

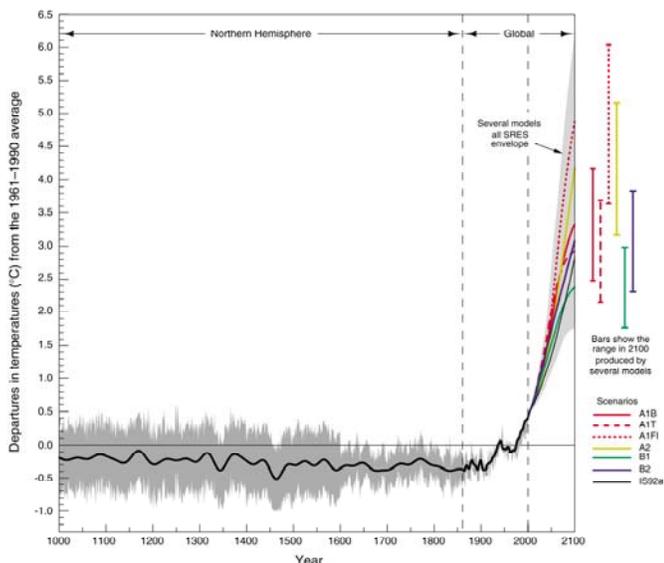


Latin America and Caribbean Region  
Sustainable Development Working Paper 19

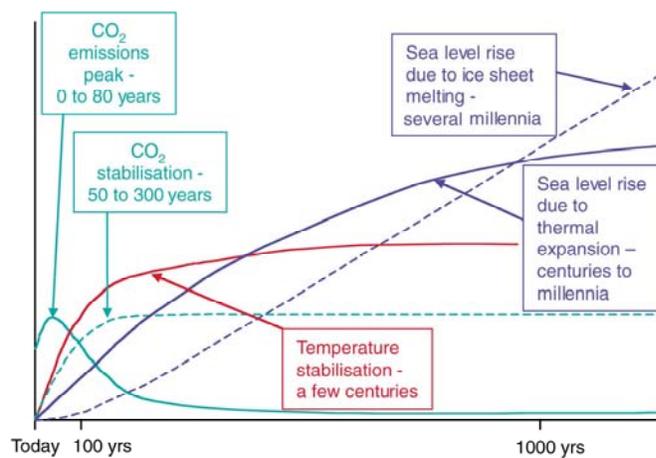
# Responding to Climate Change: Proposed Action Plan for the World Bank in Latin America

June 2004

**Variations in the Earth's Surface  
Temperature: 1000 to 2100**



**CO<sub>2</sub> Stabilization and  
Sea Level Rise**



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**Sustainable Development Working Paper No. 19**

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This working paper series is produced by the Environmentally and Socially Sustainable Development Sector Management Unit of the Latin America and Caribbean Regional Office.

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# Executive Summary

Climate change is a very serious environmental challenge that affects prospects for sustainable development. Since the industrial revolution, the mean surface temperature of Earth has increased an average of one degree Celsius per century mainly due to the accumulation of greenhouse gases in the atmosphere. Furthermore, most of this change was in the past 30 to 40 years, and the rate of increase is accelerating. A change of this magnitude is unprecedented and will result in significant impacts both at a global scale, and for Latin America and the Caribbean in particular.

While it is important to reduce greenhouse gas emissions and slow or reverse the warming trend in the long run, it is too late to prevent many of its impacts, so governments, policymakers, and civil society are increasingly concerned with anticipating the effects of global warming and searching for strategies to adapt to and mitigate them.

Latin America has much to lose as a result of global warming. Key anticipated impacts include (a) decreased water availability, (b) lower agricultural productivity, (c) changes in the composition and productivity of ecological systems, particularly coral reefs and forests, (d) damage and population displacement due to rising sea levels and flooding from heavy rainfall events, and (e) higher incidence of heat stress mortality and exposure to vector- and water-borne diseases such as malaria, dengue, and cholera.

This paper proposes an action plan for World Bank activities in Latin America that focuses on the following three main initiatives.

- a) Strengthen institutional capacity to allow regional governments and civil society to play an active and influential role in the international climate agenda by:
  - cooperating in formulation of policies, standards, and guidelines and enhancing capacity to plan, manage, and monitor those policies;
  - developing common regional positions and participating vigorously in international forums and negotiations;
  - supporting effective mechanisms for sharing best practices in climate change assessment, adaptation, and technologies;
  - promoting equity and fair valuation of carbon emission reductions and developing a portfolio of activities eligible for funding by the Clean Development Mechanism (CDM).
- b) Improve knowledge and analysis to support planning for adaptation measures and funding by:
  - strengthening knowledge and documentation on vulnerable ecosystems and human health;
  - assessing the impacts of climate change and its implications for sustainable development;
  - analyzing policy options and identifying and supporting priority adaptation measures.
- c) Increase carbon financing for mitigation actions and maximize the value of funding by seeking synergies and aligning strategies closely with local environmental and social priorities.



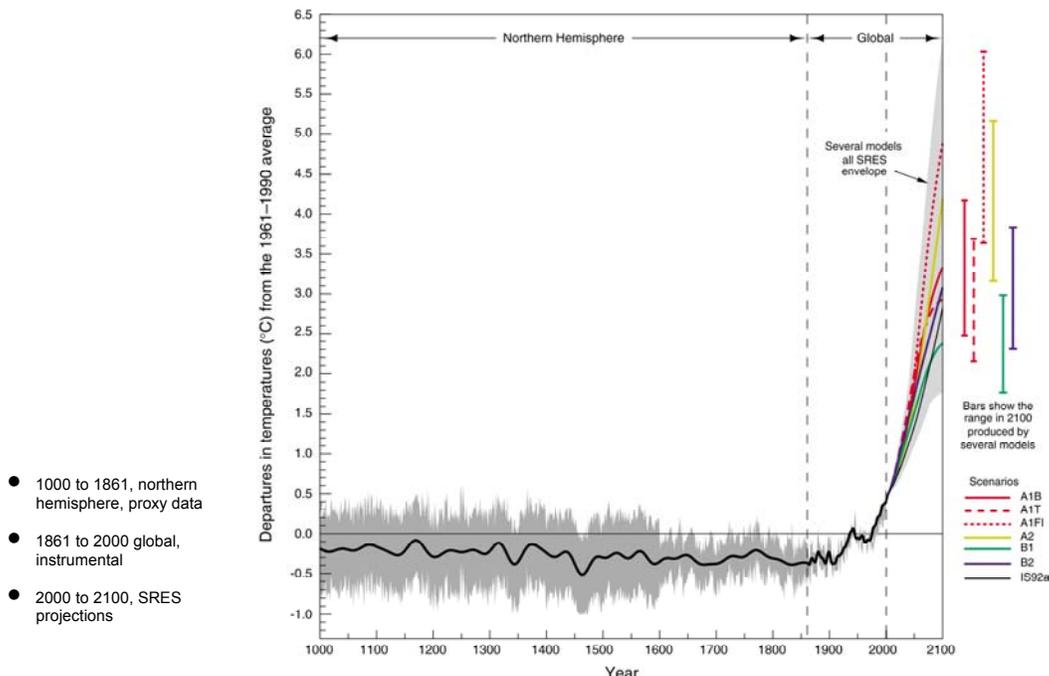
# Introduction

## Climate Change

Climate is changing rapidly at a global scale. The main cause is the atmospheric accumulation of greenhouse gas emissions from anthropogenic (man-made) activities. For example, the concentration of carbon dioxide (CO<sub>2</sub>) has risen from 280 ppm to about 370 ppm since the beginning of the industrial revolution due to the burning of fossil fuels, other industrial activities, and deforestation. During the same period, the Earth's mean surface temperature increased an average of one degree Celsius per century, with most of the change concentrated in the last decades of the 20th century. It has been rising at the rate of 2 degrees Celsius per century since 1980. Other gases that contribute to the problem include nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and others released as a result of human activity.

