to analyze the Kyoto Protocol and the impacts of the CDM on their domestic economies. As a result, questions have arisen about the compatibility of policies to simultaneously enhance economic development and reduce GHG emissions. According to the Kyoto Protocol, the host country has the right to determine if a CDM project will further national sustainable development objectives. However, it is widely recognized that most projects involve increased capital investments that may be applicable to a range of purposes. An increased reliance on low-GHG, when combined with costly energy sources, may amplify the diversion of scarce investment resources and can, also, result in limited access to improved energy services by raising their costs. This latter effect can be especially deleterious to rural poverty reduction efforts. The use of scarce public funds to invest in or subsidize the provision of low-emission and costly energy sources creates dilemmas in meeting other urgent public sector needs. This problem is exacerbated in some Latin American and Caribbean countries, especially those countries that provide tax havens for renewable energy projects financed by levies on electricity consumers. This raises further questions regarding the appropriate baseline.

The growing, yet limited, technical and institutional capacities of developing countries must be considered when weighing the, more or less, "climate friendly" options for economic development in these nations, including those in Latin America and the Caribbean. The Kyoto Protocol does not allow investor countries to provide or use official overseas development assistance (ODA) in order to support CDM project activities. Evaluating the GHG consequences of individual development options, as well as the economic consequences of different GHG trajectories involves a number of complicated technical and policy judgments, due to the uncertain nascent international market for GHG reduction credits.

Capacity building is one of the most important requirements for further progress on the CDM in many developing countries. Accordingly, the PCF has noted the need to strengthen skills in project preparation, marketing, and negotiation. In addition, the PCF reports that some countries still need help to set up Designated National Authorities (DNAs) to facilitate CDM transactions.[6] Yet, the PCF reports that even after operating for several years, they still reject between 80 and 90 percent of submitted projects.[7] While some of these rejections may be related to particular PCF requirements (as opposed to those of the CDM), most rejections result from weaknesses in project preparation, project screening to ensure compliance with the CDM eligibility criteria, and various technical issues associated with calculating baselines and related factors. Capacity building efforts directed towards improving the integration of environmental and economic objectives and identifying and evaluating CDM options have earned initial support from the bilateral initiatives of Annex B countries, the World Bank, the Inter-American Development Bank, and other multilateral institutions. However, further support for capacity building on these issues is still required.

Opportunities for synergy between economic development and GHG limitation must be evaluated against a backdrop of ongoing economic and political change in Latin America and the Caribbean, including such issues as: power sector reforms, broader changes in the international investment climate, efforts to reduce poverty, and so forth. Each of these forces gives rise to political constituencies and interests that must be mobilized if opportunities for climate-friendly economic development are to gain the approval of not just the environmental community, but of political leaders, as well.

Another concern that has arisen in connection with CDM is the possibility that early action to supply emission reduction credits to foreign purchasers would imperil the ability of the host country to affordably meet any future national commitments to limit GHGs. However, several developments militate against this concern. One is the recognition that many potential CERs generated by climate-friendly projects are of a "use or lose" nature: failure to obtain certification of certain project reductions in a timely manner could preclude their use forever. Concerns over potential conflicts associated with future commitments should be softened since developing

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[6] See *Annual Report 2003 Prototype Carbon Fund,* Washington, D.C. (also online at: www.prototypecarbonfund.org).
[7] Presentation by Ken Newcombe, Manager, World Bank Carbon Prototype Fund, International Resources Group, January 22, 2003.

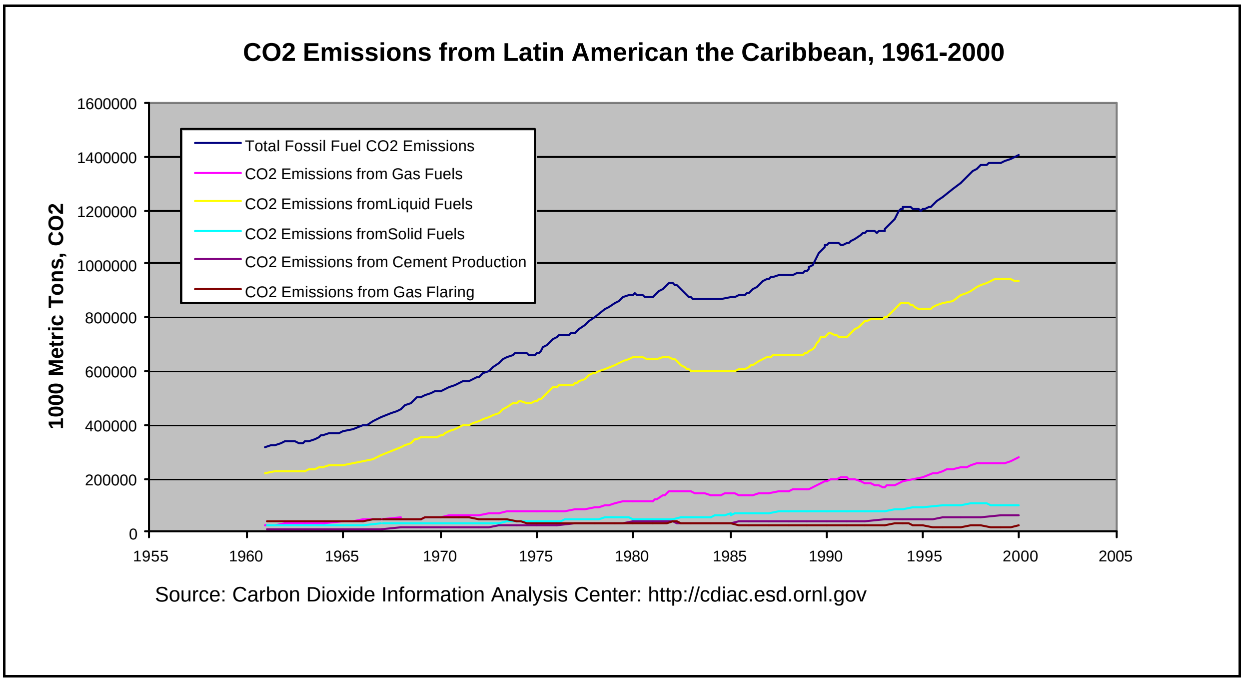
countries, themselves, have the option of going to the international emissions credit market rather than engaging in domestic abatement; this limits the risk of high future abatement costs from broadened national commitments to limit GHGs. In addition, decisions such as those emerging from the ongoing negotiations of the Conference of the Parties allow host countries to supply credits on their own to the international market rather than remaining dependent on an international partner. This "unilateral CDM" limits the host countries' risks of losing credit value from the exercise of market power by purchasers. Taken together, these observations suggest that the focus of discussion should shift from potential negative consequences arising from host nations' participation in the CDM, to the degree of synergy between GHG abatement and development activities in individual countries.

## The Latin American Context

Since the early 1990s, the nations of Latin America and the Caribbean have paid increasing attention to issues related to global climate change. In the mid-1990s most countries in the region established coordinating committees within their national governments to address issues raised by the UNFCCC and to carry out their obligations under the Convention, including the development of national inventories and the initial consideration of potential options for GHG mitigation. This section presents background information on the region's emission patterns, including certain international comparisons, as well as the preliminary country-specific inventory estimates.

Overall, $CO_2$ emissions in Latin America and the Caribbean have increased considerably in recent decades. Reflecting the growth in the transportation sector, particularly of private automobiles, the largest increases have occurred in the area of liquid fuels, which now account for about two-thirds of total emissions. Currently, emissions from the expanded use of natural gas represent nearly one third of those from liquid fuels, or about 20 percent of all $CO_2$ emissions. Trends in total fossil fuel $CO_2$ emissions, along with the fuel-specific components of these emissions for the period 1960-2000, are displayed in figure 1.

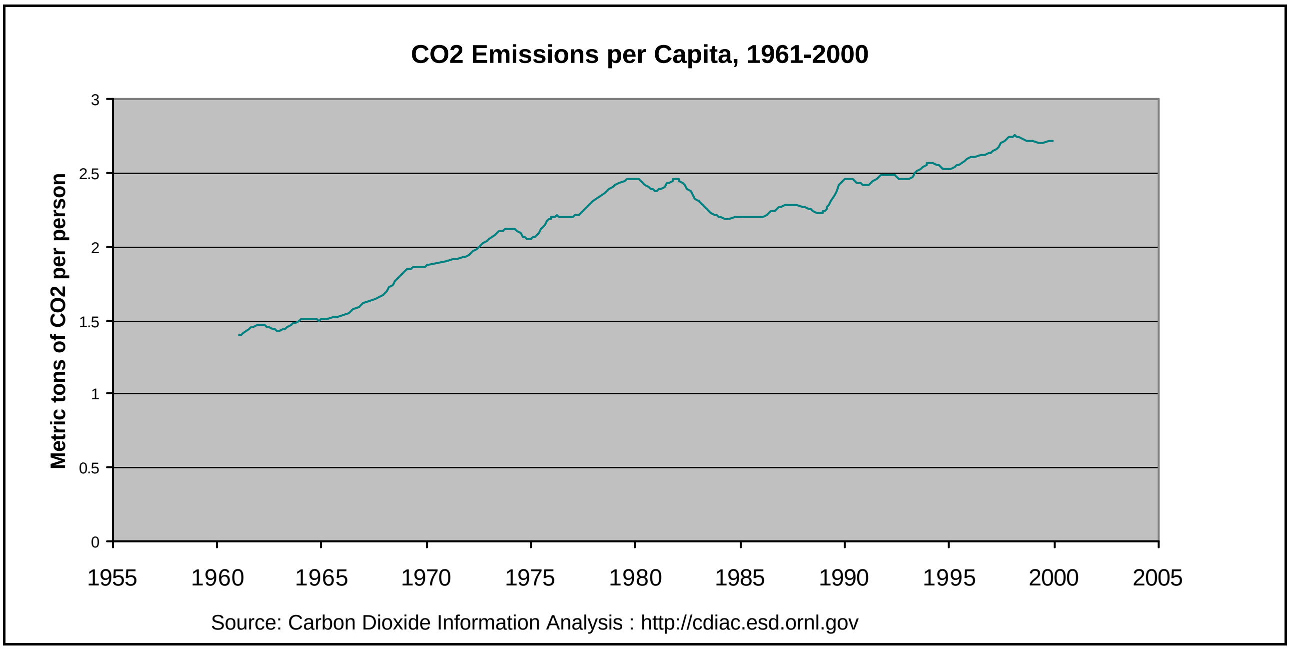
**Figure 1: $CO_2$ Emissions from Latin America and the Caribbean, 1961-2000**




Two widely used indicators of the region's contribution to the global environment are per capita $CO_2$ emissions and energy intensity. In recent decades the growth in $CO_2$ emissions has reflected population and economic growth patterns in the region. Although not increasing continuously over the period, per capita emissions virtually doubled between 1961 and 2000 (see figure 2). Reflecting the doubling of both the population and the per capita emissions over the forty-year period, total $CO_2$ emissions more than quadrupled. While per capita emissions have begun to rise again in recent years, they had been remarkably stable between the mid-1980s and the mid-1990s. An analysis of the energy sector in the region reveals a number of factors underlying the observed decade-long stability of per capita emissions, including the expanded use of low carbon fuels, such as natural gas, and increased reliance on hydroelectric power.[8]

