# Review of the Efficiency and Effectiveness of Colombia's Environmental Policies

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RESOURCES FOR THE FUTURE

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An RFF Report

**SPANISH ACRONYMS USED IN THIS REPORT**

| | |
|---|---|
| AAU | *Autoridad Ambiental Urbana* – Urban Environmental Authority |
| ACCI | *Agencia Colombiana de Cooperación Internacional* – The Colombian International Cooperation Agency |
| ASOCARs | *Asociación de Corporaciones Autónomas Regionales de Desarrollo Sostenible y Autoridades Ambientales de Grandes Centros Urbanos* –Association of Autonomous Regional Corporations, Sustainable Development Corporations and Urban Environmental Authorities |
| AVMA | *Autoridad Ambiental Urbana del Area Metropolitana del Valle de Aburrá* – Aburrá Valley Urban Environmental Authority |
| CAR | *Corporación Autónoma Regional* – Regional Autonomous Corporation |
| CDS | *Corporación de Desarrollo Sostenible* – Sustainable Development Corporation |
| CNE | *Comité Nacional de Emergencias* – National Emergencies Committee |
| CNPAD | *Comité Nacional para la Prevención y Atención de Desastres* – National Disaster Prevention and Attention Committee |
| COLPAD | *Comité Operativo Local para la Prevención y Atención de Desastres* – Local Operative Disaster Prevention and Attention Committees |
| CONPES | *Consejo Nacional de Política Económica y Social* – National Council on Economic and Social Policy |
| COP | *Pesos Colombianos* – Colombian Pesos |
| CREPAD | *Comité Regional para la Prevención y Atención de Desastres* – Regional Disaster Prevention and Attention Committees |
| CVC | *Corporación del Valle del Cauca* – Autonomous Regional Corporation of the Cauca Valley |

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| DADIMA | *Autoridad Ambiental Urbana del Distrito de Barranquilla* – Barranquilla Urban Environmental Authority |
| DAGMA | *Autoridad Ambiental Urbana de Cali* – Cali Urban Environmental Authority |
| DAMA | *Autoridad Ambiental Urbana de Santafé de Bogotá* – Bogotá Urban Environmental Authority |
| DANE | *Departamento Administrativo Nacional de Estadística* – National Administrative Statistics Department |
| DGPAD | *Dirección General para la Atención y Prevención de Desastres* – General Direction for the Attention and Prevention of Disasters |
| DNP | *Departamento Nacional de Planeación* – National Department of Planning |
| FNC | *Fondo Nacional de Calamidades* – National Calamity Fund |
| FONAM | *Fondo Nacional Ambiental* - National Environmental Fund |
| IDEAM | *Instituto de Hidrología, Meterología y Estudios Ambientales* – Institute of Hydrology, Meteorology and Environmental Studies |
| INDERENA | *Instituto Nacional de los Recursos Naturales Renovables* – National Institute of Natural Renewable Resources and Environment |
| IGAC | Instituto Geográfica Agustín Codazzi – Agustín Codazzi Geographic Institute |
| IIAP | *Instituto de Investigaciones Ambientales del Pacifíco* – Institute for Pacific Environmental Research |
| INURBE | *Instituto Nacional de Vivienda de Interés Social y Reforma Urbana* – National Social Housing and Urban Reform Institute |
| INVEMAR | *Instituto de Investigaciones Marinas y Costeras José Benito Vives de Andréis* – José Benito Vives de Andréis Marine and Coastal Research Institute |
| MAVDT | *Ministerio del Ambiente, Vivienda y Desarrollo Territorial* – Ministry of Environment, Housing and Territorial Development |
| MMA | *Ministerio del Medio Ambiente* – Ministry of Environment |

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|---|---|
| MVDE | *Ministerio de Vivienda y Desarrollo Económica* – Ministry of Housing and Economic Development |
| ONPAD | *Oficina Nacional para la Prevención y Atención de Desastres* – National Disaster Prevention and Attention Office |
| PAT | *Plan de Acción Trianual* – Triennial Action Plan |
| PGAR | *Plan de Gestión Ambiental Regional* – Regional Environmental Management Plan |
| PNPAD | *Plan Nacional para la Prevención y Atención de Desastres* – National Disaster Prevention and Attention Plan |
| POAI | *Plan Operativo Anual de Inversiones* – Operative Annual Investment Plan |
| POTs | *Planes de Ordenamiento Territorial* – Land Use Plans |
| SIA | *Sistema de Información Ambiental* – Environmental Information System |
| SIAC | *Sistema de Información Ambiental de Colombia* – System of Colombian Environmental Information |
| SINA | *Sistema Nacional Ambiental* – National Environmental System |
| SINCHI | *Instituto Amazónico de Investigaciones Científícas* – Amazon Institute of Scientific Research |
| SNPAD | *Sistema Nacional para la Prevención y Atención de Desastre*s – National Disaster Prevention and Attention System |
| UAESPNN | *Unidad Administrativa Especial del Sistema de Parques Nacionales Naturales -* National Natural Parks System Special Administrative Unit |

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## 1. Introduction

Over the past several decades, Colombia has introduced major reforms in its environmental management. For example, it was one of the first countries in Latin America to organize environmental administration along watershed boundaries, pilot a system of pollution taxes, require environmental impact assessments for large construction projects, and institutionalize legal remedies against polluters.

At the same time, Colombia continues to face major challenges. Degradation of its land, air, and water resources compromise its potential for sustainable economic growth. Many major urban centers, including Bogotá, Cali, Medellín, Barranquilla, Cartagena, and Barrancabermeja, suffer from severe air pollution. Water supply and sanitation infrastructure are inadequate in many parts of the country. Almost 10% of Colombians lack access to a source of improved water, only half the drinking water meets government standards for potability, and a fifth of Colombia's cities lack sewage facilities. Most solid and hazardous waste is dumped illegally or in facilities without adequate environmental controls. Oil, gas, and coal industries have damaged sensitive Amazonian ecosystems. Finally, farming, ranching, and logging have contributed to rapid deforestation and habitat loss.

As part of its restructuring efforts, the Government of Colombia has requested a World Bank Sustainable Development Structural Adjustment Loan (SAL), accompanied by a Technical Assistance Loan (TAL). The SAL and TAL will support the government's medium-term program to promote sustainable development, with a focus on mainstreaming environmental concerns in the development agendas for major sectors and improving the effectiveness and efficiency of environmental management.

To assist in the planning of its restructuring efforts, the Government of Colombia has contracted with Resources for the Future (RFF), a nonprofit research organization based in Washington, D.C., to study the effectiveness and efficiency of Colombia's environmental policies. This report, the final product of that contract, evaluates the relevance, efficiency, and effectiveness of environmental policies designed and/or implemented in Colombia from 1993 to 2003. The assessment examines those policies that address environmental planning and management, as well as those that utilize command-and-control regulations, market-based instruments, legal mechanisms, administrative procedures, and mediation. It identifies areas of concern in the environmental management system and assesses whether the persistence of particular problems reflects shortcomings of environmental policy design and/or implementation. The study also makes recommendations for future improvements.

The study team comprised Dr. Allen Blackman and Dr. Richard Morgenstern, both of RFF, Libardo Montealegre Murcia of El Consultores, Ltd. (Bogotá), and in the early stages of the work, Juan Carlos García de Brigard, an independent consultant based in Bogotá).

This report represents the summation and integration of five tasks undertaken as part of the contract:

*Task 1:* Scoping research, including collection and review of documents and identification and prioritization of research needs.

*Task 2:* Characterization and description of environmental policies.

*Task 3:* Analysis of policy design.

*Task 4:* Analysis of policy implementation.

*Task 5:* Identification of lessons learned and development of recommendations.

The RFF team recognized from the outset that documentary evidence would not be sufficient to respond to the Terms of Reference for this study, for two reasons. First, by their nature, some of the issues addressed by this report are quite sensitive. For political reasons, frank evaluations of poorly performing government institutions are rarely written down. Second, as documented in our report (and in many other reports), reliable, consistent, and up-to-date data—needed to evaluate the performance of government institutions and track changes in environmental quality—are exceptionally scarce in Colombia. This study therefore relies upon original interview data as well as documentary data. Sources for the documentary data are cited in the body of the report. Individuals interviewed for this study as well as for two previous studies prepared by RFF for the World Bank are listed in Annexes 1 and 2, which appear at the very end of this document.

The outline of the report is as follows:

**Chapter II** examines the management of solid and hazardous waste programs in Colombia. The chapter describes the major policies in place in large urban areas as well as in smaller cities and in rural areas and assesses their effectiveness and efficiency. The recommendations for reform of solid and hazardous wastes policies address problems identified in various geographic and population settings.

**Chapter III** analyzes Colombia's air quality management system. Following a description of the stationary and mobile source policies in operation at the national, regional, and urban levels, extensive data are presented on the performance and efficiency of the system. Relevant tax and subsidy policies are also examined. Specific recommendations are provided on measurement and monitoring, ambient standards, and stationary, mobile, and nonpoint sources.

**Chapter IV** focuses on water issues. The chapter presents extensive data and analysis of permitting , discharge standards, and discharge fees. Although the focus is on territorial water quality, information on coastal management is also presented. Eleven specific recommendations cover the full range of topics.

**Chapter V** examines land degradation issues, with a focus on salinization and soil erosion. Extensive data are presented on the magnitude and dimensions of the problems, along with analyses of the policies in place in the areas of environmental regulation, land use planning, and forestry and agriculture. Eight specific recommendations are presented to strengthen overall land management and reduce both salinization and soil erosion.

**Chapter VI** addresses Colombia's activities in the area of climate change, including both adaptation and mitigation. Drawing on the nation's First National Communication to the United Nations Framework Convention on Climate Change, the chapter summarizes Colombia's inventories of sources and sinks of greenhouse gases (GHGs) and its vulnerability to climate change, as well as a range of policies either in place or under consideration. The chapter also presents current information on project-related activities to reduce emissions and increase sequestration of GHGs, as well as a series of recommendations to strengthen the evolving programs.

**Chapter VII** analyzes Colombia's national disaster policies. Extensive information is presented on the legal framework and the frequency and cost of national disasters, as well as on the design and implementation of prevention and response policies. Overall, the focus is on institutional design, funding, disaster planning, land use planning, and construction standards. Recommendations cover a broad array of issues relevant to the design and implementation of national disaster policies.

# 2. Waste Management

## *2.1. Introduction*

This chapter addresses the design and implementation of waste management activities in Colombia. Several major studies have been conducted in recent years on this topic (e.g., Salamanca 2004; Sánchez and Opaluch 1996), but the purpose of this chapter is to summarize major points relevant to new and unresolved policy issues.

Waste is broadly defined as unwanted material left over from manufacturing processes or refuse from places of human or animal habitation. Within that category are many types of waste, including municipal solid waste, hazardous waste, and radioactive waste, whose properties may make them dangerous or potentially harmful to human's health and the environment. Waste and contaminated lands are particularly important to environmental health because they may expose living organisms to harmful material.

Historically, the development and implementation of waste management programs have been a relatively low priority in Colombia, and it was not uncommon to find wastes on the streets, sidewalks, waterways, parks, and empty lots and in the sewage systems of large cities. However, over the past decade, several cities have developed formal waste collection systems. At the same time, disposal in open pits is still common in many municipalities, particularly smaller ones. Birds, insects, and domestic animals can readily spread vector-borne diseases from such sites, especially via the "recycling people" who live and/or work nearby. Open burning is also quite common.

Although an estimated two-thirds of waste generated is disposed of in sanitary landfills, mostly in densely populated urban areas, more than half the municipalities in Colombia—typically representing the lower income areas of the country—do not have appropriate disposal facilities. Even where landfills are in use, disposal is largely unregulated and there are no standards for landfill development and operation. Outside certain large cities, such as Bogotá, Medellin, and Cali, there is often inadequate management of leachate discharges containing high concentrations of toxics, methane leaks, particulate emissions,and other pollutants.

The 2002 Integrated Waste Management Guidelines come closest to a comprehensive national waste management policy. Yet these guidelines lack the necessary legal authority to be enforceable for all municipalities. Despite some efforts to adhere to the guidelines—for example, all municipalities are required to submit formal plans by September 2005—overall management of the system has been a major challenge, especially in the absence of well-defined monitoring mechanisms and clear management accountability.[1]

Colombia is party to the Basel Convention on the control of transboundary movement of hazardous wastes (1989), which established the right of signatories to prohibit the import and export of hazardous wastes. This also holds for trade to and from countries that are not party to the convention. The parties also agree that the illegal traffic of hazardous wastes is a crime. However, the regulations governing hazardous and medical wastes are not widely enforced except in Bogotá and Cali and possibly a few other large cities. In practice, hazardous and nonhazardous wastes are often mixed together and treated as municipal wastes, with potentially serious consequences for public health and the environment.

Although growing in popularity on international basis, economic incentive measures, such as charge systems for waste disposal or deposit-refund schemes for glass bottles or other materials, are not widely used in Colombia. As discussed herein, the current approach to waste management is most aptly described as a patchwork quilt of policies and practices—almost exclusively of the command-and-control variety—rather than as an integrated management system.

This chapter is organized as follows: Section 2 provides historical and background information on solid waste management in Colombia, including the 2002 Integrated Waste Management Guidelines. Section 3 focuses on the performance of the solid waste management system, including the disposal methods and programs in various autonomous regional corporations (CARs). The final section (4) concludes with a series of recommendations. Appendix 2.1 reviews the laws and decrees governing solid waste management in Colombia , and Appendix 2.2 provides detailed information on the programs of some CARs.

## 2.2. Background and Brief History

This section provides a brief history and essential background information of the solid waste management system in Colombia. Subsection 2.1 considers the legislative background prior to 1991 and more recently as well; subsection 2.2 describes selected national policies governing waste management; subsection 2.3 lays out the goals for waste management established in the

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[1] MAVDT, Resolution 1045, September 26, 2003.

National Development Plan 2002–2006, including basic budget information. A fuller description of the legislative and regulatory provisions regarding waste disposal is container in Appendix 2.1.

### 2.2.1. Legislative Background: Before 1991

***Pre-1991 Activities***

The Natural Renewable Resources and Environmental Protection National Code, Decree 2811-1974, was issued in 1974, based on Law 23-1973. This decree, which is still in effect, defined the tools for protection of rural areas, forests, water, and biological resources. It also covered the storage, recollection, and final disposal of solid wastes in urban areas. However, authority for regulation and implementation of the relevant policies was not placed in a single agency. Rather, it was dispersed among several national entities: INDERENA, DIMAR, Health and Mining Ministries, as well as among various local agencies, such as CARs and health authorities. In general, those agencies have not been well coordinated and have failed to establish clear and consistent standards for waste management.

***Post-1991 Activities***

In 1991, with the introduction of the new Constitution, Colombia adopted the principles of sustainable development as a guide to economic development. The state was assigned responsibility for advancing individual rights to enjoy a healthy environment and to participate in critical decisions as part of a larger set of rights that the Constitution labeled "Collective and Environmental Rights." These rights may limit the exercise of certain other rights, for example, those associated with the ownership of private property.

Among the constitutional provisions most relevant to waste management are those that assign the Colombian state the following responsibilities:

- to protect environmental diversity and integrity;
- to preserve special ecologically important areas, including national parks;
- to plan the management and exploitation of natural resources to guarantee sustainable development, conservation, restoration, or substitution;
- to prevent and control environmental deterioration; and

- to impose legal sanctions and require reparation when damage is caused.

At the same time, the Constitution assigned to municipalities the duty to regulate the use of the soil and to manage and maintain the country's ecological heritage. These responsibilities clearly carry major implications for economic development, especially for industrial and energy-intensive activities.

In December 1993, Congress approved Law 99, which authorized the creation of the Ministry of Environmental and the National Environmental System (SINA). Law 99 also created autonomous regional corporations (CARs) in those regions of the country where such corporations did not already exist. Further, it established urban environmental authorities (AAUs) in cities with more than 1 million inhabitants, five institutes of environmental research, and a special unit for the administration of the National Natural Parks System. Law 99 also defined new sources for financing environmental management along with new avenues for citizen participation and consultation with interest groups. The overall goal of these reforms was to establish a strong, coherent, internationally visible environmental management system that, at the same time, would be decentralized, democratic, participatory, fiscally solvent, and socially legitimate.

### 2.2.2. Selected national policies for solid waste disposal

***Decree 605-1996***

Decree 605-1996, based on Law 142-1994, lays out the basic procedures for solid waste management in Colombia, including collection, storage, recollection, transport, and final disposal.

At least in principle, Decree 605-1996 is analogous to the U.S. Resource Conservation and Recovery Act (RCRA) in its breadth and coverage. Unlike RCRA, however, Decree 605-1996 is not supported by a broad set of agency-issued regulations, standards, and policies—all backed up by federal and state enforcement procedures—as is the case with RCRA. Thus, Decree 605 is more of a grand design than a specific implementing regulation for the management of solid wastes.

***Law 430-1998***

Law 430-1998 prohibits the introduction of hazardous wastes into the national territories under the terms of the Basel Convention. It also governs the management of hazardous wastes generated within the country, including the equipment required by customs authorities to detect their presence. The overall goals of Law 430 are to minimize the production of hazardous wastes, prevent their entry into the country, upgrade obsolete industries that may produce them, and advance policies for clean production processes. Law 430 establishes the duty of the waste generator to determine the physical and chemical properties of the wastes at properly authorized laboratories. Special provisions also cover wastes from hospitals, clinics, medical centers, and laboratories that analyze or research pathogens.[2]

**2.2.3. Integrated Waste Management Guidelines**

In 2002, the Ministries of Environment and Economic Development developed guidelines for the integrated management of wastes within the framework of the Quality of Urban Life Program. The program is intended to increase the efficiency of production processes and regulate landfills for the appropriate disposal of wastes. Specific near-term objectives include the following:

- minimizing waste production by helping establish a cultural norm to reduce waste generation and encourage source separation at the source, and by the establishment of clean production programs; and
- increasing the economic value of waste, e.g., organic and recyclable materials.

Specific goals for recycling or reuse of waste materials have been established, with an interim target set at 30%. The overall objective of the guidelines is to "provide the tools that allow the environmental authorities to support urban and regional areas for integrated management of solid wastes, based on national policies established by the Ministry of Environment."[3]

Although the guidelines were sent to all municipalities, they are not backed by any legal authority. Nonetheless, they contain detailed technical data on the integrated solid waste management program and provide a wealth of information on the procedures that territorial entities need to follow to build and operate a sanitary landfill. Given the comprehensive nature

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[2] The Ministry of Health issued Decree 1669-2002, which regulates medical and related wastes (known as GIRHYS, *gestión integral de residuos hospitalarios y similares*). It establishes standards concerning pharmaceutical laboratories, defines terms in the field, establishes new competences for health and environmental authorities, and requires that waste be incinerated after its deactivation at incineration plants or cement factories that hold an environmental license for this particular use.

[3] MMA, "Seleccion de Tecnologias de Manejo Integral de Residuos Solidos," Guia, 2002.

of the guidelines, some have called for transforming them into a mandatory rule on landfill management.

The guidelines include the following main points:

- definitions of wastes and landfills;
- information on how financial institutions should characterize investment in waste management projects;
- specific recommendations on the formulation of the project, selection of alternatives, identification of environmental impacts, actions to mitigate environmental impacts, and indicators for project management;
- descriptions of the concept and physical structure of a landfill and the biological and chemical reactions that take place when treating waste;
- guidelines on siting landfills in accordance with a territorial management plan;
- a description of the environmental studies required for environmental valuation of the project;
- technological options and design criteria depending on landfill type and the system's level of complexity;
- advice on construction, operation, supporting infrastructure, and the management of landfill cells;
- instructions to control gasses and leachates that are by-products of waste in landfills; and
- instructions on procedures to discontinue use of landfills.

### 2.2.4. Clean Production Agreements

Additional instruments for environmental management involve agreements with industry or other relevant organization. In 1997 the National Environmental Council approved the National Policy of Clean Production. This consensus-based policy has a number of broad objectives:

- to optimize the use of Natural Resources and raw material;
- to increase the environmental efficiency and quality of energy resources;

- to prevent and minimize the production of pollution agents;
- to prevent, mitigate, correct and compensate the negative environmental impacts on local population and sensitive ecosystems;
- to adopt clean and practical technologies in order to continuously improve environmental management; and
- to minimize the waste production and use already produced wastes as a source of raw material.

Beginning in 1995, agreements for cleaner production have been signed with several major sectors.

**2.2.5. National Development Plan 2002–2006**

The National Development Plan for 2002–2006 includes the following specific objectives regarding waste disposal:

- to develop a regulation regarding solid wastes that includes the following:
- clear definitions of covered waste streams, generators, and other items;
- provisions for storage;
- provisions for biosolids; and
- provisions for profitable use or reuse of certain materials;
- to evaluate the impact of the signed agreements for cleaner production and establish a strategy for their reformulation and implementation and a control-and-surveillance system;
- to enforce the strategy to extend to the regions the Cleaner Production Policy and establish at least three regional hubs;
- to promote a special credit line so that small and medium-sized enterprises can adopt newer and cleaner technologies and convert their production systems (once this credit line is established, $2.5 million will be devoted to implementation);
- to evaluate the impact of potential exemptions to the value-added tax (VAT) and formulate mechanisms to support adoption of cleaner technologies;

- to develop the required measures to prevent and control contamination caused by wastes or dangerous residues;
- to formulate a national plan to implement the Stockholm Convention regarding persistent organic pollutants and to support the management of priority chemical substances;
- to conduct a strategic environmental evaluation of ports, roads, trains, mining, and the hydrocarbon sector and four strategic subsectors related to industrial farming processes;
- to formulate a plan under CONPES on integrated management of solid waste and to complete the municipal database for the Solid Waste Information System and the Implemented Actualization System;
- support territorial entities in the development of municipal plans for integrated management of solid waste per Decree 1713-2002; and
- to promote the implementation of recycling programs in 10 big, medium and small cities, with the cooperation of autonomous regional corporations and the territorial entities.

The overall budget planned for MAVDT in 2005 is COL$160.738.150 (US$63,835,640).[4] Approximately 60% of this budget, COL$98.039.300 (US$38,935,390), is devoted to basic sanitation. Although the bulk of the funds is devoted to wastewater treatment, some portion of the money is available for solid waste management. Unfortunately, we have not been able to obtain reliable estimates of this amount.

**2.2.6. Plans for Integrated Solid Waste Management (PGIRs)**

With Resolution 1045 from September 26, 2003, the Ministry of Environment, Housing, and Territorial Development (MAVDT, successor to the Ministry of Environment) established the obligation for all municipalities in the country to have a plan for integrated solid waste management (PGIR) with an initial assessment, future projections, and a viable financing plan for continuous improvement of services, including an evaluation of the results.[5] Resolution 1045 established a methodology to create PGIRs, whose structure must include objectives and

[4] TRM: $2,518 = US$1.

[5] MAVDT, Resolution 1045, September 26, 2003, Article 1.

specific goals on solid waste management defined through programs, taking into account demographic projections for each municipality in the country, waste generation, expansion of urban areas, and soil usages.

The deadline for submission of the PGIRs is September 2005.[6]

## 2.3. Effectiveness of the Waste Management System

This section reviews available information on the performance of Colombia's waste management system from different perspectives. Subsection 3.1 presents information on generation of solid waste throughout the country; subsection 3.2 presents information on the management of solid wsates; subsection 3.3 reviews available data on hazardous and medical wastes; subsection 3.4 provides limited evaluative information on the clean production agreements; subsection 3.5 covers selected additional topics on waste management. Appendix 2.2 presents more detailed information on the site visits conducted in selected CARs by one of the authors of this report.

### 2.3.1. The Generation of Solid Waste

IDEAM has developed various environmental indicators to track progress on environmental programs. IDEAM estimates that the total volume of solid waste generated by urban (including domestic, commercial, and institutional), industrial (manufacturing and extraction), and rural (agriculture and cattle rearing) sources amounted to more than 8 million tons in 2001,[7] or about 0.71 kg/person/day.

Table 2.1 shows the increasing volume of waste generated from 1998 through 2001. Over the three-year period, total waste increased from 7.26 million to 8.02 million tons, for an average increase of about 3.3% per annum. On a per capita basis, waste generation increased considerably more slowly, at an average rate of less than 1% per year.

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[6] MAVDT, Resolution 0477, April 29, 2004.

[7] Superintendence of Public Services, Ministry of Agriculture, DANE, and Ministry of Environment, Housing and Territorial Development.

**Table 2.1. Total and Per Capita Waste Generated (1998–2001)**

| Year | Tons/year | Tons/day | Kg/person/day |
|---|---|---|---|
| 1998 | 7,263,420 | 19.900 | 0.69 |
| 1999 | 7,844,203 | 21.491 | 0.73 |
| 2000 | 7,868,172 | 21.557 | 0.72 |
| 2001 | 8,015,854 | 21.961 | 0.71 |

Source: Superintendent of Domestic Public Services (SSPD).

As centers for employment and trade, cities attract large numbers of migrants seeking both economic opportunities as well as greater personal security. Large cities also typically have high concentrations of populations with above-average income levels. As shown in Table 2.2, affluence is generally associated with greater amounts of waste generated per capita.

Interestingly, it appears that the urban-rural differences may be narrowing somewhat over time. Over the four-year period 1998–2001, the amount of waste generated per capita in cities of more than 1 million was roughly constant. In contrast, per capita waste generated in small municipalities increased substantially, especially in those with fewer than 30,000 inhabitants.

**Table 2.2. Population Density and Generation of Wastes (1988–2001)**

| Population | Production per capita (kg/inhabitant/day) | | | |
|---|---|---|---|---|
| | 1998 | 1999 | 2000 | 2001 |
| More than 1,000,000 inhabitants | 0.82 | 0.82 | 0.82 | 0.81 |
| 500,000 to 1,000,000 inhabitants | 0.73 | 0.84 | 0.73 | 0.65 |
| 100,000 to 500,000 inhabitants | 0.66 | 0.70 | 0.66 | 0.67 |
| 50,000 to 100,000 inhabitants | 0.59 | 0.68 | 0.59 | 0.66 |
| 30,000 to 50,000 inhabitants | 0.69 | 0.70 | 0.69 | 0.62 |
| 10,000 to 30,000 inhabitants | 0.68 | 0.68 | 0.68 | 0.71 |
| Fewer than 10,000 inhabitants | 0.62 | 0.61 | 0.62 | 0.68 |

Source: Superintendent of Domestic Public Services (SSPD).

One recent study identified the composition of solid wastes from a cross-section of municipalities across Colombia.[8] Since the sample includes some of the largest cities in the

[8] Jaime Salamanca, 2004, "Study for Regulation of Final Disposal of Solid Wastes in Colombia," Colombian Technical Cooperation Agency (ACCI) and MAVDT, Bogotá, August 2004. The sample cities were Bogotá, Cali, Medellín, Barranquilla, Bucaramanga, Manizales, Tunja, Pasto, Florencia, Neiva, Cartago, Villavicencio, Marinilla, La Ceja, Cereté, Ipiales, Piedecuesta, Chiquinquirá, Puerto Boyacá, Santander de Quilichao, Palmar de Varela, Samaniego, La Virginia, Espinal, Caicedo, Marsella,

country, the results may not be completely representative of small municipalities. Nevertheless, it gives some indication of the composition of solid waste in the country.

Like most developing countries, a major portion of the waste matter is composed of organic material (60%), including both domestic and agricultural waste (Table 2.3). Plastics and paper account for 13% and 11% of waste generated, respectively, and glass, metal, textiles, and leather make up the rest.

**Table 2.3. Composition of Waste**

| Type of Waste | Percentage of Waste Disposed |
|---|---|
| Organic material | 60% |
| Plastics | 13% |
| Paper and pasteboards | 11% |
| Glass | 6% |
| Metals | 4% |
| Textiles and leather | 4% |
| Others | 2% |
| **National total** | **100%** |

### 2.3.2. The Management of Solid Waste

Useful data on waste management are difficult to obtain. This subsection presents recent information on the waste disposal methods employed in different municipalities, the extent of waste management programs in different CARs, the extent and nature of recycling of wastes, and the results of site visits to selected CARs in December 2004.

One lens on the waste management issue is an examination of the particular disposal method employed. Based on data collected by Salamanca, Table 2.4 illustrates the volume and disposal practices for solid wastes among Colombia municipalities.

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Concordia, Zapatoca, Santuario, Líbano, Urrao, Apartadó, Viracachá, Chimichagua, Lorica, and Castilla la Nueva.

**Table 2.4. Final Disposal of Wastes**

| **Type of Disposal** | **Municipalities (n)** | **Waste Disposed (tons wastes/day)** | **Municipalities (%)** | **Wastes Disposed (%)** |
|---|---|---|---|---|
| Sanitary landfills | 358 | 14.799 | 33% | 65% |
| Dump sites with burning | 338 | 1.946 | 31% | 9% |
| Dump sites without burning | 237 | 4.315 | 22% | 19% |
| Interment | 45 | 1.072 | 4% | 5% |
| Water stream | 20 | 66 | 2% | 0% |
| Incineration | 3 | 26 | 0% | 0% |
| Others | 56 | 185 | 5% | 1% |
| Information not available | 31 | 425 | 3% | 2% |
| **National total** | **1,088** | **22,835** | **100%** | **100%** |

Source: Calculations by Eng. Jaime Salamanca, consultant, with information provided by SSPD for 2001.

Even though 65% of solid waste generated in Colombia ends up in sanitary landfills, this accounts for waste only from 33% of municipalities around the country. These municipalities represent more densely populated urban areas and hence account for the disproportionately large share of waste.

Conversely, 28% of waste generated by 53% of the municipalities (575) disposes their wastes in open sky dumpsites, with or without burning processes. Three hundred and thirty-eight municipalities dispose waste through burning while 20 municipalities dispose their wastes directly into streams and rivers at a rate of 26 tons per day. These disposal methods do not include lixiviation or the control for vectors that may spread diseases within the population.

A recent investigation by the delegated procurator for Environmental and Agrarian Affairs found that from a sample of 194 locations for final disposal of solid waste, 168 responded to the survey. Of those surveyed, 121 (62%) had environmental licenses, 96 (49%) informed the surveyors that they did not have a defined environmental management plan, and 104 (54%) reported that they were situated near a source of water.

Another lens on the issue is to examine patterns and trends in waste recycling. Table 2.5, displays the percentage of waste in different categories that was recycled during 1998–2000. As shown, recycling rates are relatively high for pasteboards and papers (42–50%) as well as for metals (34–42%). For glass, 16% was recorded as being recycled.. Overall, however, since metals, paper, and glass account for less than 10% of the total waste generated, the proportion of total waste recycled in the entire waste stream is substantially less—on the order of 15% in 1999. At the same time, trends in recycling are quite favorable. Over the two-year period 1998–2000, total recycling rose from 915,211 tons to 1,255,763 tons, an increase of 37%. If corroborated by other data, these are clearly impressive gains.

**Table 2.5. Solid Wastes Recycled, by Material (tons per year)**

| Year | Metal | % | Pasteboards and papers | % | Glass | % | Total recycled |
|---|---|---|---|---|---|---|---|
| 1998 | 315,310 | 34 | 449,630 | 50 | 150,271 | 16 | 915,211 |
| 1999 | 400,888 | 42 | 398,020 | 42 | 152,545 | 16 | 951,453 |
| 2000* | | | | | | | 1,255,763 |

Sources: IDEAM (2002b) and *Superintendent of Domestic Public Services (SSPD).

There is also wide variation in the extent of formal waste disposal programs among the CARs. Table 2.6 displays the percentage of municipalities in the various CARs that report operating disposal programs for their wastes. Overall, only five CARs (Carder, Coralina, Corprocaldas, Corpogravio, and CRA) report that 80% or more of their municipalities have operating waste programs. The vast majority of CARs report that fewer than half of their municipalities have operating programs for disposal of waste.

**Table 2.6. Disposal of Solid Waste in CARs**

| CAR | Municipalities | Percentage of municipalities with waste disposal programs |
|---|---|---|
| CAM | 37 | 54% |
| CAR | 104 | 57% |
| CARDER | 14 | 100% |
| CARDIQUE | 21 | 5% |
| CARSUCRE | 19 | 16% |
| CAS | 74 | 36% |
| CDA | 8 | 13% |
| CDMB | 13 | 62% |
| CODECHOCO | 31 | 3% |
| CORALINA | 2 | 100% |
| CORANTIOQUIA | 80 | 70% |
| CORMACARENA | 10 | 10% |
| CORNARE | 26 | 31% |
| CORPAMAG | 30 | 10% |
| CORPOAMAZONIA | 31 | 26% |
| CORPOBOYACA | 87 | 15% |
| CORPOCALDAS | 27 | 93% |
| CORPOCESAR | 25 | 4% |
| CORPOCHIVOR | 25 | 16% |
| CORPOGUAJIRA | 15 | 13% |
| CORPOGUAVIO | 8 | 88% |
| CORPOMOJANA | 7 | 0% |
| CORPONARIÑO | 64 | 44% |
| CORPONOR | 40 | 18% |
| CORPORINOQUIA | 64 | 16% |
| CORPOURABA | 19 | 11% |
| CORTOLIMA | 47 | 30% |
| CRA | 23 | 83% |
| CRC | 41 | 2% |
| CRQ | 12 | 58% |
| CSB | 24 | 4% |
| CVC | 42 | 45% |
| CVS | 28 | 14% |

Source: ASOCARS.

A final source of information relating to waste management is a series of field visits and reviews of three-year aaction plans (PATs) conducted by one of the present investigators in December 2004. Although the information collected was not completely consistent across all CARs visited, summary information on the selected CARS is displayed in Table 2.7. More detailed information on the individual CARs is presented in Appendix 2.2. Even though the selected municipalities have independent waste disposal programs, a look at the last column on disposal shows that only part of the waste generated is disposed appropriately.

**Table 2.7. Characteristics of Waste Programs in Selected Areas**

| CAR | **Municipalities** | **Area (sq. km)** | **Population** | **Waste generated (tons/day)** | **Disposal remarks** |
|---|---|---|---|---|---|
| Corantioquia | 80 | 36,048 | 4,162,139 | | ½ of waste disposed properly |
| Cornare | 26 | 8,276 | 598,012 | 182 | Recycled 174,444 (ton/2003) |
| Cortolima | 47 | 23,981 | 1,302,998 | 650 | Landfills 10,080 tons Open Dump 5,460 tons |
| Valle Del Cauca- CVC | 42 | 21,306, 8 | 4,460,850 | Domestic waste 2,500 | Sanitary Landfills 427 tons/day |
| Sinu And San Jorge Valleys-CVS | 28 | 25,045 | 1,348,591 | | 68.7% of the municipalities use open dumpsites |
| Corporation Of Atlántico-CRA | 23 | 3,388 | 2,413,803 | 1,902 | 1,496 are disposed in Baranquilla's Sanitary Landfill |
| Bogotá-UESP | DC | | 6,635,960 | (Includes construction waste) 29,540 | Doña Juana Landfill 4,842 |

**2.3.3. Hazardous and Medical Waste Management**

The manufacturing industry is the major generator of hazardous wastes in Colombia, particularly the petrochemical, carbon-chemical, and thermoelectric industries. Other important sources include mining, agriculture, health care, and some segments of the commercial sector. Sánchez and Opaluch (1996) reported that the only efforts in hazardous residual management at the time were the ones made by Occidental in the petroleum production field of Cano Limon, BASF in the manufacturing plant of Medellin, and Dow Chemical in Mamonal. Certain other private companies reportedly carried out partial efforts, building secure residual landfills for fiberglass and selected toxic materials. Sánchez and Opaluch (1996) also reported that only 6% of the public and private laboratories in Colombia were able to analyze solid wastes and that none of these laboratories had equipment to analyze or sample hazardous wastes.