Seen over the last millennium, this rapid warming represents a strong deviation from the norm (Figure 1). With the continuing emission of greenhouse gases, it is now projected by the Intergovernmental Panel on Climate Change (IPCC) that the mean surface temperature may increase 1.5 to 6 degrees Celsius during the next 100 years. A change of this magnitude is unprecedented and will result in significant impacts that will be felt at a global scale, potentially disrupting the overall ecosystem (biosphere). Climate change is a very serious environmental challenge.

**Figure 1. Variations in the Earth's Surface Temperature, 1000 to 2100**



Source: IPCC Third Assessment Report, 2001

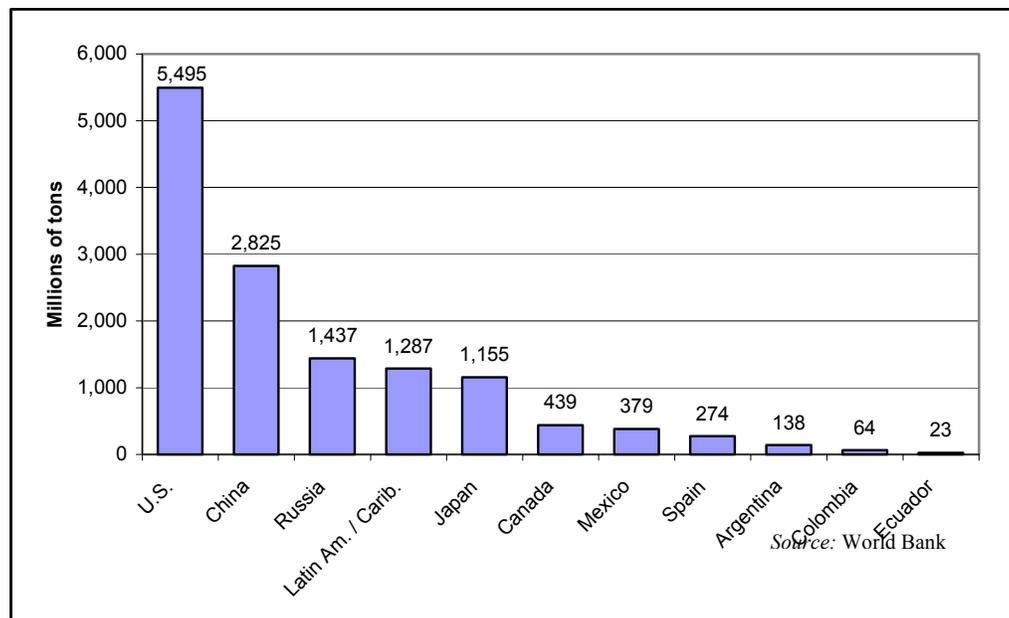
Insular marine habitats are among the most vulnerable. Climate change will affect the physical and biological characteristics of oceans and coastal areas, modifying ecosystem structure and function. Nations that depend on reef and coastal systems are threatened by loss of marine biodiversity, fisheries, and shorelines. Wetlands, reefs, atolls, keys, and mangroves are among the ecosystems considered most vulnerable to climate change because of limited adaptive capacity.

High mountain ecosystems are another of the most vulnerable areas, with a projected increase in temperature of 1°C to 3°C and lower rainfall. These changes would raise the altitudinal limits of the ecosystems between 400 and 500 meters. Glaciers and paramos would continue to shrink.<sup>1</sup> This would mean not only a loss of biodiversity but the loss of much of the environmental goods and services provided by these ecosystems, especially water supply, basin regulation, and associated hydropower potential.

*Regional Contribution to the Emission of Greenhouse Gases*

The Latin America and Caribbean region has about 15 percent of the world’s population, but accounts for less than 6 percent of global greenhouse gas (GHG) emissions. In addition, the rate of growth of GHG emissions in Latin America is dramatically lower than in all other regions of the developing world except sub-Saharan Africa. This means that the region’s share of the blame for global warming is limited, and that emissions reductions in the region are likely to have only a limited impact on the outcome of worldwide emissions reduction efforts.

**Figure 2. Comparison of CO<sub>2</sub> Emissions in Selected Countries, 1999**



1. For example, the Colombia First National Communication (NC1) estimates that 78 percent of glacial ice and 56 percent of paramos might disappear by 2050.

### *The Impacts of Climate Change in the Region*

On the other hand, the region is very vulnerable to the impacts of climate change and these could seriously impair the prospects for sustainable development in the continent. Latin America has a large endowment of natural resources, represented by large tracts of primary forests, major reservoirs of biodiversity, substantial freshwater resources, large areas of wetlands and aquatic zones, and a varied climatic and ecosystem composition, all of which may to various degrees be affected by climate change. **In other words, the region has a lot to lose.** Climate change impacts have been identified by the IPCC and anticipated impacts have been characterized. In the context of the characteristics of the region, these include:

**Decreased water availability in many water scarce regions**, especially in arid and semi-arid lands in the subtropics. Net reduction in rainfall and impacts on water availability are likely to have widespread impacts on agriculture and water supply, which may tax an already burdened water system in many nations in the region. Latin America has the second largest reservoir of fresh water; but to a large extent, the watersheds in the region are dependent on the ecology of the Andes. Thus, an increase in the desertification of high mountain ecosystems raises serious concerns. Island nations in the Caribbean may also experience a reduction in rainfall in an environment that is already short of fresh water, compounding an already difficult situation.

**Reduction in agricultural productivity** is anticipated (a) in the tropics and subtropics for almost any warming, and (b) in middle latitudes for warming more than a few degrees. These will result from increased surface temperature and increases in the rates of evapotranspiration. Added to the expected net water reductions in some areas, the impacts could be severe and imply an increased dependence on food imports and disruption of economic activity in many agricultural regions.

**Changes in the productivity and composition of ecological systems**, with coral reefs and forests being most vulnerable. **For coral reefs in the Caribbean the situation is dramatic.** Corals are the nursery of the seas, providing the habitat for many marine species. In additions, these are very productive ecosystems. However, corals are very sensitive to changes in temperature and their upper thermal tolerance is very near the current sea surface temperature. It is expected that coral reefs will be affected if seasonal maximum temperature sea surface temperatures increase even slightly. In addition, increases in CO<sub>2</sub> will affect the ability of reef plants and animals to calcify and thus reduce the ability of reefs to grow vertically and keep pace with anticipated rising sea levels.