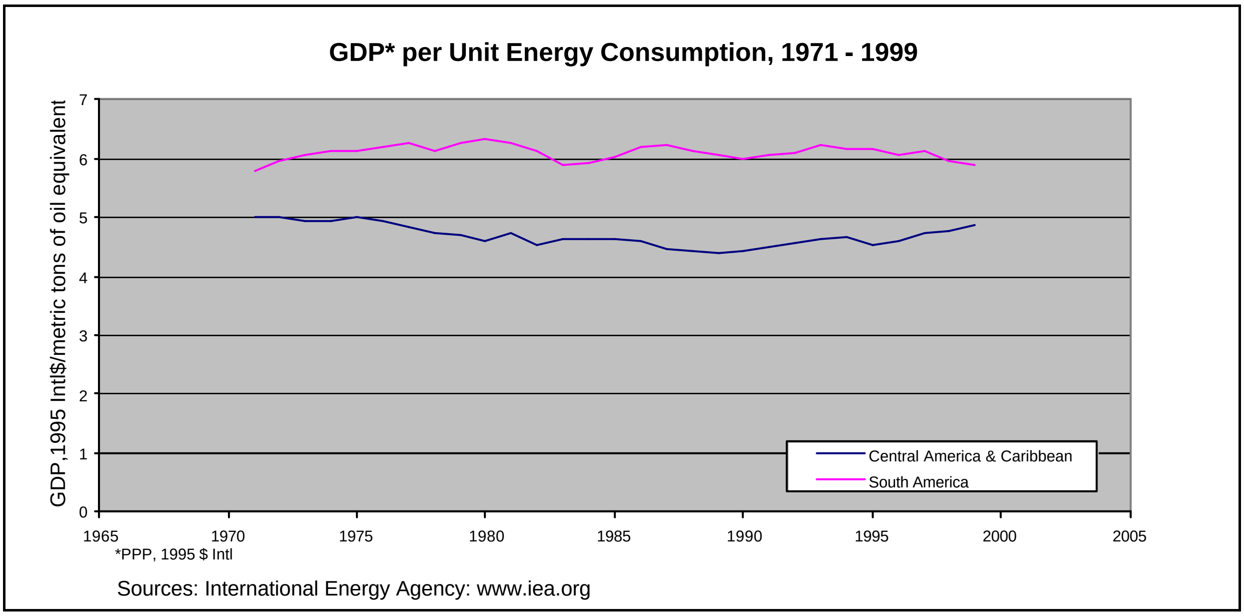
[8] Carlos E. Suarez, "Climate change mitigation in Latin America: A Review of the Latin American Contribution to Climate Change Mitigation," Essays on Climate Change and Development (p323-336), Gomez-Echeverri, Luis, ed., Yale School Forestry and Environmental Studies, 2000.(available at: http://www.yale.edu/forestry/publications/climate/contents.htm).

**Figure 2: Per Capita $CO_2$ Emissions in Latin America and the Caribbean. 1961-2000**




Energy intensity, which is another commonly used indicator of performance, is the amount of GDP per unit of energy use. It is measured in billions of US dollars per metric ton of oil equivalent with GDP adjusted for purchasing power parity. As shown in figure 3, energy intensity has remained generally constant in Latin America and the Caribbean over the last several decades. Since energy intensity on a global basis has declined by about one-fourth during the same time period, there is at least a *prima facie* case that energy efficiency improvements in the region have lagged behind the global average.

**Figure 3: GDP per Unit of Energy Consumption, Latin America and the Caribbean, 1971 – 1999**




When comparing progress in Latin America and the Caribbean with that of other world regions, it is important to consider that energy consumption statistics do not include traditional energy sources such as fuel wood, other forms of biomass, and animal power. As the region has industrialized, and both electrification and primary fuel consumption have increased, *measured* energy consumption has increased markedly. However, this increase at least partly reflects a change in the type of energy used resulting from important changes in the composition of economic output in the region. For example, agriculture as a percentage of GDP has nearly halved during this time period (from 12-13 percent in 1971 to 6-7 percent in 2000), while the share for industry remained fairly constant in Central America and fell by roughly 25 percent in South America (from 39.3 percent in 1971 to 29.3 percent in 2000). Yet, with growing emphasis on energy intensive activities, energy consumption in both agriculture and industry more than doubled. Overall, the move away from traditional energy sources, many of which are not counted in official statistics, combined with the changing composition of output, mask the considerable efficiency gains in the region over the past several decades.

One of the responsibilities of all signatory nations under Articles 4 and 12 of the UNFCCC is the submission of national inventories of GHG emissions. Virtually all Latin American and Caribbean nations have developed these inventories, which typically incorporate detailed sector-specific estimates of emissions. Table 2 displays country-specific emissions for 1994 (the most recent year available on the UNFCCC website) for the principal GHGs ($CO_2$, $CH_4$ and $N_2O$). Emissions for all three gases are presented in $CO_2$ equivalent terms. Brazil emissions, however, are only available for $CO_2$.

**Table 2: Total GHG Emissions from Latin America and the Caribbean, 1994 (MMT $CO_2$ Equivalent)**

| Country | Total GHG Emissions | Total $CO_2$ | Total $CH_4$ | Total $N_2O$ |
|---|---|---|---|---|
| Antigua and Barbuda [a] | 388 | 288 | 98 | 2 |
| Argentina | 264,481 | 119,603 | 87,919 | 56,959 |
| Bahamas | 2,197 | 1,866 | 21 | 310 |
| Bolivia | 24,790 | 10,282 | 13,723 | 784 |
| Brazil [b] | NA | 234,678 | NA | NA |
| Chile | 57,178 | 37,097 | 12,461 | 7,620 |
| Colombia | 137,583 | 60,917 | 48,307 | 28,359 |
| Costa Rica [a] | 10,751 | 4,555 | 3,902 | 2,294 |
| Cuba | 38,105 | 23,497 | 9,356 | 5,251 |
| Dominica | 152 | 77 | 63 | 13 |
| Ecuador [a] | 32,179 | 20,028 | 11,847 | 304 |
| El Salvador | 11,728 | 4,515 | 3,119 | 4,095 |
| Grenada | 1,606 | 135 | 1,471 | 1 |
| Guatemala [a] | 14,856 | 4,245 | 4,191 | 6,420 |
| Haiti | 5,105 | 157 | 2,651 | 2,297 |
| Honduras [b] | 13,786 | 4,081 | 8,092 | 1599 |
| Jamaica | 116,430 | 8,561 | 1,229 | 106,640 |
| Mexico [a] | 388,758 | 308,632 | 76,475 | 3,651 |
| Nicaragua | 9,379 | 2,728 | 5,699 | 952 |
| Panama | 12,073 | 4,315 | 4,838 | 2,920 |
| Paraguay | 142,148 | 3,802 | 64,690 | 73,386 |
| Peru | 61,604 | 30,657 | 17,044 | 13,904 |
| Saint Kitts and Nevis | 165 | 71 | 59 | 34 |
| Saint Lucia | 893 | 269 | 602 | 23 |
| Saint Vincent and the Grenadines | 380 | 95 | 64 | 221 |
| Uruguay | 29,815 | 4,210 | 15,477 | 10,129 |
| Total* | 1,376,530 | 889,361 | 393,398 | 328,168 |

[a] 1990 data
[b] 1995 data
* Totals for GHG, CH4, and N2O do not include Brazil.
Sources: U.N. Framework Convention on Climate Change; Carbon Dioxide Information Analysis Center. (Note these are the most recent country-specific data available from the UNFCCC as of December 2003.)

Despite the incomplete (and dated) nature of the reported country-specific information and some differences in methodologies among nations, it is useful to consider the initial results. Overall, the inventory data show that Latin American and Caribbean nations emitted about 890 million metric tons (MMt) of $CO_2$ in 1994. The three largest nations (Mexico, Brazil, and Argentina) account for about three-fourths of the total $CO_2$ emissions. Not surprisingly, there is considerable variation in the relative contributions of the different gases. For countries reporting emissions of all three gases (i.e., excluding Brazil), $CO_2$ accounts for an average of 47.5 percent of total GHG emissions, $CH_4$ accounts for an average of 28.6 percent of total GHG emissions, and $N_2O$ accounts for an average of 23.8 percent of total GHG emissions. However, the reported percentage contribution of $CO_2$ varies dramatically by country and depends upon per capita income, the resource base, the degree of industrialization, and other factors. For example, Mexico, a relatively high income, industrialized country, reports percentages of $CO_2$, $CH_4$, and $N_2O$ emissions of 79.4 percent, 19.7 percent, and 0.9 percent, respectively. In sharp contrast, the corresponding percentages for a relatively low income, agricultural nation like Haiti, are 3.1 percent, 51.9 percent, and 45 percent, respectively.

In addition to the direct emissions of GHGs from combustion and other industrial and agricultural activities, it is important to consider the impacts of changes in land use and of the forestry sector. Overall, this sector is a net contributor to total GHG emissions in Latin America and the Caribbean. Based on the UNFCCC inventory, which excludes information for Brazil, net annual $CO_2$ emissions for the sector were approximately 130 MMt $CO_2$ during the early 1990s.[9] However, a handful of countries did achieve a net negative balance of $CO_2$ emissions within this sector. Guatemala and Argentina reported the largest sinks, with Guatemala reporting a net reduction of MMt $CO_2$ in 1990, and Argentina a net reduction of 34,731 MMt $CO_2$ in 1994. Chile and Cuba followed, with net reductions in 1994 of almost 30,000 MMt $CO_2$. Nicaragua reported net reductions of close to 15,000 MMt $CO_2$. Only Guatemala, Nicaragua, and Cuba remain sinks over all sectors of their economies, with emissions reductions from land-use change and forestry that are 9.3 times greater than total national emissions in Guatemala, 5.4 times greater in Nicaragua, and 1.1 times greater in Cuba. The largest net emitters in the land-use change and forestry sector were Mexico, Peru, and Bolivia. Mexico reported net emissions of 135,857 MMt $CO_2$ in 1990, while Peru and Bolivia reported net emissions of 37,197 MMt $CO_2$ and 34,080 MMt $CO_2$, respectively, in 1994.

## Comparing Latin America and the Caribbean to Other Regions

It is useful to compare recent activities involving GHG reduction activities in Latin America and the Caribbean with those of other regions of the world. Eight of the 14 projects submitted to the CDM Executive Board in June/July 2003 were from Latin America and the Caribbean and one of the two approved projects was from the region.

PCF data are the most comprehensive available on actual projects and are available for all major regions of the developing world. So far, the PCF appears to be relatively bullish on Latin America, as no less than 30 percent of the earmarked funds through 2003 were for Latin American projects, compared to 23 percent for Eastern Europe, 20 percent for Africa, and 12 percent for East Asia.[10] The most recent data, covering the period 2002 through the third quarter

[9] This estimate uses 1994 emissions data, filling it in with 1990 data for countries that did not report 1994 data. As noted, it excludes Brazil, for which data for this sector was not available.

[10] Early PCF investments include four hydro and wind-power projects in Chile and Costa Rica. For example, the PCF has assisted a Nicaraguan rice and flourmill in using rice husks rather than diesel for

of 2003, indicate that more than 60 percent of emission reduction projects were in Latin America and the Caribbean, compared to about 30 percent in Asia, and 5 percent in Africa (table 3).[11]

**Table 3: Location and Sector of Emission Reduction Projects Supported by the Prototype Carbon Fund, 2003**

| | As of December 2004 | | Projects 2002-Q3: 2003 | |
|---|---|---|---|---|
| **Region** | Asia | 51% | Asia | 20% |
| | East Asia | 31% | Latin America | 40% |
| | South/Central Asia | 20% | Transition Economies | 15% |
| | Latin America | 22% | Africa | 5% |
| | Eastern Europe | 16% | OECD | 20% |
| | Africa | 11% | | |
| **Sector** | Waste | 19% | Landfill Gas | 30% |
| | Management | 18% | Hydro | 15% |
| | Small Hydro | 14% | Biomass | 15% |
| | Energy Efficiency | 7% | Fuel Switching | 12% |
| | Cement Manufacture | | 6 Other Sectors | |
| | 6 Other Sectors | | | |

Source: Derived from *State and Trends of Carbon Market*, 2003, World Bank, Washington, D.C. Numbers are rough figures read from graph in the report

Overall, it appears as if a significant fraction of the early CDM and other project-based activity has been based in Latin America and the Caribbean. As developers in other regions assemble viable projects, the region's share is likely to experience somewhat of a decline. For example, the PCF expects that both India and China will become major players in the future. Nonetheless, as the level of global activity increases, the total volume of projects in Latin America and the Caribbean is expected to rise substantially.