In 2002 the National University and the technical personnel at UESP created the Program for Researching Solid Wastes (PIRS). They estimated that Colombia generated 500,000 tons of hazardous waste a year. There is no complete inventory of hazardous wastes in Colombia, and hence this may be an underestimate. However, this is much lower than the amount generated by Mexico, which generates 8 million tons a year.

PIRS estimates that the city of Bogotá produced 73,000 tons of hazardous waste in 2002. Including nearby industrial municipalities like Soacha and Cota raises the estimate to 90,000 tons a year.

The study found that the most common form of disposal was incineration. In Bogotá there are six incinerator kilns, each with a capacity of 200 kgs per hour. Some factories specialize in treating wastes like solvents, used oils and PCBs (polychlorinated biphenyls), which are often exported to countries for disposal.

Several developed countries dispose of hazardous wastes by incinerating them in kilns in cement factories. In Colombia, MAVDT has begun doing this with fungicide containers, contaminated soils, used oils, and tires. Coprocessing, as it is called, guarantees high temperatures, adequate retention times, and environmental control of the emissions. The ash produced as a result is added to the cement without affecting its quality. Bogotá can dispose 45% of the hazardous wastes produced, which leaves more than half inadequately disposed of in open landfills and dumps.

More recently, Bogotá has developed a master plan for integrated waste management that defines various waste streams, including hazardous waste. Based on data from 1999, the office of the mayor of Bogotá reported that 41 tons of hazardous waste was disposed of at the Dona Juana landfill, and 9 tons of waste qA reused, presumably as fuel in an unidentified facility.

In Cali, of the total medical and hazardous wastes generated, 1% is sterilized and buried in a temporary deposit at Navarro. The other municipalities deactivate and burn those wastes and then deposit the ashes in dumpsites or sanitary landfills.

Regarding medical wastes, Sánchez and Opaluch (1996) report that pathogenic contaminated waste generated at five hospitals in Bogota varied from 0.13 kg/bed-day to 0.18 kg/bed-day in 1992.

A recent document developed by the Regional Autonomous Corporation of the Sinu and San Jorge Valleys (CVS) identified nine issues associated with the management of medical wastes:

- atmospheric pollution caused by open burning;
- inadequate incineration and improper atmospheric emissions from stationary sources;
- uncertainty about the reliability of microbiological sterilization;
- disposal of untreated medical waste;
- lack of information about wastes produced by clinic laboratories;
- lack of information about environmental and health risks;
- lack of planning for emergencies;
- contamination of nonhazardous wastes by hazardous wastes;
- improper burying of medical waste at the hospital; and
- inappropriate disposal sites and systems.[9]

### 2.3.4. Clean Production Agreements[10]

***Background***

The strategy of developing and promulgating regulatory standards and guidelines that are not strictly mandatory has been a focus of both the Ministry of Environment (and its successor, MAVDT) and some CARs practically since the passage of Law 99 in 1993. The past three ministers of Environment in particular have emphasized the use of voluntary regulations. Two types of voluntary regulations are popular in Colombia. The first is to negotiate clean

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[9] CVS, Environmental Diagnostic f the Hydrographic Basin of the Sinu River, Version 01. Inventory of works for productive and domestic activities, 03/05/2004.

[10] Much of the information contained in this subsection is derived from interviews conducted by the authors in March 2004. See Blackman et al. (2004), "Institutional Análysis of Colombia's Autonomous Regional Corporations (CARs)," report prepared for the World Bank, RFF.

production agreements *(convenios de produccion limpia)* with polluters. The agreements target either specific economic sectors (e.g., transportation or agriculture) or specific regions. Typically, they involve a *quid pro quo:* polluters pledge to improve environmental performance over a specified period, and in exchange, the regulator declares a certain grace period during which existing command-and-control standards are not enforced. The ostensible purpose of such agreements is to mitigate the problem of chronic noncompliance in certain sectors and certain regions by "building consensus" among polluters on the need for compliance, and by providing polluters with some guidance on how to achieve compliance. Many clean production agreements were signed in the mid-1990s. Self-reported data collected by the Association of CARs and AAUs (*Asociación de Corporaciones Autónomas Regionales de Desarrollo Sostenible y Autoridades Ambientales de Grandes Centros Urbanos,* ASOCARs) indicates that by 2002, CARs had signed a total of 101 clean production agreements with various sectors (ASOCARs 2002). Basic information on selected agreements established in 1995–1998 is displayed in Table 2.8.

**Table 2.8. Selected Clean Production Agreements, 1995–1998**

| Type of Agreement | Region | Year | Signatories |
|---|---|---|---|
| | Mamonal industrial corridor | 1995 | Mamonal Foundation (49 companies), CARDIQUE, DAMARENA |
| | Eastern industrial corridor | 1995 | Corporacion Empresarial del Oriente (33 companies), CORNARE |
| Coal | | 1996 | Ecocarbón, Fenalcarbon, Intercor, CARs from Valle del Cauca, Cauca, Norte de Santander, Cesar, Antioquia, Guajira, and Boyaca |
| Hydrocarbons | | 1997 | Ministry of Mining, ECOPETROL,; CARs from Orinoquia, Tolima, Norte de Santander, Boyaca, the Amazonia |
| | Sogamoso industrial corridor | 1997 | Sogamoso and Nobsa mayoralties, Ecocarbón, CAR from Boyaca |
| Electric | | 1997 | Ministry of Mining, companies in the sector, DAMA, CARs from Nare, Caldas, Valle, Cundinamarca, Atlantico |
| Agricultural chemicals | | 1998 | National Industrial Association (33 companies), Ministry of Agriculture, Colombian Farming Institute (ICA), DAMA, CARs from Atlantico, Valle, Cesar, Antioquia, Tolima, Dique, Uraba, Orinoquia |
| | Barranquilla industrial corridor | 1998 | National Industrial Association (33 companies). Barraquilla's AAU, CAR from Atlántico |

Source : Document CEDE 2003-09 ISSN 1657-7191.

Environmental guides *(guias ambientales),* a second type of voluntary regulation, are also popular in Colombia. These manuals detail options for improving environmental performance in specific sectors. They typically focus on pollution prevention rather than end-of-pipe abatement strategies. Environmental guides have their origin in the national Cleaner Production Policy, a policy paper issued by the National Environmental Council *(Consejo Nacional Ambiental).* Fifty-seven environmental guides have been published covering approximately 60% of all productive sectors. The guides have been written for sectors where licensing is mandatory, and also for sectors where licensing is not required, such as livestock production. Clean production agreements and environmental guides have both strengths and weaknesses.

***Strengths***

As noted above, the intent of clean production agreements is to build consensus for improved environmental performance in sectors or regions where compliance is a chronic problem. According to one interviewee formerly affiliated with DAMA, the urban environmental authority for Bogotá, clean production agreements can have an impact, at least at the regional level. This interviewee maintained that several clean production agreements negotiated and administered by DAMA had been successful.[11] The interviewee who described these success stories took pains to emphasize, however, that in his view, voluntary agreements work only in sectors and regions where environmental regulatory institutions are strong, and only as a complement to conventional command-and-control regulation.

One of the architects of Colombia's environmental guides attributed several strengths to these manuals. First, industrial sectors have input into the guides, and therefore they build consensus for improved environmental performance. Second, they fill a significant gap in Colombian regulation—a lack of technical guidance on how emissions standards are to be met. Such gaps imply that emissions standards are unrealistic for most firms, which lack the technical information (or other types of resources) needed to purchase and operate abatement devices or to adopt clean technologies.

Third, environmental guides clarify exactly what polluters need to do to obtain a license and therefore facilitate consistent and transparent licensing. As discussed below, licensing requirements and processes differ markedly across CARs, and *ad hoc* and corrupt licensing is a major concern for many firms and farms. According to this interviewee, in sectors where licensing is required, the environmental guidelines constitute *de facto* binding *(vinculantes)* regulations, and efforts are underway to give the guidelines the legal status of regulation—that is, to make them *de jure* binding.

Fourth, by improving polluters' technical capacity and establishing uniform standards, environmental guides reduce the transaction costs of permitting for firms, CARs, and the

[11] One such program focused on small and medium enterprises in Bogotá. A second successful voluntary program called *Programa Excelencia* is not a conventional clean production agreement. It involves rating the environmental performance of polluting facilities and then publicizing these ratings.

ministry. Fifth, in sectors where permits are *not* required, the guides may help firms improve their environmental performance by lowering the information costs of pollution prevention and pollution abatement investments. Finally, environmental guides may help firms meet growing demands for cleaner production in the international marketplace. According to this interviewee, several sectors require some type of certification that firms are producing in an environmentally friendly manner. The environmental guides facilitate this certification.

*Weaknesses.* Notwithstanding those potential benefits, both interview and documentary data suggest that clean production agreements typically have not succeeded in improving environmental performance. During the grace period specified in the agreement—that is, the period during which polluters have committed to investing in pollution control and prevention and during which regulators have promised not to enforce regulations—polluters do not actually make any significant new investments. In any case, regulators typically have no means of assessing environmental performance because the clean production agreements do not include indicators or establish a baseline. Thus, the agreements simply end up legitimizing inaction on the part of both polluters and regulators. Evidently, this has been the pattern for most national-level sectoral clean production agreements. One interviewee noted that voluntary agreements are very attractive politically, perhaps for this reason. According to this same interviewee, as noted above, clean production agreements work only as a complement to strong command-and-control regulation, and only in sectors and regions where regulatory institutions are strong.

Estreling Lara (2003) evaluated a sample of 13 voluntary clean production agreements, including both single-sector and multisector agreements as well as agreements at the national and regional levels. Estreling Lara's findings are decidedly mixed. He found that many of the agreements suffered from weaknesses that rendered them ineffective. For example, commitments made by the signatories to the agreements—and moreover, the consequences of failing to keep these commitments—were typically vague and ill defined. In addition, the agreements did not identify sources of financing for costly pollution abatement and prevention investments. Finally, the legal status of the agreements was unclear. Such conditions created incentives for stakeholders to sign the agreements even if they had no real intentional of meeting their commitments.

Estreling Lara developed a system to rank the extent to which signatories complied with various components of the voluntary clean production agreements in his sample. In general, these rankings were quite low. For example, in evaluating a voluntary clean production agreement signed by the national coal sector, Estreling Lara assigned rankings of "zero" (on a scale of zero to 100) to all the components that concerned "incentives and financial resources" and "followup and evaluation." Similarly, in evaluating electricity sector agreements, Estreling Lara assigned rankings of zero to eight of the nine components of the agreement on "clean production promotions strategies," three of the four sections on "legal and technical environmental norms," and three of the five sections on "incentives and financial resources."

Our interviewees also identified weaknesses in Colombia's 57 environmental guides. First, they are being used for a purpose other than that originally envisioned, and as a result they do not serve that function very well. The guides were originally conceived as a way of implementing the national Cleaner Production Policy. Specifically, they were to enable facilities to move beyond compliance with existing command-and-control regulations by adopting clean (pollution-prevention) technologies. However, as discussed above, in sectors where licenses are required, they have evolved into guides for achieving compliance with existing regulations. Unfortunately, the guides do not serve this end very well. There is often no clear link between existing command-and-control regulations and the information in the environmental guides. Hence, there is no guarantee that a firm that follows the advice provided in the guide will actually meet existing regulatory standards.

Second, the environmental guides typically provide a limited range of technological alternatives for pollution prevention and pollution control. These alternatives are not always the most appropriate for all scales and types of firms in the sector. For example, they may be appropriate for large firms, but not for the small and midsize firms that may constitute the bulk of firms in the sector.

### 2.3.5. Selected Other Issues Relevant to Waste Management

Based on the information presented in the previous subsections, one can see a broad outline of the waste situation in Colombia. Total waste generation continues to rise, although only modestly so on a per capita basis. Most of the per capita growth seems to be occurring outside the large cities.

In terms of management of solid wastes, the picture is quite mixed across the country. Although they are not codified in formal regulation, guidelines for integrated waste management have been issued and significant programs are in place in large cities. In some CARs, presumably the wealthier ones, smaller municipalities also have programs in place. In other CARs, basic solid waste management programs are nonexistent in many municipalities. Even in those municipalities where programs are in place, little is known about the technical and qualitative aspects of the programs. This problem is exacerbated by the lack of enforceable regulations for waste management.

Recycling seems to be somewhat of a bright spot. For more valuable materials like metals and some types of paper, recycling rates are substantial, and based on 1998–1999 data, they appear to be growing rapidly. Regarding the management of hazardous waste, Colombia is a signatory to the Basel Convention, and a few large firms and at least one large city (Bogotá) have developed limited programs. However, there is no national policy in place for either hazardous or medical wastes. At a minimum, the absence of a national hazardous waste program hinders compliance with the Basel Convention. Clean production agreements are in place with many enterprises throughout the country. However, little is known about the performance of these agreements. The limited information that is available does not provide great confidence that the agreements are encouraging environmental behavior beyond what one might label business as usual.

Beyond those observations, five additional points can be made.

- Salamanca (2004) highlights the lack of regulation in the management of solid wastes and the lack of institutional planning and coordination among governmental entities.[12] For example, municipalities and governmental entities have been unable to coordinate decisions on siting of landfills, even though the territorial management plans have established environmental zoning rules.
- The current regulations do not specify the appropriate type of landfill relative to the size and characteristics of the municipality it serves. They also do not define any technical specifications with respect to soil permeability, collection of gases, and treatment of rainwater and leachates. The regulations are also silent on issues relating to management and technical supervision of companies in charge of the operation.
- As in many other developing countries, the largely unregulated recycling industry composed of "scavengers" plays an important part in Colombia's waste management program. As recently as 1986, the scavengers worked independently, eking out a living

[12] Colombian Technical Cooperation Agency ACCI; Ministry of Environment Housing and Territorial Development; agreement of Japan Donation 051886-CO World Bank. Contract signed with Eng. Jaime Salamanca Leon for the development of a study for regulation on final disposal of solid wastes in Colombia, August 2004.

by selling scrap or any waste with slight resale value from landfills and waste dumps. In 1986, the *Fundación Social*, a nongovernmental organization, tried to encourage scavengers to form cooperatives and provided the co-ops with legal, administrative, and business assistance. Since its formation in 1986, membership in the *Fundación Social* has swelled to nearly 100 member co-ops. In 1997, the foundation donated funds and made loans to the co-ops worth approximately US$700,000. The program developed an organizational structure that included a national as well as regional and local associations of co-ops. The co-op program allows the affiliated co-ops to sell recyclables in large volume to obtain higher prices. However, it is difficult to obtain actual figures on the volumes of waste recycled by these co-ops.

- Financing of waste management systems is a major issue. Sánchez and Opaluch (1996) report that larger cities are usually able to cover costs by imposing direct charges. However, in small and medium -sized municipalities, charges are often not collected. Thus, waste management services must be financed from other municipal income or from the national treasury.
- There is a growing emphasis on economic incentive mechanisms, such as targeted charge systems or depost-refund schemes. A review of such schemes as applied to waste management can be found in Sánchez and Opaluch (1996) and a new report by the U.S. Environmental Protection Agency, entitled *International Experiences with Economic Incentives for Protecting the Environment* (2004).

## 2.4. Recommendations for Solid Waste Management in Colombia

The preceding sections of the report demonstrate that Colombia has made some advances in solid waste management, especially in urban centers. The fact that 65% of waste is disposed of in sanitary landfills is an important indicator of progress. Similarly, there also appears to be some progress in the area of recycling. At the same time, it is clear that Colombia needs a more effective policy on waste management. The operation and management of the few landfills that do exist are often substandard. There are no clear regulations concerning disease vectors, no specific regulations to control and regulate explosive gases, no clear policies on the analysis of soil types and their hydrogeologic effects on landfills. Most important, more than half of all municipalities in the country are still disposing of their wastes in open dumpsites without any treatment, or discharging them directly into water streams, thus posing potentially serious public health hazards to the nation. Further, the current system does not adequately address certain major issues, including the separation and management of hazardous wastes. Medical waste is another area of concern.

The government is aware of many of the problems associated with waste management. In a presentation entitled "Policies for the Final Disposal of Solid Wastes" during the environmental analysis workshop held in Bogotá in August 2004, there was widespread recognition of the need to establish a coherent policy for the integrated management of waste.[13]. The following recommendations are intended to support future reforms:

1. Establish legally binding standards for landfills in urban areas. The obvious starting point for these standards is the 2002 integrated waste management guidelines— the closest thing to a waste management policy in Colombia. Most municipalities are already familiar with these technical guidelines. The lack of a comprehensive set of standards for landfills has resulted in wide differences in operating practices for landfills across the urban areas where they exist. A common standard will establish a minimum requirement that landfill operators have to meet, thus reducing the risks to human health and the environment.

2. Develop recommendations for smaller municipalities. Establishing state-of-the-art landfills in small municipalities may not be cost-effective, but there is nonetheless a clear need for action. Instead of mandating the same standards as for urban landfills, the government could develop recommendations appropriate to smaller municipalities. Sanitary landfills are expensive to build and operate and involve substantial investments in capital and infrastructure and may be not be financially viable for smaller municipalities. In such cases, lower-cost alternatives like the "manual sanitary landfill" may be appropriate. Instead of requiring bulldozers and heavy construction equipment, a manual landfill uses light compacting equipment operated manually by workers. This is a viable option because the denser, more organic garbage generated in the low-income areas of developing countries does not need to be compacted as much as the waste in industrialized centers. The manual operation of landfills also provides jobs to local workers. Some areas in Colombia already operate these manual sanitary landfills.

3. Compile and disseminate information on best practices of solid waste management within Colombia and in selected other countries as well so that municipalities can learn

[13] MADVT, Presentation on Policies for Final Disposal of Solid Wastes, Country's environmental analysis workshop, August 27, 2004.

from the experiences of other regions. Information on the risks of untreated wastes—both hazardous and nonhazardous—should also be included with the examples of best practices.

4. Enforce territorial management plans especially regarding the siting of landfills. The territorial management plans contain some zoning regulations on locating landfills, yet these are not adequately considered when making the siting decisions.

5. Adopt a decentralized approach to developing landfills. The conventional waste disposal method uses a centralized approach, in which one or a few large landfills are built and operated with heavy construction equipment. An alternative approach is to design and construct several, smaller landfills scattered around the urban area. In this way, many communities would handle the collection, transport, and final disposal of their own wastes. This decentralized approach would create jobs in the communities and would minimize the need for some collection and transportation equipment. These landfills should be depositories for mostly nonrecyclable materials and for materials for which there is no demand.

6. Despite the existence of formal regulations for hazardous waste, noncompliance is apparently a serious problem. It is recommended that the current regulations be evaluated with the goal of simplifying the definitions and requirements and, simultaneously, improving monitoring and enforcement. One option is to review the hazardous waste policy of another country as a template and tailor it to local requirements.

7. Currently, medical wastes are regulated through Decree 2676-2000, which establishes relatively high standards for the disposal of wastes through incineration. However, there is a lack of effective monitoring in this program. It is recommended that a special evaluation be carried out for medical wastes with the goal of both simplifying the regulations and improving monitoring and enforcement.

## *Appendix 2.1. Environmental Legislation and Regulation Regarding Waste Disposal*

| Regulation | Public entity | Description |
|---|---|---|
| Law 23-1973 | National Congress | This law authorizes the president to issue the Natural Renewable Resources and Environmental Protection National Code; to prevent and control contamination; and to improve, conserve, and restore renewable natural resources and defend the health and welfare of all the residents in the country. This was the very first regulation that assigned responsibility to those who cause harm to the environment. |
| Decree 2811-1974 | National Government | This decree is the Natural Renewable Resources and Environmental Protection National Code. Regarding waste disposal, it orders: "The best methods, according to the state of science and technology, must be used for (recollection, treatment, processing, and final disposal)." The decree also promotes research to find new methods for integrated waste management and the development of new methods for collection and treatment. It also forbids that waste disposal harm soils and urban areas. |
| Law 44-1975 | National Congress | This law addresses the hazards of poisoning from benzene, as adopted by the General Conference of the International Labour Organization (Geneva 1971). It applies to all activities involving exposure of workers to benzene; promotes the use of harmless or less harmful substitute products when they are available, establishes regulation for the storage and management of benzene where its fabricated or used, and sets forth measures to prevent the emission of vapors into the atmosphere and ensure that concentrations do not exceed a maximum, which shall be fixed by the competent authority. |
| Law 9-1979 | National Congress | This law, the National Sanitary Code, orders sanitary measures for the protection of the environment. It refers to the |

| | | |
|---|---|---|
| | | responsibility of waste producers for collection, transportation, and final disposal processes as well as damages caused to public health and the environment. It establishes regulations for protection of workers against the risks of the manipulation, generation, storage, use, transportation, trade, and final disposal of pesticides, as well as the importation or exportation of samples for research and experimentation purposes; it also regulates the management and control of surgical specimens and those coming from medical and domestic activities. |
| Decree 1594-1984 | Ministry of Health | This decree partially regulates the use of water and liquid wastes. Regarding the wastes from sediments, mud, and solid substances coming from systems for water treatment, it prohibits their discharge into surface water, groundwater, water bodies, or sewage systems. |
| Decree 1601-1984 | Ministry of Health | This decree implements Law 9-1979 regarding port sanitation and epidemiologic surveillance on ships and terrestrial vehicles. It calls for control and surveillance of terminals to prevent the arrival, departure, and propagation of diseases that may harm humans, flora, and fauna, and requires that every terminal have a solid waste collection and final disposal system and meet the requirements for storage of biological products, agrochemical products, pesticides, acids, flammable products, explosives, and other chemical products. It also orders that port terminals be classified according to several aspects, including optimal collection systems, disposal, treatment, and types of wastes, buildings, installations, equipment, epidemiologic surveillance, etc. |
| Resolution 2309-1986 | Ministry of Health | This resolution establishes regulations for the management of special wastes—their storage, transportation, treatment, and other general measures. Some of its articles were rescinded by Law 99-1993 because |

| | | |
|---|---|---|
| | | some functions were assigned to the Ministry of Environment; however, some aspects are still effective. Among them are the responsibilities of those who produce special wastes for management, collection, transport, and final disposal. It allows the hiring of third parties for waste management assigns responsibility for the effects that the management may have on the environment. Some of the criteria used in this resolution are still valid for flammable, toxic, and volatile wastes; the specifications for their containers, vehicles, or compartments for transportation; and guidelines for the management of incompatible wastes and substances. |
| Decree 755-1990 | Ministry of Health | This decree regulates the use and management of pesticides and their residue, including toxicity classification and their permitted uses in the country; their development, production, processing and formulation, storage, distribution and sale; their transport, application, authorizations, sanitary licenses, registries, permissions and concepts; the labeling of the containers, building sanitation, medical control, human resources, epidemiologic surveillance, sanitary control, and sanctions. |
| Decree 1842-1991 | Ministry of Economic Development | National Statute of the Users of Domiciliary Public Services |
| Constitution of 1991 | National Constituent Assembly | The Constitution contains 49 articles regarding the environment; among them are the duty of the state to protect environmental biodiversity and integrity and to control and prevent the causes of environmental deterioration, as well as the right of every person to enjoy a healthy environment; the introduction of nuclear and toxic wastes into the country is prohibited. |
| Law 99-1993 | National Congress | This law creates the Ministry of Environment, places the public sector in charge of environmental and renewable |

| | | |
|---|---|---|
| | | natural resources management and conservation, and organizes the National Environmental System (SINA). It covers the topic of solid waste management, regulating the general conditions for the environment sanitation with the aim of reducing and preventing pollution impacts, and called for the establishment of maximum limits based on technical studies concerning emission, unloading, transport, storage, manufacture, distribution, usage, and disposal of substances that may damage the environment, such as chemical or biological products used in agriculture and livestock operations. It also establishes, as a function of the Ministry of Environment, the ability to dictate regulations to prevent the entry of nuclear and toxic wastes and their by-products. |
| Law 142-1994 | National Congress | It contains the Domiciliary Public Services regime. It requires the companies in charge of the Domiciliary Public Services to perform their activities without affecting the environment by providing guidelines for the social function of public and private property and the ecological function of protecting biodiversity and the integrity of the environment. It establishes that medical care must be considered as an essential service and so, collection and disposal of medical wastes must be done according to the environmental and sanity regulations. |
| Resolution 189-1994 | Ministry of Environment | It defines the criteria that must be used to catalogue wastes according to their infectious, toxic, explosive, corrosive, flammable, volatile, combustible, radioactive, or reactive characteristics; it also lists the substances that make the wastes toxic. |
| Resolution 541-1994 | Ministry of Environment | This resolution regulates the loading, unloading, transport, storage, and final disposal of construction and demolition debris, elements, concrete, and loose materials, as well as the organic layer, soil, and subsoil from excavation. It prohibits |

| | | |
|---|---|---|
| | | the final disposal of these materials in public places and their mixture with other types of liquid or dangerous wastes. Regarding their final disposal, it requires municipalities to determine where the materials must be deposited and to require environmental licenses. |
| Decree 948 -1995 | Ministry of Environment | It implements the Natural and Renewable National Code and Laws 9-1979 and 99-1993 regarding the prevention of air pollution and control of air quality. It establishes that the incineration or burning of substances and dangerous and/or toxic wastes must be controlled by environmental authorities. It gives the Ministry of Environment the duty to list substances whose emission is prohibited, to set emissions standards, and to establish storage conditions for volatile toxic products. It also defines the duty of providing contingency plans approved by the environmental authority for those who explore, exploit, manufacture, refine, transform, process, transport, or store toxic or dangerous substances. |
| Law 253-1996 | National Congress | This law makes the Basel Convention on the control of transboundary movements of hazardous wastes and their disposal (adopted by the conference of the plenipotentiaries on 22 March 1989) a Colombian law. |
| Decree 605-1996 | Ministry of Economic Development | It implements Law 142-1994 regarding the public service of waste recollection and final disposal and related areas on levels, types, modalities and quality, the regime of the companies in charge of the service and the users' regime. It establishes the adequate management of solid wastes regarding their presentation, storage, recollection, transport, and final disposal, as well as the responsibilities of those involved in processes that could damage the environment and public health. According to this decree, hospitals, clinics, medical centers, and laboratories that |

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| | | analyze or research pathogenic factors must have special collecting services. |
| Technical Standard GTC/11996 | ICONTEC | The Colombian Technical Guide for Environmental Management and Solid Wastes provides guidelines on source separation and the color code for recyclable and nonrecyclable wastes. |
| Resolution 619-1997 | Ministry of Environment | It implements Decree 948-1995. It partially forests the permitted level of atmospheric emissions from nonmobile sources and incinerators of toxic and nondangerous industrial and domestic wastes, in accordance with Decree 948-1995, Article 73. |
| Law 388-1997 | National Congress | It governs the establishment of mechanisms that allow municipalities to regulate land use in their jurisdictions, the equitable and rational use of the soil, the preservation and defense of ecological and cultural heritage, disaster prevention on high-risk settlings as well as the adoption and execution of efficient urban actions. It also calls for the adoption of the public function of land regulation by classifying the land on urban, rural and urban expansion soil, as well as establishing the characteristics of the structures for transport, disposal, and treatment of solid, liquid, toxic, and dangerous wastes and the equipment for essential services, such as schools, medical centers, and airports. |
| Law 430-1998 | Ministry of Environment | It prohibits the introduction of dangerous wastes of any type according with the Basel Convention, and assigns responsibility for the integral management of wastes generated within the country. The law also regulates the equipment required by custom authorities so that importation of such wastes can be detected. The priority is to minimize the production of dangerous wastes, prevent their introduction and stop illegal traffic from other countries, design strategies to upgrade obsolete industries that may produce them, and establish policies and actions to substitute clean |

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| | | processes. Finally, it establishes the duty of waste producers to analyze its physical-chemical properties in properly authorized laboratories. |
| Decree 337-1998 | Ministry of Health | It establishes regulations for natural resources used in pharmaceutical processes, given that some elements related to those processes may cause contamination or need special service while being collected or stored. It also regulates the use of chemical products like pesticides. |
| Law 511-1999 | Ministry of Environment | It establishes the duty of providing safe conditions for people working in recycling and related activities. |
| Law 491-1999 | Ministry of Environment | This law defines criminal activities related to environmental protection and creates ecological insurance. |
| Resolution 1096-2000 | Ministry of Economic Development | This resolution involves internal regulation of the potable water and basic sanitation sector. Regarding collection and final disposal, it established the main principles and operational criteria that must be followed to achieve an adequate management of solid and dangerous wastes and minimize risks to human health and the environment, among them source reductions, reuse, recycling, treatment, and final disposal. It also includes general guidelines regarding adequate management of medical wastes that may be dangerous. |
| Decree 2676-2000 | Ministries of Health and Environment | This decree regulates the integral management of medical wastes generated by persons or companies involved in providing medical services to humans or animals and by those who generate, identify, pack, collect, transport, store, handle, recover, transform, treat, or dispose those wastes in activities related to health services, including health promotion, disease prevention, diagnosis, treatment, and rehabilitation; teaching and research with live specimens or cadavers; biotechnology laboratories, cemeteries, |

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| | | funeral homes, crematory kilns, consultories, clinics, pharmacies, tattoo centers, veterinary laboratories, and zoos. |
| Decree 2695-2000 | Ministry of Environment | This decree, implementing Article 2 of Law 511-1999, regards recycling workers' national day. |
| Law 715-2001 | National Congress | The law establishes the General Participation Systems, which provides territorial entities with resources. Articles 3 and 76 establish participation for general purposes, including resources for investment in potable water and basic sanitation; also included are resources to promote and finance projects to decontaminate streams affected by municipal effluent as well as projects for the final deposition, elimination, and recycling of solid and liquid wastes. |
| Resolution 0058-2002 | Ministry of Environment | It establishes requirements for incinerators and standards of atmospheric emissions for waste incineration. |
| Decree 1713-2002 | Ministry of Environment | The decree regulates the public service of waste collection, according to Laws 99-1993, 142-1994, 632-2000 and 689-2001. |
| Resolution 233-2002 | Commission for Water Regulation and Public Sanitation | This resolution sets fees for users of the public waste collection service. |
| Resolution 1045-2003 | Ministry of Environment | The resolution establishes the plans for integrated solid waste management (PGIRS) and their methodology. |

## *Appendix 2.2: Solid Waste Management in Selected Areas*

This appendix reviews progress in waste management in selected CARs based on data collected in December 2004. The CARs surveyed were CORONTIOQUIA, Cortolima, CVC, DAGMA, Corporguavio, CVS, CAM, CRA, DAMAB, and Bogotá.

### 1. CORANTIOQUIA

Corantioquia has jurisdiction over 80 municipalities in the Department of Antioquia in a territory that covers an area of 3,604,809 hectares (55% of the department's area). There are 4,162,139 inhabitants, 80.38% of whom live in urban areas and 19.62% in rural areas.[14] For administrative purposes, Corantioquia is divided into seven regions according with common geographic characteristics.

The current state of solid waste disposal in the municipalities under Corantioquia's jurisdiction is recorded in the following table. Twenty-seven municipalities do not have adequate disposal facilities.

**Table 2.2.1. Solid Waste Disposal in Regions of Corantioquia**

| Regions | Municipalities | Good Disposal | Deficient Disposal | Substandard Disposal |
|---|---|---|---|---|
| Aburra Norte y Sur | 15 | 12 | 2 | 1 |
| Cartama | 11 | 4 | 4 | 3 |
| Citará | 8 | 5 | | 3 |
| Hevéxicos | 10 | 4 | 2 | 4 |
| Panzenú | 7 | 1 | 1 | 5 |
| Thamíes | 17 | 11 | 3 | 3 |
| Zenufaná | 12 | 3 | 1 | 8 |
| **Total** | **80** | **40** | **13** | **27** |

Source: Corantioquia PAT 2004–2006.

### 2. CORNARE

Cornare's jurisdiction is the eastern part of the Department of Antioquia. Its territory of 26 municipalities has an approximate area of 827,600 hectares, which represents 13% of the

[14] Corantioquia, Tri-Annual Action Plan 2004–2006.

department'sarea. There are five subregions in Cornare: San Nicolas Valley, Forest, Waters, Porce Nus, and Paramo. The 2005 population is estimated at 598,012 inhabitants, 45% of whom live in urban areas[15]

As shown in the table, total waste generated has risen slightly over the five-year period 1999–2003. However, recycling has increased substantially. Accordingly, waste sent to final disposal has declined by almost 20%.

**Table 2.2.2. Generation of Ordinary Solid Waste in the Urban Areas of the Municipalities of Cornare[16]**

| Year | Waste Generated (tons/year | Annual Percentage Change | Waste Recycled (tons/year) | Percentage Recycled |
|---|---|---|---|---|
| 1999 | 65,960.04 | | 5,276.80 | 7.99 |
| 2000 | 47,942.85 | –27.31 | 5,753.14 | 11.99 |
| 2001 | 52,643.88 | 9.80 | 8,949.36 | 16.99 |
| 2002 | 60,710.40 | 15.32 | 13,356.36 | 22.00 |
| 2003 | 66,470.40 | 9.48 | 17,444.4 | 26.24 |
| **Total** | **293,727.57** | | **50,780.06** | **17.04 (average)** |

### 3. CORTOLIMA

Cortolima is the environmental authority of the Department of Tolima, whose jurisdiction covers 47 municipalities with an area of 23,981 square kilometers and a population of 1,302,998 inhabitants. Within Cortolima, 64% of the people live in urban areas.

Overall, 18,563 tons of solid waste was produced in Cortolima's jurisdiction, of which 10,080 tons (54%) was adequately disposed in sanitary landfills, 5.460 tons (29%) was disposed in open dumpsites, 657 tons (4%) was buried, 810 tons (5%) received integrated treatment, and 1,556 tons did not have final disposal treatment.