There is already widespread evidence of a catastrophic collapse. Studies sponsored under a GEF-funded project, Caribbean Planning for Adaptation to Climate Change (CPACC),<sup>2</sup> has provided information on the bleaching of corals caused by exposure to high temperature and explored the ecological and economic consequences for the economies of the nations in the region.

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2. Implementation Completion Report for the Planning for Adaptation to Global Climate Change Project. Report No. 24911. World Bank. 2001

Specifically, in terms of coastal ecosystems of the Pacific and Atlantic,<sup>3</sup> many wetlands will be affected by changes in storm surges. These may result in large-scale translocation of populations in low lying areas. Mangroves and coastal lagoons are expected to undergo rapid change and perhaps be lost altogether as functioning ecosystems. Low-lying coastal areas and associated swamps could also be displaced by saltwater habitats, disrupting freshwater ecosystems. Such changes are likely to result in displacement of migratory birds and aquatic species that are not tolerant to increased salinity or flooding.

**Aquatic and wetland ecosystems are very vulnerable to climate change.** Increases in water temperature are expected to disrupt patterns of plant and animal distribution. Inundation of coastal wetlands by rising sea levels threatens the viability of coastal wetlands and may alter many ecosystem processes, with potential impacts on fisheries.

The combined pressures of sea level rise and coastal development could also reduce the availability of intertidal areas, resulting in loss of feeding habitats and catastrophic declines in wintering shorebirds. Migratory and resident birds and fish may lose important staging, feeding, and breeding grounds that are difficult to replace under competing demands for scarce land. All these may affect commercially important fish species and cause a shift of marine production toward the poles, seriously affecting the sustainability of fisheries in the Caribbean.

**Impacts on range and composition of forests.** Similarly, while less immediate, impacts are anticipated for forest composition, with the rate of increase in surface temperature far outpacing the ability of forest species to migrate to more temperate latitudes. This can affect the large tracts of primary forests in the Amazon basin as well as mountain forests in the Andes in ways as yet unforeseen. While, a lot of attention has been focused on corals and specific forest ecosystems, practically all ecosystems will suffer the impacts of climate change, with consequences that are yet to be fully evaluated.

**High mountain ecosystems seem to be particularly vulnerable.** High-mountain ecosystems are considered strategic because they are key to the water cycle (regulating water outflow and supplying high quality water for social and economic uses). Thus, one of the most important environmental services of the high Andean systems is to supply potable water, and water for power generation. High mountain ecosystems offer other natural goods and services such as storage and distribution of nutrients, CO<sub>2</sub> capture, protection against soil erosion and filtering and purification of pollutants. As temperatures increase, the biota in high mountains will have no place to go. In addition, the mountains contain the headwaters of most rivers in the region and a significant fraction of lakes that are the primary source of potable water and hydropower. Global warming will affect evaporation rates and very possibly reduce the net supply of water. Finally, moorlands (paramo), a unique high mountain ecosystem, characterized by a high degree of endemism and a known water supply regulator in the region, may be at the greatest danger. Studies in Colombia show that at the current rates of temperature rise, these ecosystems may totally collapse in the course of the century. No one really knows the extent of all the downstream impacts.

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3. Interlinkages between biological diversity and climate change. Secretariat of the Convention on Biological Diversity. CBD Technical Series, 2003.

**Increased risk of floods, potentially displacing millions of people**, due to sea level rise and heavy rainfall events, especially in small island states and low-lying deltaic areas are expected. These areas are particularly vulnerable to the effects of global climate change because of their limited natural resources, fragile and closely linked ecosystems, limited economic bases, and relatively high population densities. Possible impacts of climate change and associated phenomena on insular and oceanic environments include mean sea level rise, increased mean air and sea-surface temperatures, changes in rainfall patterns, and altered frequency of severe weather events like tropical cyclones and related occurrences. Effects related to climate change will impact environmental aspects like ecosystems productivity, natural resources (fresh water, soil, flora and fauna, etc.), and biodiversity; infrastructure from public services and transportation systems; economic activities such as fishing, agriculture, and tourism; and social features like food production, human health, and cultural survival of native communities. For the countries in the Caribbean, this is a significant challenge. Not only is sea level rise, expected to result in land loss, but also in impacts on water supply, placing an additional burden on already stretched resources. Coastal areas in Latin America are inhabited by millions of people and are the focus of a lot of economic activity.

**Health Impacts.** Global climate change will likely lead to higher heat stress mortality as well as greater exposure to vector-borne diseases such as malaria and dengue and water-borne diseases such as cholera, especially in the tropics and subtropics (Figure 3).

*Malaria and dengue* are becoming progressively more common around the world and particularly in the tropics of Latin America. These diseases are associated with rises in temperature and changes in rainfall, which affect their development and facilitate their dissemination. They are an important cause of high mortality and responsible for loss of technical and financial resources that must be invested in diagnosing and treating victims, including economic losses for reduced labor. In recent years these diseases have become a highly significant issue of public health with the number of victims rising far faster than the increase in the population as a whole. Expansion of these vectors represents an additional load to health systems that are already overstretched.

**Figure 3. Vector (Insect)–Borne Diseases**

Disease	Vector	Population at risk (millions)	Present distribution	Likelihood of altered distribution with warming
Malaria	mosquito	2,100	(sub)tropics	✓✓
Schistosomiasis	water snail	600	(sub)tropics	✓✓
Filariasis	mosquito	900	(sub)tropics	✓
Onchocerciasis (river blindness)	black fly	90	Africa/Latin America	✓
African trypanosomiasis (sleeping sickness)	tsetse fly	50	tropical Africa	✓
Dengue	mosquito	unavailable	tropics	✓✓
Yellow fever	mosquito	unavailable	tropical South America & Africa	✓

Likely            ✓  
 Very likely    ✓✓

Source: Modified WHO, as cited in Stone (1995).

### Climate Change Impacts Are Now Unavoidable

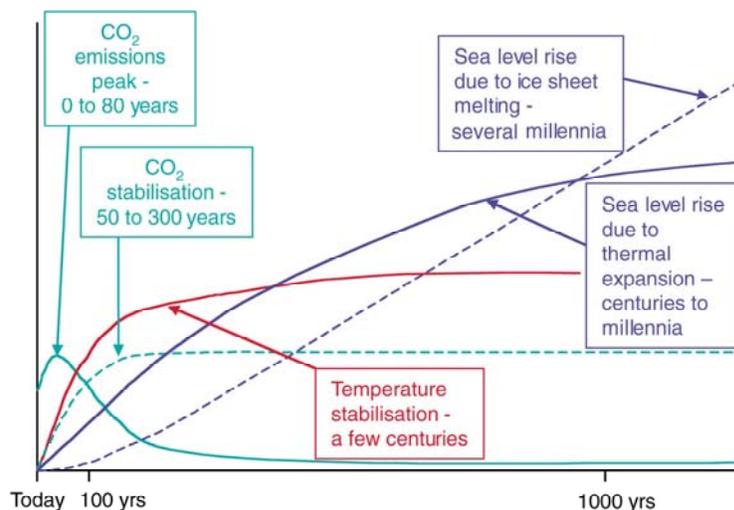
Even if drastic actions are taken that would dramatically reduce emissions of GHGs, there is very little that can now be done to address some of the anticipated trends. For example, consider the impact on sea levels (Figure 4). The increases in global temperatures are expected to result in sea level rises, resulting from melting of ice in the poles and the thermal expansion of the seas. These will continue even if GHG concentrations in the atmosphere were to stabilize immediately. The consequences are long-lasting and illustrate the strategic importance of complementing forceful action in reducing emissions with adaptation measures.