Beyond early project-based activities across different regions of the world, it is useful to compare recent trends in emissions across regions. Three specific measures are considered: total $CO_2$ emissions, $CO_2$ emissions per capita, and carbon intensity (metric tons of $CO_2$ per million GDP in 1995 dollars). Results of these various measures are shown in table 4 for the years 1980, 1990, and 2000. (Note that the reported totals differ slightly from the country-specific results of the inventory compiled by UNFCCC shown in table 2, largely because of different coverages across countries.)

fuel. Pending PCF projects include a Mexican plant that uses sugarcane bagasse for energy and a Brazilian power plant fueled by a landfill's e missions of methane.

[11] *State and Trends of Carbon Market*, 2003, World Bank, Washington, D.C. (Derived from a graph (page 14))

## Table 4: Regional Comparison of $CO_2$ Emissions

| $CO_2$ Emissions (MMT) | | | | | |
|---|---|---|---|---|---|
| **Region** | **1980** | **1990** | **2000** | **1980-1990 (percent change)** | **1990-2000 (percent change)** |
| North America | 5,199,619 | 5,481,388 | 6,392,269 | 5.4 | 16.6 |
| Latin America and the Caribbean | 875,271 | 1,032,702 | 1,355,096 | 18.0 | 31.2 |
| Western Europe | 3,756,432 | 3,689,908 | 3,729,696 | -1.8 | 1.1 |
| Eastern Europe and Former U.S.S.R. | 4,188,417 | 4,754,897 | 3,004,198 | 13.5 | -36.8 |
| Middle East | 504,914 | 742,425 | 1,104,652 | 47.0 | 48.8 |
| Africa | 539,366 | 724,699 | 878,415 | 34.4 | 21.2 |
| Asia and Oceania | 3,573,027 | 5,296,345 | 7,243,842 | 48.2 | 36.8 |
| **$CO_2$ Emissions per Capita (Metric tons per person)** | | | | | |
| **Region** | **1980** | **1990** | **2000** | **1980-1990 (Percent change)** | **1990-2000 (Percent change)** |
| North America | 20.6 | 19.8 | 20.4 | -3.9 | 3.0 |
| Latin America and the Caribbean | 2.4 | 2.4 | 2.6 | 0 | 8.3 |
| Western Europe | 8.7 | 8.1 | 7.8 | -6.9 | -3.7 |
| Eastern Europe and Former U.S.S.R. | 11.6 | 12.2 | 7.7 | 5.2 | -36.9 |
| Middle East | 5.5 | 5.7 | 6.6 | 3.6 | 15.8 |
| Africa | 1.1 | 1.2 | 1.1 | 9.1 | -8.3 |
| Asia and Oceania | 1.5 | 1.8 | 2.1 | 20.0 | 16.7 |
| **Carbon Intensity (Metric tons per million 1995 dollars of GDP)** | | | | | |
| **Region** | **1980** | **1990** | **2000** | **1980-1990 (Percent change)** | **1990-2000 (Percent change)** |
| North America | 997 | 769 | 661 | -22.8 | -14.0 |
| Latin America and the Caribbean | 568 | 695 | 686 | 22.4 | -1.3 |
| Western Europe | 506 | 403 | 359 | -20.3 | -10.9 |
| Eastern Europe and Former U.S.S.R. | 3,547 | 2,781 | 3,836 | -21.6 | 37.9 |
| Middle East | 1,378 | 1,440 | 1,715 | 4.5 | 19.1 |
| Africa | 1,183 | 1,352 | 1,352 | 14.2 | 0 |
| Asia and Oceania | 751 | 729 | 744 | -2.9 | 2.0 |

Source: Energy Information Administration: www.iea.org

A number of observations can be drawn from a review of this cross-regional data. $CO_2$ emissions appear to be growing more rapidly in Latin America and the Caribbean than in more developed regions. In 2000, $CO_2$ emissions in the region totaled 1,355,096 MMt, a 31.2 percent increase from 1990. In contrast, Western Europe displayed only a 1.1 percent increase over this period, and North America presented a 16.6 percent increase. Growth in the Middle East, however, has been the most rapid, with almost a 50 percent increase in total emissions between in both of the past two decades (19801990 and 1990-2000). Despite rapid emissions growth in Latin America and the Caribbean, the region is still well behind most areas in its total emissions levels. In 2000,

$CO_2$ emissions in Latin America and the Caribbean stood at only one-fifth of the emissions in North America, and less than half of the emissions in Western Europe and Eastern Europe and the Former Soviet Union.

Despite the rapid increase in total $CO_2$ emissions in Latin America and the Caribbean over the past two decades, emissions per capita have risen only slightly over the same time period. As previously noted, these modest increases are primarily due to the expanded use of natural gas and increased reliance on hydroelectric power. At 2.6 metric tons per person in 2000, emissions per capita in the region are slightly greater than those of Africa, Asia and Oceania. Furthermore, the region's per capita emissions are less than 15 percent of those in North America, and about 30 percent of those in Western Europe.

Eastern Europe and the former Soviet republics, the Middle East, and Africa have, by far, the most carbon-intensive economies. Asia and Oceania, Latin America and the Caribbean, and North America are all similarly carbon-intensive, while Western Europe is the least carbon-intensive. Total $CO_2$ emissions and emissions per capita in Latin America and the Caribbean are well below those of North America. However, in the year 2000, Latin America and the Caribbean slightly exceeded North America's carbon intensity. If current patterns continue, it is likely that the carbon intensity difference between North America and the Latin American and Caribbean region may become more pronounced over the next few decades. Carbon intensity in North America has declined significantly over the last 20 years, while it appears to be leveling out or declining more slowly in Latin America and the Caribbean.

# 2. The Case Studies

This section summarizes the results of the case studies, which were conducted by major academic centers in Latin America and the Caribbean, and covers three distinct topics: innovative options for GHG abatement from reform of the urban transport system (Santiago, Chile); the capture and combustion of methane, one of the most potent GHGs, through more efficient management of solid household waste (Chile); and sustainable forestry development and increased carbon sequestration through the creation of carbon sinks (Argentina). Each case study examines options for enhancing economic development in the identified sector(s) and assesses the extent to which GHG limitation and key development objectives, including enhanced economic growth and poverty alleviation, compliment or conflict with one another.

The case studies consider both technical and policy issues. At the technical level, the studies examine the methodologies and the data requirements for assessing different development initiatives for generating certified emission reduction credits, the economic costs of different options, and the kinds of resources (human, financial, and other) that are required to carry out such evaluations by different governmental units. At the policy level, the studies consider a broad range of issues, including the scale of participation in international GHG reduction markets and the importance of establishing clear policy baselines in individual countries.

The case studies also address a number of institutional hurdles. One such obstacle relates to the questions of whether there are shortages of knowledge or specialized capital that might impede the realization of synergies between economic progress and GHG limitation in the identified sector(s). A second issue refers to existing regulations and/or institutions and whether they do or do not limit the ability of private, as well as public, decision makers to benefit from such synergies. A third problem, in respect to political dynamics, exists over who the societal winners and losers from different development and GHG emission paths are. The fourth topic addresses the congruency or dissonance of the goals and agendas held by the individuals who are influential to the identified public sector(s). A final issue relates to the significance of the broader political economy considerations that are associated with economic development. The complete case studies are available (in Spanish) as IDB publications.[12]

### Greenhouse Gas Abatement and Urban Transport in Santiago, Chile[13]

This section considers the potential use of the CDM to support efforts to improve the organization and modernization of Santiago's public transport system. The seriousness of the air quality problem in Santiago and, especially, the role of the urban transport system in exacerbating air pollution and congestion in the city, are both critical elements of this case study. It considers major reforms and modernization tactics for the system that alter the incentives facing transit operators and passengers, in addition to planned efforts that go well beyond the already planned system changes.

The potential use of the CDM to support the reform and modernization of a major urban transport system represents a novel and innovative use of this Kyoto mechanism that has not been widely

12 The reports and technical annexes are available for download at: http://www.iadb.org/sds/env/

[13] This section summarizes the results of a study prepared by the Department of Industrial Engineering of the University of Chile. The principal investigator was Raul O'Ryan.

discussed in the literature (though it has been explored in the context of the GEF). The authors of this case study employ complex transportation and energy models to estimate the impacts of the proposed changes. Three major topics are considered: (i) the size of the potential GHG reductions achievable via additional reforms of the transport system; (ii) the effect of the CDM on the decisions to both modernize and to incorporate new technologies into the system; (iii) the political, economic, and institutional aspects of the overall decisions.

Over the past two decades Chile has undergone a major economic transformation. Currently, average per capita income is almost US$5000, placing it among the world's upper middle-income countries. According to a recent national census (2002), more than 86 percent of the population lives in urban areas and almost 40 percent lives in Santiago.

The principal modes of transport in Santiago are cars, taxis, *colectivos* (taxis with a specified and fixed route), and buses. Santiago, also, has one of the most successful metro systems in the world. While the government has paid capital costs, the system no longer requires operating subsidies. All transport modes, except the metro system, are privately owned. In 2001, of the 16.2 million commuter trips made during a typical working day, 25.9 percent were via bus, 23.7 percent via car, 4.1 percent via metro, and 37.6 percent on foot. Despite a relatively well-organized urban transport system, congestion is a large and growing problem in the city. As affluence increases and trip origins and destinations become more diffuse, the demand for private vehicles is increasing rapidly. Over the past 14 years, use of private cars as a percentage of total trips increased by more than 60 percent compared to a 27 percent increase in bus travel over the same time period.

Santiago ranks as one of the most polluted cities in the world. In 1996 the Greater Santiago region was declared a saturated zone exceeding WHO ambient standards for particulates, ozone, and carbon monoxide. Santiago's pollution problem is exacerbated by the local topography: the surrounding mountains significantly limit air circulation, a situation similar to that of Mexico City and Los Angeles. Mobile sources contribute 92 percent of the city's carbon monoxide emissions (CO), 71 percent of nitrogen oxides ($NO_x$), and 46 percent of volatile organic compounds (VOCs). Both nitrogen oxides and VOCs are precursors to the formation of tropospheric ozone and fine particles. Buses are believed to pose the greatest public health threat because they are the principal sources of direct particulate emissions and operate in densely populated areas, directly exposing many people to toxic automotive exhaust fumes.

The government has responded aggressively to the dual problems of congestion and poor air quality in Santiago. Early policies imposed emission standards for new vehicles and age limits for existing fleets, including buses. Routes and frequency of operation have also been subject to regulation. In areas that suffer from serious problems of congestion and/or particularly poor air quality, transit operators are obliged to operate with fixed schedules on specified routes. Furthermore, a series of metropolitan-wide transportation and air quality plans, such as: the Urban Transport Plan for Santiago of the Inter-ministerial Secretary of Transportation (SECTRA), 1995 and 2000; and the Greater Santiago Air Pollution Prevention and Decontamination Plan (APPDP), 1998 and 2002, have been developed and are in the process of implementation.

*The Economics of Bus Transport in Santiago*

According to financial estimates developed by the case study authors, bus operations in the city generate relatively high returns on investment, on the order of 13 percent annually. These high returns indicate that, at least in principle, opportunities may exist to redesign the system so as to reduce congestion and/or improve air quality without forcing increases in passenger fares. Alternatively, the high returns may create opportunities for reforms that may, actually, reduce fares. A key question is whether the high estimated returns are truly a long-term phenomenon and, if so, why such returns persist in a transport system characterized by free entry for bus owners and operators.

The case study identified three different sources of inefficiency in the Santiago transit system: the organization of the network as a whole, the particular forms of competition between and within each route, and the operating characteristics of the individual companies. Concerns have been raised about the potentially excessive rewards to the drivers (and the unions) that provide additional opportunities for reform. However, all these issues involve important political economy issues as well.