Cortolima, according to its three-year action plan for 2004–2006, is planning two regional projects for the management, treatment, and final disposal of solid wastes. The first is Chicala's Environmental Park, which will benefit 17 municipalities, including Ibagué, the capital city. The

[15] Cornare, Regional Environmental Management Plan, 2003–2020

[16] Cornare, "Sustainability Indicators. First Report," November 30, 2003.

second is a project for integrated management of municipal solid wastes, with a plant for selection, classification and temporarily storage, treatment, and final disposal and with three possible transfer stations to facilitate transportation of wastes generated in 13 municipalities in the north of Tolima.[17]

**Table 2.2.3. Solid Waste Disposal in Cortolima**

| Municipality | Production per capita (kg/inhab./day) | Generation/Month (tons) | Treatment and/or Final Disposal | | | | |
|---|---|---|---|---|---|---|---|
| | | | Sanitary Landfills | Open Dumpsites | Burial | Integral Management (treatment) | Without Final Disposal |
| Apujarra | | 30 | | | 30 | | |
| Alvarado | | 64 | | | | | 64 |
| Ambalema | | 67 | | | 67 | | |
| Anzoátegui | | 60 | | 60 | | | |
| Armero-Guayabal | 0.7 | 320 | | | 320 | | |
| Ataco | | 90 | | 90 | | | |
| Cajamarca | | 330 | | | | 330 | |
| Carmen de Apicalá | 0.74 | 180 | | | | | 180 |
| Casbianca | 0.75 | 36 | | 36 | | | |
| Coello | 0,79 | 30 | | | | | 30 |
| Coyaima | | 90 | | 90 | | | |
| Cunday | 0.87 | 60 | | 60 | | | |
| Chaparral | 0.68 | 390 | | 390 | | | |
| Dolores | | 120 | | 120 | | | |
| Espinal | 0.79 | 1680 | | 1680 | | | |
| Falan | | 48 | | | | | 48 |
| Flandes | 0.72 | 420 | | | | | 420 |
| Guamo | 0.68 | 300 | | | | 300 | |
| Herveo | | 60 | | 60 | | | |
| Honda | | 480 | 480 | | | | |
| Ibagué | 0.79 | 9420 | 9420 | | | | |

[17] Cortolima, Tri-Annual Action Plan 2004–2006.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Icononzo | 0.67 | 60 | | 60 | | | |
| Lérida | | 390 | | 390 | | | |
| Líbano | 0.66 | 520 | | 520 | | | |
| Mariquita | 0.7 | 624 | | 624 | | | |
| Melgar | 1.1 | 810 | | | | | 810 |
| Murillo | | 4 | | | | | 4 |
| Natagaima | 0.69 | 210 | | 210 | | | |
| Ortega | 0.72 | 150 | | | | 150 | |
| Palocabildo | | 52 | | 52 | | | |
| Piedras | | 30 | | 30 | | | |
| Planadas | | 150 | | 150 | | | |
| Prado | 0.65 | 60 | | 60 | | | |
| Purificación | 0.75 | 240 | | | 240 | | |
| Rioblanco | | 60 | | 60 | | | |
| Roncesvalles | | 60 | | 60 | | | |
| Rovira | | 180 | 180 | | | | |
| Saldaña | 0.76 | 210 | | 210 | | | |
| San Antonio | | 120 | | 120 | | | |
| San Luis | | 90 | | 90 | | | |
| Santa Isabel | | 60 | | 60 | | | |
| Suárez | 0.56 | 30 | | 30 | | | |
| Valle de San Juan | | 30 | | | | 30 | |
| Venadillo | 0.47 | 150 | | 150 | | | |
| Villahermosa | 0.14 | 28 | | 28 | | | |
| Villarrica | | 30 | | 30 | | | |
| **TOTAL** | | **18,563** | **10,080** | **5,460** | **657** | **810** | **1,556** |

Source: Cortolima 2005.

## 4. REGIONAL AUTONOMOUS CORPORATION OF VALLE DEL CAUCA (CVC)

CVC has jurisdiction over an area of 21,306 square kilometers, including 42 municipalities in the Department of Valle del Cauca with a population of 4,460,850 inhabitants; 86.5% of the people live in urban areas.[18]

In its 2004–2006 action plan, CVC identified the inadequate management of solid and hazardous wastes as an environmental issue with high impacts in the region.

Domestic wastes produced in the department amount to 2,500 tons per day, of which 427 tons per day (17.1%) is disposed in sanitary landfills, 1,712.6 tons per day (68.4%) is disposed in the temporary deposit of Navarro, 205.6 tons per day (8.2%) in open dumpsites, 28.5 tons per day (1.1%) in mixed dumpsites; 123.5 tons per day (4.9%) in covered dumpsites, and .3 tons per day (0.3%) in plants with integral management. Construction debris, constituting an estimated 18% of total wastes, are disposed in local dumpsites or thrown by the sides of the highways, or used as covers for dumpsites.[19]

Of the total medical wastes, sludge, and hazardous wastes generated in Cali, 1% is sterilized and buried in the temporary deposit of Navarro. The other municipalities deactivate and burn those wastes and then deposit the ashes in dumpsites or sanitary landfills.

Apart from improvements to the Presidente Regional Sanitary Landfill (located in San Pedro and where 16 municipalities send their wastes), no other projects or programs are currently planned to address these issues.

## 5. DAGMA

The Administrative Department for Environmental Management (DAGMA) is the environmental authority in Cali, which has, through UMBA (Basic Unit for Environmental Monitoring), a program for the monitoring and control of industrial activities and the local service sector. Interviews with local officials indicate that as many as 75 dumpsites are currently operating in the area. A problem of particular concern is the disposal of construction debris.

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[18] Allen Blackman, Richard Morgenstern, and Elizabeth Topping, "Institutional Analysis of Colombia's Autonomous Regional Corporations (CARs)," RFF, Basic Data Table 4.1, June 29, 2004.

[19] CVC, Tri-Annual Action Plan 2004-2006.

Local officials cite the lack of interest in the local community as an important impediment to progress on this issue.[20]

**6. CORPOGUAVIO**

CORPOGUAVIO's territory is the east-central sector of the country and mostly includes mountainous zones of the eastern Andes mountains. It has an area of 366,999 hectares (0.3% of the country's territory) and includes eight municipalities: Fomeque, Gama, Gachalá, Gacheta, Guasca, Junin, Medina, and Ubala. The population is estimated at 80,731 inhabitants, 80.4% of whom live in rural areas.

Wastes in the urban centers are being collected twice a week. Gachetá, Junín, Gama, and Ubala send their solid wastes to a treatment plant in Gachetá. Fomeque has its own treatment plant, and Guasca, Gachala, Junín, and Medina send wastes to open dumpsites.[21]

**7. REGIONAL AUTONOMOUS CORPORATION OF THE SINU AND SAN JORGE VALLEYS (CVS)**

The jurisdiction of CVS includes 28 municipalities in the Department of Cordoba with an area of 25,045 square, kilometers and a population of 1,348,591 inhabitants, 50.1% of whom live in urban areas.[22]

A study of regionalizing the construction of sanitary landfills in each of CVS's six subregions was begun in 2003.

An environmental study of the Sinu River Basin, made by CVS as part of the process to arrange the basin area where most of the population lives, after an evaluation of the current problems in managing solid waste, concludes that the inadequate treatment of wastes in the region has caused damage to natural resources, especially water, since in some cases waste is discharged directly into water bodies, and open dumpsites have proliferated.

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[20] DAGMA, Management Report from the Basic Unit for Environmental Monitoring, Third Quarter 2004

[21] Corpoguavio, Environmental Management Plan 2002–2012.

[22] Allen Blackman, Richard Morgenstern, and Elizabeth Topping, "Institutional Analysis of Colombia's Autonomous Regional Corporations (CARs)," RFF, Basic Data Table 4.1, June 29, 2004.

On Sinu Basin, 10 of the 16 municipalities (62.5%) have a solid waste collection system; 43.7% use waste compactors and 18.7% rely on car wagons or animal vehicles. The other 6 municipalities do not have any system.

There are no sanitary landfills operating in this area. All final disposal is in open-air dumpsites.

It is estimated that 68.7% of the municipalities use open dumpsites without any technical action, 18.7% use some kind of technical action (to expand the wastes until fill the site) and the other 12.5% use urban fields.

Regarding medical wastes, the main troubles encountered are as follows:

- atmospheric pollution caused by open burning;
- technically inadequate incineration and lack of proper permits for atmospheric emissions from stationary sources;
- uncertainty about the reliability of the microbiological sterilization;
- untreated medical sewage;
- lack of information about the wastes produced by clinical laboratories;
- lack of information about environmental and sanitary risks;
- lack of planning for emergencies;
- contamination and mixing of hazardous wastes with nonhazardous materials;
- burying of medical waste at the hospital location; and
- inappropriate disposal sites and systems[23]

## 8. REGIONAL AUTONOMOUS CORPORATION OF THE HIGH MAGDALENA (CAM)

CAM has jurisdiction over the 37 municipalities of the Department of Huila, covering an area of 18,710.2 square kilometers and an estimated population of 996,618 inhabitants, 62.6% of whom live in urban areas.

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[23] CVS, Environmental Diagnostic of the Hydrographic Basin of the Sinu River, Version 01, Inventory of works for productive and domestic activities, March 5, 2004.

During the past five years, CAM has initiated projects to build four treatment plants for wastes, with recycling processes, in the north, south, east, and west of the department.

CAM's Integrated Management Plan 2001–2010 is evidence of interest in improving the management of solid wastes in the department; however, until recently, because of financial constraints, it has not been possible to fully implement this policy.[24]

### 9. REGIONAL AUTONOMOUS CORPORATION OF ATLÁNTICO (CRA)

The Department of Atlantico is in the north of Colombia, in the center of the Caribbean region; its area is completely flat and surrounded by the Magdalena River delta, the Guajaro Depression, and the Valley of the Canal del Dique. It has 23 municipalities in an area of 3,388 squared kilometers, 0.3% of the nation. According with the information provided by the Municipal Secretaries for Planning Affairs, from SISBEN polls, the population of this department is 2,413,803 inhabitants, 93% of whom live in urban areas.

There has been no defined policy on solid waste management in the department. Atlantico generates 1,902 tons per day of solid waste, and 1,496 tons of this is disposed in Baranquilla's sanitary landfill. The other 406 tons, produced by the other municipalities, are not adequately managed. The situation has caused the proliferation of open dumpsites. CRA's three-year action plan for 2004–2006 specifies how this issue should be addressed:

- Environmentally sound and sanitary final disposal of 100% of the domestic solid waste generated in the department is to be achieved by implementing a regional system: three regional sanitary landfills, plus improvements to two municipal sanitary landfills to reduce impact on water bodies and to ensure human health.[25].
- The 14 existing landfills that will be made obsolete by the new regional landfills will be closed to reduce environmental impacts, with a benefit for 795,762 inhabitants.[26]

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[24] CAM, Environmental Management Plan 2001–2010.

[25] Contributing on the reduction of the EDA cases PAT, 2004–2006.

[26] CRA, Tri-Annual Action Plan 2004–2006.

## 10. ADMINISTRATIVE ENVIRONMENTAL DEPARTMENT OF THE DISTRICT OF BARRANQUILLA (DAMAB)[27]

Barranquilla has a plan for integrated solid waste management. The high volume of domestic wastes is collected, transported, and disposed by the Tripe A Company; some of the industrial waste is managed by TRANSBAIN, and medical waste is handled by the SAE Company.

**Table 2.2.4. Population (thousands), Waste Production (tons/day), and Production Per Capita (kg/inhab/day) in Colombia and Barranquilla, 1982–2010**

| | 1982 (1) | 1987 (2) | 1991 (3) | 1993 (4) | 1995 (5) | 1997 (6) | 2010 (7) |
|---|---|---|---|---|---|---|---|
| POPULATION, COLOMBIA | 27.632 | 30.552 | 32.812 | 33.951 | 35.184 | 36.462 | 45.980 |
| PRODUCTION OF WASTE, COLOMBIA | 11.975 | 4.335 | 15.891 | 17.080 | 18.043 | 19.188 | 21.045 |
| PRODUCTION PER CAPITA, COLOMBIA | 0,4334 | 0,4692 | 0,4843 | 0,5016 | 0,5128 | 0,5263 | 0,6227 |
| POPULATION, BARRANQUILLA | 854 | 946 | 986 | 1.026 | 1.053 | 1.081 | 1.278 |
| PRODUCTION OF WASTE, BARRANQUILLA | 608 | 727 | 786 | 843 | 892 | 939 | 1.315 |
| PRODUCTION PER CAPITA, BARANQUILLA | 0,7116 | 0,7682 | 0,7970 | 0,8216 | 0,8470 | 0,8692 | 1,0285 |

Sources:

(1). Ministry of Health. Environmental Sanitation Direction. Recycling Program.. Bogotá May 1993

(2). Ministry of Health and Planning National Department. La Salud en Colombia, Vol. II, Medio Ambiente. Bogotá, 1990.

(3). Ministry of Health, ASEAS and OPS. Diagnostic of Public Service in Colombia. Bogotá, abril 5 de 1992.

(4) 2do. National Seminar of Recycling. Wastes' Generalities. Manizales, 1993.

(5). Ministry of Environment. Towards a clean agreement, Consensus Meeting on Solid Waste Management and Recycling. Bogotá, 4 y 5 de mayo de 1995.

(6,7). DADIMA. Formulation of the Environmental Management Plan. District of Barranquilla, 1997.

Solid waste production in the Barranquilla district had its highest increase in the 1982–1987 period, 19.57% (3.91% per year); the lowest increase was 5.27%, in 1995–1997 (2.64% per year). In these same periods the city's population increased 10.77%, (2.15% per year) and 2.66% (1.33% per year), respectively. It is expected that the city will generate1.0285 kilograms of waste per inhabitant per day, surpassing the production of 1997 by 18.33%.

[27] BAMA, Integral Management Plan 2004–2014.

**Table 2.2.5. Growth Rates in Population, Production of Solid Waste (tons/day), and Production Per Capita (kg/inhab/dia) In Barranquilla and Colombia, 1982–2010**

| | 1982–1987 | 1987–1991 | 1991–1993 | 1993–1995 | 1995–1997 | 1982–1995 | 1982–1997 | 1982–2010 |
|---|---|---|---|---|---|---|---|---|
| POPULATION, COLOMBIA | 2.03% | 1.80% | 1.72% | 1.80% | 1.80% | 1.88% | 1.87% | 1.84% |
| PRODUCTION OF WASTE, COLOMBIA | 3.66% | 2.61% | 3.52% | 2.93% | 3.13% | 3.20% | 3.19% | 2.03% |
| PRODUCTION PER CAPITA, COLOMBIA | 1.60% | 0.80% | 1.77% | 1.11% | 1.30% | 1.30% | 1.30% | 1.30% |
| POPULATION, BARRANQUILLA | 2.08% | 1.03% | 2.02% | 1.30% | 1.30% | 1.63% | 1.58% | 1.45% |
| PRODUCTION OF WASTE, BARRANQUILLA | 3.65% | 1.95% | 3.59% | 2.86% | 2.62% | 3.00% | 2.95% | 2.80% |
| PRODUCTION PER CAPITA, BARRANQUILLA | 1.54% | 0.92% | 1.54% | 1.54% | 1.30% | 1.35% | 1.34% | 1.32% |

Source: Enviromental Management, DADIMA, 1997.

The growth rate in per capita production of solid wastes (kg/inhab/day) in the 1982–1987, 1991–1993, and 1993–1995 periods in the District of Barranquilla was an average of 1.54%; the lowest rate was 0.92% in 1987–1991. The waste generated in the Barranquilla District is 51.89% organic and 48.11% inorganic.

**Table 2.2.6. Composition of Solid Waste in Barranquilla (tons/day), 1978–2010 (projected)**

| | ORGANIC | INORGANIC | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | | PASTEBOARD AND PAPER | PLASTIC | GLASS | METAL | TEXTILES | BONE | OTHERS | |
| 1978 | 386 | 37 | 22 | 17 | 10 | 10 | 4 | 31 | 517 |
| 1980 | 409 | 44 | 26 | 21 | 11 | 11 | 5 | 34 | 561 |
| 1985 | 475 | 66 | 39 | 32 | 17 | 14 | 6 | 45 | 594 |
| 1990 | 485 | 89 | 52 | 44 | 22 | 15 | 8 | 53 | 768 |
| 1995 | 506 | 125 | 73 | 64 | 31 | 18 | 10 | 66 | 893 |
| 1997 | 505 | 143 | 83 | 74 | 35 | 19 | 10 | 71 | 940 |
| 2000 | 496 | 173 | 100 | 91 | 43 | 21 | 12 | 80 | 1.016 |
| 2005 | 454 | 240 | 138 | 130 | 59 | 24 | 14 | 97 | 1.156 |
| 2010 | 365 | 332 | 190 | 185 | 80 | 28 | 18 | 117 | 1.315 |
| **Average** | 453 | 139 | 80 | 73 | 34 | 18 | 10 | 66 | 873 |

Source: Enviromental Management, DADIMA, 1997.

## 11. DISTRICT OF BOGOTA, SPECIAL UNIT FOR PUBLIC SERVICES (UESP)

Bogotá, the country's capital, has a population of 6,635,960, according to the mayor's projection for 2005. Solid waste is managed through private operators under UESP coordination and is supervised by DAMA, the environmental local authority.

Bogotá's master plan for the integrated management of solid waste addresses ordinary, hazardous, dangerous and medical wastes, construction debris, and mud as well, taking into account both current and future amounts.

According to this plan, for 1999 the generation of waste in Bogotá was distributed as follows:

**Table 2.2.6. Disposal of Waste (tons/day) in Bogota, 1999**

| | Final disposal at Doña Juana Landfill | Other management method | Type of method | Total | Percentage |
|---|---|---|---|---|---|
| Ordinary Solids | 4,513 | 1,604 | Recycling | 6,117 | 99% |
| Hazardous Solids | 41 | 9 | Reusage | 50 | 1 |
| Medical Waste | 11 | 2 | Incineration | 13 | 0 |
| **Subtotal** | 4,565 | 1,615 | | 6,180 | 100 |
| Construction Debris | 277 | 22.812 | Landfills | 23,089 | |
| Mud | 0 | 280 | | 280 | |
| **Total** | 4,842 | 24,707 | | 29,540 | |

Source: UESP, Office of Mayor (Bogotá).

# 3. AIR QUALITY

## 3.1. Introduction

Many nations face air quality problems in their urban areas, where population, automobiles, and industry are most concentrated. In the case of Colombia, where 72% of the people live in cities, polluted urban air can have particularly severe national consequences. In addition to lowered visibility and damage to buildings and vegetation, increased incidence of respiratory illness and the associated premature mortality are the principal air pollution–induced problems identified in the international literature. Although several major pollutants are of concern in urban areas, including carbon monoxide (CO), volatile organic compounds (VOCs), and nitrogen oxides ($NO_x$), elevated concentrations of fine particles of 10 microns or less in diameter (PM10) are believed to be the most serious. One recent study calculated that air pollution in Colombia is responsible for an estimated 6,000 premature deaths and 7,400 new cases of bronchitis every year, including children and adults (Larsen 2004). Despite significant improvements in the air quality management programs in Bogotá and several other cities, the available data suggest that air pollution—especially elevated levels of fine particles—remains a problem in most major population and industrial centers in Colombia. As with many other forms of pollution, the impacts of air pollution often fall disproportionately on the poor, compounding the effects of other environmental problems, such as the lack of clean water and poor sanitation.

For policymaking purposes it is important to know the relative contribution of stationary sources (power plants, industry), mobile sources (cars, trucks, buses, motorcycles), and so-called nonpoint sources (biomass burning, construction). It is also important to understand the possible routes of policy intervention. For example, in the case of mobile sources, improvements in fuel quality, vehicle technology, and vehicle maintenance can all affect urban air quality, as can policies for mass transit, fuel subsidies, and others. To be effective, policies must provide incentives for individuals and firms to limit emissions from existing sources and avoid delay in adopting cleaner technologies and fuels.

Basic management choices involve selecting traditional forms of regulation, known as command-and-control or direct regulation, or economic incentives as the implementing mechanisms (Harrington et al. 2004). Although experiences in a number of countries confirm the advantages for incentive-based mechanisms—or at least a combination of incentive and command-and-control policies—at present, Colombia's air quality management strategy is based almost entirely on direct regulation. Apart from some small exemptions to VAT taxes for environmental investments, the principal use of economic incentives in air quality management involves the pricing of motor fuels. Unfortunately, the mobile source incentives are in the form of subsidies, which tend to encourage fuel use and thereby increase emissions. Current plans are to phase out the fuel subsidies by 2006. Also, economic incentives for the use of alternative fuels in vehicles are under active consideration.

Cost-effectiveness and affordability are important elements of successful environmental policies. Further, both public and private institutions must have the necessary resources and the skills to support these measures and to evaluate their effectiveness as a means of improving air quality over time.

Good data are clearly an essential element of policymaking. As documented in recent reports by the Contraloría (2003) and by SIAC (2002), as well as in a document assembled by Peña Villamil (2003), inadequate data collection infrastructure—including too few or poorly equipped environmental laboratories and monitoring stations, limited data documentation and management, and limited modeling capabilities—are impediments to improved environmental management across all media in Colombia. This is especially true for the management of air quality, where detailed, source-specific data are essential for crafting viable solutions. Much of the available information is dispersed in the urban environmental authorities or the CARs, and sometimes not readily accessible to the national government or outside parties. In some cases the paucity of data limits our ability to understand the full nature and causes of the problems. Despite these limitations, 17 of Colombia's cities and industrial corridors do have some type of air quality monitoring network in place (including Bogotá, Area Metropolitana del Valle de Aburra, Barranquilla, Bucaramanga, and Cali, where the principal industries are situated). The information generated by these networks form a major part of the performance data presented in this chapter.

This chapter considers the scope of the air quality problems in Colombia and describes and evaluates recent measures to reduce emissions from multiple source categories. Following this brief introduction are three main sections. Section 2 presents a range of background information on air quality management in Colombia. The focus is on the legal and institutional frameworks plus the procedures and standards established for implementation. Section 3 examines the actual performance of the air quality management system. The available information on emissions, ambient air quality, and outcomes of specific air quality management programs is reviewed. Section 4 presents recommendations for reform.

## 3.2. Background on Air Quality Management

This section presents information on air quality management in Colombia. Subsections describe the legal framework, major pollutants, air quality standards, stationary source controls, fuel subsidies, mass transit, nonpoint sources, and summary information on the social and economic effects of air pollution.

### 3.2.1. Legal Framework

The origins of the current air quality management system in Colombia can be traced to Law 2811-1974, the National Code of Renewable Natural Resources and Protection of the Environment, which established the basic framework for the modern system. Law 9-1979, or the "Sanitary Code," serves as the primary regulation for air quality management. The primary authorities governing air quality management prior to Law 99 are displayed in Table 3.1.

**Table 3.1. Development of National Norms on Air Quality Before 1993**

| | |
|---|---|
| Decree Law 2811 of 1974. National Code of Renewable Natural Resources and Protection of the Environment, Arts. 73–76, Arts. 33, 192 and 193 | On the atmosphere, airpace, and noise. |
| Law 9 of 1979. National Sanitary Code, Arts. 41–49, and 202 | On atmospheric emissions and noise. |
| Decree 2 of 1982 | Atmospheric emissions, fixed sources. |
| Decree 2206 of 1983. Modifies Title XVI of Decree 2 of 1982. | Surveillance, control, and fines for atmospheric emissions from fixed sources. |
| Resolution 08321 of 1983 | Ministry of Public Health. Protection and conservation of health from production and emission of noise. |
| Resolution 19622 of 1985 | Procedures for the analysis of the quality of air. Sulfur dioxide ($SO_2$). |
| Resolution 02308 of 1986 | Procedure for the analysis of the quality of air. Total suspended particles. |

Source: General Attorney's Office of the Nation (1993).

The development of modern air quality standards has its origins in Decree 948-1995, which establishes two types of regulation: air quality rules and specific emissions rules. These provide the basis for actions by environmental authorities to manage air quality. Subsequent actions address a broad array of technical and policy issues for both stationary and mobile sources, as described in Table 3.2.

**Table 3.2. Development of National Norms on Air Quality Since 1995**

| **Law / Decree / Regulation** | |
|---|---|
| Decree 948-1995 | It establishes specific regulations regarding the air resource:<br>• Regulates the protection and control of air quality and noise.<br>• Establishes rules regarding allowed levels of polluting emissions.<br>• Classifies the pollution sources and the prohibited and controlled substances.<br>• Defines rules regarding noise control.<br>• Assigns functions and competences to the environmental authorities regarding air quality and air pollution control.<br>• Establishes an administrative punitive system and enforcement measures to be taken against violators.<br>• Establishes parameters for community participation in controlling the air pollution. |
| Decree 2107-1995 | This decree eases off some restrictions regarding heavy oils, controlled burning, and the time required to adopt cleaner technologies to protect the atmosphere (issued in Decree 948-1995). It established stricter regulations on diesel vehicles and emissions from mobile sources, and it made emissions evaluation a requirement for the emissions permits. |
| Resolution 898-1995 | The resolution regulates environmental criteria for the quality of solid and liquid combustibles used in commercial and industrial kilns and boilers and internal combustion engines of vehicles.<br>• Defines regulation of quality of liquid combustibles, gasoline, and diesel.<br>• Establishes regulation of quality of mineral coal to be used in kilns and boilers.<br>• Establishes 1.7% of weight as the maximum sulfur content for oil burned in industrial uses. |
| Resolution 1351-1995 | This resoltuion adopted the IE-1 (Industrial Emissions) form, "Report of the State of Emissions, which must be filled by the emitter responsible or its legal representative and must be presented to the competent environmental authority. |
| Resolution 005-1996 | The resolution includes a glossary of technical definitions, general regulation for emissions, procedures to measure emission levels, requirements for the operation of measuring equipment, the certification for mobile sources, the mandatory verification process, and the surveillance of diagnostic centers. This resolution was partially modified by Resolution 909-1996. |

| | |
|---|---|
| Resolution 378-1997 | It establishes the characteristics for emission certification tests for vehicle manufacturers and importers. |
| Resolution 619-1997 | This resolution determines the factors for granting emission permits to nonmobile sources. |
| Decree 1228-1997 | The decree obligates vehicle manufacturers and importers to obtain emission certificates based on dynamic tests showing that the vehicles meet the current regulations according to their weight. The certificate is issued by MAVDT. |
| Resolution 528-1997 | The resolution prohibits the manufacture of household refrigerators and freezers that require or contain chlorofluorocarbons (CFCs) in their production or operation, and it also establishes requirements for the importation of such appliances. This resolution was issued as part of the obligations Colombia incurred when it signed the Montreal Protocol on substances that deplete the ozone layer. |
| Decree 1697-1997 | This decree partially modifies Decree 948 regulating air quality, establishing new definitions on used lubricant oils and the presence of lead, sulfur, or other polluting substances in combustibles. |
| Resolution 0415-1998 | This resolution concerns used oils and establishes specific requirements depending on the source, the further usage, concentrations, etc. It also establishes permits for this usage and requires users to maintain records of the used oil provider, the source of the oil, the volume and proportion of the oil used in the mixture, and the type of fuel mixed with the used oil. |
| Resolution 0623-1998 | This resolution modifies Resolution 898—1995, on the quality of solid and liquid fuels used on commerical and industrial kilns and boilers, by establishing new parameters for mineral coal quality or its mixtures to be used as fuel. |
| Resolution 1048-1999 | The resolution establishes allowable levels for emission of polluting agents produced by diesel and gasoline engines, based on dynamic tests, for vehicles built after 2001. |
| Resolution 0970-2001 | It establishes requirements, conditions, and maximum allowable limits for emissions when pesticide containers are incinerated in kilns at cement factories. |
| Resolution 0304-2001 | The resolution establishes measures for the importation of hazardous substances that affect the ozone layer. |
| Resolution 058-2002 | This resolution concerns maximum allowable limits for emissions by incinerators and crematory kilns of solid and liquid waste:<br>• average daily emissions of the polluting agent<br>• average hourly emissions for polluting agent<br>• emission of heavy metals<br>• emission of dioxins and furans<br>It also establishes requirements for maintenance and control of incinerators. |

### 3.2.2. Major Pollutants

Major sources of air pollution include stationary point sources, such as factories and power plants; mobile sources that consist almost entirely of exhaust from vehicles; and nonpoint sources, such as include agriculture, construction, and emissions from the residential and commercial sectors.

Particulate matter is the term for airborne particles, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are directly emitted into the air from a variety of sources, such as vehicle exhaust, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Particles can also be created by atmospheric conversion of sulfur dioxide and nitrogen oxides to sulfates and nitrates. The most common measurements of particulate matter in Colombia are total suspended particles (TSP ) and PM10 (particles with a diameter of 10 microns or less). There is strong scientific evidence that elevated concentrations of PM10 cause respiratory illness associated with premature mortality, and even more so for ultrafine particles—those with a diameter of 2.5 microns or less (PM2.5).[28]

Sulfur dioxide ($SO_2$) is a by-product of burning fossil fuels, such as crude oil and coal. $SO_2$ concentrations in Colombia have decreased in the past two decades, mainly because of an increase in the use of lower-sulfur fuels for the generation of energy. $SO_2$ is a stinging gas that causes respiratory ailments among humans. In moist environments, $SO_2$ emissions result in acidification and winter smog. As noted, $SO_2$ can be transformed in the atmosphere into sulfates that appear as fine particles.

Nitrogen oxide ($NO_x$) pollution results from vehicle exhaust, power plants and other combustion installations, and industrial and agricultural activity. Catalyzers in car exhausts can reduce $NO_x$ emissions. $NO_x$ reacts with other air pollutants in the atmosphere to form ozone as well as fine particulates (nitrates) in the lower atmosphere, and contributes to acidification and eutrophication processes. This pollutant, too, results in respiratory ailments among humans.

Volatile organic compounds (VOCs) consists of several contaminants, including organic compounds and solvents. These compounds are derived from petroleum reservoirs, storage of gasoline and other volatile compounds, industrial processes and fuel combustion, paints and

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[28] No systematic monitoring information is available in Colombia on PM2.5.

cleaners, and agricultural activities. VOCs are the main cause of smog in the lower atmospheric layer and cause health problems ranging from irritation of eyes to a decrease in lung capacity, and even cancer.

Carbon monoxide (CO) is formed during the incomplete combustion of fuels. CO binds to hemoglobin in the blood, preventing the transport of oxygen to vital organs.

### 3.2.3. Air Quality Standards

Air quality rules specify the volume of gases, smoke, noise, and odors that are allowed in a specific zone. Specific regulations cover particulate matter, $SO_2$, CO, and expelled photochemical oxidants such as ozone ($O_3$) and nitrogen dioxide ($NO_2$). These regulations establish the maximum allowed ambient concentrations of these substances over three averaging periods: annually, daily and hourly.

The annual limit allows days with higher concentrations as long as the annual average concentration does not exceed the specified levels. Similarly, the daily limit means that at some hours of the day, high concentrations may be allowed if the average concentration on that given day is below the specified level. The hourly limit means that high concentrations for some minutes are permitted as long as the average concentration in that hour is below the specified limit. Among the three types of rules, the hourly limit is usually the strictest. The national ambient standards originally issued in 1982—and which are still in effect today—are displayed in Table 3.3.

**Table 3.3. Air Quality Standards: Decree 2 of 1982**

| Pollutant | Standards | Observations |
|---|---|---|
| Suspended particles (TSP) | 100 $\mu g/m^3$<br>400 $\mu g/m^3$ | Geometric average of all daily samples<br>Maximum concentration, only once a year |
| Suspended particles (PM10) | No standard established | |
| Sulfur Dioxide ($SO_2$) | 100 $\mu g/m^3$<br>400 $\mu g/m^3$<br>1500 $\mu g/m^3$ | Arithmetic average of all daily samples<br>Maximum concentration, only once a year<br>Maximum concentration of one sample once a year |
| Carbon Monoxide (CO) | 15 $mg/m^3$<br>50 $mg/m^3$ | Maximum concentration of one sample taken during 8 continuous hours<br>Maximum concentration of one sample continuously collected during 1 hour |
| | | |

| | | |
|---|---|---|
| Nitrogen Oxides ($NO_x$) | 100 µg/m$^3$ | Arithmetic average of 2 daily samples or maximum concentration of one sample |
| Photochemical Oxidants ($0_3$) | 170 µg/m$^3$ | Taken during 1 continuous hour, once a year |

*Daily samples collected during 24 continuous hours in 12 months (one year).

Despite the failure to incorporate the research findings of the past two decades into revised national ambient standards,some large urban areas have updated local air quality standards. In Bogotá, for example, DAMA issued Resolution 1208-2003, which established more stringent requirements or shorter averaging periods for several pollutants and, most importantly, introduced a formal standard for PM10. For the purpose of measuring air quality, DAMA has divided the city into five sectors that are served by 14 stations with air quality monitors, which have been in operation since 1997. Rules for monitoring and standards for concentration levels are included in DAMA's resolution 391-2001. The standards in effect in 2003, along with future requirements for 2006 and 2010, are shown in Table 3.4.

**Table 3.4. Standards for Air Quality in Bogotá; DAMA, Resolution 1208-2003**

| Polluting agent | Period | Description | Unit | 2003 | 2006 | 2010 |
|---|---|---|---|---|---|---|
| Carbon Monoxide (CO) | 8 hours | Average hourly concentration in 8 hours | µg/m$^3$ | 12000 | 11000 | 10000 |
| | 1 hour | Average hourly concentration | µg/m$^3$ | 40000 | 40000 | 40000 |
| Sulphur Oxides ($S0_2$) | Annual | Arithmetic average of the average daily concentrations in 365 days | µg/m$^3$ | 80 | 70 | 60 |
| | 24 hours | Average hourly concentration in 24 hours in 12 months | µg/m$^3$ | 350 | 325 | 300 |
| | 3 hours | Average hourly concentration in 24 hours in 12 months | µg/m$^3$ | 1400 | 1350 | 1300 |
| Nitrogen Oxides ($NO_x$) | Annual | Arithmetic average of the average daily concentrations in 365 days | µg/m$^3$ | 100 | 100 | 100 |
| | 24 hours | Average hourly concentration in 24 hours | µg/m$^3$ | 220 | 180 | 150 |
| | 1 hour | Average hourly concentration | µg/m$^3$ | 320 | 320 | 320 |
| Ozone ($O_3$) | 8 hours | Average hourly concentration in 8 hours | µg/m$^3$ | 130 | 110 | 100 |
| | 1 hour | Average hourly concentration | µg/m$^3$ | 170 | 155 | 150 |
| Total Suspended Solids (TSP) | Annual | Geometric average of the average daily concentrations in 365 days | µg/m$^3$ | 100 | 85 | 80 |

| | | | Unit | 2003 | 2006 | |
|---|---|---|---|---|---|---|
| | 24 hours | Average hourly concentration in 24 hours in 12 months | µg/m³ | 400 | 300 | 300 |
| Particulate Matter (PM10) | Annual | Arithmetic average of the average daily concentrations in 365 days | µg/m³ | 80 | 55 | 50 |
| | 24 hours | Average hourly concentration in 24 hours | µg/m³ | 180 | 155 | 150 |

Decree 948-1995 established a four-category system to classify air quality: level 1 is the most desirable level, in which there is believed to be no danger to human health. The other three levels involve some form of nonattainment: level 2 is considered preventive, level 3 represents an alert, and level 4 is regarded as an emergency.

DAMA has established IBOCA as the primary indicator of air quality in the city. The IBOCA indicator, which operates on a scale of 0 to 10, is a ratio of the average concentration of the polluting agent to the established standard for that polluting agent multiplied by 10. The indicator calculates hourly concentrations for CO, $NO_x$, $O_3$, and daily averages for PM10 and $SO_x$. The air quality designations defined by IBOCA are displayed in Table 3.5.