**In this context, adaptation efforts represent the first priority for climate change work in the region.** Planning for adaptation and capacity building to understand and address adaptation issues are therefore the first order activities in the field of climate change. Regrettably, the political will for a strong support of adaptation efforts is still weak, and there is considerable confusion (see below). Yet even under uncertain circumstances, the region should emphasize work in adaptation, focusing on the areas that are the most vulnerable.

Climate change cannot be seen as an isolated phenomenon but rather as part of a series of impacts caused by unsustainable practices, with linkages to several other environmental challenges. Changes in land use, for example the elimination of forest cover to make room for extensive cattle raising, a process that has led to the destruction of large tracts of rainforest in the Amazon region, not only leads to biodiversity loss, but also eliminates carbon sinks and thus contributes to a net increase of GHGs in the atmosphere.

Likewise, in urban areas air quality has deteriorated from the uncontrolled emission of airborne pollutants. Some of these, notably volatile hydrocarbons and nitrogen oxides (NO<sub>x</sub>), contribute to the formation of tropospheric ozone, which by itself may contribute to global warming. These and other linkages illustrate the complex interactions between different environmental impacts and highlight the need to develop strategic and comprehensive strategies to deal with impacts from climate change.

**Figure 4. CO<sub>2</sub> Stabilization and Sea Level Rise**



## Response of the International Community

### *United Nations Framework Convention on Climate Change*

The international community has taken steps to address the challenge. At the Rio Conference in 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was signed by most nations. Under the Convention, nations commit to reduce the anthropogenic impacts on global climate to prevent “dangerous human interference with the climate system.”

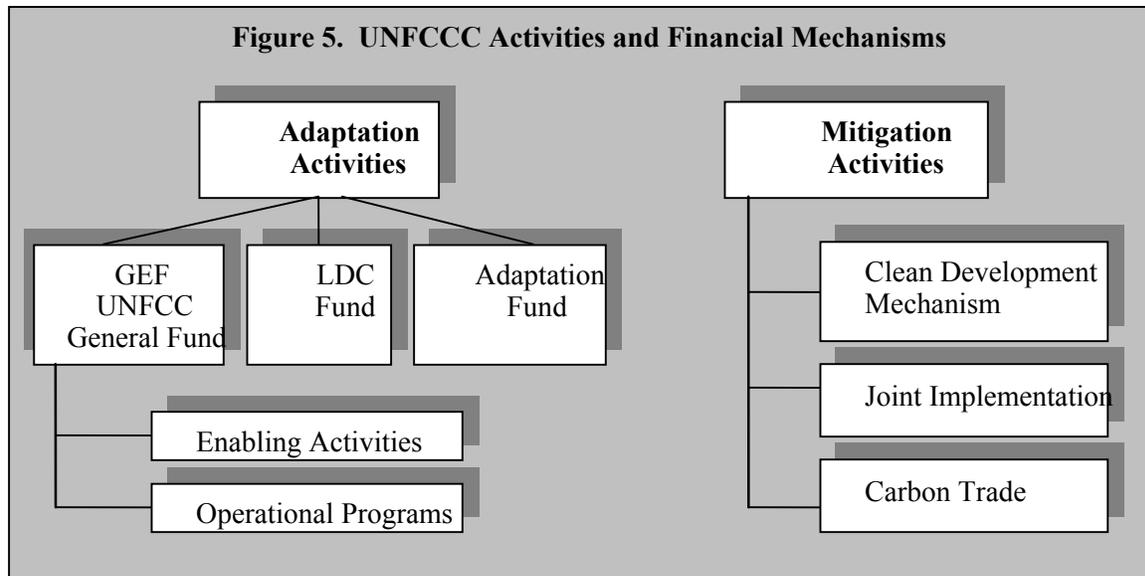
The Framework Convention has set guiding principles, including: “The principle of *common but differentiated responsibilities* of states which assigns the financial lead in combating climate change to industrialized countries. Other principles deal with the *special needs of developing countries*, and the importance of *sustainable development*.”<sup>4</sup> Together, these principles translate into specific commitments for industrialized countries. The commitments involve *mitigation activities* to reduce overall greenhouse gas emissions. They also involve a pledge to developing countries to meet specific obligations under the Convention to meet the costs (in part or in full) of *adaptation activities* to the adverse effects of climate change, and to promote the transfer and access of environmentally sound technologies (the Clean Technology Initiative, CTI). The corresponding eligibility criteria for funding, cost sharing, and resource mobilization mechanisms is an ongoing and evolving process. The Conference of the Parties (COP) of the Climate Change Convention manages that process. While financial mechanisms are already operational for some well-defined activities, others are still in the process of being negotiated and finalized. New financial tools are likely to emerge in the future as the Climate Change Convention continues to evolve. The COP has entrusted GEF with the financial responsibility to provide resources to developing nations to assist them in achieving their duties and responsibilities under the convention (Figure 5).

Under the GEF, a series of operational programs have been structured that provide financing for eligible countries to address the root causes of global warming and remove barriers for the development of response actions in areas that include energy efficiency, renewable energy resources, transport, and others.

In 1997 the Conference of the Parties adopted the Kyoto Protocol to the Climate Change Convention. The protocol sets specific targets for reduction of domestic emissions of GHGs by industrialized nations. Under the protocol some 40 industrialized nations would be obligated to cut their emissions by an average of 5.5 percent below 1990 levels. Developing countries would not be obligated to cut their emissions until the next round of the treaty takes effect. To help meet these targets the protocol establishes three flexibility mechanisms designed to provide developed countries with market-driven and efficiency-enhancing (cost-minimizing) instruments: joint implementation, emissions or carbon trading, and the

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4. Information Sheet #19, [Climate Change Information Kit](#), July 2001, [www.unfccc.org](http://www.unfccc.org)



Clean Development Mechanism (CDM).<sup>5</sup> The CDM allows industrialized countries to implement projects that reduce GHG in non-industrialized countries. Emission reductions generated by the project activities have to be “certified” to comply with emissions commitments. The United States, the largest GHG emitter, does not participate in the Kyoto protocol and this, besides limiting the size of the market, raises a question of equity in international efforts to address the problem.