Inefficiencies in the organization of the network are directly related to load densities, which are generally low in Santiago. With respect to the route structure, the absence of barriers along specific corridors that, in effect, allows companies to compete over the most profitable routes, creates excess capacity and causes increases in both pollution and congestion. It is possible to reduce these inefficiencies, as well as some of the pollution and congestion associated with the current system, via redesign of routes and the use of improved technologies without increasing fares.

### *Urban Transport Plan For Santiago (2000-2010)*

Full implementation of the APPDP is expected to lead to significant air quality improvements in Santiago: 2010 emissions of particulate matter less than 10 microns in diameter ($PM_{10}$) are projected to decline by 25 percent, while those of $NO_x$ are expected to fall by 60 percent compared to the 1997 emissions inventory. Achievement of these goals will require buses to be retired after 12 years of use and will also result in major investments in new diesel engines according to a specified schedule.[14] Achievement of these goals also requires significant changes to the road infrastructure for buses as defined by the so-called Program 7 of the Urban Transit Plan for Santiago. These changes include the creation of exclusive bus lanes separated by concrete barriers along certain routes, the use of particle traps by 50 percent of the bus fleet in order to reduce emissions of $PM_{10}$ and other pollutants. Estimated emissions for 2005of $PM_{10}$, $NO_x$, and $CO_2$ associated with the proposed changes to the bus system are shown in table 5.

[14] EPA91/EURO1 (30%), EPA94/EURO2 (37%), EPA98/EURO3 (33%).

**Table 5: Projected Baseline Emissions of the Santiago Transport System for $PM_{10}$, $NO_X$, $CO_2$, in 2005**

| Type of Vehicle | $PM_{10}$ [ton/year] | NOx [ton/year] | $CO_2$ [ton/year] |
|---|---|---|---|
| Licensed buses | 162 | 6,621 | 727,672 |
| Other buses | 7 | 128 | 14,462 |
| Trucks | 213 | 3,030 | 505,092 |
| Private autos | 0 | 5,557 | 3,430,227 |
| Taxis | 0 | 802 | 589,878 |
| Commercial vehicles | 59 | 3,315 | 1,695,608 |
| **TOTAL** | **441** | **19,453** | **6,962,939** |

Source: The transport model ESTRAUS and the emissions model MODEM are used for these simulations. Detailed descriptions are available in the full case study. Note that these estimates are based on the implementation of the APPDP, which assumes modal shifts resulting in a reduction in use of private cars and commercial vehicles of 3 percent per year. See full case study for details.

*Additional GHG Reductions*

Although the local pollution goals of the APPDP are expected to be achieved through the full implementation of the transportation and air quality plans, which are already underway, additional design changes could achieve further reductions in GHGs while, at the same time, creating additional improvements in local air quality. Two scenarios for further reform were evaluated in the case study: a redesign of the whole system and the introduction of technological changes in buses in the redesigned system.

The proposed redesign of the system, which corresponds to what is known as the "Tran Santiago Project," considers the use of transport modes that have been traditional in Santiago (buses, metro, *colectivos*, and, eventually, trams) but with better organizational arrangements that take advantage of network externalities. Physically, the proposed redesign includes three types of changes:

- Introduction of main (trunk) services that are formed by the principal axis of the city's public transportation system, where the main network operates via high-capacity, high-quality vehicles, known as articulated buses. These services would not compete among themselves, although they might involve multiple operators.

- Establishment of number of feeder services, operating in different geographical areas of the city. The function of the feeders would be to meet the demand for local trips inside each of the geographic areas and to interface with the main services.

- Creation of a network of independent transport services, which currently consists of the Santiago metro but, in the near future, could also include trams and trolleys.

The redesigned system would rely on the existing diesel bus fleet that complies with current emission standards and, each year, retire those buses that reach the maximum age limit of twelve years. These retired buses would then be replaced by buses with cleaner engines. Beginning in

2005 with 1000 vehicles, articulated buses with diesel trap technology would replace the retired buses in the main trunk services. The estimated capital cost of the proposed system-wide modifications is $300 million.[15] These modifications would be partially offset by annual fuel cost savings of $16 million. Overall, it is estimated that there would be a reduction of an additional 454,000 tons of $CO_2$ per year as a result of the implementation of the redesigned system. This reduction in emissions is equivalent to nearly 7 percent of projected $CO_2$ emissions in 2005, assuming full implementation of the baseline reforms. With a 10 percent discount rate and no capital depreciation, the incremental cost of the 454,000 tons of $CO_2$ would exceed $30 per ton, which is well above current market prices.[16] Of these reductions, 43 percent come from decreases in the number of kilometers buses may travel, while 57 percent of the reductions arise from the expected modal shift away from private automobiles due to adoption of a more attractive and more efficient bus system.

Beyond these changes, the second scenario evaluated several additional GHG reduction policies, based on changing the bus technologies used in the main trunk services. The technologies considered include: use of only new diesel buses (EPA 98/EURO3), use of hybrid buses, and use of CNG dedicated buses. These technologies would reduce GHG emissions only modestly (less than 15,000 tons per year) and at relatively high cost (estimated to be as much as $1,700 per ton $CO_2$). CNG buses are the most attractive of the three technologies, but the per ton costs are still quite high ($393/ton $CO_2$).[17] Thus, these technologies are not included in the proposed CDM option.

If the only benefits of the redesigned system were the fuel savings and the incremental $CO_2$ reductions, the case study finds that it would be difficult to justify the required $300 million in additional investments at the prices currently anticipated for CERs. However, based on the methodology adopted by the Chilean Ministry of Planning and Development, the authors developed monetary estimates of the 5-10 percent reduction in travel times forecasted for both bus and private car passengers.[18] Valuing the reduced transit time at the rate of approximately $1 per hour, the case study estimates that society-wide benefits exceed the incremental (annualized) infrastructure investment costs by a considerable margin. Specifically, the report calculates net benefits to society, including the value of trip time savings and reduced fuel use, ranging from $200 to $500 per ton of $CO_2$ reduced. If, in addition, the incremental reductions in $PM_{10}$ (7 percent) and $NO_x$ (16 percent) generated by the redesigned system were monetized, the net benefits would be even greater. The most practical means of realizing the financial gains from the conventional pollutant reductions would involve the establishment of an innovative emissions trading system whereby stationary pollution sources would purchase the incremental emission reductions achieved in the mobile source sector via the redesigned transit system.[19]

[15] The $300 million is for investments required to implement the Tran Santiago Project. These funds are additional to the baseline investments for the APPDP and SECTRA.
[16] The $30 per ton estimate is not technically comparable to the ERC prices reported in table 1 because of possible differences in the vintage of the credits, nominal (vs. real) dollars per ton, and other factors.
[17] These calculations are based on gas prices in early 2003. Most recently, gas prices have risen because of shortages in Argentina. Thus, the costs per ton of $CO_2$ abated from using CNG buses are likely to be higher than previously estimated.
[18] These estimated travel time reductions were developed by the Transantiago project. The Chilean Ministry of Planning and Development (MIDEPLAN) considers the value of time in urban areas to be 724 Chilean pesos, the equivalent of US$1.00 per passenger hour (at an exchange rate of .00137825 US dollar per peso).
[19] Conceptually, of course, one could consider some type of congestion pricing scheme, although this was not analyzed in the case study.

In terms of the distributional impacts among the different agents, the main beneficiaries of the reforms would be the users, since the tariff would remain unchanged while the overall quality of the service would improve. In contrast, the bus operators would suffer losses as their (estimated) high rates of return would be reduced to normal levels.

### *Economic, Political and Institutional Issues*

Technical and policy obstacles hinder the use of the CDM to support reforms in the urban transport sector, such as those addressed in this case study. One such important policy issue involves the occasional optimistic statements issued by the regulatory authorities, in regards to future plans and projects. If such statements are treated as accurate descriptions of current policy and are used to construct the baseline, the additional gains from new policies will, generally, be lower. If, however, it is recognized that optimistic policy statements of this sort are likely to be revised downward (as they have been in the past), then it is possible to construct a more realistic baseline scenario. Calculations for this case study have adopted the official forecast of SECTRA and APPDP as their baseline. Had they, instead, assumed less than full implementation of these plans, the incremental benefits of the proposed reforms would likely have been greater.

Interestingly, the relatively large value of the monetized congestion and environmental benefits may pose a challenge for CDM eligibility. Arguably, one would need to make a case for a significant market failure since neither the congestion nor the environmental benefits are captured via normal market-based institutions. Clearly, the CDM Executive Board would need to rule on this issue before a project of this magnitude could proceed.

A key technical issue involves estimating changes in consumer demand for bus travel (so-called modal shifts) associated with reforms of the system. Significant modal shifts from private cars to buses are essential to achieving the GHG reductions estimated by the case study. However, the underlying estimates for such shifts are notoriously unreliable since they involve major behavioral changes on the part of individual commuters. Invariably, the models focus on the underlying (marginal) economic choices and are often less reliable in predicting large, discrete shifts, such as those involved in modal choice.

The development of suitable monitoring and verification plans for complex transit reforms, much like those considered by the case study, poses particular challenges. For example, in order to achieve higher capacity utilization of the bus fleet, the existing practice of free bus competition on individual streets throughout the metropolitan area must be altered. Day-to-day enforcement of such reforms would likely impose significant burdens on local authorities. In addition, the use of private autos must also be closely monitored. In terms of governance, improved policy coordination among various agencies at the local and regional levels would be required to implement the new policy regime.

Any effort to generate CDM credits from the redesign of the Santiago transit system also raises some interesting legal issues. Although the potential CERs generated by the system can clearly be linked to the additional infrastructure investments (both public and private) an estimated 57 percent of the actual emission reductions would occur through operational changes in the privately owned vehicles. Thus, even apart from the measurement and monitoring issues, basic questions about the ownership of the CERs need to be resolved. One such question is concerned with which individual would receive credit for the reduced $CO_2$ emissions associated with the decreased use of private automobiles. Arguably, these CERs would accrue to the benefit of the public sector but further discussion among legal experts is, also, in order.

Further, it is important to directly confront the political economy implications of the proposed changes as regards the bus owners and the operators (and their unions). Since both these groups are expected to suffer some losses under the proposed system redesign, it is only reasonable to expect a well-organized opposition to the proposed changes. Thus, it may be appropriate to develop some form of proactive strategy to address the (legitimate) concerns raised by these groups.

Finally, it is useful to consider the total value of the CERs to be derived from these transport reforms. At a price of $5 per ton of $CO_2$ the estimated reductions of 450,000 tons per year would yield $2.25 million annually.[20] When the necessary monitoring and verification costs are added, the net gains would be even lower. While not an unimpressive sum, as a percentage of annual operating costs of a major transit system, such as that in Santiago, even the full $2.25 million would likely be seen as fairly small. The fact that the gains from participation in the CDM are so modest does not undermine the significance of the proposed reforms. In fact, the case study makes a strong case for the reforms based on the reduced congestion and associated savings in transit times. As previously noted, the additional reductions in local pollution are, also, an important factor.

Overall, the innovative nature of the transportation reforms, combined with the clear sustainable development benefits, make a strong case for considering the proposed restructuring of the Santiago transport system as a candidate for the CDM. At the same time, the institutional challenges to implement these as a CDM project are considerable and the financial gains may be relatively modest. The next case study, which also originates in Chile but focuses on a separate technical and economic situation, offers a different set of opportunities and challenges.

### Greenhouse Gas Abatement Policies and Economic Development in Chile[21]

This case study considers the potential reduction of GHGs that are associated with improved management of biogases emitted via the decomposition of domestic solid waste in sanitary landfills. Specifically, this study focuses on the emission reductions associated with the capture, combustion, and possible use of biogas for generating electricity.