**Table 3.5. Air Quality Designations for IBOCA**

| IBOCA Values | Interpretation |
|---|---|
| 0-1.25 | Good; there is no effect on human health. |
| 1.26-2.5 | Moderated; there is no effect on population in general. |
| 2.51-7.50 | Unhealthy; this air quality is associated with increased discomfort to people with respiratory and cardiovascular ailments specifically, and light discomfort to the population in general. |
| 7.51-10 | Very unhealthy; the health of people with cardiac and respiratory diseases deteriorates, and healthy people are affected. |
| 10 > | Dangerous; human health is at high risk. |

### 3.2.4. Stationary Source Controls

Emission rules specify the maximum amount of gas, smoke, vapors, noise, or odor to be discharged through a pipe or a generating source. Emission rules are not directly related to levels of air quality, since multiple emission sources, including both point and nonpoint sources, along with meteorological conditions, all contribute to local air quality. Emission rules govern the volume and concentration of particulate matter that may be emitted to the outside air through a duct. They also establish minimum allowable stack heights.

Particulate matter is classified according to the type of activities involved:

- boilers based on carbon;
- cement industry, with its kilns (where clinker is produced), mills (where clinker is crushed), and clinker coolers;
- metallurgy industry, which uses induction kilns and electric arc furnaces;
- asphalt factories; and
- incinerators, including crematories and incinerators for wastes of any kind (domestic, industrial, special, and hazardous).

As a general matter, particulate matter is regulated only in the industrial sector, which includes electric utilities. There are no regulations governing the service sector, quarries, etc.

The allowable stack height for boilers depends on the location—rural or urban. The minimum height is 15 meters. The allowable concentration is based on energy consumption. The standard is stated in terms of kilograms of particles per million of kilocalories consumed per hour. Decree 2-1982 established the emissions standards for boilers. These standards are still in effect today. The standards for facilities situated at sea level are shown in Table 3.6.[29]

**Table 3.6. Standards for Coal Boilers (Decree 2-1982)**

| Heat consumption per hour (million kilocalories) | Rural areas (million kilocalories) | Urban areas (million kilocalories) | Reference height (meters) |
|---|---|---|---|
| >10 | 3.00 | 2.00 | 15 |
| 25 | 2.24 | 1.45 | 20 |
| 50 | 1.79 | 1.14 | 25 |
| 75 | 1.57 | 0.99 | 30 |
| 100 | 1.43 | 0.90 | 40 |
| 200 | 1.15 | 0.71 | 45 |
| 300 | 1.01 | 0.61 | 50 |
| 400 | 0.92 | 0.55 | 55 |
| 500 | 0.86 | 0.51 | 60 |
| 750 | 0.75 | 0.45 | 100 |
| 1000 | 0.68 | 0.40 | 115 |
| 1500 or more | 0.60 | 0.35 | 120 |

[29] For Bogotá and other high-altitude areas, more stringent requirements are in effect based on a simple formula adjustment to Table 3.6.

Allowable emissions for clinker kilns in the cement industry depend on output. That is, the standard is stated in terms of particulate matter per tons of cement produced. The minimum height of the chimneys is 30 meters. There are specific controls on emissions for some activities. For example, allowable $SO_2$ emissions from the production of sulfuric acid ($H_2SO_4$) are stated in terms of $SO_2$ per ton of output. The minimum stack height is set at 25 meters. Specific controls also apply to boilers, kilns, and other combustion processes that generate $SO_2$ emissions. Article 79 of Decree 2-1982 does not limit the concentration of emissions but does govern the stack height according to the sulfur content of the fuel.

Resolution 58-2002 regulates emissions from incinerators and applies to "the operation and maintenance of incinerators and crematory kilns in which the following wastes may be incinerated: liquid and solid wastes with hydrocarbons (oil, petroleum, etc.), nonexplosive liquid or solid waste combustibles, wastes and additives for lubricant oils and wood and remnant treated with halogenated compounds" (Article 2).

Although detailed information about compliance is not available for these standards, it is widely believed that noncompliance is a serious problem. In the case of incinerators, informal interviews with industrial experts suggest that the combination of stringent technical standards and siting problems may be an important deterrent to compliance.

### 3.2.5. Mobile Source Controls

Resolution 5 (January 9, 1996) regulates the emission of hydrocarbons, CO, and $NO_x$ from vehicles. Mobile source standards apply to all new vehicles except those with three or fewer wheels, machinery vehicles, agricultural vehicles, trains, and classic cars. The requirements for new gasoline and diesel vehicles are displayed in Tables 3.7 and 3.8. These standards apply to private vehicles in the main cities. However, they do not apply to buses or large trucks.

**Table 3.7. Standards for Gasoline Vehicles**

| Year of production | Percentage carbon monoxide (CO) volume | Hydrocarbons (HC) (ppm) |
|---|---|---|
| 2001 and later | 1.5 | 300 |
| 1998–2000 | 3.5 | 400 |
| 1996–1997 | 5 | 600 |
| 1991–1995 | 5.5 | 700 |
| 1981–1990 | 7 | 850 |
| 1975–1980 | 8 | 1050 |
| Before 1974 | 10 | 1300 |

**Table 3.8. Standards for Diesel Vehicles (Opacity Tests)**

| Year of production | Light vehicle | Midsize vehicle | Heavy vehicle |
|---|---|---|---|
| 2001 and later | 50% | 50% | 50% |
| 1996–2000 | 60% | 60% | 60% |
| 1991–1995 | 60% | 60% | 60% |
| 1986–1990 | 65% | 65% | 65% |
| 1981–1985 | 70% | 70% | 70% |
| Before 1980 | 75% | 75% | 75% |

In the 1990s DAMA (Bogotá), DAGMA (Cali), and a few other urban environmental authorities established environmental vehicle control programs. Requirements were established for vehicles to undergo a periodic emissions test. Emissions certificates are issued at specialized diagnostic centers (CDRs) to those vehicles that pass an electronic test. If the vehicle does not pass the test, the owner must perform the required adjustments to the engine. Audits of the CDRs are conducted periodically to determine whetherthe proper procedures are being followed.

In some cities, a program of mobile brigades has also been introduced to audit for the presence of a current emissions certificate on vehicles on the road. In Bogotá, a program entitled "a day without my car" has been introduced on a pilot basis for one day per year. On the designated day, private vehicles (excluding buses or taxis) are banned from city streets.

In addition to tailpipe standards, fuel quality is a major contributor to mobile source emissions. Standards for the sulfur content of regular and premium gasoline and of diesel and premium diesel are displayed in Table 3.9. In Bogotá, with the introduction into service of the TransMilenio System, a new type of fuel, "diesel extra," was introduced for use in buses (Resolution 68, January 18, 2001). The sulfur content of diesel extra is 1200 ppm.

**Table 3.9. Regulation of the Sulphur Content of Gasoline and Diesel Fuels**

| Regulation | Sulfur content of regular and premium gasoline | Sulfur content of diesel | Sulfur content of diesel premium |
|---|---|---|---|
| Resolution 898 (August 23, 1995), Ministry of Environment | 1500 ppm (0.15%) | 6000 ppm (0.6%) | |
| Resolution 68 (January 18, 2001), Ministry of Environment | 1000 ppm (0.10%) | 4500 ppm (0.45%) | 1200 ppm (0.12%) |

According to Resolution 1565, issued December 27, 2004, by MAVDT and the Ministry of Mining and Energy, the maximum allowable content of sulfur for all fuels used in Colombia is scheduled to drop to 500 ppm starting on July 1, 2008. To meet this new standard, it is expected that a new hydrotreatment program will be implemented at the Barrancabermeja refinery. Plans are reportedly also underway to modernize the refinery at Cartagena. If those modernization plans are not completed on time, imports may have to be increased. Finally, efforts are underway to further increase the availability of natural gas and to encourage its use as a transportation fuel, especially in Bogotá.

### 3.2.6. Fuel Subsidies

Historically, the price of fuels in Colombia has been controlled in line with domestic production costs rather than international price levels. Those price controls have served as a form of subsidy to domestic fuel consumption, thereby exacerbating congestion and air pollution and increasing health and environmental damages. One study (Krupnick et al. 1996) estimated that gasoline prices were about 30% to 35% below international levels. Diesel prices are reportedly even further below international levels.

The current policy is to reduce the future demand for fuel in the transportation sector by equalizing local and international prices of gasoline and diesel by 2006 with annual adjustments of about 15% in 2005–2006. One study (Brugman 2004) has estimated that this policy would reduce demand for transportation fuels by 8% relative to 2002 levels. Corresponding emissions reductions in PM10, $SO_x$, and $NO_x$ are estimated to be 2.3% for 2005 and 7.7% over the long term (2020). Additionally, as part of the Transmileno system (see below), a 20% local surtax on gasoline has been introduced. Half of the revenue, mostly paid by private vehicles, is used to support TransMilenio, and the other half supports road maintenance and related activities.

***Mass Transit***

TransMilenio, a mass transit system, was inaugurated in December 2000. It is part of a program called Integrated Systems for Mass Transportation (SITM), which is being implemented under the National Power Plan and the Transportation Stategic Plan 2002–2006. A major goal of SITM is to improve air quality in the largest cities in the country.

Currently, about 15% of the 7 million daily trips in pubic transportation vehicles in Bogotá involve TransMilenio.[30] TransMilenio uses high-capacity buses that run at an average speed of 27 km/hour along 56 km of exclusive corridors. For each new bus that is added to the TransMilenio system, seven old buses are retired. Universidad de los Andes, CEDE (2004) reports a research finding that although the average monthly concentrations of PM10 have continued to rise since 1996, they would have risen further without TransMilenio.[31] The same holds for ozone concentrations. As part of the TransMilenio system, extensive bicycle paths have also been constructed throughout the city.

One study (Brugman 2004) evaluated the reduction in emissions associated with mass transportation systems in Bogotá, Medellín, Cali, Barranquilla, and Pereira. According to Brugman, these systems are expected to reduce the emissions of PM10, $NO_x$, and $SO_x$, caused by mobile sources by an estimated 4.2%, 2.6%, and 0.9%, respectively, in 2005 and by 6.5%, 5.9%, and 1.6%, respectively, in 2020 (see Table 3.10).

Unfortunately, no specific data are available on the air quality effects of TransmMilenio. However, it is clear that the diesel extra fuel used by the TransMilenio buses has a lower concentration of sulfur.

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[30] See www.transmilenio.gov.co.

[31] Edwardo Uribe, "Air Pollution Management in Two Colombian Cities," draft paper, 2005, page 19.

**Table 3.10. 2001–2020 Emissions and Reductions with Mass Transportation Systems ($PM10$, $SO_x$, $NO_x$)**

| | PM-10 | SOx | NOx | Total | PM-10 | SOx | NO | Total |
|---|---|---|---|---|---|---|---|---|
| | Ton | Ton | Ton | Ton | % | % | % | % |
| Prom. 2001-2003 | 36067 | 108017 | 237961 | 382045 | 100.0% | 100.0% | 100.0% | 100.0% |
| Reducción en | | | | | | | | |
| 2004 | 684 | 443 | 2820 | 3947 | 1.9% | 0.4% | 1.2% | 1.0% |
| 2005 | 1500 | 1014 | 6124 | 8638 | 4.2% | 0.9% | 2.6% | 2.3% |
| 2010 | 2480 | 1528 | 12183 | 16192 | 6.9% | 1.4% | 5.1% | 4.2% |
| 2015 | 2296 | 1643 | 12550 | 16488 | 6.4% | 1.5% | 5.3% | 4.3% |
| 2020 | 2333 | 1750 | 14124 | 18207 | 6.5% | 1.6% | 5.9% | 4.8% |

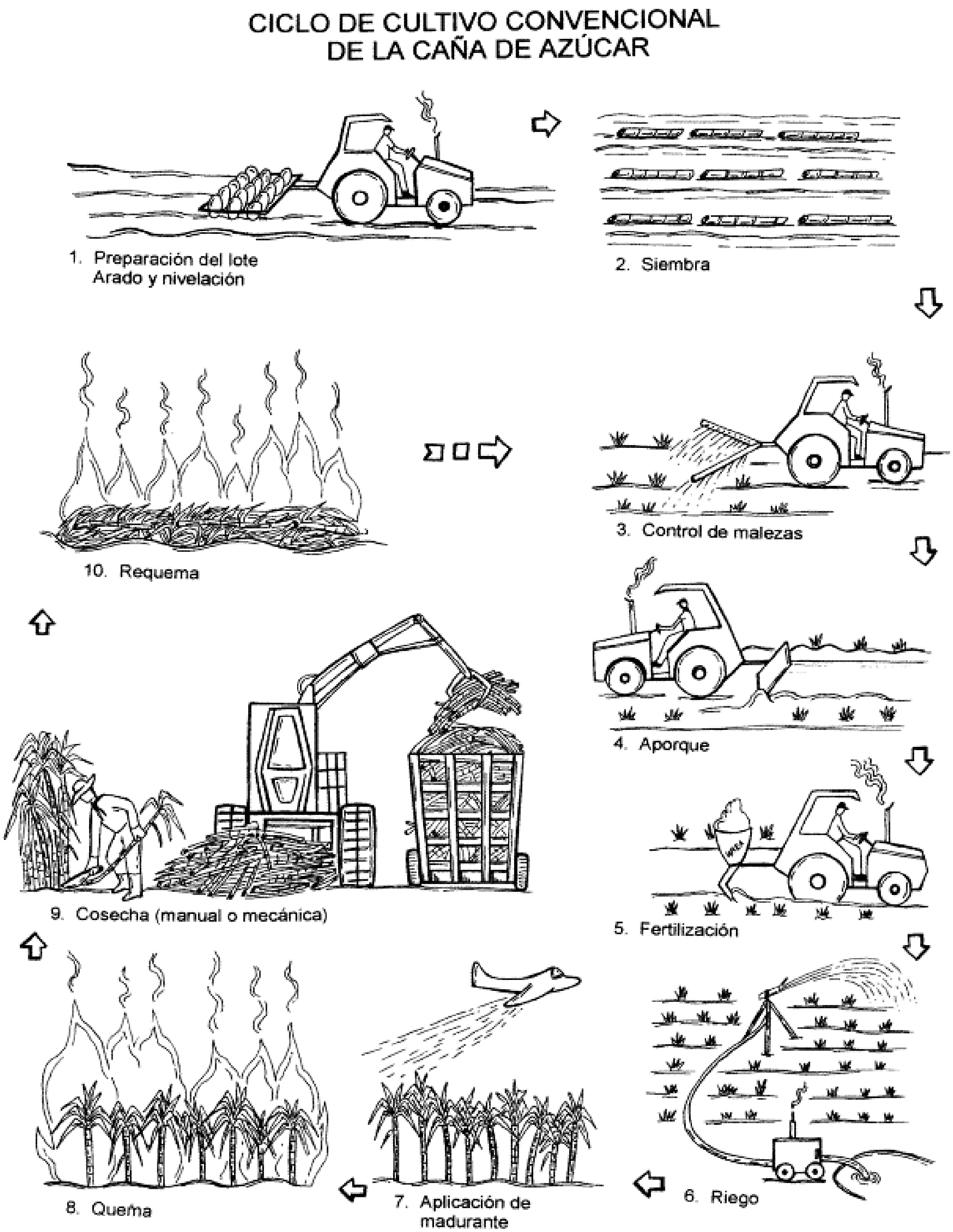
Source: Brugman, Alberto. Design of an economic instruments program for managing and controlling urban atmospheric pollution in Colombia. MAVDT. December 2004

### *Nonpoint Sources*

Although nonpoint sources contribute to degrade air quality in Colombia, most attention has focused on emissions from burning practices in the sugar cane fields. A schematic representation of the cultivation process is shown in Figure 3.1. The burning and reburning (steps 8 and 9) processes can cause serious air pollution problems during certain stages of cultivation.

Efforts have been made to restrict the burning and reburning in populated areas. In CVC, for example, the association of sugar cane farmers has agreed to use the so-called green cut method for harvesting crops within 1,000 meters of urban perimeters, 30 meters of villages, 80 meters on each side of the highways, and 30 meters around high-tension transmission lines.

**FIGURE: 3.1**




Source: Image taken from the "Study Case on Conventional and Agro-Ecologic Management of Sugar Cane Plantations in Valle del Cauca, Colombia," by CIPAV (Centro para la Investigación de Sistemas Sostenibles de Producción Agropecuaria). www.cipav.org.co.

### 3.2.7. Social and Economic Effects of Air Pollution

Using standard methodologies from the epidemiologic literature, a recent study by Larsen for MAVDT (2004) estimated that particulate pollution was responsible for an estimated 6,000 premature deaths annually and 7,400 new cases of chronic bronchitis every year in Colombia. Pollution-related hospitalizations are estimated at 13,000, and emergency room visits and outpatient hospitalizations are estimated at 255,000 per year (see Table 3.11). Valuing these health impacts via standard economic criteria, Larsen estimated the annual cost of air pollution in Colombia is $1,500 billion COP. Of this total, 65% is associated with mortality and 35% with morbidity. Measured in terms of DALYs (disability-adjusted life years), mortality represents 50% and morbidity represents 50%.

Using the same analytical criteria, Larsen estimated that the annual cost of health impacts from indoor air pollution associated with the use of traditional fuels, mainly fuel wood, is $415 billion COP. Taken together, the damages associated with indoor and outdoor pollution represent almost 1% of the gross domestic product (GDP).

**Table 3.11. Estimated Health Impact Of Urban Air Pollution in Colombia**

| **Health categories** | **Total cases** | **Total DALYs** |
|---|---|---|
| Premature mortality | 6,040 | 45,300 |
| Chronic bronchitis | 7,410 | 16,300 |
| Hospital admissions | 12,970 | 210 |
| Emergency room visits, outpatient hospital visits | 255,000 | 1,150 |
| Restricted-activity days | 42,000,000 | 12,640 |
| Lower respiratory illness in children | 585,000 | 3,800 |
| Respiratory symptoms | 135,000,000 | 10,100 |
| **Total** | | **89,500** |

Source: Reproduced from Larsen et al. (2004).

## *3.3. Performance of the Air Quality Management System*

This section presents information on the performance of Colombia's air quality management system. The available information is generally of two types: process and outcome measures. Process measures are specific actions undertaken with the goal of improving air quality, such as the number of vehicles inspected or the number of hectares of sugar cane harvested with so-called green cuts. Outcome measures are more direct indicators of air quality, such as ambient concentrations of fine particles or other major pollutants, calculated on a daily or annual basis. Despite the obvious limitations, emissions are also treated as outcome measures of the air quality management system.

Individual subsections address a wide range of performance issues: emissions, ambient concentrations of PM10 for select areas, pollutant abatement expenditures, mobile source policies, fuel quality and fuel pricing, recent developments in the energy sector, nonpoint source emissions associated with burning sugar cane stalks, and proposed new air pollution policies, including economic incentive measures.[32]

### 3.3.1. Emissions by Pollutant

As described in Section 3.2, air quality regulations have been in effect in some form for more than two decades in Colombia. IDEAM has developed a number of baseline indicators. The methodology underlying these indicators has been used to develop national estimates and to assist with the management of urban air quality throughout the country. This subsection reviews the basic information available to measure emissions and air quality with an emphasis on large urban areas.

Emissions estimates for $SO_x$, $NO_x$, CO, and particulate matter are based on a fairly standard formulation that relies on emissions factors rather than monitoring data.[33] Information on

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[32] Clean production agreements, which generally cover multimedia activities, are not explicitly covered in this chapter. The available information on these agreements is presented in Chapter 5, which covers waste management issues.

[33] $E_i = \sum_{j=1}^{n} \{(P_j * FE_{ij}) * (1 - R_{ij})\}$

Where:

economic activity is derived from DANE's yearly manufacturing survey.[34] Emissions factors are taken from various sources, including the Industrial Pollution Projection System (IPPS), the World Bank, the Intergovernmental Panel on Climate Change (IPCC), the U.S. Environmental Protection Agency (EPA) and CORINAIR. Emissions estimates include 232 municipalities covered in the DANE's manufacturing survey, but only those firms with more than 10 employees and/or those with outputs valued at 70.5 million pesos or more per year (1999 values). Thus, brick kilns and other small firms—which may be large sources of emissions—are typically excluded. The results for the 232 municipalities studied, for $SO_x$, $NO_x$, CO, and PM10, are shown in Table 3.12. The results for the 10 Colombian cities with the highest emissions are displayed in Table 3.13.

**Table 3.12. Total Annual Emissions of Selected Pollutants, 1999**

| Polluting Agent | Tons/year |
|---|---|
| $SO_x$ | 177,438.5 |
| $NO_x$ | 106,560.4 |
| CO | 97,738.4 |
| PM10 | 78,569.4 |

Source: IDEAM.

**Table 3.13. Annual Emissions for Selected Pollutants for Large Municipalities, 1999**

| | | Polluting agent (tons/year) | | | |
|---|---|---|---|---|---|
| **Municipality** | **Department** | **SOx** | **NOx** | **CO** | **PM** |
| Bogotá | DC | 17,928.9 | 12,689.3 | 12,503.4 | 10,154.9 |
| Barrancabermeja | Santander | 22,567.5 | 13,056.3 | 11,738.3 | 2,064.7 |
| Yumbo | Valle | 18,930.4 | 8,348.0 | 11,057.4 | 7,637.3 |
| Barranquilla | Atlantico | 17,755.9 | 7,708.0 | 5,280.4 | 8,313.3 |
| Cartagena | Bolivar | 12,517.4 | 7,676.5 | 5,294.4 | 3,396.1 |
| Medellín | Antioquia | 6,969.5 | 5,854.2 | 7,571.7 | 2,621.7 |
| Nobsa | Boyaca | 5,635.2 | 2,524.1 | 4,950.2 | 1,948.4 |
| Cali | Valle | 3,824.1 | 3,045.6 | 4,969.6 | 1,281.0 |
| Puerto Nare | Antioquia | 5,352.7 | 2,485.3 | 302.5 | 2,588.7 |
| Palmira | Valle | 2,700.6 | 1,903.0 | 3,407.7 | 1,013.4 |

Source: RFF and IDEAM.

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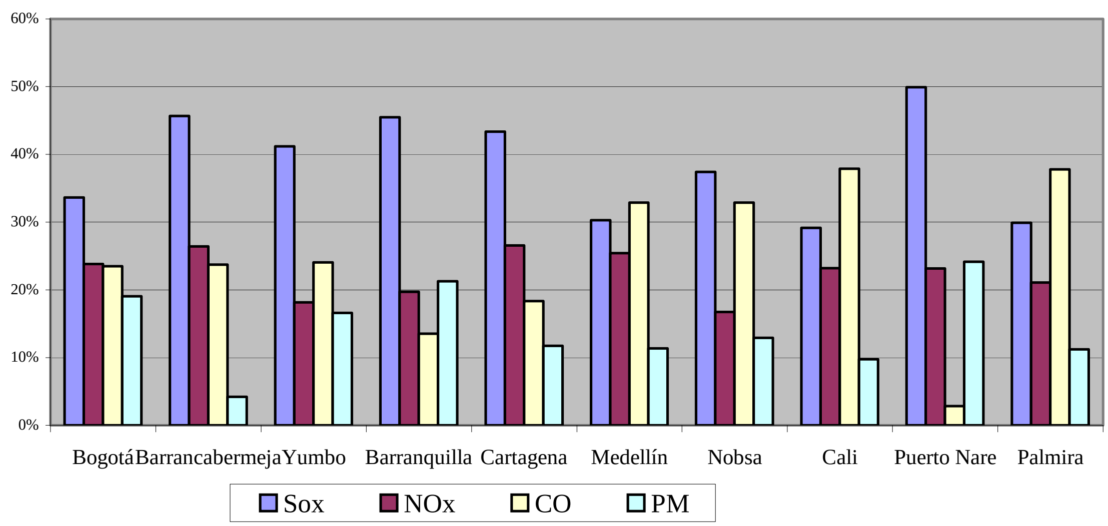
E= atmospheric emissions; P= Parameter associated with the economic activity in terms of number of employees, production volume, production's value or aggregated value; FE= emissions factor; R= coefficient of reduction of emissions; i= type of polluting agent measured.; j= type of economic activity.

[34] Manufacturing Annual Survey 1999, DANE.

Although the preferred approach for aggregating emissions across pollutants is on the basis of economic damages imposed by the emissions, a simple aggregation on the basis of total tons can reveal patterns about emissions sources. Table 3.13 reveals that although Bogotá clearly tops the list in terms of total (aggregate) tons emitted, total emissions in Barrancabermeja and Yumbo are quite close. Not surprisingly, however, the composition of emissions varies considerably across cities. As shown in Figure 3.2, $SO_x$ accounts for 40% or more of total tons emitted in half of the cities but considerably less than 40% in the other half. Presumably, these disparities in $SO_x$ emissions are caused by the presence of a relatively large number of power plants or other industrial facilities burning coal or high-sulfur oil in particular areas. There is also considerable variation across cities in the proportionate contributions of CO and $NO_x$, presumably reflecting the presence of large vehicle fleets in some areas with a high proportion of older, dirtier vehicles. Of course, other factors are also important in some cities. The municipality of Nobsa, for example, with a population of less than 10,000 inhabitants, has higher emissions than large cities like Cali, Bucaramanga, Pareira, and Manizales because of the relatively high concentration of artisan brick kilns and cement and steel factories.

**Figure 3-2: EMISSIONS OF SELECTED POLLUTANTS FOR LARGE MUNICIPALITIES**



It is also useful to look beyond the legal boundaries of cities and consider emissions in the broader context of urban and industrial centers. Again, focusing on total tons emitted as opposed to economic damages, Table 3.14 displays point source emissions and population information for the eight largest urban and industrial corridors in Colombia. Side-by-side comparison with Table 3.13 reveals the sometimes-large differences, measured in tons of pollution, between emissions from the municipalities versus those from the larger urban and industrial centers. For example, point source emissions from the urban and industrial area around Bogotá are almost 50% higher than from the city of Bogotá itself. Point source emissions from the larger urban and industrial area in the Aburra Valley are almost triple those from the nearby city of Medellin. The ratio is even higher for Cali.

Overall, based on estimates for 1999, the eight largest urban and industrial centers contain about only 42% of the population, but they account for about three-quarters of the total tons of point source emissions in the country. The metropolitan areas of Bogotá, Medellin, and Cali, with about 30% of the population, account for more than half of national point source emissions.

**Table 3.14. Population and Emissions in Urban and Industrial Centers, 1999**

| Industrial corridor | Population | Percentage of national population | Emissions (tons/year) | Percentage of national emissions |
|---|---|---|---|---|
| Bogotá | 7,536,468 | 16.6% | 75,961.1 | 21.9% |
| Medellín | 3,309,031 | 7.3 | 63,984.8 | 18.5 |
| Cali | 2,869,662 | 6.3 | 47,627.8 | 13.8 |
| Barranquilla | 1,798,551 | 4.0 | 41,855.8 | 12.1 |
| Manizales | 1,338,863 | 3.0 | 28,884.5 | 8.3 |
| Bucaramanga | 1,145,851 | 2.5 | 54,535.0 | 5.8 |
| Cartagena | 1,004,074 | 2.2 | 18,841.7 | 5.4 |
| Sogamoso | 180,442 | 0.4 | 14,462.7 | 4.2 |
| **Total** | **19,182,942** | **42.4%** | **346,153** | **75.2%** |
| **National Total** | **45,294,953** | | **460,306** | |

Source: Advance for Conpes Document. August 25, 2004.

Table 3.15 presents national-level emissions by pollutant and sector, based on 1996 data. Figures 3.3–3.7 display the same information in chart form. As shown, thermal electricity generation was the leading source of sulfur oxides and nitrogen dioxide in 1996, and industry was the leading source of particulate pollution and a major source of sulfur oxides. Transportation was the leading source of hydrocarbons and carbon monoxide. More recently, the share of emissions from mobile sources has risen, especially for CO, hydrocarbons, and $NO_x$ (SIAC 2002).

**Table 3.15. Sectoral Contributions to Total Emissions of Air Pollutants, 1996**

| Sector | Particles | Sulfur oxides | $NO_x$ | Hydrocarbons | CO |
|---|---|---|---|---|---|
| Electricity generation | 7% | 43% | 66% | 1% | 6% |
| Industry | 48 | 41 | 21 | 11 | 7 |
| Transport | 4 | 5 | 8 | 77 | 83 |
| Residential | 41 | 11 | 6 | 10 | 4 |

Source: Planning Unit of Mining and Power. Environmental Impact Module for 1996.

**Figure 3.3. Particulate Matter by Sector, 1996**

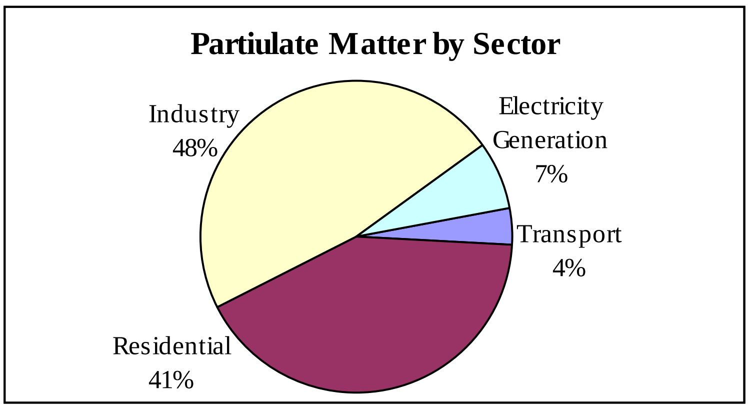



**Figure 3.4. Sulfur Oxides by Sector, 1996**

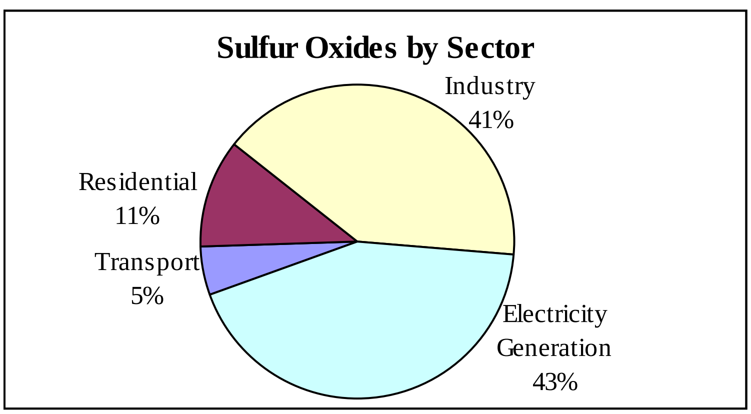


**Figure 3.5. Nitrous Oxides by Sector, 1996**

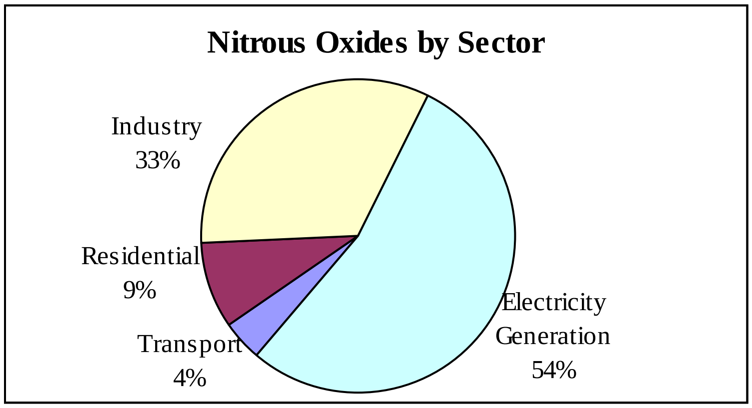



**Figure 3.6. Hydrocarbons by Sector, 1996**

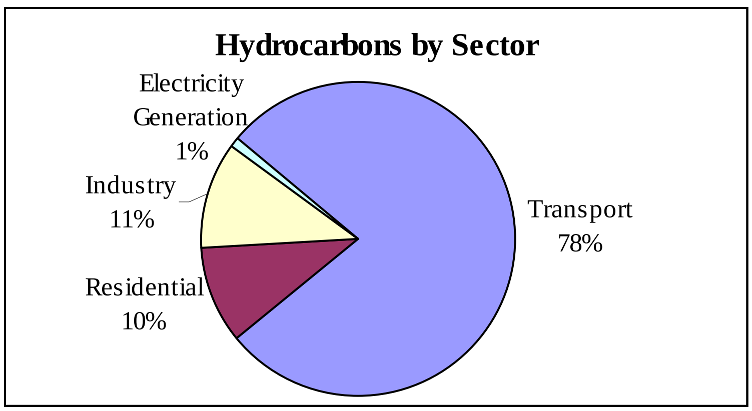
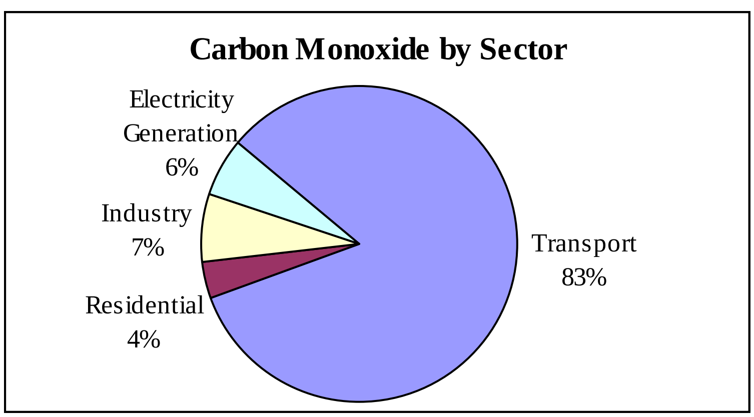



**Figure 3.7. Carbon Monoxide by Sector, 1996**



More detailed information is available for selected areas. In Bogotá, Universidad de los Andes, CEDE (2004) reports that emissions from fixed sources grew by 182% over the decade 1989–1999, with industrial kilns and furnaces—including many small and medium enterprises—representing three-fourths of the emissions from these sources. The principal fuels used in the manufacturing sector in Bogotá are diesel (44.9%), crude oil (24.7%), and coal (7.5%).[35] In Medellin and the 10 surrounding municipalities that form the metropolitan area of the Aburra Valley, the main polluting industries are paper, cement, brick making, and steel. The major energy sources are hydroelectric (16.6%), diesel (12.2%), coal (49.2%), and crude oil (22.1%).[36]

Unfortunately, we were able to collect very little information about compliance among fixed sources of emissions. However, in Bogotá, Universidad de los Andes, CEDE (2004) indicates that the 2,372 permitted facilities self-report their emissions on an annual basis. DAMA randomly selects a group of 70 facilities to audit. In 2003, these facilities recorded a 63% compliance rate with national air emissions standards (Decree 2-1982) and a 41% compliance rate with the stricter local standards (Resolution 391-2001).[37]. In Medellin, random inspections of industries are also conducted. Universidad de los Andes, CEDE (2004) reports that 160 inspections were conducted in 2003, corresponding to about 30% of the total number of industrial establishments. In addition, 53 inspections were conducted in response to public complaints. Unlike Bogotá, Medellin has not issued specific regulations for air pollution control. Thus, the national standards are applied. However, even information on the degree of noncompliance with the national standards is not available.

### 3.3.2. Ambient Monitoring for Selected Areas

In contrast to emissions, which are the mass of pollution entering the atmosphere, ambient concentrations indicate the quality of air that people are actually exposed to. Although CO, $O_3$, $NO_x$, VOCs, and TSP are all associated, either directly or indirectly, with respiratory or other health effects, the strongest epidemiological link between air pollution and premature mortality is via elevated concentrations of PM10. As calculated by Larsen (2004), an estimated 6,000 premature deaths in Colombia result each year because of elevated PM10 concentrations. Thus, in our review of the monitoring data, we focus on ambient concentrations of this pollutant.