#### *The CDM Potentially Offers Sizable Net Financial Flows to the Region*

The market created by the CDM (even in the absence of the United States,) is considerable. Taken together the EU, Japan, Canada, and other industrialized nations, under the provisions of the protocol, create a significant market for carbon reduction transactions that can be worth several billion euros per year. Thus, a sizable source of net financial flows, one that does not involve financial liabilities and that can also be linked to transfers of technology is available to developing nations. The Latin America region can benefit from CDM resources by creating a reliable source of emission reductions. The current commitment period for the CDM (2005-2012) is necessarily just a first step, which in all likelihood needs to be complemented with additional actions.

Further ahead, if governments decide to stabilize the atmospheric concentration of carbon dioxide at 550 ppm (about twice the pre-industrial level), global emissions would have to peak by about 2025 and fall below current levels by 2040 to 2070. This would mean that all regions would have to deviate from current trends within a few decades, with significant financial commitments required to achieve the intended targets for emission reductions. “A key challenge would be an equitable distribution of emissions rights, recognizing that most anthropogenic emissions of greenhouse gases to date have

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5. Joint implementation allows Annex I countries to implement projects that reduce GHG by sources (or enhance removals by sinks) in the territories of other Annex I countries. Emission trading or carbon trading allows Annex I countries to trade part of their respective “assigned amount” (i.e., target level of emissions during the commitment period) with each other.

come from industrialized countries, and that even though total emissions from developing countries will soon exceed those from industrialized countries, projected per-capita emissions would still be lower in developing countries.”<sup>6</sup>

**The Adaptation Fund.** The Kyoto protocol plans to establish a fund to finance adaptation activities. Resources for the Adaptation Fund are expected to come from a levy on global carbon trade (2 percent has been suggested) and additional pledges by industrial countries. This Adaptation Fund will become operational during the implementation period of the Kyoto Protocol.

The adaptation fund being proposed under the CDM is also expected to be a source of resources. However, the outset of the adaptation fund has yet to be decided. A first option is that it would be operative with the first commitment period (2008). Alternatively it may operate as soon as the Kyoto Protocol enters into force. This would occur when at least 55 nations representing 55 percent of industrialized countries’ greenhouse gas emissions ratify the treaty.

Independent of the availability of CDM funds for adaptation, it is becoming clear that, given the priority character of the issues, funding through the convention’s financial instrument (GEF) dedicated to adaptation is likely to increase. The region has important pioneering activities in adaptation (such as the CPACC and MACC projects in the Caribbean) and has a strong case for increased funding given the expected permanent impacts from climate change over which it has little control or influence.

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6. IPCC, Third Assessment Report. 2001.

## Proposed Action Plan

The action plan proposed for World Bank activities in Latin America focuses on three main initiatives: (a) strengthening institutional capacity to allow regional governments and civil society to play an active and influential role in the international climate agenda; (b) improving knowledge and analysis that supports planning and implementation of adaptation measures and access to funding; and (c) increasing carbon financing for mitigation actions and maximizing the value of funding by seeking synergies and aligning strategies closely with local environmental and social priorities.

The first two initiatives are described below, while the third is discussed in a separate section on page 12 that gives a sector-by-sector analysis of potential mitigation actions, funding opportunities, and synergies.

### *Institutional Capacity Priorities*

Climate change is a complex issue. Many aspects of the convention, the protocol, and the CDM are engaging, at times controversial, and frequently highly technical. A number of issues or barriers could severely constrain the CDM. Key issues could be negotiated and regulated in ways that may favor market efficiency and maximize investments in the developing world, or they could do the opposite. Institutional development is therefore, very important for countries in the region to:

- Cooperate in the formulation of climate change policies, standards, and guidelines that are applicable to the region, and enhance national capacity to effectively plan, manage, and monitor climate change policies;
- Develop common regional positions for international negotiations on issues related to the intersection of climate change, emissions and sequestration, energy, land use, and sustainable development;
- Participate vigorously in climate change-related international forums and negotiations to advance the agenda related to the net impacts in the region;
- Develop and support effective mechanisms for the systematic transfer of global best practices and capacity in vulnerability assessment, adaptation and mitigation strategies, and techniques and technologies towards clean, sustainable development strategies;
- Strengthen the capacity to understand and plan for adaptation to climate change impacts;
- Promote the goals of equity and fair valuation of carbon emission reductions;
- Identify and promote a portfolio of CDM-eligible activities.

### *Knowledge and Analysis to Support Adaptation Planning and Financing*

Besides the priorities already outlined for capacity building, there is an urgent need to support planning and capacity building for adaptation. While the adaptation fund is made available, GEF resources for climate change could be tapped for adaptation efforts. The GEF role is to build capacity for the deci-

sionmaking required to develop and adopt climate change adaptation programs and measures. These activities are framed within decisions taken at the Seventh and Eighth Conference of the Parties (COP7 and COP8) emphasizing the need to focus GEF resources on adaptation issues. Furthermore, COP7 reinforced these provisions by deciding that the GEF, as an operating entity of the financial mechanism, should provide financial resources to developing country Parties not only for the activities identified in paragraph 7 of decision 5/CP.7, but for other activities, including “strengthening the implementation of country-driven state II adaptation activities . . . and supporting the continuation of the ‘country-team’ approach, which enhances the collection, management, archiving, analysis, interpretation and dissemination of data on climate change issues . . .”

At the GEF Council meeting of November 2003 and COP9 in December 2003, a business plan was adopted that for the first time recognizes the funding needs of adaptation activities under a pilot window designed to identify policy options and measures that could demonstrate how adaptation to climate change can be implemented. This is a significant development, which for the first time allows GEF resources to be invested in the implementation of specific adaptation measures. Independent of the source of financing, adaptation efforts could focus on:

- a) **Strengthening of the knowledge base** required to better document global climate change impacts on vulnerable ecosystems, and human health issues. Support is required for (i) improving climate monitoring systems, focusing on rainfall, sea level, temperature and surface temperature measurements, and on monitoring key indicators of vulnerable ecosystems such as coral reefs (corals, sea grasses, mangroves) and high mountain ecosystems (sub-paramos, paramos, glaciers, endorreic basins); (ii) strengthening the ability to downscale global climate models to design and select climate change scenarios and to interpret results to define expected impacts; (iii) improving the knowledge base for key ecosystems (high mountain ecosystems and coral ecosystems) including gathering baseline data, assessing historical development trends, characterizing key ecosystem cycles and identifying environmental services; and (iv) completing a detailed epidemiological assessment for tropical diseases.
- b) **Assessing climate change impacts**, including the identification and characterization of the anticipated impacts of climate change on vulnerable ecosystems. Also, support of national institutions and stakeholders to (i) identify the induced changes on malaria and dengue vectors; (ii) assess expected impacts of climate change on high mountain ecosystems, small islands, and coral reefs and associated ecosystems (sea grasses, mangroves), and examine the implications for sustainable development; and (iii) assess sectoral impacts on water resources (water supply, hydroelectric power generation, and agriculture); and
- c) **Assessing policy options and identifying and implementing adaptation measures**. In particular, it is necessary to (i) identify policy options; (ii) prepare cost-benefit analysis of applicable policy options; (iii) develop an implementation strategy, including an institutional analysis, legal and regulatory assessments, stakeholder analysis, defining a public awareness dissemination strategy, and developing actions, targets, performance indicators, responsibilities and implementation timeframes; and (iv) support of key pilot adaptation measures that illustrate how these could be put in place to mitigate impacts and adapt the countries to climate change effects.