Under anaerobic conditions, trash decomposition generates biogas, consisting of approximately equal proportions of $CO_2$ and methane. Since based on its global warming potential methane is roughly 21 times as potent a GHG as $CO_2$, improved management of biogas is an attractive GHG abatement option. Furthermore, due to the high calorific content of methane, biogas can, potentially, be used to generate power, thereby offsetting the emissions of other more polluting fuels. As in the first case study, the methodology used in this study involves the development of a baseline for the generation of biogas in Chile's landfills and comparisons with alternative regulatory scenarios.[22]

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[20] Of course, with a more realistic baseline the $CO_2$ reductions achieved, and the corresponding CER revenues, would be greater.

[21] This case study was undertaken by Bitran & Associates of Santiago, Chile. The principal author was Sebastián Valdés.

[22] The full case study characterizes the waste sector in considerable detail, including the current institutional arrangements in the sector, the potential for reductions in GHG emissions from the capture of biogas, the possible use of the gas for the generation of electricity, and the challenges associated with using the CDM. This summary omits many of the technical and institutional issues covered in the full report.

Almost 5 million tons of domestic waste is generated annually in Chile, 85 percent of which is deposited in landfills. Currently, this waste is deposited in a total of 282 dumps and landfills throughout the country's 13 regions. In order to calculate the potential generation of biogas from these landfills, the study used secondary information from recent land registries and other studies. Additionally, expert judgments from international and domestic specialists in the sector were used to assess current practices of capturing and managing biogas in the country's landfills.

Per capita domestic waste generation in Chile has increased in recent years at an annual rate of 2 percent. When added to population increases, which are also estimated at 2 percent annually, the annual growth in waste generation is about 4 percent. Current levels of domestic waste generation average approximately 0.9 kilos for each inhabitant per year, on a national basis. Passive ventilation and simple combustion of biogas are growing in importance in the waste sector, principally motivated by an interest in controlling the risks of labor accidents and explosions. However, in the absence of new regulatory requirements or economic incentives, the case study argues that, in the near term, these practices are not likely to extend to more than 25 percent of the biogas generated, based on current management practices and technologies. Thus, the potential for additional reductions in GHG emissions would come from an increase in the amount of biogas captured beyond the 25 percent level, and its possible conversion to electrical energy.

Currently, 176 of the nation's 282 sites are more accurately classified as dumps rather than landfills, since they rely on considerably primitive management techniques. However, these sites only account for about 15 percent of waste by volume. The remaining 85 percent of waste is deposited in formally authorized landfills where biogas would be generated on a relatively large scale. The government is conducting a study in order to evaluate the feasibility of converting all dumps into landfills so that environmental and sanitary advantages of these relatively new technologies would be achieved throughout the country. Specifically, the new regulations would aim to increase the capture and burning of the biogas that would be generated by large-scale adoption of this technology.

Uncertainty remains about the final form of any new regulation since neither the stringency of the regulation nor its coverage has yet been specified. However, the new regulation is likely to mandate the implementation of relatively simple systems designed to reduce the risks of accidents and explosions. The relatively weak economic situation in many of the country's municipalities precludes the adoption of more stringent practices throughout the country.

### *Additional GHG Reductions*

Two baseline scenarios were developed to analyze the CDM opportunities for further capture and possible use of landfill biogas. One of these scenarios claims that all of the country's landfills must capture biogas at levels that are similar to those of current practices (25 percent of biogas generation). The other scenario involves regulation that would require a doubling of the current level of capture, to 50 percent of gas generation. With participation in the CDM, the case study assumed that capture would increase to 75 percent. The specific scenarios modeled are as follows:

- *Scenario 1*: The current estimated 25 percent rate of biogas capture in present landfills rises to a capture rate of 50 percent with the implementation of the new regulation in 2007. In this case, only emissions beyond the 50 percent rate can be considered additional under the CDM.

- *Scenario 2*: This scenario is similar to the previous one, but it assumes that the new regulation is enacted without imposing requirements for additional biogas capture. In this case, the capture of emissions beyond the 25 percent rate would be considered additional under the CDM.

If capture and burning of biogas were increased to a rate of 75 percent, as proposed under the CDM participation scenario, it is estimated that reductions of GHG emissions between 80 and 115 million tons of $CO_2$ (equivalent) would be achieved over a 25-year period, depending on whether or not the approved landfill regulation mandates the capture of biogas as a means to control the risk levels beyond those of currently authorized landfills.[23] The study calculates that, based on standard economic assumptions, if collected biogas is used to generate electrical energy, as much as 625,750 additional tons of biogas could be reduced within a 13-year period. Thus, the potential of this sector to reduce emissions is considerable.

International experience indicates that, from the purely technical perspective, these GHG reductions are clearly achievable. In North America and Europe more than 1100 energy plants using landfill biogas as fuel are reportedly in operation. Each year additional plants are brought on line.[24]

The case study estimates that 18 of Chile's existing landfills have the potential for power generation lasting at least 13 years, that will vary between 0.8 MW (Las Bandurrias) and 66 MW (Loma Los Colorados). Based on a series of technical and economic assumptions, the case study estimates the potential $CO_2$ reductions achievable from these landfills. Interestingly, to reflect the uncertainties involved in the widespread application of the landfill gas technologies in Chile, such as the uneven management capabilities in the landfill sector, the study assumes that only 50 percent of the calculated CERs would actually be sold. While this appears to be a somewhat arbitrary and fairly conservative assumption, it is not an unreasonable means of reflecting the underlying uncertainties. Note, also, that this approach contrasts with the assumption made by the Santiago transportation study that all the CERs that have been derived from the proposed system design changes would be available for sale. Furthermore, the landfill case study assumes an electricity price of 2.97 cents (US) per KWH (the ten year average price in Chile). Although comprehensive data on electricity prices is not presented in the case study, this may also be a conservative assumption as new power generation is, reportedly, commanding higher prices. Finally, similar to the analysis of the Santiago transport system, a fairly standard 10 percent internal rate of return was assumed in developing the estimates.

If the 50 percent of CERs that were sold received a price of \$5/ton, for how many landfills would it be profitable to increase gas capture up to the 75 percent level? In the case of baseline Scenario 1, the study calculates that 3 of the 18 landfills could profitably capture additional gas and

[23] Since waste is deposited in landfills over many years, biogas emissions tend to increase in the initial years before they (eventually) decline. The precise time path of emissions depends principally on the annual waste deposits and the rate of decomposition. Using the US EPA model-based calculations, the case study reports emissions over the entire 25-year period.

[24] The case study reports that 333 biogas energy recovery projects are currently in operation in the United States, divided between 229 projects with a total capacity of 977 MW of electricity generation and 104 projects with power in direct use totalling 45,807,500 MMBtu. Additionally 40 more projects are reported as under construction with a projected electricity generation capacity of 120 MW (28 projects) and 5,110,000 MMBtu (12 projects). One hundred and eighty-four additional projects are in the planning phase, with 89 expected to generate electricity (277 MW) and 95 expected to use the gas directly (30,112,500 MMBtu) (Atcha and Van Son, World Resources Institute, Sept. 2002). In Europe, 573 MW of installed power is operating, and it is expected to increase to 700 MW in coming years (Bates and Haworth, 2001).

generate electricity for total $CO_2$ (equivalent) reductions of 1.31 million tons per year. For baseline Scenario 2, the same technical and economic assumptions would make it profitable for seven additional landfills to capture biogas and generate electricity. When combined with some capacity expansions that would also be profitable at the same three landfills selected in Scenario 1, total $CO_2$ (equivalent) reductions of 4.16 million tons per year would be achieved under Scenario 2, more than three times as much as in Scenario 1.

Sensitivity analyses indicate that additional reductions would be achieved at higher prices for both CERs and electricity. In general, the smaller landfills required higher CER and/or electricity prices to profitably capture the additional gas and to use the gas to generate electricity. To make it profitable for Chile's smallest landfill to capture the gas under Scenario 1 requires a CER price of \$23/ton of $CO_2$. Under Scenario 2, the same landfill requires a CER price of \$12/ton to undertake the necessary investments. Sensitivity analyses for Scenario 1 suggest that relatively large electricity price hikes (ranging between 18 and 122 percent) would be needed to encourage the 75 percent rate of gas capture plus electrification. Slightly smaller price hikes (ranging between 1.7 and 102 percent) are required to achieve the 75 percent rate of gas capture for Scenario 2.

Overall, the landfill sector presents important opportunities for reducing GHGs. Based on the calculations for this case study, as many as 4 million tons of $CO_2$ (equivalent) emission reductions per year may be achieved with the help of CDM support. However, such results depend upon such factors as current regulatory activities and international CER prices. It does appear, though, as if basic economics favors capture and flaring, as opposed to electric generation. The relatively high costs of investment and operation of capture and conversion systems, combined with the relatively low cost of electricity (mostly fueled by natural gas from Argentina), will not support the implementation of large-scale electric generation at Chilean landfills.

### *Economic, Political, and Institutional Issues*

Chile's strong development record and stable market-based economy put the nation in a relatively good position to participate in the global CER market. Chile has already contracted with the PCF to sell \$7 million worth of GHG reductions from the privately owned hydroelectric power station of Chacabuquito. It is expected that this experience could be replicated in other sectors.

At the same time, the lack of precise and detailed information about the characteristics of the landfill sector creates uncertainties about the true potential for GHG reductions. The information developed in the case study is, largely, from secondary sources but, while it has been helpful in illustrating project potential, more precise information will be needed in order for specific projects to proceed. A key challenge is to expand the information base available to developers and government officials about the potential benefits and costs of further efforts to capture and use the biogas resource. This information base should be further expanded to also include mechanisms to accelerate waste decomposition and boost the flow of gas. Additional information about the economics of biogas-based electricity generation is also needed.

The case study proposes an option for strengthening the local knowledge base by establishing a national program modeled after the US EPA's Landfill Methane Outreach Program, in order to facilitate the development of projects that capture and use biogas from landfills. Such a program would generate technical information, facilitate institutional support and cooperation, and streamline access to experts and equipment suppliers. Such support could also help mitigate the all too common "not in my backyard" syndrome by expanding information about the potential benefits of biogas facilities, including reduced energy prices for affected communities. The case study also suggests that a technical support program of this type might represent an opportunity for international financial institutions, like the IDB and the World Bank, in cooperation with Chile's National Environmental Commission, to further explore the potential for modernization of selected landfills.

Finally, the case study suggests that steps be taken to enhance public information about landfills, including the local and global environmental gains from improving the operation of Chile's landfills. Improved public understanding can be a critical component of any effort to modernize this sector, either with or without CDM support.

### Carbon Capture and Sustainable Forest Development in Patagonia, Argentina[25]

Despite its vast resources, the forest sector in the Argentine Patagonia has experienced relatively slow development in recent decades. This case study examines whether the CDM could be used to enhance the region's forest resources, thereby increasing carbon sequestration while, at the same time, advancing sustainable development. Three broad aspects of this question are considered in the case study:

- The potential of the forest sector to sequester GHGs in the context of the CDM, and to contribute to the overall sustainable development goals of the region, with a focus on the south-central region of Neuquén province, along with other areas including Rio Negro and Chubut;
- The identification of the potential barriers to using the CDM, as well as possible solutions;
- The potential role for international organizations in helping to overcome the key barriers to effective implementation.

Specifically, the case study examines: (i) the profitability of potential CDM-supported forest projects, based on a sample project involving weighty pine (an exotic species); (ii) the views of local organizations concerning the potential barriers to forest development, as well as the local perspectives about overcoming these barriers; and (iii) the implications for local policies and the key priorities for adapting to the requirements of the CDM. Likewise, the study considers the regulatory framework relevant to Argentina and, particularly, to Patagonian forests; the socioeconomic and environmental impact of the forest projects in the region; and a number of methodological and technical issues that need to be resolved before the CDM can support any forestry projects.