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[35] Edwardo Uribe, "Air Pollution Management in Two Colombian Cities," draft paper, 2005, page 2.

[36] Ibid., page 3.

[37] Ibid., page 22.

As discussed in Section 3.2 and displayed in Table 3.4, DAMA and other urban authorities have taken the lead in establishing ambient $PM_{10}$ standards in the large urban areas. Unfortunately, only limited monitoring data are available to measure compliance with these standards.

Masami (2004) reports there are about 70 air quality monitoring stations in Colombia. Most of them track TSP; only a few monitor PM10; none regularly monitor PM2.5. There are no nationwide specifications for monitoring equipment or operating procedures. Only automated instruments are used in Bogotá, Cali, Bucaramanga, and Baranquilla; manual or manual-automated combinations are used in other areas. Various technical problems have been reported in the operation and maintenance of the automated instruments that rely on sophisticated electronics.[38] Further, the data that are collected are not analyzed at a central level. Issues have also been raised about the location of the monitors—specifically, that they exclude likely "hot spots." There are said to be plans to relocate some stations.[39]

Notwithstanding the many technical issues surrounding the data, we display in Table 3.16 the available monitoring results for annual PM10 concentrations in Bogotá and selected other urban areas, for various years. In Bogotá, monitoring stations are distributed throughout the city. In most other urban areas, monitoring is more limited. For example, in Bucarramanga, only a single site is reported.

Overall, virtually all citywide estimates (except San Nicholas Valley) and most individual monitoring sites report annual PM10 concentrations in excess of the annual 50 $ug/m^3$ standard established by U.S. EPA. Since the standards in Colombia are generally less stringent than 50 $ug/m^3$, not all these results are counted as violations in the local areas. For example, even though the standard in Bogotá is scheduled to be tightened to the level of the U.S. EPA standard in 2010 (see Table 3.4), the city's current annual standard for PM10 is 80 $ug/m^3$.[40] Thus, with an average reading across all monitors of 60 $ug/m^3$, Bogotá is technically in compliance with the annual standard. At the same time, four of the monitoring stations (Corpas, Carrefour,

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[38] Lack of funds to perform annual maintenance (including dynamic gas calibration systems for diluting concentrated certified gas with zero air), purchase calibration gases, and pay for repair service and spare parts has resulted in instrument malfunctions and data of questionable quality. In some cases, such as nonoperational hydrogen generators for hydrocarbon analysis, the staff reported having worked on the problem for six months without success. Minor problems have been encountered in operating manual instruments. See Kojima (2004), page 1.

[39] Kojima (2004), page 2.

[40] In Cali the current annual standard is 70 $ug/m^3$.

Fontibon, and Merck) located in the industrial areas of the city recorded annual averages well in excess of the local standard.

Among the other cities with reported monitoring information, Medellin and Baranquilla report annual averages above 60 ug/m$^3$, as do two of the stations in Yumbo. Bucarramanga, the San Nicholas Valley, Palmira, and the stationary Yumbo center site all report annual averages below 60 ug/m$^3$.

Although it is difficult to make a strong statement about trends in air quality based on such limited time series, we have made an "eyeball assessment" of the available information. The results are reported as up or down arrows on the right-hand side of Table 3.17. Overall, a mixed picture emerges of the trends in air quality. In Bogotá the measured trend for the citywide average is favorable, although the reverse is true for the industrial areas of the city already in violation of the standards. Given the large increase in vehicles (estimated by the local transit authority to have risen by one-third in 2001–2003), the observed improvement in the citywide (average) air quality represents a substantial achievement reflecting, no doubt, the restrictions on vehicle use, improvements in mass transit, increased use of natural gas, and other policies recently put in place.

In other cities, the data are more limited and trend analysis is more problematic. In some cities the available data are not recent enough to capture certain newly instituted policies, such as vehicle restrictions in Medellin.

**Table 3.17. Annual Ambient PM10 Levels in Cities (ug/m$^3$)**

| Region | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | Change |
|---|---|---|---|---|---|---|---|---|
| **Bogotá** | | | | 65 | 67 | 60 | | ↓ |
| CADE | 71 | 65 | 68 | 52 | 54 | 46 | | ↓ |
| Sony | 80 | 79 | 69 | 75 | 74 | 56 | | ↓ |
| Cazuca | 85 | 75 | 70 | 62 | 65 | 56 | | ↓ |
| Santo Tomas | 32 | 30 | 38 | 33 | 42 | 33 | | ↓ |
| MAVDT | 49 | 49 | 53 | 42 | 55 | 42 | | ↓ |
| Escuela | | | | | 50 | 53 | | ↑ |
| Bosque | 33 | 31 | 32 | 30 | 26 | | | ↓ |
| Corpas | 54 | 45 | 42 | 61 | 97 | 92 | | ↑ |
| Carrefour | | | | 59 | 97 | 89 | | ↑ |
| Fontibon | | | | 93 | 93 | 97 | | ↑ |
| Merck | | | | 96 | 92 | 101 | | ↑ |
| Olaya | 64 | | | | | | | |
| **Bucaramanga** | | | | 50.8 | 56.2 | 57.0 | | ↑ |
| **Medellin♦** | | | | | 59 | 63 | 64 | |
| Aguinaga | | | | | | 63 | | |
| Corantioquia | | | | | | 63 | | |
| Guayabal | | | | | | 65 | | |
| **Yumbo and Palmira** | | | | | | | | |
| Palmira | | 43.1 | | 54.1 | | | | ↑ |
| Yumbo Center (Sta. Station) | | | | 30.5 | | | | |
| Yumbo Center (Mobstation) | | | | 68 | | | | |
| Acopi | | | 70 | | | | | |
| **Barranquilla** | | | | | | | | |
| Agrecon | | | | | | | 70* | |
| Bibilioteca | | | | | | | 96** | |
| **San Nicolas Valley** | | | | | | | | |
| Salenca | 31.6 | 26.6 | 32 | 26.3 | 32.8 | | | ↑ |
| Hospital | 37.8 | 61.1 | 41.5 | 21.7 | 30.6 | | | ↓ |
| Zona Franca | 29.8 | 21.3 | 24.2 | 17.6 | 23.1 | | | ↓ |

* Mean of February—June 2004 reading (60, 90, 60, 60, 80).

** Mean of Feb—June 2004 reading (110, 120, 50, 180, 120).

♦ Annual average of 24-hour measurements taken every 3 days.

Sources: Universidad Pontificia Bolivariana, Redaire's operator at Valle de Aburra. Information provided by Chemical Engineer, Maria Victoria Toro, Redaire's Director, 2005; district offices of selected regions.

### 3.3.3. Daily PM10 Concentrations

As opposed to imposing a limit based on the annual average concentration, a daily standard establishes a ceiling on the maximum average pollutant concentration over a 24-hour period. The daily standard is usually stricter than the annual standard. Although quite limited information is available on a daily basis nationwide, in Bogotá extensive PM10 observations are available on a daily basis. Table 3.18 presents summary information on the average 24-hour concentrations measured in Bogotá in 2002–2003. The observations highlighted in bold indicate where the measured PM10 levels are above the local standard. Three of the four maximum PM10 levels were recorded in the morning between 7 and 8 a.m. Figure 3.8 illustrates the spatial distribution of PM10 levels. Unfortunately, we were not able to obtain any time series information on daily measurements. However, Universidad de los Andes, CEDE (2004) reports that average monthly concentrations of PM10 have increased since 1996.[41]

**Table 3.18. 24-Hour PM10 Concentrations, Bogotá, 2002–2003**

| **Monitoring station** | **PM10 24 hours (ug/m$^3$)** | | | | |
|---|---|---|---|---|---|
| | **Mean** | **Median** | **Minimum** | **Maximum** | **Date and Time** |
| **Bogotá** | | | | | |
| Bosque | 34.45 | 30 | 4 | 103 | 06/12/2003 02:00 |
| MVDT | 38.94 | 38 | 5 | 99 | 27/02/2003 05:00 |
| Sony | 52.98 | 52 | 20 | 114 | 05/11/2003 14:00 |
| IDRD | 68.44 | 67 | 29 | 131 | 07/04/2003 09:00 |
| Carrefour | **84.40** | **83** | **26** | **246** | **12/06/2003 08:00** |
| Cazuca | 52.21 | 50 | 16 | 106 | 22/01/2003 09:00 |
| Escuela | 54.56 | 51 | 19 | 121 | 01/01/2003 06:00 |
| St. Toto | 32.54 | 31 | 4 | 70 | 25/12/2003 17:00 |
| Corpas | **91.98** | **88** | **25** | **207** | **08/04/2003 07:00** |
| Cade | 39.92 | 38 | 6 | 100 | 19/02/2003 20:00 |
| Merck | **101.91** | **98** | **37** | **216** | **08/12/2003 17:00** |
| Fontibón | **96.78** | **95** | **7** | **194** | **26/04/2003 07:00** |

[41] Edwardo Uribe, "Air Pollution Management in Two Colombian Cities," draft paper, 2005, page 19.

**Figure 3.8. 24-Hour PM10 Levels across Bogotá**

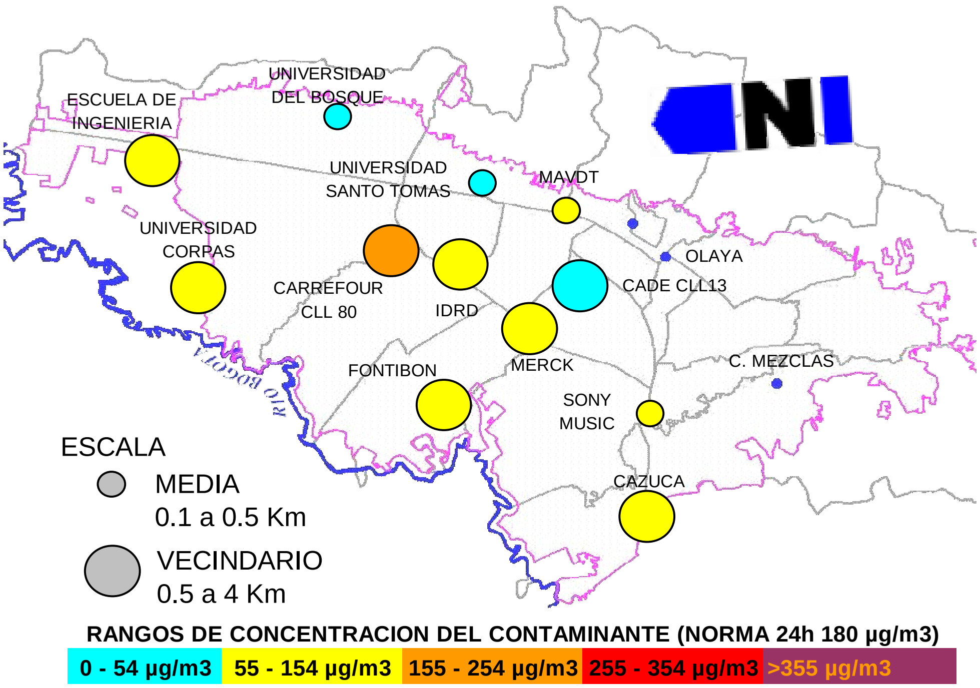


Figure 3.8 and Table 3.16 reveal that, like the violations of the annual standards, the highest PM10 concentrations were registered in the western area of the city. This is predominantly an industrial area that includes Merck and Fontibón in southwestern Bogotá, and Calle 80 and Clinica Corpas in northwestern Bogotá. Carrefour in the middle-western section of the city has the highest recorded maximum level of PM10. Recorded levels of PM10 in the eastern part of the city are within the standards set by the local municipality.

In Medellin, more limited PM10 data are available on a 24 hour basis. Only three monitoring stations in the city report daily PM10 data. Information reported from the REDAIRE network, an initiative of the Sectional Health Service and the Secretary of Health Affairs of Medellin, Metrosalud, is shown in Table 3.19. Daily levels appear to be quite high, as concentrations exceeded U.S. EPA standards 69% to –84% of the days reported at the three stations, based on a combined measure of TSP and PM10 readings.

**Table 3.19. Total Suspended Particles and PM10 concentrations in Medellin, 2003**

| Medellin | Maximum | Minimum | Mean | Percentage of days exceeding U.S. EPA standards♦ |
|---|---|---|---|---|
| Aguinaga | 118 | 27 | 63 | 69% |
| Corantioquia | 127 | 24 | 63 | 73 |
| Guayabal | 137 | 27 | 65 | 84 |

♦ EPA Standards: 100 μg/m³ for TSP and 50 μg/m³ for PM10

Source: Redaire Information Bulletin No. 14, February 2004.

### *Tolima*

In Tolima, vehicle exhausts represent a major source of emissions, as do both industrial and agricultural activities, including the pretreatment of land and application of agrochemical products. A comprehensive air quality monitoring network began operations in 2004 with stations in the municipalities of Ibagué, Payandé, Lérida, and Espinal. The monthly average readings for PM10 are shown in Table 3.20. Since the monthly average readings are not strictly consistent with the daily (or annual standards), it is not possible to make a clear assessment of these results. However, the network is still evolving, and in future years it is expected that the reported information will be reported in a format consistent with data from other regions.

**Table 3.20. Concentration of $PM_{10}$ ($\mu g/m^3$) in Tolima (Monthly Geometrical Average)**

| Municipality | Payande | Payande | Payande | Lerida | Espinal | Espinal | Ibague | Ibague | Ibague | Ibague |
|---|---|---|---|---|---|---|---|---|---|---|
| Station | Corregi-duria | Vivero | Garita | Hospital | Hospital | IPEIT | El Salado | Cortolima | Policia | Hospital |
| **Local Annual Standard** | **92.32** | **92.45** | **91.95** | **96.39** | **95.64** | **88.72** | **88.83** | **94.78** | **50.0** | **50.0** |
| **Local Daily Standard** | **369.29** | **369.81** | **367.79** | **385.55** | **379.12** | **382.55** | **354.88** | **355.32** | **150.0** | **150.0** |
| February | | | 49.33 | | | | | | | |
| March | 93.31 | 86.99 | 88.71 | 66.04 | 66.02 | 63.37 | 96.78 | 83.78 | | |
| April | 80.84 | 50.19 | 52.05 | 75.45 | 70.18 | 80.02 | 90.22 | 88.31 | | |
| May | 64.22 | 52.72 | 71.24 | 55.13 | 58.46 | 85.41 | 92.80 | 77.39 | | |
| June | 65.79 | 61.81 | 46.42 | 72.18 | 70.09 | 106.26 | 91.56 | 71.54 | | |
| July | 98.00 | 67.78 | 58.28 | 71.95 | 81.93 | 92.74 | 101.09 | 68.15 | | |
| August | 69.17 | 67.99 | 51.60 | 83.93 | 80.25 | 91.67 | 77.69 | 68.40 | 54.27 | 40.44 |
| September | 79.52 | 83.93 | 52.85 | 73.10 | 62.25 | 88.64 | 98.38 | 79.11 | 51.94 | 43.65 |
| October | 66.60 | 63.97 | 56.51 | 58.69 | 64.35 | 68.7 | 67.75 | 71.22 | 44.27 | 36.74 |
| November | 70.96 | 61.91 | 56.75 | 70.21 | 76.43 | 73.9 | 73.35 | 72.15 | 37.15 | 38.33 |
| December | 66.04 | 63.02 | 51.43 | 58.83 | 81.22 | 66.8 | 65.36 | 61.13 | 38.90 | 38.72 |

Source: Network reports for each station provided by Cortolima Planning Subdivision, 2005.

### 3.3.4. Pollution Abatement Expenditures

Expenditures on pollution abatement are often used as a measure of effort to reduce emissions. In the United States and many other nations of the Organisation for Economic Co-operation and Development, comprehensive expenditure information is generally available, including snapshot measures at different points in time. Unfortunately, the Colombian data on pollution abatement control expenditures are quite limited. There are no consistent national data even for large industrial sectors. Data that do exist come from multiple sources, often with inconsistent definitions. Time series information is virtually nonexistent. Nonetheless, it is useful to review the available data for the electricity generation and petroleum refining industries.

According to information published in the National Energy Plan (1999), companies that generate power based on gas, coal, and hydroelectricity allocate 4%, 8% and 12% of their investments, respectively, to environmental management programs. At the same time, the power generators transfer to the environmental authorities in their jurisdictions an estimated 2% to 3% of their revenues. These revenues, in turn, are used to fund activities in the local CARs and AAUs. If consistently applied to environmental management, these revenues would be considered large, even by international standards.

No consolidated information about environmental investment is available for petroleum companies that operate in the country. However, British Petroleum Company (BP) reported spending US$325 million between 1992 and 1996 on goods and services directly related to environmental impacts of its activities in Colombia. These expenditures include equipment to control petroleum leaks, reforestation programs, restoration and maintenance of basins, seismic environmental management, instruction, institutional strengthening, environmental supervision, technical studies, and biological control of water, soil, and air.

Another measure of effort relevant to investments in pollution abatement involves the VAT exemptions provided by Law 2223-1995. These exclusions were established to acquire equipment and associated supplies, national or imported, to be used in the construction, installation, assembly, and operation of control and monitoring systems for recycling and waste processing, treatment of sewage, and/or atmospheric emissions. The value of exemptions granted for 1997–2003 is displayed in Table 3.21. As shown, the value of the exemptions rose dramatically in 1997–1999 and then declined, in an equally dramatically manner, in 2000–2003. It is not clear how much these changes reflect underlying patterns of pollution abatement investment versus changes in the administration of Law 223-1995.

**Table 3.21. VAT Exemptions for Environmental Investments, 1997–2003**

| VAT Exemptions Granted by MAVDT | Colombian Pesos (millions) |
|---|---|
| 1997 | 9.005 |
| 1998 | 47.879 |
| 1999 | 57.774 |
| 2000 | 16.244 |
| 2001 | 10.984 |
| 2002 | 6.564 |
| 2003 | 8.599 |

Source: MAVDT, quoted by General Comptroller of the Republic in its report, "State of the Natural Resources and the Environment 2003–2004."

Regarding exemptions from income taxes, Law 788-2002 provides that the environmental authority should certify whether a company has the right to deduct from its annual income the amount of its environmental investments made in any given fiscal year. Unfortunately, no specific information on the operation of this provision is publicly available.

### 3.3.5. Mobile Source Policies

Reflecting the large contribution of vehicle emissions to urban air quality problems, mobile source programs have been established in major Colombian cities. This subsection reports on recent progress.

In Bogotá, DAMA has implemented an extensive program to limit mobile source emissions[42]:

- Audits of certified diagnostic centers (CDRs) verify results of current regulation, procedures, and specifications of equipment used to issue emissions certificates to vehicles meeting the standards. Overall, the centers have been improving their

[42] DAMA, Management Report 2001–2003.

performance in recent years: in 2001 only 1.9% of centers satisfied the audits; in 2003, the number increased to 52%.

- Between October 2002 and October 2003, 615,200 certificates were issued to vehicles that passed the emissions certification tests.
- Patrols in the streets complement the certifications issued by the CDRs. In 2001, 27,411 checks were performed in the city, and 40% of the vehicles were found to have valid emissions certificates. In 2002, 30,120 checks were made, with the same percentage of vehicles found to have certificates. In 2003, the number of checks rose to 45,320 and the percentage of vehicles with a valid certificate increased to 60%. In all likelihood, the increased inspections, combined with a significant increase in the fines for violators, are responsible for the improvement in performance.
- *Dia sin Mi Carro* ("Day without My Car") is a program which excludes private vehicles (not including buses and cabs) from using city streets. There have been four days without cars in the 2001–2003 period. The results are shown in Table 3.22.

**Table 3.22. Pollution Concentrations: "Day without My Car" versus Normal Day**

| | |
|---|---|
| 2001 | Reduction: CO, 83% |
| | Increases: $NO_2$, 53%; PM10, 17% |
| 2002 | Reductions: CO, 12.2%; $NO_2$, 24.4%; PM10, 6.4% |
| Feb. 6, 2003 | Reduction: CO, 37.2% |
| | Increase: PM10, 9.4% |
| Sept. 22, 2003 | Reductions: $NO_2$, 43.2%; PM10, 26%. |
| | Increase: CO, 2.3% |

Source: DAMA, Management Report 2001–2003.

Review of the data indicate that although several indicators of air quality showed improvements on the carless day, there were also some pollution increases. The reasons for these increases are not entirely clear. The increases could be explained by weather patterns and may also reflect greater emissions from buses, which were used more extensively on the days car use was restricted.

In Cali, beginning in 1996, DAGMA established an environmental control program for motor vehicles. The results of the emissions inspections in the city over 1997–2003, for both gasoline and diesel vehicles, are displayed in Table 3.23.

**Table 3.23. Results of Emissions Inspections of Gasoline- and Diesel-Powered Vehicles, Cali, 1997–2003**

| **Inspections of Gasoline Vehicles** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
| Passed | 25,536 | 48,963 | 72,786 | 86,314 | 69,528 | 63,629 | 67,297 |
| Failed | 5,755 | 7,675 | 6,271 | 5,160 | 3,303 | 3,722 | 2,805 |
| **Total** | **31,291** | **56,638** | **79,057** | **91,474** | **72,831** | **67,351** | **70,102** |
| | | | | | | | |
| **Inspections of Diesel Vehicles** | | | | | | | |
| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
| Passed | 951 | 3,260 | 4,837 | 5,390 | 5,760 | 6,126 | 7,237 |
| Failed | 89 | 334 | 512 | 403 | 404 | 637 | 614 |
| **Total** | **1,040** | **3,594** | **5,349** | **5,793** | **6,164** | **6,763** | **7,851** |

As shown, the number of inspections to gasoline-powered vehicles rose over the period 1997–2000 and then declined somewhat thereafter. Interestingly, the failure rate has declined considerably over the entire period, from a high of 18% in 1997 to about 4% in 2003. These results are probably influenced by a series of administrative reforms undertaken in 2001, which reduced staffing levels at DAGMA and the transit authorities. For diesel-powered vehicles, which consist mostly of buses and large trucks, a slightly different story emerges. Although fewer in number, total inspections of these vehicles have continued to increase over the entire seven-year period. Although the failure rate has varied slightly from year to year, it has generally remained within the range of 7% to 9%.

The principal purpose of the inspection program is to reduce pollution in the urban environment, but DAGMA also has a financial interest in the system. As shown in Table 3.24, the inspection fees generate significant revenue. Fees have risen considerably over the 1997–2003 period. Revenues are split between the government and the participating centers. According to the data provided by CDAV, the number of vehicles registered in the city by March 2004 is 346.544 of which 4.405 are official (owned by public entities), 299.745 are privately owned, and 42.394 are public vehicles. Some vehicles, including motorcycles and vehicles used in agriculture, are exempt entirely.

**Table 3.24. Revenues Derived from Vehicle Inspection Program, Cali, 1997–2003**

| Center | Year | Price | Vehicles | Cali Partici-pation Rate | DAGMA Participation (15%) | Cali Total Income | Centers Participating | Total Income* |
|---|---|---|---|---|---|---|---|---|
| | 1997 | 11,500 | 33,126 | 30% | 57,303,543 | 114,607,086 | 267,416,534 | 382,023,620 |
| | 1998 | 14,000 | 61,715 | 30% | 125,397,875 | 250,795,750 | 585,190,083 | 835,985,833 |
| | 1999 | 15,800 | 73,255 | 30% | 172,928,610 | 345,857,220 | 807,000,180 | 1,152,857,400 |
| | 2000 | 17,400 | 97,853 | 30% | 254,169,938 | 508,339,872 | 1,186,126,368 | 1,694,466,240 |
| | 2001 | 19,000 | 74,617 | 30% | 225,902,550 | 451,805,100 | 1,054,211,900 | 1,506,017,000 |
| | | | 41,754 | 50% | 207,937,280 | 415,874,560 | 415.874,560 | 831,740,120 |
| | 2002 | 20,600 | 32,443 | 37.50% | 131,931,413 | 263,862,826 | 439.771,377 | 703,634,203 |
| CDAV | 2003 | 22,200 | 50,648 | 47.50% | 267,500,287 | 535,000,574 | 591,316,424 | 1,126,316,990 |
| Other Centers | 2003 | 22,100 | 5,921 | 50% | 32,477,150 | 64,954,300 | 64,954,300 | 129,908,600 |
| **TOTAL** | | | | | **1,475,548,646** | **2,951,097,288** | **5,411,861,726** | **8,362,950,006** |

Sources: CDAV, private centers, and DAGMA Reports.

* The product of multiplying the number of vehicles checked and the price established for each year is not exactly the shown in the chart because in the CDAV reports, some values were registered with the prior year price.

Cornare has also implemented a system to control emissions from mobile sources by establishing an emissions certificate for vehicles. According to information provided by Cornare's monitoring unit, results are as follows:

- in 2001, 47% of the checked vehicles passed the test;
- in 2002, 62.4% of the checked vehicles passed the test; and
- in 2003, 61.0% of the checked vehicles passed the test.

In Medellin, a vehicle inspection program has also been introduced. During 2002, 150,000 vehicles, representing almost 40% of the total vehicles in the area, were inspected. In the first half of 2003, the number of inspections rose 6.2% compared with the same period in the previous year. Unfortunately, there is no information available on the failure rate of these inspections.

In examining the testing programs in place in several Colombian cities, Kojima (2004) reports on the limitations of the test procedures. Specifically, she notes that reliance on the one-speed idle test is largely ineffectual, since one can reduce the CO and HC emissions from an older gasoline vehicle by delaying the ignition timing and increasing the air-to-fuel ratio. This "late and lean" approach has reportedly been widely used to pass the idle test. Yet vehicles that pass the test in this fashion routinely fail roadside tests because emissions increase considerably under load conditions. The preferred approach is to test emissions under load, which requires a dynamometer. Unfortunately, no dynamometer-based testing is available in Colombia.[43]

### 3.3.6. Fuel Quality

Refined petroleum products in Colombia are produced at refineries in Cartagena and Barrancabermeja. Based on information presented in Brugman (2004), the sulfur content of gasoline produced at these refineries is currently about 1,000 parts per million (ppm), and the sulfur content of regular diesel is about 4,500 ppm. Clear diesel produced in Barrancabermeja has a sulfur content of 1,000–1,200 ppm. Imported gasoline has a sulfur content of 300 ppm, and imported diesel contains only 500 ppm of sulfur.

As discussed in Section 3.2, the maximum allowable content of sulfur for all fuels used in Colombia is scheduled to drop to 500 ppm starting on July 1, 2008. To meet this new standard, it is expected that a new hydrotreatment program will be implemented at the Barrancabermeja refinery. Plans are reportedly also underway to modernize the refinery at Cartagena. If those modernization plans are not completed on time, imports may have to be increased to meet the new standard.

Efforts to increase natural gas use, for both stationary and mobile sources, are described in the next subsection on developments in the energy sector.

### 3.3.7. Recent Developments in the Energy Sector

***Combustibles***

In 1999 Colombia adopted a policy of price liberalization for combustibles aimed at equalizing the prices of regular gasoline and diesel with the prices of imports (using prices in the Gulf of Mexico as a reference). Also, an excise tax on gasoline was introduced to generate funds for the maintenance and paving of streets in urban areas.

Although these policies were driven primarily by economic rather than by environmental considerations, there are some clear environmental benefits. Specifically, the consumption

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[43] See Kojima (2004), pages 4–6, for more details.

of gasoline has registered a decreasing trend, from 125,300 barrels per day in 1994 to 88,612 barrels per day in 2003 (Table 3.25). This is due, in part, to the substitution of compressed natural gas (CNG) for gasoline in vehicles and the rise in gasoline prices. In contrast, consumption of diesel fuels, which continue to be subsidized, has increased, from 50,400 barrels per day in 1994 to 69.661 barrels per day in 2003.[44]

**Table 3.25. Monthly Consumption of Fuel, 1994–August 2004**

| | **Whites (Barrels per Day)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Gasoline** | | | **Bencina y Cocinol** | **Subtotal** | **Partially Distilled** | | | |
| **Year** | **Regular** | **Premium** | **Subtotal** | | | **Diesel** | **Kerosene** | **JP-A** | **Subtotal** |
| 1994 | 125,300 | | 125,300 | 1300 | **126,600** | 50,400 | 3,600 | 13,800 | **67,800** |
| 1995 | 128,576 | | 128,576 | 1114 | **129,690** | 51,756 | 3,764 | 14,608 | **70,128** |
| 1996 | 117,355 | 11,536 | 128,891 | 870 | **129,761** | 58,151 | 3,275 | 14,662 | **76,088** |
| 1997 | 120,117 | 10,913 | 131,030 | 611 | **131,641** | 60,308 | 2,990 | 15,212 | **78,510** |
| 1998 | 117,012 | 12,524 | 129,536 | 418 | **129,954** | 60,026 | 2,510 | 15,247 | **77,783** |
| 1999 | 105,488 | 9,678 | 115,166 | 382 | **115,548** | 53,581 | 2,631 | 14,872 | **71,084** |
| 2000 | 97,278 | 5,447 | 102,725 | 583 | **103,308** | 60,494 | 2,257 | 13,606 | **76,357** |
| 2001 | 87,192 | 5,057 | 92,249 | 288 | **92,537** | 59,915 | 2,057 | 14,433 | **76,405** |
| 2002 | 83,619 | 6,840 | 90,459 | 268 | **90,727** | 59,943 | 1,878 | 14,068 | **75,889** |
| 2003 | 81,984 | 6,628 | 88,612 | 222 | **88,834** | 69,661 | 3,454 | 13,776 | **86,891** |
| 2004 | 78,624 | 6,060 | 84,684 | 124 | **84,808** | 73,377 | 1,194 | 13,743 | **88,314** |

| | **Whites** | | | **Blacks** | | | |
|---|---|---|---|---|---|---|---|
| Year | Avigas | Propane | Subtotal | Fuel-Oil | Crudo de Castilla | Subtotal | Total |
| 1994 | 500 | 17,300 | 212,200 | 1,400 | 15,500 | 16,900 | 229,100 |
| 1995 | 444 | 18,500 | 218,762 | 3,948 | 15,602 | 19,550 | 238,312 |
| 1996 | 387 | 20,313 | 226,549 | 2,126 | 16,612 | 18,738 | 245,287 |
| 1997 | 384 | 21,812 | 232,347 | 2,639 | 16,800 | 19,439 | 251,786 |
| 1998 | 397 | 22,984 | 231,118 | 3,238 | 15,524 | 18,762 | 249,880 |
| 1999 | 401 | 23,322 | 210,356 | 1,971 | 11,263 | 13,234 | 223,590 |
| 2000 | 376 | 24,198 | 204,240 | 6,363 | 5,044 | 11,407 | 215,647 |
| 2001 | 349 | 24,474 | 193,764 | 6,988 | 80 | 7,068 | 200,832 |
| 2002 | 339 | 22,872 | 189,827 | 6,453 | 0 | 6,453 | 196,280 |
| 2003 | 325 | 21,595 | 197,645 | 3152 | 0 | 3,152 | 200,797 |
| 2004 | 321 | 21,153 | 194,596 | 2,239 | 33 | 2,272 | 196,868 |

Source : UPME 2005

[44] UPME. "Statistical Bulletin of Mining and Energy 1994–2004." First Edition 2005.

Table 3.26 reveals the declining trend in gasoline consumption. Note how consumption in Bogotá was reduced from 35,217 barrels per calendar day in 1994 to 17,376 in 2003.

**Table 3.26. Motor Gasoline Sales by Major Distributors**

| **Region** | **Barrels per calendar day** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Northwest | 14,137 | 14,341 | 14,651 | 15,138 | 15,398 | 14,398 | 12,976 | 11,510 | 9,182 | 8,421 | 3,922 |
| Northeast | 11,788 | 11,990 | 12,319 | 12,487 | 12,442 | 9,763 | 7,891 | 6,664 | 6,877 | 6,860 | 3,539 |
| Center | 34,918 | 36,794 | 22,490 | 40,475 | 43,820 | 34,793 | 32,131 | 28,177 | 24,913 | 28,404 | 12,417 |
| Southwest | 24,671 | 25,064 | 25,197 | 25,764 | 25,722 | 22,917 | 20,752 | 18,548 | 18,282 | 18,516 | 8,964 |
| Southeast | 4,909 | 5,047 | 5,399 | 6,070 | 6,238 | 5,089 | 5,057 | 4,810 | 4,568 | 4,826 | 2,261 |
| Bogotá | 35,127 | 34,453 | 31,863 | 31,877 | 26,994 | 27,883 | 25,712 | 22,853 | 19,439 | 13,376 | 9,061 |
| **Total** | **125,550** | **127,689** | **111,919** | **131,811** | **130,614** | **114,843** | **104,519** | **92,562** | **83,261** | **80,403** | **40,164** |

Source: UPME 2005.

### *Natural Gas*[45]

In 1994, the national production of natural gas was 400 million cubic feet per day (mpcd). It was delivered by four isolated systems: the Atlantic coast, Santander, Huila, and Meta-Bogotá. The main producing fields were situated in the Department of La Guajira (Ballena, Chuchupa, and Riohacha), and the gas transportation infrastructure was concentrated especially in the Atlantic coast, with a few minor pipelines in the interior of the country. There were no connections between the large population centers and main production areas. The amount of proved and probable reserves was estimated between 7,544 and 8,800 giga cubic feet (gpc), equivalent to 50 years of production.

By the beginning of 1997, the country had a total amount of 11,468 gpc of gas in proved and probable reserves while production (and average consumption) reached 579 mpcd (Tables 3.27, 3.28, and 3.29). Transportation of gas from the coast to the interior was expanded with implementation of the Mass Gas Plan, the construction of the Ballena-Barrancabermeja Pipeline, and the interconnection of this line with the other production centers using the Barrancabermeja-Neiva and Cusiana-Apiay pipelines.

By the end of 2003, the country had 4,040 gpc commercial reserves, equivalent to a 22-year supply. With the opening of the western pipeline in August 1997 and the increase in

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[45] Ibid.

production capacity in La Guajira due to the construction of the second platform at Chuchupa field, the availability of gas rose from 430 to 700 mpcd.

With the goal of increasing the availability of gas service to the poor, the national government, through the Ministry of Mining and Energy, established exclusive service areas for natural gas distribution in the western, eastern, and central zones of the country in 1997 and 1998.

The benefits of the implementation of Mass Gas Plan are the increasing use of gas in both the domestic and industrial sectors. In 1994 there were 790,000 gas installations; by June 2004 there were 3,250,000, which means that almost 14 million Colombians now have a cleaner and cheaper source of fuel.

**Table 3.27. Proved Gas Reserves, 1991–2003**

| **Relation Reserves/Gas Production** | | | | |
|---|---|---|---|---|
| Year | Ecopetrol | Association | Total | Years of Reserves |
| 1991 | 470.3 | 3,010.0 | 3,480.3 | 19 |
| 1992 | 643.0 | 5,898.0 | 6,541.0 | 32 |
| 1993 | 776.0 | 6,675.0 | 7,451.0 | 29 |
| 1994 | 758.0 | 6,786.0 | 7,544.0 | 26 |
| 1995 | 711.0 | 6,949.0 | 7,660.0 | 41 |
| 1996 | 677.0 | 6,990.0 | 7,667.0 | 38 |
| 1997 | 182.0 | 6,746.0 | 6,928.0 | 27 |
| 1998 | 193.3 | 6,734.8 | 6,928.1 | 26 |
| 1999 | 108.9 | 6,532.1 | 6,641.0 | 26 |
| 2000 | 229.8 | 4,309.2 | 4,539.0 | 25 |
| 2001 | 212.0 | 4,295.0 | 4,507.0 | 24 |
| 2002 | 212.2 | 4,012.8 | 4,225.0 | 23 |
| 2003 | 162.4 | 3,877.6 | 4,040.0 | 22 |

Source: UPME 2005.