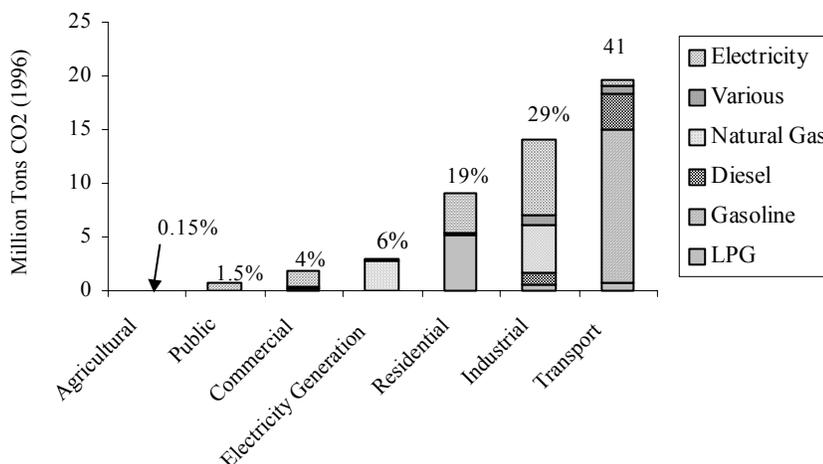
## Potential Opportunities for Carbon Finance and Synergies with Development Priorities

The Kyoto Protocol and the CDM are potentially very important tools for addressing climate change impacts and simultaneously contributing to local development. Further, it can be argued that the resources of carbon financing managed by the Bank should be primarily used as a tool to foster the goals of sustainable development in the context of the local social and environmental circumstances where each project is to take place, contributing to the objectives of country assistance strategies. By linking carbon revenues to local social and environmental indicators, these resources would be responding to the spirit of the Clean Development Mechanism. For example, there are substantial opportunities for use of the CDM in the region in support of transport priorities as well as a catalyst for renewable energy, improvements in energy efficiency, and even solid waste management and wastewater treatment. Some of the areas of potential include:

### Transport Sector

The transport sector is a major source of greenhouse gases in the region, and certainly the largest in an urban environment. While far less energy-intensive than transport systems in the United States, there nevertheless has been a continuing trend toward higher emissions per capita.

**Figure 6. Direct CO<sub>2</sub> Emissions in the Mexico City Metropolitan Area, by Fuel Type (1996)<sup>7</sup>**



Source: Opportunities for harmonization of climate change and air pollution measures. Summary of studies for the preparation of the Mexico: Introduction of Climate Measures in Transport Project. 2001

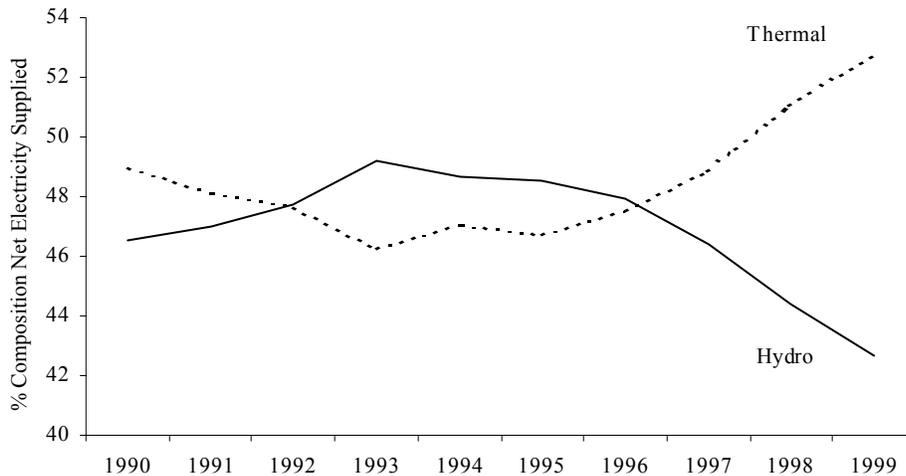
7. Does not take into account associated fugitive emissions or leaks.

From a mitigation perspective, transport is not an easy source on account of its diffuse character (many small emitters) and the limited impact that, at current prices, the purchase of emissions has on the overall financing of less energy intensive transport systems. Nevertheless, there is some considerable potential, in particular in systems that may induce a modal shift from small capacity, private vehicles to a system based on larger capacity, energy efficient vehicles, as the example of Transmilenio in Bogota, has already demonstrated. In this context, the CDM can support the goals of an efficient, safe, and environmentally beneficial transport system. While Transmilenio, at least in its initial phases, has not sought carbon finance as a source of funding, several follow-up projects have been proposed that include carbon finance.

Investments in Rapid Bus Transit Systems (RBTs) are synergistic with the need to provide better organized, safe, effective, and rationale transport. Carbon finance can, potentially, aid these efforts by providing a limited, yet reliable and long-term financial incentive. However, the long-term viability of investments in RBTs, needs to be predicated in the gains in efficiency and productivity (reduced congestion, increased capacity) and safety of the system.

The Carbon Finance Unit, at the World Bank, has agreed to consider a first-of-its-kind project in Mexico City as a follow up activity to an existing, GEF-supported project. The operation is expected to illustrate the difficult issues of how to estimate the baseline (business as usual emissions), and how to document the expected reductions. Under this initiative efforts are being made to develop baseline and monitoring methodologies.

**Figure 7. Share of Electricity Generation from Thermal and Hydropower in Latin America (excluding Brazil), 1990-99**



Source: Elizondo Gabriela (2003) Effects of Regulation on the Dynamics of Power Sector Liberalisation in Latin America, Imperial College London.

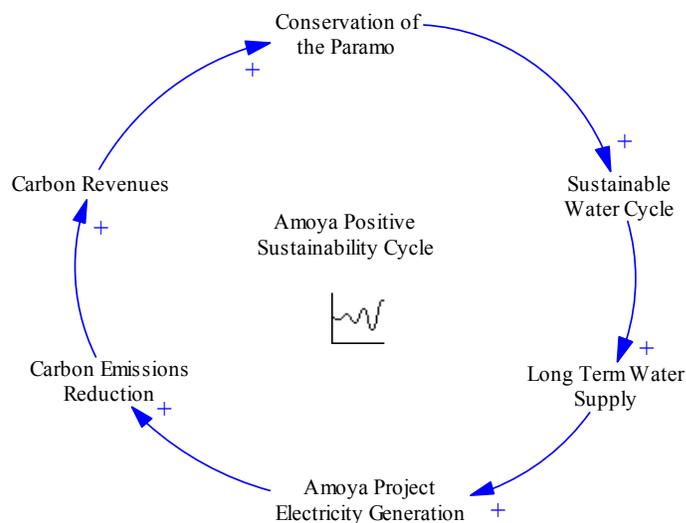
**Power Sector**

The power sector is a large source of greenhouse gases in Latin America. The CDM can support the goals of a reliable, efficient, and diversified power system in the region. In some countries (the Andean region), the power sector currently is based largely on hydropower and therefore is not a source of GHG. However, the earlier trend toward privatization and the downturn in economic growth has resulted in a tendency toward “carbonization” of the energy sector that favors installation of smaller, fossil-fuel based plants as an alternative to larger and more complex investments in hydropower capacity (Figure 7). Thus, some of the opportunities for GHG reductions have to be seen against a baseline of increasingly energy-intensive practices.