At the time the case study was completed (Fall 2003), various policy and definitional issues were not yet resolved by the Conference of the Parties to the Kyoto Protocol. These include the definitions of "forestation" and "reforestation," the treatment of "nonpermanence" (the release of carbon from sequestration projects at the end of the stated term); the methods to be used for defining the baseline, additionality, leakage, and monitoring and verification; the period during which projects will be allowed to credit CERs; the rules for evaluating local socioeconomic and

[25] This case study was undertaken by Fundación CENIT with the participation of the Buenos Aires office of the Economic Commission for Latin America and the Caribbean and San Andrés University. The project coordinator was Daniel Chudnovsky and the principal authors were Martina Chidiak, Alejandra Moreyra, and Carlos Greco.

environmental impacts; and whether or not streamlined procedures will apply to small-scale forest projects. Fortunately, these issues were resolved at COP 9 meeting in December 2003.

This study is designed to reflect the "representative" situation of a project in a medium-high quality site in the central-south region of the province of Neuquén. The purpose of focusing on a single area is to obtain specific data not only about the costs and profitability of the plantations, but also about the institutional aspects (local and provincial), as well as the perceptions of leaders within the local community. Despite the advantages of focusing on a "representative" project in a single region, there are also disadvantages to such an approach: principally, the inherent selection bias of focusing on a single region and the corresponding difficulty of extrapolating to other regions and subregions.

The primary forest sector in Argentina accounts for between 0.1 and 0.3 percent of GDP. Agroindustrial production derived from forests account for another 2 percent of GDP. From a regional perspective, the strong development of the commercial forest sector in Mesopotamia, which covers an estimated 75 percent of the area, contrasts with the situation in Patagonia, where forests cover only about 4 percent of the surface. The provinces of Neuquén, Rio Negro, and Chubut have 2 to 3 million hectares of potentially forestable areas.

Under the terms of the CDM, forest owners can capture the financial benefits from the carbon sequestration activities provided by their plantings through the sale of CERs. Although there have been extensive discussions about the possibility of granting CERs for sustainable management or the conservation of native forests, under the terms of the Kyoto Protocol (including the agreements reached at COP 9), only actual forestation projects will be eligible during the first budget period of the Protocol (2008-2012).

It is widely understood that plantation forestry can help reduce pressure on native forests and limit desertification while simultaneously contributing to economic development. At the same time, commercial forestry can also have negative environmental impacts. Thus, CDM projects must address the local and regional socioeconomic and environmental impacts, including both benefits and costs. In order to enhance the potential synergies between the CDM and the policies of sustainable forest development on a regional scale, it is also important to consider the implications for other international environmental agreements, such as those that involve the protection of biodiversity and the fight against desertification. In the context of a national strategy for CDM, all these factors must be considered in assessing whether the CDM can truly contribute to improved conservation and management of natural resources as well as to regional economic and social development.

The basic regulatory framework for forestry management was derived from the National Parks law (1934) and the Law of Defense of Forest Wealth (1948), whose aim is to protect native forests and promote commercial plantations, respectively. The National Agency of IFONA (National Forest Institute) has been responsible for forest management, since 1973. However, this regulatory framework was substantially altered with IFONA's dissolution in 1991 and the later division of responsibilities between the Secretary of Agriculture and the Secretary of Environment, which consisted of commercial forest promotion and the protection of native forest, respectively.

In 1992, with the enactment of several new laws that encouraged expansion of forested areas, the state enhanced its promotion of forest activity.[26] Overall, the case study reports that forested areas

[26] In particular, law 25,080 of forest promotion of 1999.

have increased by an estimated 350 thousand ha. between 1992 and 1999. However, these increases were not evenly distributed throughout the country. Despite the abundant resources, planting only increased by about 6 percent in Patagonia compared to an estimated 80 percent in Mesopotamia.[27]

It is widely accepted that the Andean-Patagonian region has higher levels of ecological protection in place than other regions, largely because a relatively large proportion of its wooded ecosystems (32 percent) is under the jurisdiction of the national parks system. In addition to the activities sponsored by the National Parks Administration, the Secretariat of Environment and Sustainable Development (SayDS) has developed the Social Forests Program, the Model Forests Program, and other activities to improve forest management. Nevertheless, the reach of these programs is still relatively modest, due to the limited resources available for implementation.

Despite certain incompatibilities between the goals of forest development and the generation and sale of CERs, the region has had some experience with project-based carbon sequestration activities.[28] In 1998 and 1999 the German Institute for the Environment and Development offered to buy the rights to the generation of carbon capture credits from private foresters in Neuquén, Rio Negro, and Chubut, within the framework of AIJ (Activities Implemented Jointly) program of the UNFCCC. Transactions were completed for six forest projects, two in each province that involved a total of 3600 ha. of plantations of ponderosa pine and 640 ha. of native forest. Under this program, the developers were able to sell the credits for carbon sequestration (in advance) for $60-100 (US) per ha, without affecting the ownership of the forests or the land. Even though the price per ton of $CO_2$ for this early transaction was quite low (calculated at $0.12-0.20/ton of $CO_2$), the landowners still found it advantageous to participate in the program.

### *Analysis of the Profitability of a Forest Project in Neuquén*

The profitability of a forest project in Neuquén was analyzed in terms of standard net present value (NPV) and internal rate of return (IRR) measures. Various assumptions were adopted concerning potential projects, such as the time period involved (35 years), the exchange rate (Argentinean peso = USD $0.33), and the discount rate (alternatively 8, 10 and 12 percent). Because of the long time period that is typically associated with forestry projects, the discount rate is a particularly important factor. To calculate the extent of carbon sequestration, it was assumed that 1 $m^3$ of lumber yields 0.27 ton of carbon, and soil carbon was assumed to be constant at baseline levels. It was further assumed that forestry projects are truly incremental to other activities and that no "leakage" occurs through offsetting forest management activities on either a national or international basis. It was also assumed that sequestered carbon is not (prematurely) released by natural disasters (e.g., fire) or other reasons (e.g., timber theft or land conversions). Different types of forest projects were analyzed with or without such items as:

[27] This occurred despite the strong government support for forestry development in the Patagonian provinces. Provincial law 2,367 created the Provincial Forest Plan in Neuquén oriented to promoting the increase of the annual rate of forestation through incentives and subsidies, support to small producers, basic investigation, the realization of recovery forestations and the administration of native forests, prevention and fighting of forest fires, etc.

[28] Currently, the decree regulating the law of forest promotion establishes that the amount of the received subsidy would have, in principle, to be given back once the revenue for the sale of CERs is perceived. However, other provisions require that special procedures be established to address this potential conflict.

modern management approaches, current levels of subsidy, sales of CERs, and their status as temporary or not temporary.[29]

Not surprisingly, the results reported in the case study are quite sensitive to the assumptions in the financial analysis. Specifically, the results vary considerably depending on the treatment of land costs, the extent of local subsidies, alternative discount rates, permanent vs. temporary CERs, timing of the sale of CERs, and other factors. In general, the results suggest that the CDM can contribute to considerably raising the rate of return on forest projects. The detailed results are shown in Table 6.

A principal finding of the financial analysis is that forest projects in Patagonia are only marginally profitable if they cannot benefit from plantation subsidies or from the sale of CERs. In effect, without the sale of credits for carbon capture, the estimated NPVs are only positive for a discount rate of 8 percent (without subsidy) or for rates of 8 to 10 percent (with plantation subsidy). The return on forest projects is clearly sensitive to the discount rate. Another important variable is the cost of land: the financial advantage for the landowner of not having to acquire the land is roughly comparable to that of the forest subsidy.

In the case of forest projects with additional income from the sale of CERs, the key finding of the financial analyses is that, at $3 per CER, a project of 300 ha would be profitable assuming a 12 percent discount rate, current exchange rates, and a continuation of the existing subsidy program. Note that the forest subsidies are excluded from the options involving the sale of CERs, thereby lowering the economic returns to the developers below the (hypothetical) case, which includes the subsidies. The minimum scale for a profitable project is estimated to be within the range of 231 to 618 ha. Other findings of the financial analysis are as follows:

- Based on the time value of money, the sale of CERs at the beginning of the project is considerably more valuable than at the end of period or on a year-by-year basis.

- The sale of CERs from a project with an assumed 35-year life ("permanent" CERs) is more valuable than the sale from a project with an assumed 5-year life ("temporary" CERs).

- If only the sale of CERs generated during the first period of commitment (e.g., the year 2012) is allowed, income will not be sufficient to make a marginal forest project profitable. Only with a plantation subsidy would such a project be able to reach a positive NPV at discount rates of 8 to 10 percent.

[29] Temporary CERs typically refer to carbon capture during a 5-year period rather than the full 35-year period.

**Table 6: Net Present Vale of 300 ha Patagonian Forest Project Under Alternative Scenarios (USD per ha)**

| Type of forest project | NPV @ select discount rates | | |
|---|---|---|---|
| **Without sale of carbon capture services** | **12%** | **10%** | **8%** |
| With management, cost of the land and no subsidy | -255 | -133 | 104 |
| With management, cost of the land and subsidy | -107 | 21 | 263 |
| With management, without cost of the land or subsidy | -110 | 8 | 237 |
| **With sale of CERs @ $3/ton(*)** | | | |
| With sale of CERs at the beginning (period 2) – permanent CERs (35 years): | 720 | 879 | 1153 |
| With sale of CERs at the beginning (period 2) – temporary CERs (5 years) | 161 | 299 | 552 |
| With sale of CERs at the end of the project (term) – permanent CERs | -232 | -89 | 187 |
| With sale of CERs at the end and with subsidy – permanent CERs | -84 | 64 | 346 |
| With sale of CERs generated in the year 2012 (period10) – permanent CERs | -242 | -117 | 125 |
| With sale of CERs generated in the year 2012 and subsidy – permanent CERs | -94 | 37 | 283 |

(*) Projects with management and with computation of the cost of land. Except where noted otherwise, CERs generated during the entire life of the forest project are computed and forest plantation subsidy is excluded.

Clearly, the macroeconomic situation can have a major influence on the profitability of CDM projects. The results of this case study suggest that the financial returns to forest projects in Patagonia, both with and without the sale of CERs, tend to be greater than the estimates developed in previous analyses.[30] This is primarily due to the reduced costs of planting and maintaining forest projects, when they are measured in dollar terms compared to the fixed 1990s exchange rates assumed in earlier studies.

Overall, the financial analysis reaches the key conclusion that most forestation projects in Patagonia need additional assistance in order to be profitable. Specifically, without sale of CERs or other (comparable) support, most projects are only profitable at discount rates of 8 to 10 percent. Only those projects that can rely on income from sales of CERs at the beginning of the project are calculated to be profitable at a discount rate of 12 percent. Given the many uncertainties involved in such long-term projects in Argentina, the 12 percent rate is needed to attract investors.

### *Economic, Political and Institutional Issues*

Forest plantations with exotic species (pine) in the steppe can perform important functions such as: recovering degraded ground, controlling erosion, and maintaining or increasing soil quality. Nevertheless, in order to accomplish these objectives, the case study cautions that plantations

[30] See for example, Roger A. Sedjo, 1999. "Potential for Carbon Forest Plantations in Marginal Timber Forests: The Case of Patagonia, Argentina," Discussion Paper 99-27, Resources for the Future, Washington, DC. Available at: www.rff.org/Documents/Rff-DP-99-27.pdf .

must be designed, planned, and maintained in accordance with modern guidelines for environmental management in order to minimize loss of biodiversity, fire risks, possible competition with native species, and negative impacts on the water cycle. In general, it is important to avoid creating excessively dense plantations that can inhibit the development of other herbaceous or bushy/shrubby species, due to the inaccessibility of light and rain. Furthermore, some sites may be entirely unsuitable for plantations.