**Table 3.28. Natural Gas Consumption (mpcd) by Sector, 1994–August 2004**

| **Sector** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Domestic | 30.8 | 35.3 | 38.9 | 48.3 | 59.7 | 70.1 | 76.9 | 80.0 | 89.3 | 88.4 | 95.6 |
| Ecopetrol | 72.9 | 68.1 | 109.9 | 117.3 | 115.8 | 124.5 | 122.6 | 102.5 | 90.9 | 92.3 | 82.1 |
| Transportation | 4.4 | 4.9 | 5.6 | 5.9 | 6.0 | 6.3 | 7.1 | 9.0 | 10.4 | 13.4 | 17.0 |
| Industrial | 103.6 | 107.9 | 108.1 | 109.6 | 109.9 | 107.2 | 115.9 | 169.0 | 179.0 | 193.2 | 203.2 |
| Petrochemical | 12.2 | 11.5 | 16.4 | 11.0 | 11.7 | 15.7 | 10.7 | 12.0 | 12.2 | 12.9 | 12.3 |
| Thermoelectric | 181.2 | 203.4 | 180.3 | 286.6 | 303.9 | 183.7 | 243.3 | 223.0 | 219.5 | 189.1 | 198.2 |
| **Total** | **405.1** | **431.1** | **459.2** | **578.7** | **607.0** | **507.5** | **576.5** | **595.5** | **601.3** | **589.3** | **608.4** |

Source: UPME 2005.

**Table 3.29. Natural Gas Installations by Regions**

| **Regions** | **1997–June 2004** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Dec 31/94** | **Dec 31/95** | **Dec 31/96** | **Dec 31/97** | **Dec 31/98** | **Dec 31/99** | **Dec 31/00** | **Dec 31/01** | **Dec 31/02** | **Dec 31/03** | **Dec 31/04** |
| Guajira | 12,811 | 14,566 | 19,675 | 24,789 | 28,691 | 31,521 | 35,076 | 37,298 | 40,329 | 42,211 | 42,758 |
| Atlantico-Magdalena | 191,297 | 217,329 | 253,800 | 275,758 | 313,113 | 347,626 | 370,981 | 389,381 | 403,051 | 414,113 | 418,311 |
| Bolivar-Cordoba-Sucre | 153,211 | 179,880 | 201,264 | 239,023 | 254,146 | 265,842 | 277,852 | 293,632 | 306,617 | 322,295 | 327,692 |
| Cesar | 1,197 | 1,236 | 16,198 | 27,363 | 32,785 | 36,830 | 41,618 | 53,671 | 59,318 | 64,347 | 49,288 |
| Santander | 172,917 | 186,782 | 199,215 | 211,069 | 218,828 | 225,461 | 229,558 | 223,075 | 227,578 | 232,792 | 234,908 |
| Huila-Tolima | 48,870 | 56,173 | 61,253 | 66,386 | 72,689 | 93,603 | 129,713 | 148,093 | 170,787 | 184,632 | 187,930 |
| Norte de Santander | 0 | 0 | 0 | 7,788 | 9,545 | 10,367 | 10,367 | 10,367 | 10,367 | 53,644 | 62,918 |
| Meta-Casanare | 37,463 | 48,328 | 57,730 | 60,296 | 68,268 | 70,829 | 79,202 | 85,946 | 96,040 | 102,483 | 104,878 |
| Cundinamarca-Boyacá | 172,103 | 233,319 | 321,389 | 428,234 | 577,657 | 705,060 | 815,830 | 928,943 | 1,088,178 | 1,167,947 | 1,206,959 |
| Valle del Cauca | 0 | 0 | 0 | 0 | 24,970 | 67,385 | 130,883 | 193,183 | 274,161 | 335,353 | 347,685 |
| Eje Cafetero | 0 | 0 | 0 | 0 | 17,893 | 37,414 | 44,057 | 74,682 | 106,903 | 133,923 | 139,701 |
| Antioquia | 0 | 0 | 0 | 0 | 0 | 6,970 | 17,791 | 41,324 | 77,566 | 110,701 | 119,749 |
| **TOTAL** | **789,869** | **937,613** | **1,130,524** | **1,340,706** | **1,618,585** | **1,898,908** | **2,182,928** | **2,479,595** | **2,860,895** | **3,164,441** | **3,242,777** |

Source : UPME 2005.

Along with the development of natural gas distribution systems for domestic and industrial consumption, a new program for substitution of gasoline for motor vehicles started in 1985. Over the past 20 years, only modest progress has been achieved. Despite the economic attractiveness of natural gas over gasoline, limited incentives to build gas stations to supply this fuel, the high cost of the installation in the vehicles, and continuing public concerns about safety have all constrained growth of natural gas as a source of motor fuel (Table 3.30).

**Table 3.30. Vehicles Converted to CNG**

| National Total | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **City** | **Department** | **As of Dec. 2003** | **Jan. 2004** | **Feb. 2004** | **Mar. 2004** | **Apr. 2004** | **May 2004** | **June 2004** | **Jul. 2004** | **Total 2004** | **Total Prog.** |
| Barranquilla | Atlantico | 7,673 | 174 | 177 | 229 | 206 | 199 | 158 | 103 | 1,246 | 8,919 |
| Cartagena | Bolivar | 2,259 | 102 | 109 | 147 | 143 | 139 | 132 | 125 | 897 | 3,156 |
| Santa Marta | Magdalena | 1,452 | 38 | 41 | 44 | 56 | 41 | 60 | 40 | 320 | 1,772 |
| Monteria | Cordoba | 892 | 62 | 66 | 70 | 71 | 39 | 37 | 22 | 367 | 1,259 |
| Sincelejo | Sucre | 521 | 26 | 18 | 26 | 21 | 17 | 23 | 12 | 143 | 664 |
| Cali-Yumbo | Valle | 2,268 | 89 | 159 | 175 | 176 | 202 | 176 | 172 | 1,149 | 3,417 |
| Tulua | Valle | 0 | - | 50 | 20 | 25 | 16 | 16 | 18 | 145 | 145 |
| Palmira | Valle | 0 | - | - | - | - | - | 4 | 54 | 58 | 58 |
| Armenia | Quindio | 192 | | 14 | 15 | 27 | 92 | 69 | 103 | 320 | 512 |
| Riohacha/ Cerrejon | Guajira | 210 | | | | 23 | | 0 | 0 | 23 | 233 |
| Bogotá | Cundinamarca | 8,383 | 230 | 277 | 529 | 600 | 710 | 730 | 802 | 3,878 | 12,261 |
| Bucaramanga | Santander | 1,854 | 43 | 77 | 54 | 96 | 46 | 87 | 62 | 465 | 2,319 |
| Medellín | Antioquia | 3,208 | 100 | 282 | 241 | 206 | 195 | 154 | 179 | 1,357 | 4,565 |
| Dos Quebradas | Risaralda | 129 | 38 | 5 | 0 | 5 | 6 | 8 | 3 | 65 | 194 |
| Villavicencio | Meta | 706 | 38 | 45 | 43 | 39 | 43 | 58 | 62 | 328 | 1,034 |
| Neiva | Huila | 138 | 15 | 84 | 14 | 47 | 9 | 17 | 19 | 205 | 343 |
| Ibagué | Tolima | 37 | 25 | 26 | 47 | 5 | 1 | 2 | 5 | 111 | 148 |
| **Total** | | 29,922 | 980 | 1,430 | 1,654 | 1,746 | 1,755 | 1,731 | 1,781 | 11,077 | 40,999 |

Source: Ministry of Mining and Energy and Publigás Magazine, September 2004.

### 3.3.8. Nonpoint Sources (Sugar Cane Burning)

Information on nonpoint source control in the sugar cane fields is limited. As shown in Table 3.31, an area of 30,000 to 40,000 hectares per year has reportedly been subject to "green cuts" over the past several years in CVC. This represents a maximum of 23% of the total harvested area. The practice appears to have peaked in the year 2000 and declined somewhat since then.

**Table 3.31. Hectares with Green Cuts, CVC, 1997–2003**

| Year | Hectares of green cuts | Percentage | Crops (hectares) |
|---|---|---|---|
| 1997 | 19,930 | 13% | 151,175 |
| 1998 | 28,462 | 17 | 167,399 |
| 1999 | 32,922 | 21 | 156,166 |
| 2000 | 40,171 | 23 | 176,648 |
| 2001 | 36,730 | 22 | 166,392 |
| 2002 | 34,070 | 21 | 162,152 |
| 2003* | 14,094 | 18 | 79,117 |

Source : CVC.

* Until June 30.

One expert interviewed for this project spoke of considerable resistance to green cuts in many local areas that follow traditional agricultural practices. However, according to this expert, the situation could be improved by introducing education programs and by replacing the current command-and-control policy with a policy of cooperation via new agreements with the cane producers of Valle del Cauca.

### 3.3.9. Proposed New Policies

Currently, the national government is preparing a CONPES document, "Guidelines for a National Policy on Prevention and Control Air Pollution," with options and programs to control atmospheric contamination in urban areas.

Major elements of this new policy include the following:

Energy sector :

- modernization of the Barrancabermeja[46] and Cartagena refineries;
- promotion of natural gas as a vehicular fuel;
- promotion of natural gas in the industrial sector;
- development of new, cleaner fuels, such as biodiesel and carburant alcohol; and
- parity with international prices of fuels.

[46] This refinery is expected to desulfurize 80% of the nation's gasoline and diesel with hydrotreatment.

Transportation sector:

- support for integrated mass transportation systems in urban areas; and
- retirement of obsolete public transportation vehicles.

Urban development:

- establishment of bicycle paths in urban areas;
- restrictions on the number of vehicles in the streets, such as the *pico y placa* ("peak and plate");
- location of polluting industrial activities in specific sectors using the land management plans; and
- support for industrial ecoparks.

Sanitation sector:

- collection of statistics on acute respiratory infections;
- prevention and control of diseases related or directly linked with air pollution;
- definition of risk factors and development of policies to protect vulnerable populations; and
- development of the concept of "urban life quality."

The proposed Council for Prevention and Control of Air Pollution (CONAIRE) would also improve coordination of air quality management. CONAIRE will be located in the Ministry of Environment, Housing and Territorial Development and comprise representatives of the Ministries of Transportation, Mining and Power, and Social Protection, plus IDEAM, the National Department of Planning, Ecopetrol, CARs, and AAUs. Periodically, other public or private institutions may be invited to participate. The council's main function will be to design, evaluate, and periodically adjust the national strategy to manage air quality. It will be responsible for ensuring the economic efficiency and fairness of strategies to control air pollution, pursuing complementary actions from different sectors, identifying opportunities to strengthen the responsible institutions, promoting the development of a regulatory schedule, and ensuring the development of permanent mechanisms for economic evaluation and adjustment of strategies to manage air quality. CONAIRE will also promote the creation of related councils and coordination at the local level.

Further, the Air Quality Information System (Sisaire) will be created and managed by IDEAM, with the purpose of collecting, updating, and analyzing relevant information generated by the monitoring network and the environmental, sanitation, transportation, and energy authorities.

MAVDT[47] has summarized the expected benefits of the implementation of the proposed policies of the CONPES document as follows:

● **Rationalization of the demand for gasoline and diesel through the removal of subsidies.** If parity with international and domestic prices and the equalization of taxes on gasoline and diesel are achieved, a reduction of 8% in the future demand of fuels in the transportation sector is expected, along with a reduction in emissions of PM10, $SO_x$, and $NO_x$ of 2.3% by 2005 and 7.7% in the long term (2020), relative to 2002 levels. The present value of the benefits on health is estimated at $333 million to $435 million.

● **Importation of high-quality diesel.** By importing 5,600 barrels per day of low-sulfur diesel during 2005–2007, emissions of PM10, $SO_x$, and $NO_x$ would be reduced by 0.6% in Bogotá and by 2.7% to 7.3% in other cities. Savings of about $145 million to $158 million in health costs during 2005–2007 would compensate for the costs of the additional imports, estimated to be $32.8 million to $34.7 million.

● **Barrancabermeja refinery**. Overall, the project seeks to achieve hydrogenation and desulfurization of the gasoline and diesel produced at the refinery, which represents about 80% of the nation's domestic supply. Emissions of $PM_{10}$, $SO_x$, and $NO_x$ in 2008 would be 6.4% below 2002 levels. In 2020, emissions are projected to be 3.9% below 2002 levels.[48] The value of the expected health benefits, estimated at current day prices, would be about $461 million to $616 million.

[47] Alberto Brugman, "Design of an economic instruments program for managing and controlling urban atmospheric pollution in Colombia," MAVDT, December 2004

[48] The reduction in emissions from mobile sources associated with the Barrancabermeja project gradually diminishes because of an assumed increase in better-quality imported gasoline and diesel.

● **Cartagena refinery.** The project's aim is to enlarge the refinery and to provide hydrogenation and desulfurization of the gasoline and diesel produced, which represents about 20% of the nation's domestic supply. Emissions of $PM_{10}$, $SO_x$, and $NO_x$ in 2008 would be about 2% lower than emissions levels in 2002.[49] The value of the expected health benefits, estimated at current prices, would be about $190 million to $260 million— considerably less than the cost of the investment, which is expected to be about $806 million.

● **Incentives for compressed natural gas in vehicles**. The purpose is to increase the demand for natural gas fuels and encourage the substitution of gas for 30% of the gasoline and diesel in the eight largest urban and industrial areas in the country. That substitution would reduce emissions of PM10 and $SO_x$ in 2005 by 1.3% and 0.1%, respectively, percentages that would progressively rise to 10% and 1.2% by 2020. The value of the expected health benefits would be about $559 million to $754 million, against an investment in vehicles estimated at $262 million to $280 million (not counting the net benefits caused by substitution of imported gasoline and diesel for CNG).

● **Conversion from coal to natural gas in urban factories**. With the substitution of the urban industrial usage of coal for natural gas (10 mpcd in the North Coast and 20 mpcd in the Interior), emissions of PM10, $SO_x$, and $NO_x$ will be reduced by 2.3% on a national basis. The value of the expected health benefits through 2020, estimated at current prices,would be about $458 million to $582 million; the costs of supply and transportation of gas exceed the costs for coal by about $136 million to $178 million.

● **Urban mass transportation systems**. The programs for mass transit in Bogotá (diesel), Medellín (CNG), Cali (diesel), Barranquilla (CNG), and Pereira (diesel) are expected to achieve emissions reductions of PM10, $SO_x$, and $NO_x$ of 2.3% in 2005 and 4.8% by 2020, compared with 2002 levels. The value of the expected health benefits, estimated at current prices, would be about $821 million to $1,036 million, based on the direct emissions reductions and the scrapping of old vehicles.

● **Supply of carburant alcohol.** The mixture of 10% carburant alcohol with gasoline substitutes for imports and contributes to reductions in emissions of CO.[50]

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[49] In this scenario, the refinery is still operated with the current facilities.

[50] Advance Document, CONPES Air, January 2005 version.

**3.3.10. Economic Incentive Measures**

So far, the principal economic incentives for air pollution control discussed in this chapter are the (perverse) incentives associated with subsidies for gasoline and diesel. As noted, these subsidies are scheduled to be phased out by 2006, and at least in Bogotá, a 20% surcharge on gasoline has been imposed to finance Transmillenio and road maintenance activities. However, other types of economic incentives for air pollution are possible.

Following the recommendations by Brugman (2004), MAVDT is currently studying the feasibility of introducing taxes on emissions from highly polluting fuels, particularly diesel and coal, to encourage expanded use of CNG:[51] As Brugman notes,

This concept is needed given the difference in the emissions of atmospheric pollutants of CNG compared with other fuels, whose cost for the community is not directly included in the process to establish their prices for the final consumer. [Adoption of such taxes]…will…maximize the [social] benefits associated with fuel use.[52]

Specifically, Brugman recommends that emissions taxes, as authorized by Law 99-1993,

> would be those collected by the competent environmental authority…for the two most important pollutants in terms of the potential damage to human health: $PM_{10}$ and $PM_{2.5}$ (and, if required, for emissions of $SO_2$ given its contribution on formation of secondary particulate matter). Initially, the taxes would be established at minimum levels, with additional regional-based taxes to be applied each year, based on air quality in particular cities.[53]

The proposed option would channel the tax revenues to environmental programs, monitoring networks for air quality, and health programs. Currently, the proposal is under study in MAVDT, and no final decisions have been made.

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51 Alberto Brugman, "Design of an economic instruments program for managing and controlling urban atmospheric pollution in Colombia," MAVDT, December 2004.

52 Ibid.

53 Ibid.

## 3.4. Recommendations

It is clear that Colombia has made major efforts during the past decade to improve air quality in Bogotá and several other large urban areas. Progress has been bolstered by increased awareness among the experts and the public of the links between air pollution and public health. However, as documented by Larsen, the damages to human health associated with current air pollution levels—particularly elevated concentrations of fine particles—remain quite high.[54] Despite severe data limitations, this chapter has documented a number of problems in stationary, mobile, and nonpoint sources as well as some basic measurement issues affecting all sources.

Before presenting the specific recommendations, we offer a brief note on the need for developing a strategic focus for the air quality management program. The current program appears to lack a well-articulated set of priorities consistent with the pubic health threats posed by air pollution, particularly the threats posed by elevated concentrations of fine particles. Despite ongoing concerns about ozone, air toxics, and possibly other pollutants, the overwhelming evidence points to elevated levels of fine particles as the most important casue of air pollution–related health impacts. Accordingly, we recommend that a broadscale strategy be developed to reduce exposure to elevated concentrations of fine particles. Critical elements of that strategy should include the establishment of national ambient standards for PM10 as well as PM2.5, plus the strengthening of technology-specific emissions standards for PM and its precursors ($SO_x$ and $NO_x$). Additional resources are also needed to enhance monitoring and enforcement activities to address the challenge posed by this pollutant.

MAVDT is currently designing a new policy, CONPES, that recognizes the importance of urban air pollution as a priority issue of national concern. This policy is focusing on the development of programs aimed at controlling emissions associated with the use of liquid combustibles, reducing the subsidies for these combustibles, providing incentives for the use of clean sources of energy, and building efficient transportation systems. In addition, MAVDT is examining policies to reduce emissions associated with industrial, extractive, power generation, transportation, and relevant household sources.[55]

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[54] Bjorn Larsen, 2004, "Cost of Environmental Damage," MAVDT, July 30, 2004.

[55] Advance Document, CONPES Air, August 25, 2004.

The actions under development are critical steps toward improving air quality in Colombia. Yet at this point, CONPES is still in the planning stage. Full implementation is a ways off. As discussed in Blackman et al. (2004a, 2004b), regulatory capture—whereby interest groups exert undue influence on the activities of environmental authorities—appears to have been a major factor in slowing implementation of previous laws or policies. Given the historical experience, sound management requires that new efforts be undertaken to strengthen the implementation process. In our view, the most effective way to counter the undue influence of interest groups on environmental authorities is to strengthen the hand of NGOs and other elements of civil society involved in the relevant issues. Although how this might be done is beyond the scope of this project, we believe such reforms are vital to the success of any efforts to strengthen the process of air quality management in Colombia. See Blackman et al. (2004a, 2004b) for further discussion of this issue.

The technical recommendations are given in five categories:

- measurement and monitoring;
- ambient standards;
- stationary sources;
- mobile sources; and
- nonpoint sources

**3.4.1. Measurement and Monitoring**

The old adage that it is not possible to manage what is not measured is particularly applicable to air quality. The importance of this point cannot be overstated. Specifically, it is recommended that standards for air quality monitoring equipment and procedures be established at the national level and that monitoring networks be strengthened in major municipalities throughout the country. The modest amount of actual data presented in this chapter is indicative of the problem. In some cities only single monitors are in operation. Specialized equipment, regular maintenance, standardized protocols for reading and interpreting the data, and training of personnel are all essential elements of viable control policies. Further, a centralized depositary should be established to review and analyze the data from across the country. Overall, a strong institutional structure combined with solid funding and continuing oversight are essential for achieving reliable and consistent measurements over time.

### 3.4.2. Ambient Standards

The national ambient standards for major air pollutants first issued in Colombia in 1982 are still in effect today. Over the past two decades considerable advances have occurred in our understanding of the link between air pollution and public health. Most nations with large urban populations have adjusted their standards accordingly. The fact that Bogotá and a few other large cities in Colombia have updated the 1982 standards is a positive step. However, it is clearly time to revise the standards at the national level. Accordingly, we recommend that the 1982 national ambient standards be updated to reflect the latest developments in science and policymaking. Given the demonstrated health damages associated with elevated concentrations of fine particles, we specifically recommend that national standards be established for PM10 and PM2.5.

### 3.4.3. Stationary Sources

Reflecting our review of the regulatory structure for stationary sources, we make the following recommendations:

- As with the ambient standards, major emissions standards for stationary sources should be updated to reflect scientific and technological advances, with a focus on fine particles.
- Efforts to improve fuel quality used by power plants and heavy industry should be encouraged, including the expanded use of natural gas to replace coal, and the use of low-sulfur oil. The deadlines for upgrading fuels contained in the CONPES should be maintained.
- New regulatory programs should be established for specific sectors (and smaller sources) not currently covered by enforceable regulations. As noted, brick kilns are a major source of air pollution in some areas, such as Nobsa. Innovative programs in Mexico and other developing countries can serve as models for these activities.
- The compliance and enforcement systems need to be extensively reformed. At present, the penalties for noncompliance appear to be extremely modest. We recommend that a more serious penalty system be adopted and accompanied by strong oversight by MAVDT.

National-level sanctions could include the withholding of financial support for continued failure to uphold the laws.

- A major audit should be conducted of existing tax incentives for new pollution abatement and related equipment. Based on the findings of the audit, recommendations should be made for appropriate reforms, including possible expansion of the incentives.

**3.4.4. Mobile sources**

Mobile sources represent a large and growing source of urban air pollution. The CONPES document already reflects important policy directions for these sources. To reinforce CONPES, we make the following specific recommendations:

- Efforts should be continued to raise the prices of motor fuel—both gasoline and diesel—to international levels. The 2006 deadline shold be maintained.
- Efforts should be continued to improve fuel quality by undertaking major investment programs at Bucarramanga and Cartagena refineries, and by increasing imports of clean fuels. The 2008 deadlines should be maintained.
- Efforts should be continued and expanded to encourage use of CNG in vehicles.
- Additional funding should be made available for upgrading urban bus fleets and other forms of mass transit in major cities.
- Additional funding should be made available for programs to scrap older vehicles.
- The testing methods for vehicle exhausts should be reexamined in light of the experience of other countries (e.g., Mexico and the United States), and more rigorous approaches to testing vehicle emissions should be considered.
- Following the proposals by Brugman for additional incentives to encourage use of natural gas, economic incentives consistent with the provisions of Law 99 should be adopted.

**3.4.5. Nonpoint sources**

Burning of sugar cane residue is the sole nonpoint source examined in this chapter. The evidence presented indicates that compliance with "green cut" procedures is inadequate to limit potentially harmful pollution levels at certain times of the year. Part of the resistance to the use of green cuts is associated with allegiance to traditional practices. Accordingly, it is recommended that education programs for local officials and the general population be introduced in the affected areas. It is also recommended that cooperative agreements be established with the producers to increase green cuts, and that appropriate monitoring programs be implemented. At the same time, the possibility of national-level sanctions, including the withholding of financial support for continued noncompliance, should be built into the arsenal of compliance tools available to the authorities.

# 4. Water Issues

## 4.1. Introduction

Given limitations on resources available for this study, an all-inclusive review of Colombian water policy would necessarily be quite superficial. To make a more substantive analysis practical, we have limited the scope of the analysis and focused on those issues that (i) are most important, and (ii) are not being covered in other studies commissioned over the past year by MAVDT or the World Bank. We have made several decisions in this regard. First, we have focused on water quality issues as opposed to water quantity issues. We have not omitted water quantity issues because they lack importance—to the contrary, they are vitally important, as the recent effort to draft a new water law demonstrates—but because the quality issues are stressed by the Terms of Reference for this report and water quantity issues are covered by other studies commissioned by MAVDT, including Roesner et al. (2004). Second, we have chosen to focus on water pollution control policies rather than drinking water supply policies because the former are more a conventional concern of environmental policy. Third, we have chosen to focus on the two pillars of Colombian water pollution control policy: discharge standards and discharge fees. We have not focused on environmental licensing and environmental impact assessments, which are addressed in a separate study commissioned by MAVDT. Finally, we do not cover voluntary pollution control agreements, which were discussed in detail in Blackman et al. (2004a) and Blackman et al. (2004b).

The chapter is organized as follows. Section 4.2 briefly reviews national-level water quality data. Section 4.3 discusses the design of Colombian water pollution control policies. It summarizes the legal framework, provides a brief synopsis, and presents an analysis of policy design. The next three sections evaluate the implementation of three pillars of Colombian water pollution control policy—Section 4.4 evaluates permitting, Section 4.5 evaluates discharge standards, and Section 4.6 evaluates discharge fees. Section 4.7 presents an analytical discussion of both the design and implementation of these three instruments. Finally, Section 4.8. presents recommendations.

## 4.2. Environmental Quality

This section provides a brief overview of the water quality in Colombia and some of the principal factors that affect it.

### 4.2.1. Overview of Water Quality

According to IDEAM (2001), the collection and management of information on ambient water quality in Colombia are inadequate. Although monitoring stations do exist for selected rivers and aquifers, coverage is limited and data collection and management are not standardized. As a result, the state of water quality in the country is difficult to establish at a national level.

That said, there is a general consensus that many of Colombia's water basins are severely polluted. According to IDEAM (2002a), the following rivers are all in critical condition: Bogotá, Cali, Cauca, Medellín, de Oro, Lebrija, Pasto, Pamplonita, Combeima, and Otún. According to the Contraloría (2003), the Bogotá River is reputed to be one of the most polluted rivers in the world. SIAC (2002) attempted a classification of all 45 of Colombia's river basins. It assigned each basin an "index of vulnerability" ranging from 2 to 7, where the lowest values (< 4.5) represent "those water basins more vulnerable as a result of their biophysical conditions and the human pressures exerted on them" (Table 4.1). Eleven of the river basins—roughly a quarter of the total—have vulnerability indices lower than 4.5.

**Table 4.1.Vulnerability Indices of Colombia's River Basins**

| Code | Basin | Vulnerability index |
|---|---|---|
| 1 | Alto Magdalena | 4.4 |
| 2 | Sabana de Bogotá | 4.0 |
| 3 | Medio Magdalena | 4.0 |
| 4 | Rio Sogamoso | 3.6 |
| 5 | Bajo Magdalena | 4.3 |
| 6 | Rio Cesar | 4.2 |
| 7 | Alto Cauca | 4.2 |
| 8 | Medio Cauca | 3.8 |
| 9 | Bajo Cauca | 5.0 |
| 10 | Rio Nechi | 4.5 |
| 11 | S.N.S. Marta - occ. | 4.4 |
| 12 | Rio Tolo | 6.4 |
| 13 | Rio Atrato | 6.2 |
| 14 | Sinú-Caribe | 4.4 |
| 15 | S.N.S. Marta - norte | 4.6 |
| 16 | Alta Guajira | 2.0 |
| 17 | Bajo Guajira | 3.8 |
| 18 | Rio Catatumbo | 3.9 |
| 19 | San Andreas y Prov. | 3.3 |
| 20 | Rio Arauca | 3.1 |
| 21 | Alto Meta | 4.6 |
| 22 | Bajo Meta | 3.1 |

**Table 4.1 con't**

| | | |
|---|---|---|
| 23 | Rio Vita | 4.3 |
| 24 | Rio Tomo-Tuparro | 4.5 |
| 25 | Rio Vichada | 5.1 |
| 26 | Alto Guaviare | 5.6 |
| 27 | Medio Guaviare | 6.2 |
| 28 | Bajo Guaviare | 6.8 |
| 29 | Río Inírida | 6.7 |
| 30 | Río Atabapo | 5.5 |
| 31 | Río Guanía | 6.6 |
| 32 | Río Vaupes | 6.8 |
| 33 | Río Apaporis | 6.8 |
| 34 | Alto Caquetá | 5.1 |
| 35 | Bajo Caquetá | 6.6 |
| 36 | Río Puré | 6.9 |
| 37 | Río Putumayo | 6.6 |
| 38 | Río Mira-Guiza | 5.6 |
| 39 | Alto Patía | 3.2 |
| 40 | Bajo Patía | 5.4 |
| 41 | Río Saquianga-Patia Norte | 6.3 |
| 42 | Ríio Micay | 6.1 |
| 43 | Río Coyanero-Dagua | 5.7 |
| 44 | Río San Juan | 6.3 |
| 45 | Río Baudo y directos | 6.8 |

Source: SIAC 2002.

Systematic information on groundwater quality is also lacking. However, some aquifers are clearly polluted—a special concern in regions where groundwater is used for drinking. According to IDEAM (2004a), 40 municipalities rely on groundwater exclusively for this purpose.

#### 4.2.2. Sources of Discharges

As discussed in Contraloría (2002), according to the National Department of Planning (DNP), there is no reliable analysis of water pollution at the national level (DNP-PNUD 1994). DNP estimates that the three largest contributors to biochemical oxygen demand (BOD) in surface waters in Colombia are, in order of importance: (i) agricultural and livestock nonpoint sources (84%); (ii) domestic wastewater from large urban centers, such as Bogotá, Medellín, Cali, Barranquilla, Manizales, and Cartagena (10%); and (iii) industrial point sources (6%; Table 4.2). Note that the BOD discharged from agriculture and livestock nonpoint sources is an order of magnitude greater than from either domestic or industrial sources. In this regard, Colombia is typical—nonpoint sources are a leading cause of water pollution in many countries with significant agricultural sectors. (Unfortunately, nonpoint sources are particularly difficult to control, and as a result policymakers tend to focus on point sources.) Among industrial activities, the DNP report identifies as particularly important beverages and alcohol, industrial chemicals, and the cardboard and paper industry.

**Table 4.2. Daily BOD Production by Sector**

| Sector | Tons | Percentage |
|---|---|---|
| Agriculture, livestock | 7,100 | 84 |
| Domestic wastewater | 800 | 10 |
| Industrial wastewater | 520 | 6 |
| TOTAL | 8,420 | 100 |

Source: DNP 1994.

More recent evidence confirms that among point sources, urban wastewater is responsible for the lion's share of BOD. According to IDEAM (2002a), in 1999, the total BOD discharged from point sources was 624,746 tons, with 74% coming from the domestic sector and 26% from industry. IDEAM (2002a) identifies the greatest contributors as the industrial centers of Cali, Bogotá, Medellin, Manizales, Barranquilla, Cartagena, and Bucaramanga.

Major causes of groundwater pollution include agricultural runoff, septic tanks, and landfills. In addition, the depletion of aquifers in coastal areas has caused some to be contaminated by seawater (IDEAM 2002).

### 4.2.3. Urban Wastewater

DNP (1994) estimated the total national generation of wastewater in the urban centers at 67 cubic meters per second. Bogotá represented 15% of this amount; Antioquia, 13%; Valle del Cauca, 10%; and the other departments, less than 5%. Unfortunately, the vast majority of this wastewater is not treated. This problem has several dimensions. First, a significant percentage of wastewater is not collected because many households are not connected to municipal sewer systems. Second, many municipalities lack wastewater treatment, so even when wastewater is collected, it is generally not treated. Third, many of the existing wastewater treatment plants operate inefficiently or not at all. Finally, wastewater treatment relies almost exclusively on high-cost, high-technology, conventional treatment plants. We discuss each of these points below.

First, only approximately 75% of the people living in urban areas in 2001 (31,339,130 inhabitants) have access to sewer systems (Table 4.3). Thus, 7,803,000 people lack access to this service.

**Table 4.3. Urban Coverage of Sewer Systems, 2001**

| **Department** | **Municipalities** | **Municipalities with coverage** | | | **Average coverage** |
|---|---|---|---|---|---|
| | | **> 80%** | **70%–80%** | **< 70%** | |
| Antioquia | 125 | 77 | 22 | 26 | 87.9 |
| Atlántico | 23 | 0 | 2 | 21 | 61.7 |
| Bogotá | 1 | 1 | 0 | 0 | 80.0 |
| Bolívar | 45 | 3 | 2 | 40 | 48.9 |
| Boyacá | 123 | 100 | 11 | 12 | 88.4 |
| Caldas | 27 | 23 | 2 | 2 | 90.6 |
| Caquetá | 16 | 6 | 3 | 7 | 50.7 |
| Cauca | 41 | 17 | 7 | 17 | 81.6 |
| Cesar | 25 | 4 | 7 | 14 | 71.0 |
| Córdoba | 28 | 3 | 0 | 25 | 48.0 |
| Cundinamarca | 116 | 50 | 8 | 58 | 62.1 |
| Chocó | 26 | 1 | 0 | 25 | 20.4 |
| Huila | 37 | 27 | 9 | 1 | 82.2 |
| La Guajira | 14 | 3 | 2 | 9 | 52.5 |
| Magdalena | 26 | 1 | 1 | 24 | 48.1 |
| Meta | 29 | 18 | 3 | 8 | 74.7 |
| Nariño | 63 | 21 | 12 | 30 | 76.5 |
| Norte de | 40 | 30 | 4 | 6 | 78.8 |
| Santander | | | | | |
| Quindío | 12 | 4 | 7 | 1 | 83.6 |
| Risaralda | 14 | 14 | 0 | 0 | 86.1 |
| Santander | 87 | 73 | 4 | 10 | 89.3 |
| Sucre | 24 | 2 | 3 | 19 | 50.4 |
| Tolima | 47 | 17 | 4 | 26 | 76.3 |
| Valle del Cauca | 42 | 35 | 1 | 6 | 82.3 |
| Arauca | 7 | 0 | 1 | 6 | 50.7 |
| Casanare | 19 | 9 | 0 | 10 | 76.3 |
| Putumayo | 13 | 0 | 1 | 12 | 50.1 |
| San Andrés y Prov. | 2 | 0 | 0 | 2 | 48.9 |
| Amazonas | 2 | 0 | 1 | 1 | 68.7 |
| Guainía | 1 | 0 | 0 | 1 | 25.0 |
| Guaviare | 4 | 1 | 1 | 2 | 57.1 |
| Vaupés | 3 | 0 | 0 | 3 | 35.9 |
| Vichada | 4 | 0 | 0 | 4 | 7.6 |
| TOTAL | 1086 | 540 | 118 | 428 | 75.1 |

Source: Universidad de Los Andes and Ministry of Environment (2002) as reported in Contraloría (2002).

Second, Contraloría (1999) reported that as of 1999, only 16% of Colombia's 1089 municipalities had operating treatment plants (Table 4.4). Of these plants 78% were owned by the municipality. 128 more plants were planned or projected.