The region has a considerable endowment of renewable energy sources. With carbon financing, several projects are being developed and others are under preparation to foster the development of these resources. Some of the most interesting options include:

**Run-of-river hydro plants.** These units are relatively small, can have limited environmental impacts, and are more suited to address slow increases in demand and local reliability of power systems. Two of these projects have already been approved or are under advanced preparation in the region. Because high mountain ecosystems are particularly vulnerable to climate change impacts, run-of-river hydro can help ensure the sustainability of energy production. Carbon revenues are anticipated to add 1-2 percent to return rates. Yet the true return of these facilities should be sought in the contribution they made to preserve mountain habitats and their inhabitants. There is substantial potential to expand the experience being gained with the Chacabuquito and Amoya projects to the rest of the Andean region.

**Figure 8. Amoya Positive Sustainability Cycle**



Furthermore, under the Amoya project,<sup>8</sup> a linkage has been established between the revenues for carbon emission reductions and the protection of the high mountain habitat, which enables the water cycle and the generation of renewable power (Figure 8). The project is designed to maximize positive feedbacks that promote sustainable use of the services of the páramo ecosystem in the region. Conserving the páramo is key to maintain the water cycle in the long term, which in turn makes viable its use for generation of clean energy. The clean energy component is designed to have a minimum ecological footprint in the area (underground works, access roads reverting to natural landscape, no reservoir). The generation of clean energy helps displace emissions of GHG which are sold in the international market. These revenues make the project financially viable and in turn help finance a social program to improve the welfare of the farmers in the area and involve them in the process of conserving the páramo.

**Wind energy.** Wind energy generation capacity is rapidly increasing (30 percent annually),<sup>9</sup> although it still accounts for less than 1 percent of the world total. Yet of all the renewable energy alternatives, it is the source that is likely to best compete with fossil fuels in the short term. Recent trends, such as efforts to strengthen regional generation capacities, trying to reach off-the-grid areas, and increases in the cost of gas, tend to favor wind power.

There is a considerable potential for wind generation in the region, mostly along coastal and insular areas, as well as in high mountains and in the southern regions of the continent. Also, frequently the wind regimes are complementary to hydrology cycles, contributing to increase the robustness of power systems. While still marginal economically, the wind option should continue to be pursued with the help of the CDM. Carbon revenues will assist in reducing the gap between rates of return for traditional fossil fuel plants and wind systems, and will promote activities that help gain experience for further market penetration of wind power. Populations in coastal and high mountain areas suitable for wind development should be made part of the benefits from the CDM, as has been done in the Jepirachi project.<sup>10</sup>

The Jepirachi carbon offset project purchases the emission reductions caused by the operation of a new 15-megawatt wind-farm, located in Wayuu Indian territory in northern Colombia. This specific project illustrates the potential linkages of the CDM with local development issues. Having been taken as a model for the Community Development Carbon Fund, the project invests about 15 percent of the carbon revenues in a social program that includes water supply, education, health services, and other community benefits for the local indigenous population at the site. Jepirachi also illustrates the potential for on-grid renewable energy generation, particularly in countries such as Colombia, México, Brasil, Chile, and Costa Rica, where actions in this area can make a substantive difference to the worldwide agenda for renewables. In other countries, off-grid renewables may help reach poorer populations and extend electrification to unserved communities in remote locations for which least cost technologies frequently are wind, solar, or biomass.

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8. Colombia: Amoya River Environmental Services Project. Project Appraisal Document. Report No. 26364-CO. World Bank, 2004.

9. Vital Signs 2001. The Worldwatch Institute, 2001.

10. Colombia: Jepirachi Carbon Offset Project. Project Appraisal Report. Report No. 24913-CO, World Bank. 2002.

**Biomass energy.** Carbon revenues have the potential to improve the economic viability of biomass energy systems, which are by nature specially suited for rural and off grid locations. Biomass fuels are still expensive to collect and process, but they are associated to zero emissions. Some opportunities that should be pursued include: Bio-diesel (for power or transport), alcohol fuels, and burning of biomass. In all cases, emissions of local pollutants (particulates, chemical smog) should be avoided. Credits however cannot be claimed for avoided deforestation.

**Energy efficiency and conservation.** The CDM can assist in attaining the goals of improved energy efficiency and conservation through the internalization of global benefits from investments in these areas. Energy efficiency measures are a win-win opportunity where the economic worth of energy savings can be complemented with carbon revenues. The challenge is to identify those that are really additional to the business-as-usual scenario.

### *Environment Sector*

The emission of GHGs is often associated to the release of local criteria pollutants. Therefore, local environmental goals, such as cleaner water, air, and improvements in solid waste management, can be advanced through CDM-sponsored activities. For example:

**Wastewater treatment.** In Latin America there is an important gap between collection of wastewater and its treatment that has not been bridged because of financial difficulties and the lack of economic incentives for full treatment. In fact, there is a worrisome trend toward de-linking sewage collection from sewage treatment; only a small fraction of sewage is treated.

On the other hand, primary and secondary business-as-usual wastewater treatment facilities contribute about 10 percent of global anthropogenic emissions of CH<sub>4</sub> (about 40 metric tons/year). N<sub>2</sub>O emissions from facultative lagoons also contribute to global warming. CH<sub>4</sub> that is collected from sewage activated sludge can be used for power generation and to process heat, while technology changes can eliminate the formation of N<sub>2</sub>O. Specifically, anaerobic wastewater treatment systems could provide opportunities for (a) **abatement of CH<sub>4</sub> from the primary and secondary wastewater treatment** through optimization of the capture, collection, and flaring systems of CH<sub>4</sub> emissions; (b) **abatement and prevention of emissions of N<sub>2</sub>O from the secondary treatment** through modification of existing secondary wastewater treatment, shifting from facultative to permanent or intermittent aerated regime, and inducing reductions in N<sub>2</sub>O emissions; and (c) **displacement of emissions from the generation of power** through installation and operation of CH<sub>4</sub>-fueled, cogeneration power plants. Carbon revenues could make viable these investments and thus support the development of secondary treatment facilities in developing countries.