The socioeconomic impacts of the plantations are on local employment, the skill levels of the jobs created, and the implications for related sectors, such as sawmills. As far as competition with other economic activities, forestation usually extends to the steppe where there are limited opportunities for other productive activities. Some of these areas were previously used for cattle but were subsequently abandoned due to high rates of erosion. In regions with higher soil quality, cattle ranching can compete with forestry activities. The relative importance of these different situations is a matter of some debate in the region. However, the case study finds that small and medium scale cattle producers seem to be most vulnerable to competition from other economic activities.

In terms of local employment, the little information available suggests that large-scale forestations can generate seasonal employment, since most plantation activities take place during the autumn and winter. Pruning and thinning activities are also seasonal. In general, the case study argues that this work does not compete with most seasonal jobs, since it takes place at a time of reduced rural activity, and contributes to the annual revenue of the rural settler. According to the case study, the largest impact, in terms of employment, is typically found in associated services, such as: the production of breeding stock; other service activities (e.g., pruning and thinning, provision of materials, road construction, transportation, investigators); and the forest-industrial activities typically located downriver (sawmills, dryers, carpentry shops, construction activities).

A further, indirect effect of plantation forestry is increased timber output and the corresponding reduction in wood and wood product prices. According to the case study, these price reductions would tend to reduce construction costs and stimulate new residential and commercial construction.

Interviews with several social actors in the region revealed a number of observations about the future operation of the CDM:

- Several interviewees recommended that the CDM should be oriented towards the management of native forest, activities of low profitability, and highly positive social and environmental impacts.

- The Patagonian environmental ministry recommended that the CDM be used to help consolidate the various government programs that have been designed as a means to improve protected areas and restore the degraded native forest and steppe.

- Other interviewees, acknowledging the provisions already adopted for the CDM, suggested that the type of forest projects likely to benefit in the short term would be plantations with exotic species (pine). In the medium and long terms, however, the CDM would create incentives to convert low value plantations of exotics to other species, either native or exotic, that can generate greater sequestration benefits.

Interestingly, the case study did not identify significant opposition to the use of the CDM to encourage plantations of pines in Neuquén. Nevertheless, it notes that a latent potential for opposition to the plantation projects clearly exists, particularly if these projects were to arise on a large scale. In fact, a number of interviewees expressed concern that the CDM will only benefit large forest producers because of the high costs of certification and monitoring. The CDM is also associated with large plantations because it may not be compatible with the forest subsidy, according to Argentine law.[31] Foresters who decide to participate in CDM projects would have to give back the benefits received through the subsidy. The presumption exists that most small foresters will choose to continue participating in the subsidy programs because of the short-term benefits provided. In principle, a number of small forest projects could be bundled into one large project, so as to take advantage of the CDM. However, the potential for such bundling is untested. Some interviewees suggested that provincial officials, including the forest extension service, had a key role to play in diffusing information and encouraging the bundling of small-scale projects.

Through institutional analysis and information obtained through field work, the identified a series of barriers to the use of the CDM for the forest sector in Patagonia:

- *Information barriers*: Currently, beyond large foresters and their consultants, there is only a limited amount of information available in the region about the CDM.

- *Barriers of knowledge and technical capacities*: In general, none of the interviewed people has identified the lack of qualified human resources as a barrier for the use of the CDM or for forest development. However, the lack of knowledge and research about certain aspects connected to lumber yield in Patagonian forests, both native and plantation, was mentioned as a possible issue. In particular, knowledge gaps were identified on such topics as: growth by species and quality of site, development of tools of analysis and planning, management of plantations and of native forest, and the impacts on carbon capture.

- *Institutional barriers*: Two types of challenges for a greater local diffusion of the CDM and its effective implementation were identified: i) the need to improve coordination of forestry policies among national government agencies charged with these responsibilities, and ii) the need to improve coordination of policies among federal, regional, and local agencies.

The results of the Patagonia case study suggest that the CDM has the potential to increase the profitability of marginal forest projects while generating local and regional sustainable development benefits. From the strictly economic point of view, the CDM can clearly increase profitability at a wide range of sites in Neuquén. These results indicate larger gains from the CDM than those of previous studies, principally because of the drastic currency devaluation. Nevertheless, it is important to recognize that the profitability of these projects is very sensitive to the discount rate and to the timing of the revenues from the sale of CERs.

The case study found that presumption that only large-scale forest projects will be profitable is unfounded, since the minimum economic scale is estimated to be within the range of 300-700 ha, which is a relatively small area in Patagonia. This suggests that small and medium scale forest projects can have a place in a regional or national strategy with respect to the use of the CDM.

[31] The case study indicates that discussions are underway in Argentina to consider modifying this provision. However, no official action has yet been taken.

Overall, this case study identifies a number of conditions necessary for the CDM to contribute effectively to sustainable forest development in the Patagonia. The first requirement is the implementation of national and regional policies that encourage the CDM while limiting the potential negative environmental impacts of the large-scale plantations. One of the examples cited is the need for policies and guidance to support silviculture in the area. Second, the study emphasizes the development of forest projects with favorable impacts on local sustainable development goals. For example, regional authorities can contribute to the generation of small-scale forest projects and can facilitate the bundling of such projects for possible presentation to the CDM or other mechanisms. Third, the study argues for additional research and analysis on a number of issues, including the potential for carbon capture in native species as alternatives to pine, and the management of more suitable carbon capture practices. Additional analysis is needed to identify the forest projects with best performance in terms of additionality. Now that COP 9 has clarified the rules for forestry CDM, this latter task may proceed.

## Comparative Assessment of the Case Studies

The case studies present a rich body of information and analysis that can enhance the quality of discussions concerning GHG mitigation and economic development in Latin America and the Caribbean. At the same time, it is important to recognize certain limitations of these studies. The most important of these limitations is the selection bias that is inherent in the three analyses. This bias occurs in the individual cases selected for study and in the particular nations chosen to represent the region. Although the cases are oriented towards the prospect of a strong demand for CERs by Annex B nations under the terms of the Kyoto Protocol, the *de facto* softening of the targets at COP7, the withdrawal of the US from the Protocol, and the delays in formal ratification all serve to dim the prospects for a robust CDM, at least in the near term. Nonetheless, many of the issues raised in the case studies have implications for economic and environmental policies that extend well beyond the Kyoto Protocol. This section attempts to draw together a series of crosscutting observations about the lessons learned from the case studies.

While the cases are quite different in both content and results, there are also important similarities among them. Each case demonstrates the potential to achieve the twin objectives of GHG mitigation and economic development; has a focus on technically achievable, relatively low, or medium cost mitigation options; and presents ancillary environmental benefits or other types of sustainable development advantages associated with the GHG abatement. None of the cases appears to present truly intractable problems from the political economy perspective. Table 7 summarizes the results of the three case studies according to ten different evaluation criterion: the technical feasibility, the quantity of CERs involved, the estimated marginal abatement costs per ton of $CO_2$ abated, the extent of identified environmental and economic benefits, the presence of complex issues associated with baselines, the legal and institutional contexts, the monitoring and/or enforcement, or the local political economy situation.

**Table 7: Comparative Results of Three Case Studies**

| | Santiago Transport | Chilean Landfills | Patagonian Forestry |
|---|---|---|---|
| Technically Feasible | Yes | Yes | Yes |
| Quantity of CERs Involved | Low | Medium | High |
| Estimated Marginal Costs per CER | Medium-High | Low | Low |
| Identified Environmental Benefits | Substantial | Some | Some |
| Identified Economic Benefits | Substantial | Modest | Substantial |
| Complex Baseline Issues | Yes | Yes | Potentially Complex |
| Complex Legal/Institutional Issues | Yes | No | Some |
| Income Distribution Impacts | Favorable | Potentially Favorable | Potentially Favorable |
| Complex Monitoring/Enforcement Issues | Yes | Some | Yes |
| Political Economy Issues | Substantial | Modest | Modest |

In terms of technical feasibility, all of the cases involve fully demonstrated technologies. The engine technologies, control equipment, and traffic management systems that were required to implement the proposed redesign of the Santiago transport system have all been fully tested in urban areas around the world, including some applications in Latin America. The same holds true for the increased collection and use of biogas in Chilean landfills. However, the study notes the importance of developing an improved understanding at the local level of the technologies involved, including the benefits of biogas capture and use, as a means of countering the "not in my backyard" syndrome present in many communities. Although the forestry methods in Patagonia are well established, the case study asserts the need for more research and analysis on the potential for growing different species at alternative sites, the management of plantations, and other related issues.

Based on detailed modeling and other analyses, the case studies demonstrate the potential for generating a significant number of CERs in all three projects. However, because of some differences in the degree of conservatism used to develop the estimates, it is not appropriate to make strict quantitative comparisons among them. Notwithstanding this limitation, it appears that the Patagonian forestry initiative (which may eventually cover a broad geographic area) has the potential to generate the largest number of CERs. This *potential*, however, must be tempered by the observation that environmental concerns, competing land use issues, and other such matters will influence the *actual* number of CERs derived from the region. In the case of the Chilean landfill, the number of CERs is restricted by the physical limits of the waste stream and the fact that baseline emissions are already reduced as a result of policies that are either, currently, in place or under active consideration.

Similarly, though there are significant opportunities to reduce $CO_2$ emissions in the Santiago transport system, the current and planned air pollution and transport reforms have significantly reduced baseline emissions, thereby limiting the number of CERs likely to be creditable to new policies. Ironically, if there were fewer initiatives in the modernization of landfills or the reform of the transport system, the baseline emissions would be higher and the potential gains from CDM participation would be greater.

The estimated marginal abatement costs per ton of $CO_2$ vary considerably across the different cases. However, much like the issues associated with the quantity estimates described above, differences in the degree of conservatism of the estimates prevent strictly quantitative comparisons. It appears that, among the three cases, the Patagonian forestry initiative has the potential to generate the largest number of low cost reductions. The true potential of this initiative depends, to some extent, upon the permanent or temporary nature of the projects, the circumstances surrounding the sale of the CERs (up front versus annual payments), and the degree of political resistance generated by development of large-scale plantations. The initial indication from the case study is that there is considerable potential for low cost sequestration in Patagonia.

The true marginal abatement costs associated with further transportation reforms in Santiago is quite sensitive to the type of cost analyses used in the calculations, particularly whether the focus is on social or private costs. If the only category of benefits of the redesigned transport system were the fuel savings, then the marginal abatement costs would likely exceed $30 per ton of $CO_2$. However, when the reduced commuting times of bus passengers, as well as those in private cars, are valued at $1.00 per hour (the standard estimate developed by the Chilean Ministry of Planning and Development), the authors calculate net benefits, rather than costs, associated with these investments. If, the incremental reductions in $PM_{10}$ and $NO_x$ generated by the redesigned transport system were also included, the net benefits would be even greater. As previously noted, the inclusion of the monetized value of these ancillary environmental and congestion-reduction benefits raises a number of interesting policy issues for the CDM, many of which still need to be resolved by the CDM Executive Board.

The estimated marginal abatement costs for Chilean landfills likely fall somewhere between the abatement costs associated with forestation in Patagonia and further reforms of the Santiago transport system (when costs are measured on a gross basis without including the environmental and congestion benefits). Interestingly, because landfill biogas consists principally of methane, a potent GHG, the economics of capturing and possibly using the gas are potentially quite attractive. This is reflected in the fact that 30 percent of the global emission reductions contracted by the PCF for 2002-2003 involve landfill gas projects.[32] At the same time, the case study identifies a number of factors that may tend to raise marginal abatement costs: existing landfill regulations (which serve to reduce the baseline emissions), relatively low prices for natural gas (which enters Chile via pipelines from Argentina), and management concerns, particularly those of smaller sites. As noted above, the case study introduces some degree of conservatism into the estimates by dropping one-half of the biogas emissions that had been calculated by the financial model. Undoubtedly, this conservatism is exacerbated by the recent rise in natural gas prices (2004) stemming from shortages in Argentina. Based on the available data and the various assumptions involved in such calculations, the author concludes that the marginal abatement costs associated with the capture and possible use of landfill biogas in Chile may not be so attractive, despite the appeal of biogas capture as a mitigation strategy in other Latin American and Caribbean nations. Clearly, more detailed research and possible demonstration is needed to further clarify the local situation.