**Table 4.4. Number of Operating and Planned Municipal Wastewater Treatment Plants, 1999**

| Region | No. municipalities | No. treatment plants | No. owned by municipality | No. planned plants |
|---|---|---|---|---|
| Atlantic | 181 | 62 | 54 | 41 |
| Pacific | 341 | 27 | 23 | 25 |
| Central-East | 450 | 61 | 41 | 41 |
| Orinoquía | 80 | 20 | 14 | 17 |
| Amazone | 37 | 0 | 0 | 4 |
| TOTAL | 1089 | 170 | 132 | 128 |

Source: Ministry of Development as reported in Contraloría 1999

The Ministry of Development estimated (as reported in Contraloría 1999) that Colombia's treatment plants treat less than 1% of total urban wastewater (Table 4.5). This percentage compares unfavorably with the average for other countries in Latin America, which according to Contraloría is 2%.

**Table 4.5. Wastewater Treatment as a Percentage of Total Flow, 1999**

| Parameter | Estimate |
|---|---|
| Urban population | 29,386,109 |
| Water consumption ($m^3$/day) | 6,788,191 |
| Wastewater flow ($m^3$/day) | 5,407,044 |
| Treated wastewater flow ($m^3$/day) | 11,680 |
| Percentage of wastewater treated | 0.21 |

Source: Ministry of Development (1999) as reported in Contraloría (1999).

A third important problem related to urban wastewater in Colombia is that many of Colombia's plants do not operate effectively. The Ministry of Development estimated that 19% of total flows into wastewater treatment plants are not treated at all. Even among those plants that do treat wastewater, a significant percentage still do not meet national discharge standards. The Ministry of Development found that in a sample of 40 municipal wastewater treatment plants, only 40% were in compliance with Decree 1594 of 1984 standards for the removal of 80% of BOD and 65% of total suspended solids (TSS) (Table 4.6).

**Table 4.6. Efficiency of Organic Load Removal in 40 Wastewater Treatment Plants**

| Municipality | Flow (l/s) | Removal BOD[a] (%) | Removal COD[b] (%) | Removal TSS[c] (%) |
|---|---|---|---|---|
| Bucaramanga | 2.50 | 74.00 | 60.00 | 48.00 |
| Bogotá | 3.50 | 84.00 | 50.00 | 40.00 |
| Alvarado | 4.76 | 78.10 | 71.80 | 70.10 |
| Barrancas | 14.00 | 38.20 | 30.00 | 80.00 |
| Becerril | 50.92 | 58.11 | 83.33 | 83.90 |
| Cajicá | 105.4 | 79.00 | 78.00 | 92.00 |
| Chía | 41.80 | 73.00 | 71.03 | 82.49 |
| Chiriguaná | 52.82 | 32.90 | 48.30 | 62.70 |
| Chocontá | 13.23 | 65.20 | 70.00 | 43.00 |
| Concepción | 26.86 | 55.80 | 85.90 | 46.70 |
| El Paso | 16.50 | 41.80 | 30.20 | 65.90 |
| Espinal | 84.07 | 85..00 | 81.00 | 90.00 |
| Fonseca | 123.19 | 40.86 | 20.38 | 21.50 |
| Gachancipá | 6.08 | 25.00 | 38.00 | 40.00 |
| Guacarí | 40.00 | 81.10 | 65.73 | 94.35 |
| Guamal | 46.38 | 75.00 | 78.00 | 89.00 |
| Hato Nuevo | 54.42 | 70.00 | 80.20 | 83.40 |
| La Unión | 20.00 | 83.70 | 81.00 | 98.45 |
| Maicao | 133.00 | 77.51 | 77.70 | 82.20 |
| Mosquera | 83.62 | 86.00 | 85.00 | 91.00 |
| Roldanillo | 40.00 | 80.50 | 81.30 | 88.70 |
| Sesquilé | 4.74 | 74.73 | 78.43 | 82.00 |
| Sopó | 7.90 | 90.00 | 80.14 | 78.43 |
| Suesca | 68.00 | 46.20 | 92.00 | 50.00 |
| Tocancipá | 9.71 | 81.30 | 82.30 | 90.00 |
| Toro | 20..00 | 83.00 | 72.80 | 97.80 |
| Urumita | 8.22 | 53.40 | 68.44 | 65.15 |
| Villanueva | 135.00 | 74.10 | 61.00 | 88.00 |
| Zipaquira I | 44.10 | 97.00 | 83.38 | 20.00 |
| Zipaquirá II | 167.75 | 93.00 | 74.09 | 83.33 |
| Cota | 9.00 | 81.00 | 77.00 | 91.00 |
| Funza | 145.00 | 88.00 | 90.00 | 92.00 |
| Facatativa | 86.00 | 77.00 | 82.00 | 80.00 |
| San Francisco | 59.00 | 80.00 | 78.00 | 82.00 |
| Anapoima | 8.12 | 72.40 | 88.20 | 90.00 |
| Ginebra | 51.90 | 81.10 | 71.400 | 84.20 |
| Tenjo | 11.00 | 65.00 | 80.00 | 74.00 |
| Guatapé | 7.58 | 85.00 | 80.00 | 88.00 |
| Icononzo | 7.43 | 60.00 | 56.00 | 80.00 |
| Ubaté | 3.70 | 78.00 | 94.00 | 85.00 |

[a]Biochemical oxygen demand; [b]Chemical oxygen demand; [c]Total suspended solids

Source: Ministry of Development (1999) as reported in Contraloría (1999).

A final problem with urban wastewater treatment in Colombia is cost. Table 4.7 presents data on the estimated costs of required aqueducts and sewers in urban areas for the period 2001–2010. The cost of required municipal wastewater treatment is $US2.5 billion—or $2.5 million per year—which represents 72% of the total cost of all water infrastructure.

**Table 4.7. Estimated Costs of Required Aqueducts and Sewers in Urban Areas, 2001–2010**

| Type of expenditure | Cost (US2000$) |
|---|---|
| New aqueducts | 461.3 |
| Rehabilitation of potable water plants | 3.1 |
| New potable water plants | 17.2 |
| New sewers | 515.2 |
| New wastewater treatment plants | 2,568.5 |
| TOTAL | 3,567.4 |

Source: MMA 2002

Table 4.8 presents data on actual expenditures on urban wastewater treatment plants in seven cities in the four years between 1998 and 2001.

**Table 4.8. Investment in Wastewater Treatment Systems, 1998–2001**

| City | Investment (million pesos) |
|---|---|
| Bogotá | 229,120 |
| Medellín | 354,200 |
| Pereira | 18,330 |
| Cartagena | 21,000 |
| Santa Marta | 35,970 |
| Manizales | 8,661 |
| Conhydra * | 4,468 |
| TOTAL | 696,948 |

*Marinilla/Santafé de Antioquia

Source: EPS.

According to MAVDT (2001, 126), "The construction of wastewater treatment infrastructure is realized by individual cities. There is no mechanism for regional panning that permits grouping nearby cities and grouping the resources for collective treatment."

An important contributor to the exorbitant cost of treating urban wastewater in Colombia is the country's virtually exclusive reliance on high-cost, high-technology conventional treatment plants. There are few low-technology, low cost solutions, such as lagoons, anaerobic processes, anaerobic filters, and seasonal stabilization reservoirs for agricultural reuse (Libhaber and Foster 2002).

#### 4.2.4. Industrial Wastewater

According to a report on the state of environmental quality in Colombia's urban areas MMA (2002g), treatment of industrial wastewater is limited. In 66% of the cities studied, no firms treated wastewater as mandated by Decree 1594. In 23% of the cities, less than 50% did, and in 7.5% of cities, between 50 and 100% did. In only 3.1% did 100% of the firms treat their wastewater.

## 4.3. Policy Design

This section summarizes the legal framework for Colombian water pollution control policy and then provides a brief synopsis of this policy.

#### 4.3.1. Legal Framework

A few preliminary notes on Colombian law—specifically, the hierarchy of legal instruments and the relationship between old and new laws—may prove useful. The ultimate legal authority in Colombia is the Constitution: all other legal instruments must comport with its general principles and specific details. Laws are next in the hierarchy. They create institutions and specify general dictates. Finally, presidential decrees flesh out laws: they provide specific details and procedures needed to implement the laws. In general, regional environmental authorities, including CARs and AAUs, can pass laws that are more restrictive than national laws, but not less. In other words, national laws set a floor for the stringency of local laws. New laws and regulations completely supersede old ones only when the new law explicitly stipulates so. But this is rare. Typically, new laws include language to the effect that "this law overrules all regulations that contradict it." In such cases, some provisions of old laws remain in place.

Although many Colombian legal documents touch upon water quality, only a handful establish the basic structure of water quality regulation: (i) Decree-Law 2811 of 1974, which laid out the National Natural Renewable Resources and Protection of the Environment Code; (ii) Decrees 1541 of 1978 and1594 of 1984, which regulate the code's provisions on water management; (iii)

Law 99 of 1993, which creates SINA; and (iv) Decrees 901 of 1997 and 3100 of 2003, which regulate discharge fees. We discuss each of these laws and regulations below.

***Decree-Law 2811***

Decree-Law 2811 of 1974 establishes the *Codigo Nacional de los Recursos Naturales Renovables y del Ambiente* (CNRN), which for some time was Colombia's main environmental policy document. Below, we summarize the provisions of Article 2, which concern water quality. These provisions are quite general; specifics were set forth in subsequent decrees.

Ownership. According to Decree-Law 2811, virtually all water is considered to be in the public domain. Companies and individuals can obtain rights to use surface and ground waters only by one of two mechanisms: law and concession. Water is considered private property only when it originates and terminates on the same piece of private property. When ground or surface waters are in danger of depletion or pollution, new concessions in that basin or zone can be suspended and existing concessions can be circumscribed.

Public responsibilities. Decree-Law 2811 establishes that the state is responsible for guaranteeing the quality of the water used for human consumption.

Polluting discharges. Decree-Law 2811 charges the state with demarcating zones in which wastewater treatment is required and establishing concentration standards for various pollutants. Furthermore, it mandates that water users must obtain permits for discharging wastes from environmental authorities. Industries that cannot meet concentration standards can have their permits revoked or be required to locate in certain places.

Discharge fees. Decree-Law 2811 mandates that any facilities or individuals using natural resources, including water, must pay fees for the damages associated with disposing of wastes.

***Decree 1541***

Decree 1541 of 1978 regulates Article 2 of Decree-Law 2811 of 1974, including some water quality provisions. In particular, it establishes a framework for the national permit system mandated by Decree-Law 2811.

Water discharge permits. Decree 1541 states that all discharges of solid, liquid, or gaseous wastes that could contaminate water or damage human health or the normal development of flora or fauna must be treated; the standards depend on the ecological and economic characteristics of the receiving body. To facilitate this goal, the decree requires water dischargers to obtain permits from INDERENA. Applications for permits must provide information about the nature and amount of the discharge, the processing system, and the environmental impacts.

Discharge fees. Decree 1541 lays the foundation for discharge fees. It authorizes INDERENA to charge the fees necessary to cover the costs of maintaining or replacing natural renewable resources. For wastewater dischargers, the fees are to take into account both the characteristics of the wastewater and the quality of the receiving water body. Permit durations are limited to five years.

***Law 9 of 1979***

Law 9 of 1979 covers a variety of sanitary issues relating to public health. Among these is preserving and improving the quality of water intended for human consumption. Law 9 gives the Ministry of Health responsibility for defining acceptable water and deciding which uses of water are not acceptable. For example, it prohibits disposal of solid wastes in water bodies without the approval of the Ministry of Health, and it prohibits disposal of liquid wastes in rain drainage channels.

***Decree 1594***

Decree 1594 of 1984 regulates the water quality provisions of Law 9 of 1979, Decree-Law 2811 of 1974, and Decree 1541 of 1978. Within this decree, "EMAR" refers to the entity in charge of the management and administration of the resource, which could include HIMAT (IDEAM's predecessor), INDERENA, irrigation districts, CARs, and DIMAR. Annex 1 lists the substances covered by this decree.

Ambient water quality standards. Decree 1594 establishes ambient water quality standards for different types of uses, including human and other domestic consumption; preservation of flora and fauna; agriculture, including irrigation; animal production; and recreation, including swimming. Annex 2 details these standards.

Discharge prohibitions. Chapter VI of Decree 1594 governs discharges. One part of this chapter covers prohibitions. For example, it forbids the discharge of liquid wastes into the streets or storm drains and aquifers, and it forbids the discharge of sediments, sludge, and solid substances from water treatment systems into water bodies or sewage systems.

Wastewater discharge standards. A second part of Chapter VI establishes standards for wastewater discharges. The standards depend on whether discharges go into water bodies, such rivers and lakes, or public sewers. For the most part, the two sets of standards are identical. The main requirements are that existing dischargers—that is, those existing prior to the promulgation of the 1984 decree—remove at least 50% of total suspended solids (TSS) and at least 20–30% of biochemical oxygen demand (BOD), and that new dischargers remove at least 80% of TSS and at least 80% of BOD. Standards for discharges into sewers include a few additional requirements for solids that can become sediment, substances soluble in hexane, and maximum flow. All dischargers are subject to effluent concentration standards for 22 organic and inorganic substances. Annex 3 details these discharge standards. In the areas where multiple uses are assigned, the most restrictive discharge standards apply. Those who collect, transport, and handle liquid wastes from polluting facilities are required to fulfill all discharge regulations and obtain the necessary permits.

Discharge permits. Chapters VII and VIII of Decree 1594 address wastewater discharge permit applications and requirements for monitoring of effluent standards. Permits have a five-year duration. To ensure that dischargers comply with their permits, Articles 162 and 163 give the Ministry of Health (or other authority) the right to inspect dischargers at any time and take samples of their effluents. Furthermore, Article 173 mandates that the authority characterize dischargers' liquid effluents and verify their infrastructure and equipment. Annex 4 lists acceptable methods of sample collection and analysis. For dischargers that do not initially meet effluent standards, the responsiblity authority is allowed to set a schedule for eventual compliance.

Discharge fees. Chapter XII of Decree 1594 lays out a method for establishing and collecting the semiannual fee that dischargers must pay. The intent of the fee was to cover the costs MAVDT incurs in administering Decree-Law 2811 as well as the social costs of resource use. These fee calculations and collection methods were very infrequently used, however,and have since been superseded. (See discussion of Decree 901 of 1997 and Decree 3100 of 2003, below.)

Resource classification plan. Decree 1594 requires the Ministry of Health (or other authority) to develop a resource classification plan for existing uses, projections of water use needs, quality simulation models, quality criteria, discharges procedures, and the preservation of the natural characteristics of the resource. The quality simulation models, should contain, at a minimum, BOD, QOD, TSS, pH, temperature, dissolved oxygen, carried water, hydrobiologic information, and total coliforms.

Agrochemicals. Decree 1594 forbids the manual application of agrochemicals within 3 meters of a waterbody, or within 30 meters if the application is aerial. Additionally, the Ministry of Health (or other authority) is required to control application of agrochemicals in crops that require artificially flooded areas.

Environmental Impact Assessment. Decree 1594 states that the Ministry of Health (or other authority) can request an environmental impact assessment for (i) discharges that contain substances of sanitary interest; (ii) energy generation projects; (iii) exploration and extraction of nonrenewable resources; (iv) modifications of the course of waters between basins; (v) construction of aerial, maritime, and fluvial terminals; (vi) civil works that involve earthmoving; (vii) exploration of riverbeds, marine beds, and substrata; and (viii) new human settlements and industrial parks.

Sanctions. Decree 1594 states that in cases where it is not followed, the Ministry of Health (or other authority) can apply any of the following sanctions: (i) temporary shutdown; (ii) permanent suspension of works; (iii) confiscation of objects; (iv) destruction or denaturalization of articles; and (v) temporary suspension of sales or employment of products while a decision is being made.

***Law 99 of 1993***

Law 99 of 1993 created the National Environmental System. Although it introduced critically important changes in environmental management in many areas, water was not among them: most regulations for the water sector—Decrees 1541 of 1978 and 1594 of 1984—were left unchanged.

Ministry of Environment. Law 99 created the Ministry of Environment (MMA) and assigned it several responsibilities relevant to water management, including the general obligation to conserve and manage the environment and natural resources, and the more specific obligation to promulgate water quality and wastewater discharge standards.

CARs, AAUs, and other territorial entities. Law 99 also extended and redefined the purview of the autonomous regional corporations (CARs). It gave them principal responsibility for monitoring and enforcing water quality regulations, including the discharge standards and fees. It established urban environmental authorities (AAUs) in cities with populations greater than 1 million inhabitants and charged them with responsibilities analogous to those of CARs.[1] As for departments and municipalities, Law 99 requires that they undertake jointly with CARs environmental control and monitoring activities in their jurisdictions, and that they help develop decontamination and waste disposal projects.

Licensing and environmental impact assessments. Law 99 mandates that any activity that could cause serious environmental damage or significantly modify the landscape requires an environmental license. Three types of institutions—MMA, CARs, and some territorial governments—have the authority to grant environmental licenses. MMA is responsible for licenses for large-scale activities or activities that have a national impact.[56] CARs have environmental licensing authority for projects whose impacts are limited to their geographic territory. CARs may delegate this power to other territorial governments in their jurisdiction. Municipalities and metropolitan areas with populations over 1 million have the power to grant licenses within their jurisdictions.

Penalties and use fees. Building on previous regulation that mandated water use and discharge fees, Law 99 mandates penalties (*tasas retributivas*) for the disposal of wastes into water (among other natural resources). The fees are to reflect depreciation of the resource and the environmental and social costs associated with damages and restoration.

***Decree 901***

Decree 901 of 1997 regulates Law 99's provisions on penalties for water discharges. The following are its principal provisions.

Coverage. According to Article 13, pollutants covered are to be identified by the Ministry of Environment (which subsequently named BOD and TSS). As specified in Article 13, sources discharging into sewers are not obligated to pay the fee. However, sewer authorities are.

Calculation of discharge fees. As specified in Article 12, the monthly fee charged to water users depends two factors: (i) the amount of BOD and TSS in the facility's effluent stream, and (ii) whether the total discharges from all sources in a defined water basin meet targets set for each basin. The fee increases if the annual targets, established every five years, are not met.

[56] Activities that have a national impact are defined to include licenses for petroleum exploration, extraction, refining, or transportation; large mining projects; large dam projects; large energy projects; construction of large ocean ports, international airports, or other large transportation projects; construction of large irrigation districts; production of hazardous or toxic materials subject to international conventions; projects that affect national parks, involve introduction of foreign potentially invasive species, or involve generation of nuclear energy (Law 99, Article 52).

More specifically, the monthly fee for pollutant j (BOD5 or TSS), $TR_j$ is calculated as

$$TR_j = Tr_j \times Cc_j \times T$$

where

| | |
|---|---|
| $Tr_j$ | = a regional adjustment for quantity total discharges of pollutant j by all sources ($/kg); |
| $Cc_j$ | = daily pollution load of the substance (kg/day); and |
| T | = number of days of discharge |

Furthermore, Cc is calculated as

$$Cc = Q \times C \times 0.0864 \times (t/24)$$

where

| | |
|---|---|
| $Q_j$ | = average flow(l/s); |
| $C_j$ | = concentration of the contaminating substance (mg/l); |
| 0.0864 | = unit conversion factor; and |
| t | = hours per day of discharges (h) |

and $Tr_j$ is calculated as

$$Tr_j = Tm_j \times Fr$$

where

| | |
|---|---|
| $Tm_j$ | = minimum rate ($/kg); and |
| $Fr_j$ | = regional factor. |

$Tm_j$ is established annually by the Ministry of Environment. The minimum regional factor is equal to 1. It increases by 0.5 each semester (six months) that a preestablished target for total reductions of discharges by all sources is not met.

<u>Target setting</u>. Article 5 of Decree 901 concerns target setting. Every five years the board of directors of the competent environmental authority—CAR or AAU—is to establish a six-month reduction goals for total discharges of BOD and TSS into a water basin or segment. The goals

are supposed to take into account regional diversity, the capacity of the water body to assimilate pollution, socioeconomic conditions of the population affected, the manner in which the pollutants are to be reduced, and the social and environmental costs of the damages caused by the pollutants.

Monitoring and compliance. As stated in Article 16, every six months, all dischargers are required to present to the environmental authority an estimate of their discharges, along with information about how the estimate was obtained. Some users, such as sanitation authorities, are allowed to estimate discharges using pollution factors. Absent a declaration, the environmental authority may do the same. Articles 17 and 18 detail permissible methods for sampling discharges for the purpose of estimating pollution loads. According to Article 19, the environmental authority is entitled to inspect dischargers at any time to verify their discharge declarations.

Invoices and collections. Article 20 stipulates that the environmental authority will invoice dischargers each month and collect payment.

Relationship between discharge permits and fees. Article 24 mandates that paying discharge fees does not exempt users from complying with permits or discharge standards established under Decree 1594 of 1984. In theory, then—that is, assuming that the user is in compliance—discharge fees apply only to those discharges that exceed the limits. For example, for new facilities (established after Decree 1594 of 1984) required to remove 80% of BOD from their waste streams, discharge fees apply to the remaining 20%.

Ministry of Environment resolutions and guidance on discharge fees, subsequent to Decree 901 of 1997, concern emissions fees. Table 4.9 presents information on minimum fee rates ($Tm_j$) established by resolution by MMA as required by Decree 90 of 1997. Since 1998, rates have been indexed to the rate of inflation.

**Table 4.9. Ministry of Environment Resolutions on Minimum Fees ($Tm_j$)**

| Resolution | Period | BOD ($/kg) | TSS ($/kg) | Adjustment | Source |
|---|---|---|---|---|---|
| Resolution 0273 of April 1, 1997 | 4/1/97-5/5/98 | $39.50 | $16.90 | n/a | n/a |
| Resolution 0372 of May 6, 1998 | 5/5/98-12/31/98 | $46.50 | $19.90 | 17.68% | DANE - IPC97 |
| Resolution 0372 of May 6 1998 | 1/1/99-12/31/99 | $54.26 | $23.22 | 16.70% | DANE - IPC98 |
| Resolution 0372 of May 6 1998 | 1/1/00-12/31/00 | $59.27 | $25.36 | 9.23% | DANE - IPC99 |
| Resolution 0372 of May 6, 1998 | 1/1/01-12/31/01 | $64.46 | $27.58 | 8.75% | DANE - IPC00 |
| Resolution 0372 of May 6, 1998 | 1/1/02-12/31/02 | $69.39 | $29.68 | 7.65% | DANE - IPC00 |
| Resolution 0372 of May 6, 1998 | 1/1/03-12/31/03 | $74.24 | $31.75 | 6.99% | DANE _ IPC02 |

According to the Ministry of Environment implementation manual (MMA 1997a), CARs and AAUs need to accomplish the following tasks to implement a discharge system:

- develop a complete inventory of dischargers;
- register all dischargers;
- create system rules and guidance;
- create an information management system;
- characterize discharges from participating water uses;
- calculate pollution loads;
- identify water bodies and water body sections;
- set total pollution load goals for each water body or section;
- communicate the pollution load targets;
- develop a system of collection and charges;
- develop a system of managing fee revenue;
- develop a system of monitoring; and

- develop a system to evaluate regional factors (whether targets are achieved).

***Decree 3100***

Decree 3100 of 2003 regulates penalties for water discharges. It replaces Decree 901 of 1997. The main differences between the two decrees are Article 6 of Decree 3100, on collection of previous information; Article 11, on adjustment of reduction objectives; and Articles 15 and 16, on the change in the value of the regional factor and the penalty. We discuss each of these articles below.

Article 6 of Decree 3100 of 2003 establishes that, prior to collecting the penalty, the environmental authority—usually the CAR or AAU—should (i) evaluate the quality of the water sources; (ii) identify the dischargers that are required to pay penalties; (iii) ensure that those dischargers have discharge plans or licenses; and (iv) establish the quality objective for the receiving water body.

Article 11 of the Decree 3100 establishes that the users of the same water source can agree to modify the individual or collective level of discharge reduction as long as increases from one discharger are offset by reductions from other dischargers; the modifications must achieve the global reduction goal, which is established every five years. In other words, Article 11 effectively allows for trading among dischargers. Once approved by the environmental authority, such modifications are adopted for the remainder of the five years.

Article 15 of Decree 3100 modifies the provisions in Article 11 of Decree 901 that cover the calculation of the regional factor ($Fr_j$). $Fr_j$ is used to increase fees when targets for total discharges into a water body are not met. In Decree 901, $Fr_j$ was equal to 1 during the first year and was increased by 0.5 each year if water quality goals were not met, regardless of how close dischargers were to meeting goals. There was no cap on $Fr_j$. In theory, it would be 5.5. at the end of five years if targets were missed each semester and could increase even more in subsequent five-year periods. Finally, total pollution loads for all industrial facilities included amounts discharged by sewage authorities.

Decree 3100 makes three important modifications. First, the amount by which $Fr_j$ increases depends on the amount by which the discharge target is missed. Second, $Fr_j$ is not allowed to exceed 5.5 under any circumstances—a provision that codified into law a 1999 Ministry of

Environment resolution. And finally, total pollution loads measured against preestablished targets do not include loads discharged by sewage authorities.

Specifically, under Article 15 of Decree 3100, $Fr_j$ is calculated as the ratio of (the amount by which the total discharge load target was missed in the current year) to (the amount by which the target was missed in the previous year):

$$Fr_1 = Fr_0 + (Cc - CcM)/(CcL - CcM)$$

where

| | |
|---|---|
| $Fr_1$ | = regional factor for year 1; |
| $FR_0$ | = previous year's regional factor; |
| Cc | = total pollution load in kg discharged by all dischargers in the previous year net of the amount of pollutants discharged by the sewage utility service; |
| CcM | = global reduction goal for the basin (kg/year) net of the reduction goal established by the sewage utility; and |
| CcL | = Cc, but for the previous five-year period. |

And, as in Decree 901,

$$Cc = Q \times C \times 0.0864 \times (t/24)$$

where

| | |
|---|---|
| Q | = average flow (l/s); |
| C | = concentration of the contaminating substance (mg/l); |
| 0.0864 | = unit conversion factor; and |
| t | = hours per day of discharges (h) |

Finally, Decree 3100 includes three additional significant modifications to Decree 901. First, it establishes that the revenue from the fee must be used exclusively for water decontamination, although this is defined to include research. Second, it mandates that in addition to sectorwide abatement goals for entire industrial sectors allowed under Decree 901, CARs administering fee programs can set individual goals for water utilities and large sources (defined as those contributing more than 20% of discharges to a water body). Third, Decree 3100 limits the scope of the discharge fee program. It allows the program to be limited to watersheds considered a priority based on the quality of the water.

#### 4.3.2. Synopsis

This subsection presents a synopsis of Colombian water quality policy.

***Entities***

MAVDT. MAVDT is the supreme regulatory authority for water. It is responsible for both setting general policies and developing specific programs related to water. Its responsibilities include formulating, managing, and coordinating policies, regulations, and programs regarding potable water, wastewater discharges, sanitation, and (along with the Ministry of Foreign Affairs) international cooperation. In conjunction with the Ministry of Social Protection, it is responsible for defining the acceptable quality standards and uses for water and for developing a resource classification plan that includes existing uses, projections of water use needs, quality simulation models, quality criteria, and discharge procedures. The Ministry of Social Protection alone is in charge of approving water treatment, storage, and transportation when this water is for human consumption.

CARs and AAUs. Among the territorial entities, CARs and AAUs have responsibility for enforcing the water policies set at the national level. They are responsible for granting discharge and use permits; monitoring and enforcing compliance with discharge standards; calculating, charging, and collecting penalties and use fees for water; and reviewing environmental impact assessments.

Departments and municipalities. As for other territorial entities, departments and municipalities are charged with aiding CARs in monitoring and enforcement of water pollution regulation and in developing sanitation and wastewater treatment infrastructure. Also, as owners of wastewater treatment plants, they must comply with discharge criteria established by the law.

***Policies***

Colombian water quality regulation has five key elements.

Registration and permitting. The first is a system of registration and permitting. All dischargers of liquid wastes are required to register with, and obtain a permit from, the appropriate environmental authority—a CAR, AAU, or municipal authority. Most permits are essentially permissions to discharge and do not specify pollution abatement methods, equipment, or strategies.

Discharge standards. The second component of water quality policy is a set of discharge standards. Discharges of certain substances and discharges in certain areas are completely prohibited. For example, it is forbidden to discharge liquid wastes into the streets, storm drains, and aquifers, and it is forbidden to discharge sediments, sludge, and solid substances that come from water treatment systems into water bodies or sewage systems. As for standards, all dischargers are subject to effluent concentration standards for 22 organic and inorganic substances. In addition, "new" dischargers—those not in operation prior to 1984, when Decree 1594 was promulgated—are required to remove at least 80% of TSS and at least 80% of BOD from their waste streams. "Existing" facilities established prior to 1984 are allowed to adhere to slightly less stringent BOD and TSS requirement. Standards for discharges into sewers include a few additional requirements for solids that can cause sedimentation, substances soluble in hexane, and maximum flow. None of Colombia's discharge standards are industry-specific. CARs and AAUs are responsible for enforcing the discharge standards and may inspect discharging facilities at any time to sample effluents and inspect equipment.

Licensing. The third component is requirements for environmental licenses. Prior to construction, facilities that will discharge liquid effluents are required to obtain a license from environmental authorities. In most instances, the relevant authorities are CARs and AAUs. However, MAVDT issues licenses for projects such as airports of "national scale." To obtain a license, the polluting facility or project may have to conduct an environmental impact assessment and hold a public hearing. Licenses specify the manner in which water users will control water pollution. As noted above, this chapter does not focus on licensing, which is the subject of a separate study.

Discharge fees. A fourth component of Colombian water quality policy is a system of discharge fees. Some of the specifics of the fee system were changed by Decree 3100 of October of 2003 and Decree 3440 of October of 2004. Because the Terms of Reference mandate that our study evaluate water pollution control policies from 1993 to 2003, we describe here the system that was set up by Decree 901 of 1997 and persisted until October 2003, when Decree 3100 was promulgated.

All water users, including municipal sanitation authorities, that discharge liquid wastes directly into water basins—rivers and lakes but not sewers—are obliged to pay a monthly fee per unit of

BOD and TSS discharged. The amount of the fee depends on two factors: (a) the quantity of BOD and TSS in the facility's effluents, and (b) the total quantity of BOD and TSS discharged from all sources into the same water basin. Regarding (b), every five years, annual targets are set for the total quantity of BOD and TSS discharged from all sources into each water basin. If these targets are not met, then every six months, the fees that individual facilities pay are increases by a factor of 0.5. Boards of directors of CARs and AAUs set total discharge targets for all basins in their jurisdictions. Monitoring is based on a system of self-reports and random verification by CARs and AAUs.

As envisioned in Decree 90, discharge fees were meant to complement discharge standards. In theory, then—that is, assuming that the user is in compliance—discharge fees apply only to those discharges that exceed the standards. For example, for new facilities (established after Decree 1594 of 1984) required to remove 80% of BOD from their waste streams, discharge fees apply to the remaining 20%.

<u>Quality standards</u>. The final element of Colombian water quality policy is a set of quality standards for various beneficial uses, including human and other domestic consumption; preservation of flora and fauna; agriculture, including irrigation; animal production; and recreation, including swimming. The standards specify in considerable detail the maximum permissible levels of various pollutants in water destined for each of these uses.

## 4.4. Policy Implementation: Permitting

For either of Colombia's primary pollution control instruments—discharge standards and discharge fees—to operate effectively, environmental regulatory authorities must at minimum have reasonably complete, up-to-date, accurate information about the fixed sources that are discharging liquid effluents, and they must be able to grant or deny permission to discharge. In other words, a necessary condition for a well-functioning system of discharge standards or fees is a well-functioning system of permitting.

As discussed in Blackman et al. (2004b), regulatory capacity varies markedly across CARs and AAUs, and some are undoubtedly much better at permitting than others. However, considerable evidence suggests that well-functioning permit systems are the exception rather than the rule. Two problems are common. First, environmental authorities have poor inventories of dischargers. Second, permitting it not efficient. It is characterized by copious red tape and long delays, requirements that are not consistent across CARs, and in some cases, corruption.  We explore each of these issues in more detail below.

#### 4.4.1. Discharge Inventories

To our knowledge, there is no national-level database or recent study of water discharges or water dischargers. In itself, this fact is revealing. CARs and AAUs are the principal repositories of information on discharges. However, their data are far from complete and comprehensive. According to the Contraloría (2002), self-reports from CARs indicate that 40% do not have an inventory of wastewater discharges in their jurisdiction. Even so, among the 60% of CARs that do have inventories, the great majority are not up-to-date or cover only part of the jurisdiction. The fact that many polluters in Colombia are small and informal—that is, unlicensed and unregistered (for example, on-farm coffee-processing and automotive repair shops)—makes compiling emissions inventories particularly challenging. This is a problem throughout developing countries, where informal enterprises usually are responsible for a significant fraction of total discharges.

#### 4.4.2. Efficiency and Effectiveness

To our knowledge, there are no comprehensive national-level studies on the efficiency and effectiveness of water discharge permitting. We present several types of information here: (i) interview evidence gathered in four CARs and one AAU and in Bogotá; and (ii) self-reported CAR-level data gathered by MAVDT.

*Interviews*

Our interview evidence is derived from a small, nonrandom sample of public- and private-sector stakeholders, most of whom are from four regional environmental authorities: CAR, Corantioquia, Cardique, and CVC. (For a complete list of interviews used for this report, see Annex 5. Note that not all of the data collected from the interviews listed in the annex were used for this chapter.) Of these four environmental authorities, CAR, CVC, and Corantioquia are generally considered to be among the more competent regional environmental authorities. Nevertheless, virtually all interviewees agreed that permitting and licensing are quite inefficient in each of these CARs.

CAR. All of our interviewees agreed that CAR permitting and licensing are abysmally slow. CAR staff estimated that on average, both permitting and licensing take one to two years. The interviewee noted that in CAR's permit filing system, the ratio of pending applications to permits already granted is approximately 100 to 1. At least one permit has been pending for 20 years. Furthermore, CAR does not have an inventory of polluters. Therefore, it does not know how many of the sources that need to be permitted have applied for permits.

Corroborating this dismal assessment, the head of a trade association with hundreds of member firms estimated that 95% of his members had begun the process of obtaining a permit from CAR, but fewer than 5% had actually received a permit. Another industry representative stated that of the nine permits his company was required to obtain from CAR (for solid waste, air emissions, and water use in addition to water emissions), only seven had been granted, and these took between one and three years to obtain.

According to CAR interviewees, permitting is the responsibility of the regional offices, and a number of factors are responsible for the long delays in the permitting process. First, CAR regional offices must interact with other SINA entities, namely the departments, to grant them, and the delays result from poor coordination. More importantly, CAR has not developed an adequate system for permitting. These interviewees report that a program is now underway to improve this system.

According to a trade representative, an important cause of long delays in permitting is the unclear, confusing, and incomplete regulations governing permitting, but internal management problems also contribute. These include poor overall organization and problems with staff—specifically, high turnover, low morale, a poor customer service ethic, the short terms of CAR directors general, and a drastic cut in staff (of approximately 300 persons) several years ago.