**Solid waste management (landfill gas).** Proper solid waste management has long been an issue in the region. Carbon revenues linked to the capture and use of landfill gas can improve the viability of landfill operations by creating an additional source of revenue. Landfill gas is estimated to contribute 10 percent of all methane released to the atmosphere. The region already has one of these units in operation, financed through the GEF, and several others are under preparation with the involvement of carbon finance. Carbon revenues can increase the returns of methane units at landfills by 5-7 percent. The favorable financial results could also support carbon sequestration schemes to completely offset carbon emissions, virtually making these units zero-GHG contributors.

Under the short-term measures window of the GEF, a 7-megawatt methane capture plant has been financed in Monterrey, Mexico. The plant, in successful operation since September 2003, is the first of its kind in the region.<sup>11</sup> This project includes a dissemination component that the GEF intended to be used in the promotion of similar activities throughout the region wherever there is strong potential for such a system. Prime candidates are landfill sites that are well managed, with good segregation practices, and proper landfill barrier designs. Many landfills, however, do not meet these requirements and remedial work may be required before landfill collection is attempted.

**Table 1. Measures Selected to Illustrate Harmonization Opportunities in the Mexico City Metropolitan Area**

<i>Measure</i>	<i>Local Air Quality Issue</i>	<i>Global Climate Change Linkage</i>
<b>Bus Rapid Transit Systems and introduction of advanced technology buses</b>	The transport sector is the largest user of combustion fuels and is linked to large emissions of NO <sub>x</sub> , VOCs, and PM; advanced bus technologies combined with efforts to promote modal shift can reduce volume of emissions of NO <sub>x</sub> , PM, and VOCs per passenger-km traveled.	Reduced congestion and modal shift improve fuel use per passenger-km and reduce emissions of CO <sub>2</sub> . Improved engines and drive systems reduce emissions of CO <sub>2</sub> per unit of work delivered.
<b>Energy efficiency in buildings</b>	Improvements in the use of electricity reduce the need for power generation, which itself is linked to various emissions of criteria local pollutants. <sup>12</sup> Public buildings offer a homogeneous target, facilitating replication.	Improvements in energy use leads to reduction of emissions of CO <sub>2</sub> and of local criteria pollutants from thermal power generation.
<b>Solar-based water heating systems for households</b>	Water heating uses primarily LPG in the MCMA. The concentration of LPG components (hydrocarbons with low molecular weights) is high in the local air-shed and contributes to the generation of ozone. Solar energy could substitute for some of the LPG and reduce its associated VOC load in the atmosphere.	Use of solar energy would substitute LPG use and therefore reduce the generation of associated CO <sub>2</sub> .
<b>Reducing LPG leaks and efficiency in domestic installations</b>	Reduction of fugitive emissions and leaks would complement the solar water heating initiative through improvements in the efficiency of use of the LPG.	Same.
<b>Reduction of emissions at regional power plants</b>	Power plants in the region account for about 12 percent of NO <sub>x</sub> emissions	Reduction in ozone precursors may reduce generation of tropospheric ozone

11. Mexico: Methane Capture and Use at a Landfill. Project Appraisal Document, Report No. 22112-ME. World Bank, 2001.

12. Some of these emissions will not accrue in the MCMA, as the power grid draws power from outside the region.

**Air quality.** Air pollution is a serious health and environmental concern. Several cities in the region are among the largest metropolitan areas in the world. Many of them are failing to meet adequate air quality standards. A growing percentage of the total population lives in metropolitan and large urban centers and therefore may be exposed to high levels of ozone and particulate matter. Air pollution in urban areas is mostly due to (a) a high concentration of ozone, produced by the reaction of volatile organic compounds and nitrogen oxides in the presence of sunlight; (b) carbon monoxide, nitrogen oxides, sulfur dioxide, and hydrocarbons emitted by vehicles fueled with gasoline and diesel; (c) sulfur dioxide emitted by industrial processes and commercial services using liquid industrial fuels; and (d) particulate matter (PM) in the form of particles smaller than 10 microns (PM10) emitted by several sources using diesel and other fuels.

Activities that seek air quality improvements should also review opportunities for harmonization of climate change and air pollution measures. This can be done through (a) assessments of the global dimension of air quality issues in urban areas, and (b) assessment of opportunities for reduction of GHGs as an incremental part of programs designed for air quality improvements. A review of programs that could contribute both to improved air quality and reduced emissions of greenhouse gases has been conducted by the GEF in the Mexico City Metropolitan Area (MCMA).<sup>13</sup> Table 1 summarizes some of the key measures reviewed.

**Forestry and land use management.** Under the Kyoto Protocol carbon sequestration through land use management and forestry activities continues to be a controversial and unsettled topic. Without further guidance from the convention, it is difficult to comment on the potential long-term implications and opportunities. Nevertheless, the Bank is about to launch a carbon revenue Bio-Fund that would help illustrate opportunities and issues. This opens the possibility of linking climate change issues with the goals of conservation and protection of biodiversity. Projects could also be formulated that promote afforestation and watershed protection. The Bio-Fund provides an innovative tool that could have significant applications in the region.

**Community development and carbon emission reductions.** Earlier this year, the Bank launched the Community Development Carbon Fund (CDCF), which advances the spirit of the CDM in that sustainable development at the local level should be promoted as an integral part of the carbon market. The CDCF is designed to stimulate emission reductions at a lower scale, that are tied to improvements in social indicators. Thus, the fund could become an important tool to promote rural and social development.

While the region has varied and significant needs and opportunities, a program should initially start in a few regions where the potential and impacts are the most relevant. Table 2 summarizes a view of where the activities outlined before could be initially undertaken.

**Partnerships.** The activities outlined here require of a sustained and substantial effort, which will be facilitated through partnerships between the World Bank and third parties. Working examples of the benefits of linking efforts include the commitment of Conservation International in the Amoya project

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13. Opportunities for harmonization of climate change and air pollution measures. Summary of studies for the preparation of the Mexico: Introduction of Climate Measures in Transport Project. 2001.

in Colombia and the National Oceanic and Atmospheric Administration in the United States (NOAA) and the Canadian International Development Agency cofinancing of adaptation efforts in the Caribbean. However, more can be done and this needs to be pursued in a systematic manner in the Bank's regional efforts on climate change.

**Table 2. Summary of Regional Needs and Opportunities**

<i>Priorities</i>	<i>Regional, sector focus</i>
Institutional Development Assistance	All countries in the region, initially with a focus on those with the highest potential for the use of the CDM, and highest adaptation needs.
Adaptation through the GEF	Marine and insular areas (Caribbean nations, insular areas of Latin America); high mountain ecosystems (Northern Andes).
CDM opportunities:	
Transport	Mexico City, Santiago, Sao Paulo, Lima, Bogota, and other large urban areas.
Energy	Focus on potential for renewable energy sources in areas with large thermal share of power sector; and energy efficiency opportunities in the industrial sector.
Wastewater treatment	Large- and medium-scale cities and urban areas; anaerobic wastewater treatment systems; areas with high potential impact on surface waters and aquifers.
Solid waste management	Focus on Mexico, Colombia, Brazil, and Argentina, and otherwise in landfill sites with potential for gas recovery.
Air quality	All urban areas in the region.



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