[32] Note that this is an increase over the 19 percent share for landfill projects since the inception of the PCF. See *State and Trends of Carbon Market*, 2003, World Bank, Washington, D.C., page 19.

While all the cases identified significant environmental benefits, the largest such benefits appear to be in the Santiago transport case. Based on detailed transportation and economic models, the authors were able to develop quantitative estimates of incremental $PM_{10}$ reductions (7 percent) and $NO_x$ reductions (16 percent) that are significant by any measure, particularly in a city like Santiago that faces such serious air pollution problems. In contrast, fewer pollution benefits seem relevant in the case of Chilean landfills, although some reductions in local air pollution and improvements in safety are noted. Not surprisingly, the author devotes less attention to quantification of these environmental benefits. In the case of Patagonian forestry, the extent of environmental benefits are highly uncertain. Depending on the management practices followed by the developers, soil erosion and loss of native species may cause environmental damages. Alternatively, concerted efforts to support smaller scale projects, as well as an emphasis on silviculture may serve to mitigate most, if not all, such damages.

All the cases demonstrate some gains in direct economic benefits for the local population. As noted, the Santiago transport plan estimated significant reductions in transit times for commuters in both buses and private automobiles. The dollar value of these reductions (at $1 per hour) is substantial. The development of new forest plantations in Patagonia has the clear potential to expand local employment and contribute to community development. The Chilean landfills have the potential to create jobs and produce low cost biogas for use by local communities. Arguably, economic benefits in all three cases may extend beyond the tangible issues identified by the authors to include other improvements in the quality of life.

Complex baseline issues are present in at least two of the cases—Santiago transport reform and the capture and use of biogas at Chilean landfills. In the Argentinean forestry case, uncertainties about the situation on the ground raise a number of potential difficulties. As previously noted, for both cases in Chile, new policies that are, currently, being implemented create certain difficulties for developers who seek to gain eligibility for CDM projects. In the case of Santiago, the potential for optimism about the results of the current policies is evident. Thus, a potential developer seeking to gain approval is all but obliged to adopt the optimistic assumptions, thereby limiting the potential gains for the CDM project. Conceivably, it might be possible to revisit some of the projections as the current policies approach their scheduled implementation dates. However, that would likely slow development of potential CDM projects. Chilean landfills are experiencing a similar circumstance to that of Santiago, however, the details of the new policies have yet to be decided upon. Thus, a project developer faces considerable uncertainty about the appropriate baseline to choose. Even after the policy decisions are made, uncertainties will remain, as the extent of actual compliance with the new rules will remain unknown for some time.

In the case of Patagonian forestry, the question of the permanence or impermanence of GHG reductions is a potentially difficult issue. Because forests are subject to a range of natural hazards, such as fire, pests, and various man-made damages (i.e.: timber theft, inadequate forest management practices, and changing land use patterns), it is difficult to determine the actual amount of long-term sequestration in advance. At a minimum, a strong management plan, combined with stringent monitoring and verification procedures, is required. During COP 9, an agreement was reached as to the appropriate principles for the establishment of these management plans, including the issuance of temporary credits.

Complex legal and institutional issues are most pronounced in the Santiago transport case where the ownership of some of the emission reduction credits, particularly those generated by owners of private automobiles, remains open to debate. According to the case study, 57 percent of the estimated $CO_2$ reductions arise from the expected modal shift away from private automobiles, due to the adoption of a more attractive and efficient bus system. A large portion of the incremental reductions in $PM_{10}$ and $NO_x$ derive from reduced use of private automobiles. But who should reap the financial gain from the sale of CERs or conventional pollution credits (the latter most likely via emissions trading between mobile and stationary sources)? Do they belong to the owners of the private automobiles, to the government, or to some other entity? In theory, a case could be made that they belong to the owners of the private automobiles. However, since the transaction costs associated with a system are likely to be quite high, a more practical solution inevitably entails some form of government involvement. The specifics of any plan to credit these emission reductions would need to be developed.

All the projects analyzed in the three case studies are likely to increase the economic well-being and overall income levels of the participating nations. At the same time, they are also likely to affect the distribution of income within these nations. Although for most individual projects any changes in the income distribution are likely to be both small and difficult to quantify, they may be significant in some cases. Among the three cases, the results of the Santiago transport case are clearest in this regard. Specifically, the proposed redesign of the system will have the effect of reducing commuting times for those who travel via bus and private automobile, and will likely reduce some of the (estimated) high returns accruing to the owners and operators of the buses. Overall, the authors argue that this will assist low-income households and, quite possibly, disadvantage the bus owners and operators, thereby leading to a progressive impact on income distribution in the nation. Similar circumstances, although less clear cut, apply in the other two cases. Regarding Chilean landfills, the case study argues that the safety improvements associated with expanded gas collection systems will have a favorable impact on the landfill employees and the disproportionately low-income populations that live closest to the facilities. Likewise, the availability of low-cost biogas for local use will also help low-income families. In the case of Patagonian forestry, some information is presented on the favorable impact on employment, particularly for off-season, relatively unskilled jobs. Thus, a case can be made that forestry projects will also have a disproportionately favorable impact on lower income households.

All the cases present certain challenges for monitoring and enforcement. Since monitoring emissions is potentially easier than monitoring human behavior, the greatest difficulties are likely to occur in the transport and the forestry cases rather than in the landfill case. As noted by the Santiago case study authors, local transportation and police officials will need to improve their coordination and monitor the actual routes followed by the different bus operators. Also, they will need to track the use of private automobiles for purposes of commuting. In the case of Patagonian forestry, considerable effort will be required to assure the forested areas are properly managed and that no illegal harvesting occurs. Enforcement, which necessarily relies on monitoring data, involves more complex political and institutional issues. Monitoring procedures are somewhat better established for landfills.

In terms of political economy issues, the potential for conflicts is evident in all three projects. However, all of these issues appear to be relatively modest. The Santiago transport project's most controversial political economy issue involves the bus owners and operators, as well as the unions. These groups would, most likely, resist the adoption of the redesigned system. The "not in my backyard" issue is likely to be the greatest problem for landfill operators, although it seems as if more focus on information dissemination for local residents, as recommended by the case study, would be helpful. The scale of the plantations and the type of species to be grown are two potentially sensitive political issues in the Patagonian forestry case. Although the interviews conducted by the case study authors did not indicate an immediate problem, there are underlying concerns about future opposition to forest plantations, particularly as the scale of operation increases.

# 3. Conclusions

Arguably, the dual benefits of economic development and GHG mitigation are attractive goals for all countries. A key challenge for the nations of Latin America and the Caribbean is how to encourage the expansion of policies that accelerate progress toward both of these goals. A number of steps have already been initiated in the region, such as: reductions of subsidies, power sector and other regulatory reforms, regional market integration, and the general strengthening of capital markets. Similarly, there is solid progress in harnessing relatively clean forms of energy, such as: hydropower, natural gas, and landfill gas. As efforts proceed in these areas, continued attention must be placed on social goals, which would include a focus upon increasing the accessibility of reliable and affordable energy services.

With respect to $CO_2$ emissions, the challenge is to reduce the rate of growth of per capita $CO_2$ emissions in the face of increased industrial activity and continued growth in population and income. Transport is likely to continue to play an increasing role in contributing to overall $CO_2$ emissions in the region. There are many challenges facing the forestry efforts. Now that negotiators at COP 9 have reached agreement on the broad issues, credible projects can be presented to the CDM Executive Board for approval. It is particularly important for marginal timber-growing areas, like Patagonia, to assure a continued balance between traditional economic development and environmental objectives, which also include GHG mitigation. Given the long-term nature of the projects, community support is a key ingredient of any new initiative.

In considering the lessons arising from the early experiences with project-based GHG reduction projects around the world, as well as the in-depth case studies presented in this monograph, several observations are warranted.

- While critics may point to the fragility of the Kyoto Protocol and the increasingly dim prospects that the CDM will expand quickly, the longer-term prospects appear much brighter. The existence of low-cost options for GHG mitigation in Latin America and the Caribbean and other parts of the developing world is undeniable. The fact that about 30 percent of the emission reductions contracted by the PCF in 2003 are from Latin American and Caribbean nations is a clear indicator of the opportunities for synergies between GHG abatement and sustainable development in the region.

- Efforts to promote sustainable development may also generate GHG reductions as collateral benefits, in that the policy motivation need not derive from GHG abatement activities, alone. Rather, GHG abatement may be an ancillary benefit of other sustainable development initiatives. The reductions in air pollution and congestion resulting from the pending transport reforms in Santiago are a clear indicator of such ancillary benefits. The improvements in worker safety at landfills and the reduced explosion risks for neighboring (low income) residents in Chile are further examples of such ancillary gains, while additional reforms hold the promise of further gains. Overall, the existence of these ancillary benefits highlights the extent of the potential gains in economic welfare available from efforts to reduce GHGs.

- Just as patterns of economic development and GHG emissions vary considerably by country, opportunities for use of the CDM are also likely to vary by country. Conventional wisdom suggests that because methane is such a potent GHG, landfill projects may be especially attractive. As previously noted, 30 percent of the emissions reductions contracted by the PCF for 2002-2003 involve landfill gas projects. Yet, while the results of the single landfill case examined in this monograph should still be considered preliminary, the analysis presented by the case study author suggests that because of local economic and regulatory conditions, landfill projects might not be quite as attractive in Chile as they are in other countries. At the same time, the pollution and congestion situations in Santiago make it a strong candidate for a transportation-based CDM initiative. Other urban areas in Latin America might also be attractive sites for such initiatives.

- The difficulty of monitoring compliance with CDM agreements poses a number of critical challenges. As earlier noted, it is often easier to track physical emissions (as in the case of landfill emissions) than to monitor human behavior, especially that of numerous individuals (Santiago drivers), or continued forestry growth covering large land areas (Patagonian forests). Since CERs must be verified in order to be validated, it is essential to incorporate a workable monitoring strategy into the project design.

- The case studies point to the need for capacity building at the local levels on a number of key topics. The PCF experience highlights the need for skills strengthening in project preparation, marketing and negotiating emission reduction agreements. In the landfill case, the author notes that the local operators' lack of familiarity with advanced technologies, combined with local concerns about the building power generating facilities at the landfills, are impeding progress. In the Patagonian case, the authors note the need for more environmental education at the local level, particularly concerning issues of species and site choices, soil management, and other related issues. In both cases, capacity building could serve to increase the net benefits flowing to the local communities and, simultaneously, allay fears among some groups that may forestall progress on these CDM eligible projects. International support can be an important source of funding for capacity building activities. For industrial and forestry projects alike, such support can advance both economic development and GHG mitigation. Policy loans, investment loans for infrastructure improvement, and technical cooperation measures can be used to advance sustainable development goals in various sectors.

An overarching theme of the case studies is that the nature of the baseline is a critical factor in assessing the potential gains from the CDM. While baseline issues are always important to these types of programs, the rapid pace of policy reforms in some areas (e.g., Santiago transport and Chilean landfill policies) can be an important and, often complex, issue. Not surprisingly, such reforms can often be counterproductive from the perspective of the CDM if, for example, fewer reforms are already in place, then baseline emissions would be higher and, as a result, the potential gains from CDM participation would be greater. Inevitably, this will be a key issue for the CDM Executive Board to grapple with. It may even be appropriate for international institutions like the IDB to engage the Board in discussions on the subject, as a means of reinforcing both development and GHG reduction objectives.

Overall, there appear to be significant many opportunities to advance the twin objectives of economic development and GHG mitigation in Latin America and the Caribbean. The three case studies presented in this report highlight a number of these opportunities, as well as the challenges involved in making such projects a reality. It is hoped that this monograph will stimulate further policy dialogue in the region and encourage creative responses at local, national, and international levels.

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