<u>Corantioquia</u>. Interview evidence on licensing and permitting from Corantioquia staff contradicted that from private sector stakeholders. According to Corantioquia interviewees, a process has been established that limits the length of the licensing and permitting processes to 24–26 days. Furthermore, according to these interviewees, key components of this process include delegating responsibility for permitting and licensing to the corporation's regional authorities; scheduling an initial consultation with a lawyer to map out a plan of action for obtaining the permit or license; providing Corantioquia's director general with the ability to monitor the progress of every permit application; creating interdisciplinary teams—including both lawyers and technicians—to handle the application process; and making an effort to establish cooperative rather than confrontational relationships with clients.

None of our private sector interviewees shared that rosy assessment of Corantioquia's permitting and licensing performance, however. Rather, these interviewees complained of delays lasting four months to over a year, which they said were common. According to one interviewee, reasons for delays include small staff and a high turnover, resulting in a loss of institutional memory.

Cardique. All of our interviewees agreed that Cardique permitting and licensing are extremely slow. Although no reliable data were available, both Cardique staff and industry representatives estimated that on average, permitting and licensing take considerably more than a year.

CVC. Staff in charge of permitting at CVC stated that this CAR is currently undertaking a review of permitting coverage. Although the study is incomplete, the interviewee estimated that fewer than 10% of point sources are permitted.

Other interviewees. The head of a national industrial trade association based in Bogotá cited examples of year-long waits for permits.

***CAR-level data***

Table 4.10 presents self-reported CAR-level data on discharge permitting for 2002 collected by MAVDT. Unfortunately, the data do not distinguish between permits for different types of media—air, water, soil. The second column presents the CARs' estimate of the number of facilities requiring effluent permits; the third column gives the number of facilities actually permitted; and the fourth column shows the first column as a percentage of the third. On average, CARs report having permitted just 31% of the facilities that require permits.

**Table 4.10. Permitting Data by CAR (2002)**

| CAR | Facilities requiring discharge permits | Facilities permitted | Facilities permitted as percentage of those requiring permits | Cost of monitoring discharge permits (thousands of pesos) | Total operational costs (thousands of pesos) | Cost of monitoring permits as % of total operational costs |
|---|---|---|---|---|---|---|
| CAM | 75 | 13 | 17 | 6,480 | 2,314,214 | 0 |
| CAR | 399 | 92 | 23 | 193,708.009 | 41,776,567 | 0 |
| CARDER | 60 | 28 | 47 | 45,034 | 4,200,708 | 1 |
| CARDIQUE | 18 | 4 | 22 | 72,509.243 | 1,495,210 | 5 |
| CARSUCRE | 31 | 9 | 29 | 2,850 | 1,760,386 | 0 |
| CAS | 91 | 4 | 4 | 14,682.85143 | 2,949,731 | 0 |
| CDA | 8 | 1 | 13 | 21,600 | 1,447,353 | 1 |
| CDMB | 160 | 50 | 31 | 47,941 | 5,042,021 | 1 |
| CODECHOCO | 200 | 32 | 16 | 100,000 | 2,405,376 | 4 |
| CORALINA | 6 | 2 | 33 | 854 | 1,372,854 | 0 |
| CORANTIOQUIA | 599 | 235 | 39 | 61,353.627 | 7,358,330 | 1 |
| CORMACARENA | 25 | 0 | 0 | 0 | 204,040 | 0 |
| CORNARE | 33 | 31 | 94 | 21,000 | 1,652,667 | 1 |
| CORPAMAG | 70 | 53 | 76 | 22,069 | 2,992,589 | 1 |
| CORPOAMAZO | 24 | 3 | 13 | 6,000 | 2,591,431 | 0 |
| CORPOBOYACA | 450 | 170 | 38 | 14,110.085 | 1,739,872 | 1 |
| CORPOCALDAS | 9000 | 1064 | 12 | 171,000 | 2,326,764 | 7 |
| CORPOCESAR | 54 | 6 | 11 | 1,870 | 1,998,833 | 0 |
| CORPOCHIVOR | 121 | 3 | 2 | 10,403.276 | 2,142,963 | 0 |
| CORPOGUAJIRA | 21 | 4 | 19 | 26,537.68 | 2,546,597 | 1 |
| CORPOGUAVIO | 23 | 4 | 17 | 25,200 | 2,198,390 | 1 |
| CORPOMOJANA | 12 | 0 | 0 | 0 | 1,292,036 | 0 |
| CORPONARIÑO | 239 | 17 | 7 | 50,000 | 2,296,395 | 2 |
| CORPONOR | 109 | 47 | 43 | 5,200 | 3,345,325 | 0 |
| CORPORINOQUI | 28 | 23 | 82 | 17,822.462 | 3,021,748 | 1 |
| CORPOURABA | 485 | 3 | 1 | 1,4330 | 2,032,705 | 1 |
| CORTOLIMA | 89 | 56 | 63 | 148,139.244 | 3,320,345 | 4 |
| CRA | 21 | 15 | 71 | 18,251.57 | 2,144,971 | 1 |
| CRC | 7 | 5 | 71 | 46,468 | 6,238,804 | 1 |
| CRQ | 18000 | 32 | 0 | 19,232 | 3,616,016 | 1 |
| CSB | 25 | 5 | 20 | 2,196.47 | 1,461,308 | 0 |
| CVC | 88 | 69 | 78 | 241,835.261 | 22,877,745 | 1 |
| CVS | 53 | 17 | 32 | 15,000 | 2,876,484 | 1 |
| **AVERAGE** | **928** | **64** | **31** | **43,748** | **4,324,729** | **1** |

Source: Self-reported by CARs to MAVDT.

## *4.5. Policy Implementation: Discharge Standards*

Just as permitting in many jurisdictions appears to be inefficient and ineffective, so too do monitoring and enforcement of discharge standards. We present evidence of lax monitoring and enforcement from previous general assessments, interviews, CAR-level data collected by MAVDT, and a study of effluent discharges conducted jointly by IDEAM and DAMA.

### 4.5.1. General Assessments

Sánchez Triana and Medina (1994) state, "In spite of specific norms and permits, including in regions in which government entities have pollution control programs, strict compliance with regulation on the part of industries does not exist...it is important to underline that even in jurisdictional areas of corporations such as CAR, CVC or CORNARE, 50% of the industries are not inspected" (258–59).

More current national-level evidence comes from Castro et al. (2001), who write that discharge standards have "generated poor results in controlling polluting discharges…water pollution has increased in parallel to the growth of the population and economy during the post-war epoch" (18).

As noted above, according to MMA (2002), enforcement of Decree 1594 of 1984 is lax. In 66% of the cities studied, no industries treated wastewaters as mandated by Decree 1594. In 23% of the cities, less than 50% did, and in 7.5%, between 50 and 100% did. In only 3.1% of the cities did 100% of industries treat their wastewaters. According to the MMA, "we can conclude that the actions in cities to control industrial discharges are incipient and must be strengthened" (129).

Contraloría (2002) provides even more support for this view. The report states that lax monitoring "is aggravated by the limited verification, follow-up, monitoring and control capacity, given the budget, logistic and technical limitations of the majority of the corporations. For these reasons, CARs rely on self-reports carried out by the water users or on presumptive definitions of the discharges, both of which have poor validity given the information limitations." Although 100% of the CARs say they have issued discharge permits—mainly to water utilities and to industrial facilities—that make the construction of treatment systems compulsory, CARs have little reliable information about whether these facilities actually install and operate the systems. Furthermore, according to Contraloría (2002), of the 30 pollutants covered by Decree 1594 of 1984, CARs and AAUs only monitor discharges of 2: BOD and TSS. COD and other substances such as coliforms are not monitored, much less regulated. Finally, Contraloría (2002) states that most CARs do not have integrated management plans for wastewater. According to information self-reported by the CARs, only 31% have environmental management plan for wastewaters in their jurisdiction. They typically consider that the elaboration of such plans is the responsibility of territorial entities.

Additional data concern the personnel and equipment needed to monitor compliance with discharge standards. According to Contraloría (2002), 40% of the country's CARs have no environmental laboratories or have infrastructure that does not function. Many CARs that have laboratories do not operate them effectively and invest very modest sums in laboratories. In 2001, less than 7 billion pesos (1.4% of the total CAR investment) was assigned to laboratory facilities.

In 2001, IDEAM began a process of accrediting CAR laboratories. According to Contraloría (2002), however, only two laboratories (for Cornare and Corantioquia) had been certified, and two (Corpocaldas and CVC) were awaiting accreditation. This lack of accreditation implies that different CARs have different methods and standards of analysis, and thus data collected in different CARs are not necessarily comparable.

#### 4.5.2. Interviews

***CAR (Bogotá)***

Like permitting, enforcement is the responsibility of CAR's regional offices. According to CAR interviewees, enforcement is virtually negligible because of a lack of staff, technical capacity, and logistical capacity. An industry trade association representative said that enforcing is much stricter for large firms than small ones. A second industry representative stated that his large firm is inspected once a year and that the inspection is announced in advance.

***Corantioquia***

Our limited number of private-sector interviewees, all from large, modern highly visible firms, suggested that Corantioquia's enforcement is not insignificant. According to these interviewees, Corantioquia regulators collect effluent and water use fees; see that facilities have solid waste disposal contracts; require annual testing of liquid effluents in the Corantioquia laboratory; and make random, unannounced inspections. In addition, the CAR depends on reports of violations by third parties.

***Cardique***

According to various interviewees, enforcement is quite weak because of a lack of staff, technical capacity, and logistical capacity. It was widely asserted that enforcement is much stricter for large firms than for small ones. Large firms are generally inspected once a year, and the inspection is always announced in advance.

***CVC and DAGMA***

Like most environmental authorities, CVC and DAGMA rely on self-reports of discharges to monitor compliance and verify the self-reports with random checks. CVC personnel in charge of verification stated that inspectors typically find that self-reported discharges are lower than actual discharges. DAGMA personnel echoed this statement. They said that self-reported discharges were often several times smaller than actual emissions.

***Other***

According to national-level stakeholders, an important problem that contributes to low levels of compliance is a general lack of the technical information and resources needed to purchase and operate abatement devices or adopt clean technologies. Interviewees asserted that such gaps suggest that emissions standards are unrealistic for many firms.

***CAR-level data***

The last three columns of Table 4.4.1 present information on CARs' budget allocations for monitoring discharge permits. The fifth column details the annual cost to the CAR of monitoring discharge permits. As can be seen from the seventh column, this cost averages just 1% of total operational spending.

**4.5.3. DAMA**

DAMA is generally considered a relatively well functioning urban environmental authority. Nevertheless, it clearly struggles to monitor and enforce discharge standards. DAMA's 2002 environmental management report to the Contraloría provides some indication of the extent of this problem (IDEAM y Alcada Mayor de Bogotá 2002). DAMA's 2003 water quality goal is to monitor and control just 30% of registered industrial discharges in DAMA (and 30% of direct discharges into water bodies)—to say nothing of unregistered dischargers.

Further evidence comes from a detailed study of wastewater discharges in Bogotá. Beginning in the mid-1990s, IDEAM and DAMA conducted a series of joint studies of the water quality in the city. The sixth such study, completed in 2002, concerns the monitoring of industrial effluents from 626 industrial facilities in Bogotá that had been issued wastewater discharge permits. (Because some facilities had several outflows, the study actually covered 832 separate discharges). The industries involved represented a broad cross-section of different economic activities (Table 4.11). The Phase 6 report includes detailed information on the pollution control activities of these facilities and the quality of their wastewaters.

In interpreting the results, it is critical to note that the 626 facilities included in the study do not constitute the complete population of dischargers in Bogotá or even a random sample of these dischargers. The above statistic from DAMA's 2002 Environmental Management Report to the Contraloría suggests that these 626 facilities represent less than a third of the registered dischargers in DAMA's jurisdiction. Moreover, given that they are registered and permitted, those 626 firms are likely to be relatively large facilities that can control their wastewater discharges. Nevertheless, even among this sample, rates of compliance are well below 100%. Table 4.11 presents information on the pollution control measures taken by the 626 firms, broken down by economic activity.

**Table 4.11. Pollution Control for a Sample of 832 Discharges from Firms in Bogotá**

| Economic Activity | Discharges | Pretreatment | | Primary Treatment | | Secondary Treatment | | Tertiary Treatment | |
|---|---|---|---|---|---|---|---|---|---|
| | | without | with | without | with | without | with | without | with |
| Leather tanning and preparation | 215 | 5 | 210 | 125 | 90 | 215 | 0 | 215 | 0 |
| Processing and plating of metals, mechanical engineering | 180 | 126 | 54 | 160 | 20 | 180 | 0 | 180 | 0 |
| Commercial wholesalers of gaseous, liquid, and solid fuels and associated products | 137 | 4 | 133 | 90 | 47 | 137 | 0 | 137 | 0 |
| Production, processing, and preserving of meat and processed meat | 52 | 0 | 52 | 36 | 16 | 47 | 5 | 52 | 0 |
| Food processing, mainly of fruits and vegetables | 22 | 3 | 19 | 14 | 8 | 21 | 1 | 21 | 0 |
| Health services activities | 21 | 4 | 19 | 20 | 1 | 21 | 0 | 21 | 0 |
| Milk products | 15 | 1 | 14 | 11 | 4 | 15 | 0 | 15 | 0 |
| Bakery products | 14 | 1 | 13 | 10 | 4 | 14 | 0 | 14 | 0 |
| Production of pharmaceutical, medicinal, and chemical substances and botanical products | 13 | 2 | 11 | 9 | 4 | 12 | 1 | 13 | 0 |
| Animal and vegetable oils and greases | 11 | 1 | 10 | 5 | 6 | 8 | 3 | 11 | 0 |
| Soaps, detergents, perfumes | 11 | 0 | 11 | 8 | 3 | 11 | 0 | 11 | 0 |
| Fuel for motor vehicles | 9 | 0 | 9 | 3 | 6 | 9 | 0 | 9 | 0 |
| Fermented beverages | 8 | 3 | 5 | 6 | 2 | 8 | 0 | 8 | 0 |
| Soft drinks, mineral water | 8 | 0 | 8 | 6 | 2 | 8 | 0 | 8 | 0 |
| Textiles | 8 | 1 | 7 | 7 | 1 | 8 | | 8 | 0 |
| Other economic activities | 108 | 12 | 96 | 77 | 31 | 101 | 7 | 108 | 0 |
| **TOTAL** | 832 | 163 | 671 | 587 | 245 | 815 | 17 | 831 | 0 |
| Percentage | | 84 | 16 | 53 | 47 | 23 | 77 | 2 | 98 |

Source: IDEAM y Alcada Mayor de Bogotá (2002).

Of the 832 discharges, 84% are subject to pretreatment, 53% to primary treatment, 23%, to secondary treatment, and 2% to tertiary treatment.

Table 4.12 presents data on the percentage of the 832 dischargers that comply with DAMA discharge standards. Over two-thirds of the discharges comply with standards for conventional organic pollutants: BOD, COD, SST, SSD, and greases and acids present in all of the discharges. A subsample of the discharges contain heavy metals and other pollutants. For most of these pollutants, a much smaller percentage of these discharges met DAMA standards. This suggests that even among large firms monitored by DAMA, a significant percentage do not treat wastewater to remove industrial pollutants.

**Table 4.12. Compliance with Discharge Standards for a Sample of 832 Discharges in Bogotá**

| Pollutant | Percentage Compliance |
|---|---|
| BOD | 78 |
| COD | 74 |
| SST | 84 |
| SSD | 76 |
| Greases and acids | 81 |
| Cyanide | 64 |
| Copper | 39 |
| Total chrome | 33 |
| Chrome VI | 37 |
| Phenoles | 67 |
| Mercury | 96 |
| Nickel | 3 |
| Lead | 42 |
| Zinc | 72 |
| Sulfurs | 8 |
| SAAM | 88 |

Source: IDEAM y Alcada Mayor de Bogotá (2002).

## 4.6. Policy Implementation: Discharge Fees

### 4.6.1. Implementation Issues

Implementation of the discharge fee program has been marked by six issues that we consider in this section.

***Slow or limited overall implementation in some CARs***

As discussed in Blackman et al. (2004b), regulatory capacity varies markedly across CARs and AAUs. Some have far more human and financial resources than others, some are older and better established than others, and not surprisingly, some are relatively effective and efficient in implementing a wide range of environmental policies while others are far weaker. This heterogeneity persists in implementation of discharge fees and will be a recurring theme of this section of the report.

For the purposes of characterizing implementation of emissions fee programs, MAVDT has grouped environmental authorities into three categories.

Group A. These CARs and AAUs have been operating emissions fee programs for at least three semesters (18 months). They have fulfilled all the principal requirements of Decree 901 and completed the implementation steps listed in Section 4.3.1.7 above. According to MAVDT, there were nine CARS and AAUs in this category in 2002: CVC, Cornare, CDMB, Corolima, CRC, DADIMA, AMVA, Coralina, and Corpouraba.

Group B. Some CARs and AAUs have implemented the programs and are invoicing and collecting revenue, but in an incomplete or inconsistent manner. MAVDT placed 13 authorities in this category in 2002: DAMA, Carder, CAS, CAM, Codechoco, Corponor, Corantioquia, Corpoboyaca, Corpocaldas, Corporinoquia, Cormacarena, CRQ and Cardique.

Group C. These environmental authorities have yet to collect fees. In 2002, MAVDT placed 11 CARs and AAUs in this category: CVS, CAR, Corpochivor, Corponariño, Carucre, CRA, CSB, DAGMA, Corpamag, and Corpoguajira.

Table 4.13 details the dates at which the various CARs and AAUs had implemented their programs from 1997 to 2000. "Implementation" here means having set up the program, not necessarily invoicing or collecting fees. Only three CARs—CDMB, Cornare, and CVC—had operating programs in 1997. Note that CVC actually had a fee program in place prior to Decree 901 of 1997. Seven—Cardique, Carsucre, Coralina, Corponor  Corpouraba1, CRC, and CRQ—initiated programs in 1998. Six—CAM, Codechocó, Corantioquia, Cormacarena, Corpoboyacá, and Cortolima—started programs in 1999. And five—CAR, Corpamag, Corpoamazonía, Corpoguavia, and CVS—began programs in 2000.

Table 4.13 below details when each CAR began actually invoicing and collecting fees. In 1997 only 1 CAR—Cornare—invoiced or collected. Since then, six to four more CARs each year have begun invoicing. Collection has lagged behind invoicing. In 2002, 24 CARs invoiced and 21 collected.

**Table 4.13. Implementation Dates (as of 2000) and 5-year total BOD and TSS Reduction Goals**

| Entity | BOD reduction goal | TSS reduction goal | Implementation date |
|---|---|---|---|
| CAM | 18% | 23% | Sept. 99 |
| CAR | 5.7% | 10.3% | Feb. 00 |
| Carder | 9% | 120% | Apr. 98 |
| Cardique | 3.3% | 7.7% | Nov. 98 |
| Carsucre | S.I | S.I | S.I |
| CAS | S.I | S.I | S.I |
| CDA | -- | -- | -- |
| CDMB | 15% | 21% | Mar. 97 |
| Codechocó | 50% | 50% | Oct. 99 |
| Coralina | 50% | 50% | Nov. 98 |
| Corantioquia | – | – | 1999 |
| Cormacarena | 80% | 65% | Jul. 99 |
| Cornare | 50% | 50% | Sept. 97 |
| Corpamag | – | – | Mar. 00 |
| Corpoamazonía | – | – | Aug. 00 |
| Corpoboyacá | 8.35% | 8.48% | Apr. 99 |
| Corpocaldas | S.I | S.I | S.I |
| Corpocesar | S.I | S.I | S.I |
| Corpochivor | S.I | S.I | S.I |
| Corpoguajira | S.I | S.I | S.I |
| Corpoguavio | – | – | Mar. 00 |
| Corpomojana | S.I | S.I | S.I |
| Corponariño | * 163 | * 279 | S.I. |
| Corponor | 16% | 16% | Dec. 98 |
| Corporinoquía | S.I | S.I | S.I |
| Corpouraba1 | 10% | 10% | Dec. 98 |
| Cortolima | 23% | 29% | Sept. 99 |
| CRA | S.I | S.I | S.I |
| CRC1 | 34.1% | 31.7% | Nov. 98 |
| CRQ1 | 25% | 32.7% | Sept. 98 |
| CSB | S.I | S.I | S.I |
| CVCa | 31300 | 50700 | Dec. 97 |
| CVS | – | – | Oct. 00 |

Source: Contraloría 2001
*: estimated value for corporations
a: kg/day
1: goal average for BOD and TSS
S.I.: Not implemented
Note: Reduction goals that do not have a percentage are expressed in kg/semester.

***Significant differences in overall discharge reduction goals***

Table 4.13 also presents five-year goals established by each CAR for total reductions of BOD and TSS. Clearly, some goals are far more ambitious than others. For example, Cormacarena's BOD goal is an 80% reduction, while Cardique's is 3.3%. Goal setting is not required to be harmonized across CARs. In fact, Decree 901 explicitly allows heterogeneity. In setting goals, CARs are supposed to take into account, among other things, socioeconomic factors, abatement costs, the quality of receiving waters and their ability to assimilate pollution—all factors that vary widely across and within CARs. Nevertheless, this disparity in goals begs the question of whether the goal-setting process in some CARs was captured by industrial interests. Some analysts have suggested that lobbying by well-organized interest groups does, in fact, account for this variation (Enríquez 2004).

***Incomplete coverage of dischargers***

Just as not all water users that should be are permitted actually are, not all water users that should participate in the fee programs actually do. In part, the problem arises precisely because not all water users are permitted. As Castro et al. (2001) report, implementation of the discharge fee program has entailed renewed and expanded efforts to permit dischargers, and the effort has been "arduous."

Evidently, this effort has not been completely successful. Table 4.14 presents self-reported CAR-level data on the coverage of the discharge fee program. Specifically, it presents data on the percentage of water users covered by the discharge fee system that are invoiced. The percentage ranged from 100% (reported by CAS, Cormacarena, Cornare, and Corpoguajira) to a low of 0% (reported by CDA, Corpoguavio, Corporinoquía, and CSB, which presumably did not have operating invoicing systems in 2002). On average, less than half of participants were invoiced. Although this average mixes CARs that had operating fee systems with those that did not, note that many of the CARs with operating systems still had low participation rates.

**Table 4.14. Participation in Discharge Fee Programs by CAR, 2002**

| Entity | Water users potentially covered by fee system | Users invoiced | Percentage of covered users that are invoiced |
|---|---|---|---|
| CAM | 75 | 45 | 60 |
| CAR | 491 | 91 | 19 |
| Carder | 2,900 | 632 | 22 |
| Cardique | 72 | 54 | 75 |
| Carsucre | 31 | 10 | 32 |
| CAS | 91 | 91 | 100 |
| CDA | 5,418 | 1 | 0 |
| CDMB | 160 | 153 | 96 |
| Codechocó | 2,000 | 70 | 4 |
| Coralina | 49 | 6 | 12 |
| Corantioquia | 2,607 | 1,825 | 70 |
| Cormacarena | 10 | 10 | 100 |
| Cornare | 218 | 218 | 100 |
| Corpamag | 60 | 59 | 98 |
| Corpoamazonía | 22 | 9 | 41 |
| Corpoboyacá | 150 | 104 | 69 |
| Corpocaldas | 2,400 | 610 | 25 |
| Corpocesar | 54 | 49 | 91 |
| Corpochivor | 170 | 121 | 71 |
| Corpoguajira | 21 | 21 | 100 |
| Corpoguavio | 23 | 0 | 0 |
| Corpomojana | 12 | 2 | 17 |
| Corponariño | 207 | 10 | 5 |
| Corponor | 49 | 31 | 63 |
| Corporinoquía | 21 | 0 | 0 |
| Corpourabá | 485 | 391 | 81 |
| Cortolima | 86 | 67 | 78 |
| CRA | 76 | 21 | 28 |
| CRC | 90 | 80 | 89 |
| CRQ | 7,500 | 300 | 4 |
| CSB | 24 | 0 | 0 |
| CVC | 20,000 | 259 | 1 |
| CVS | 53 | 16 | 30 |
| AVERAGE | 1,383 | 162 | 48 |

Source: Self-reported by CARs to MAVDT.

### *Low collection rates in some CARs*

Table 4.15 provides self-reported CAR-level data on invoicing and collection of discharge fees between 1997 and 2002. Several patterns are noteworthy. First, in most CARs, a significant percentage of fees that are invoiced are not collected. Between 1997 and 2002, just 27% of all fees invoiced were actually collected. Collection rates vary dramatically across CARs, ranging from a low of 1% (for Carsucre, Corpoamazonía, and Corpocesar) to a high of 95% (for CDMB). Note, however, that after CDMB, the next-highest collection rate was 54%, reported by Cornare. Second, in any given year, a small number of CARs are responsible for the lion's share of all charges collected. For example, in 2002, 9116.8 million pesos were collected by all participating CARs. However, three entities (CAS, CDMB and CVC) were responsible for 6,747 million pesos, representing roughly three-quarters of the total. Third, for most CARs, invoicing increases over time as the program is implemented and, presumably, more firms are brought into the system. However, after the first few years, invoicing levels out.

**Table 4.15. Invoicing and Recovery of Discharge Fees by CARs, 1997–2002**
**(I = total invoiced million, in 2002 pesos; R = percentage of total recovered)**

| Entity | 1997 | | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | 1997–2002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I ($) | R (%) | I ($) | R (%) | I ($) | R (%) | I ($) | R (%) | I ($) | R (%) | I ($) | R (%) | I ($) | R (%) |
| CAM | | | | | | | 782.3 | 1 | 923.6 | 3 | 479.1 | 14 | 2,184.90 | 5 |
| CAR | | | | | | | | | | | 201.2 | 17 | 201.2 | 17 |
| Carder | | | | | | | | | | | 733.9 | 14 | 733.9 | 14 |
| Cardique | | | | | 987.7 | NR | 1,407.60 | NR | 1,442.40 | NR | 750.7 | NR | 4,588.30 | NR |
| Carsucre | | | | | | | | | | | 115.1 | 1 | 115.1 | 1 |
| CAS | | | | | 883 | 8 | 1,763.40 | 32 | 2,260.00 | 42 | 2,678.10 | 39 | 7,584.40 | 34 |
| CDA | | | | | | | | | | | | | NC | NR |
| CDMB | | | 584.7 | 100 | 1,496.60 | 100 | 2,096.80 | 98 | 2,572.90 | 97 | 3,366.60 | 87 | 10,117.70 | 95 |
| Codechocó | | | 191.6 | NR | 275.3 | 7 | 343.5 | 48 | 372.9 | 9 | - | | 1,183.30 | 24 |
| Coralina | | | 29.3 | 24 | 53.8 | | 160.2 | 17 | 218.2 | 14 | 306.1 | 6 | 767.6 | 13 |
| Corantioquia | | | | | | | | | 321.7 | NR | 55 | NR | 376.7 | NR |
| Cormacarena | | | | | | | 21 | NR | 75.8 | NR | 88.7 | NR | 185.5 | NR |
| Cornare | 309 | 69 | 749.3 | 57 | 1,176.90 | 85 | 1,739.00 | 55 | 1,980.70 | 42 | 829.7 | 31 | 6,784.60 | 54 |
| Corpamag | | | | | | | 385.9 | 3 | 434.3 | 5 | 442.1 | 19 | 1,262.30 | 9 |
| Corpoamazonía | | | | | | | | | | | 58.9 | 1 | 58.9 | 1 |
| Corpoboyacá | | | | | | | | | 895.2 | 12 | 1,591.20 | 2 | 2,486.50 | 6 |
| Corpocaldas | | | | | | | 2,546.70 | 9 | 2,018.10 | NR | - | | 4,564.90 | 7 |
| Corpocesar | | | | | | | | | | | 544.1 | 1 | 544.1 | 1 |
| Corpochivor | | | | | | | | | | | 52.6 | 38 | 52.6 | 38 |
| Corpoguajira | | | | | | | | | | | | | NC | NR |
| Corpoguavio | | | | | | | | | | | | | NC | NR |
| Corpomojana | | | | | | | | | | | 133.8 | 6 | 133.8 | 6 |
| Corponariño | | | | | | | | | | | | | NC | NR |

| **Entity** | **1997** | | **1998** | | **1999** | | **2000** | | **2001** | | **2002** | | **1997–2002** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **I ($)** | **R (%)** | **I ($)** | **R (%)** | **I ($)** | **R (%)** | **I ($)** | **R (%)** | **I ($)** | **R (%)** | **I ($)** | **R (%)** | **I ($)** | **R (%)** |
| Corponor | | | | | 749.2 | 15 | 1,547.30 | 18 | 1,656.60 | 20 | 1,695.20 | 14 | 5,648.30 | 17 |
| Corporinoquía | | | | | | | | | | | | | NC | NR |
| Corpourabá | | | 124.9 | NR | 867.5 | 13 | 1,143.80 | 29 | 1,530.50 | 21 | 1,070.30 | 15 | 4,737.00 | 20 |
| Cortolima | | | | | 427.3 | NR | 1,416.40 | 70 | 1,744.30 | 63 | 1,599.40 | 42 | 5,187.40 | 53 |
| CRA | | | | | | | | | | | | | NC | NR |
| CRC | - | | 177.2 | 47 | 945.6 | 38 | 1,473.30 | 36 | 2,014.50 | 8 | 114.2 | 92 | 5,724.80 | 22 |
| CRQ | | | | | | | | | 360.6 | 15 | 1,163.00 | 13 | 1,523.60 | 13 |
| CSB | | | | | | | | | | | | | NC | NR |
| CVC | | | 2,936.60 | 11 | 6,237.50 | 8 | 15,436.20 | 15 | 10,829.40 | 13 | 12,193.20 | 23 | 47,629.90 | 15 |
| CVS | | | | | | | | | 587.4 | 4 | 2,592.30 | 4 | 3,179.70 | 4 |
| **Total** | 309 | 69 | 4,790.70 | 30 | 14,100.30 | 27 | 32,239.10 | 27 | 32,263.40 | 25 | 33,854.50 | 27 | 117,557.00 | 27 |
| No. invoicing | 1 | | 7 | | 11 | | 15 | | 20 | | 24 | | | |
| No. collecting | | 1 | | 6 | | 8 | | 14 | | 16 | | 21 | | |

Source: Self-reported by CARs as reported in Contraloría (2003).
NR: Does not report information
NC: Has not charged
NF: Has not invoiced
*Estimated value from the total reported by the corporations

### *Municipal sewage utilities*

As in many developing countries, municipal sewage authorities are a leading source of pollution, particularly BOD and TSS, and also leading violators of water quality regulations. Table 4.16 presents data on the role of municipal sewage authorities in invoicing and recovery of the discharge fees between 1997 and 2002. Two patterns are notable. First, wastewater utilities are the major player in the discharge fee program. They were invoiced for more than one-third (34%) of all discharge fees. Second, collection rates for municipal sewage authorities were low in absolute standards. Of the total amount they were invoiced between 1997 and 2002, utilities paid only 40% (this figure is derived from the data in the table but not included in it). Finally, however, repayment rates for utilities were higher than for industry. Although utilities were invoiced for 34% of all wastewater fees between 1997 and 2002, they were responsible for paying more than half (52%) of all fees actually collected.

## Table 4.16. Role of Wastewater Utilities in Invoicing and Recovery of Discharge Fees by CARs, 1997–2002

### (I = total invoiced millions, in 2002 pesos; R = percentage of total recovered)

| Entity | 1997 | | 1998 | | 1999 | | 2000 | | 2001 | | 2002 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | R (%) | I | R (%) | I | R (%) | I | R (%) | I | R (%) | I | R (%) | I | R (%) |
| CAM | | | | | | | 782.3 | 1 | 923.6 | 3 | 479.1 | 14 | 2,184.90 | 5 |
| utilities (%) | | | | | | | 0 | 0 | 83 | 23 | 84 | 36 | 53 | 29 |
| CAR | | | | | | | | | | | 201.2 | 17 | 201.2 | 17 |
| utilities | | | | | | | | | | | 87 | | 87 | |
| Carder | | | | | | | | | | | 733.9 | 14 | 733.9 | 14 |
| utilities | | | | | | | | | | | 24 | | 24 | |
| Cardique | | | | | 987.7 | | 1,407.60 | | 1,442.40 | | 750.7 | | 4,588.30 | |
| utilities | | | | | 41 | | 27 | | 27 | | 26 | | 30 | |
| Carsucre | | | | | | | | | | | 115.1 | 1 | 115.1 | 1 |
| utilities | | | | | | | | | | | 94 | 79 | 94 | 79 |
| CAS | | | | | 883 | 8 | 1,763.40 | 32 | 2,260.00 | 42 | 2,678.10 | 39 | 7,584.40 | 34 |
| utilities | | | | | 73 | 0 | 56 | 14 | 58 | 29 | 46 | 23 | 55 | 23 |
| CDA | | | | | | | | | | | | | NC | |
| utilities | | | | | | | | | | | | | | |
| CDMB | | | 584.7 | 100 | 1,496.60 | 100 | 2,096.80 | 98 | 2,572.90 | 97 | 3,366.60 | 87 | 10,117.70 | 95 |
| utilities | | | 84 | 84 | 82 | 33 | 83 | 83 | 88 | 89 | 85 | 87 | 85 | 86 |
| Codechocó | - | | 191.6 | | 275.3 | 7 | 343.5 | 48 | 372.9 | 9 | - | | 1,183.30 | 24 |
| utilities | | | 91 | | 88 | | 89 | | 99 | | | | 101 | |
| Coralina | | | 29.3 | 24 | 53.8 | | 160.2 | 17 | 218.2 | 14 | 306.1 | 6 | 767.6 | 13 |
| utilities | | | 97 | 86 | 96 | | 99 | 97 | 100 | 99 | 68 | 98 | 87 | 95 |
| Corantioquia | | | | | | | | | 321.7 | | 55 | | 376.7 | |
| utilities | | | | | | | | | 13 | | 41 | | 17 | |
| Cormacarena | | | | | | | 21 | | 75.8 | | 88.7 | | 185.5 | |
| utilities | | | | | | | | | | | | | | |
| Cornare | 309 | 69 | 749.3 | 57 | 1,176.90 | 85 | 1,739.00 | 55 | 1,980.70 | 42 | 829.7 | 31 | 6,784.60 | 54 |
| utilities | 0 | | 5 | 0 | 26 | 0 | 40 | 0 | 38 | 0 | 44 | 0 | 32 | 0 |
| Corpamag | | | | | | | 385.9 | 3 | 434.3 | 5 | 442.1 | 19 | 1,262.30 | 9 |
| utilities | | | | | | | 67 | 1083 | 97 | 0 | 118 | 0 | 95 | 118* |
| Corpoamazonía | | | | | | | | | | | 58.9 | 1 | 58.9 | 1 |
| utilities | | | | | | | | | | | 100 | 100 | 100 | 100 |
| Corpoboyacá | | | | | | | | | 895.2 | 12 | 1,591.20 | 2 | 2,486.50 | 6 |
| utilities | | | | | | | | | 44 | 68 | 55 | 1119* | 51 | 291* |
| Corpocaldas | | | | | | | 2,546.70 | 9 | 2,018.10 | | - | | 4,564.90 | 7 |
| utilities | | | | | | | 37 | 15 | 109 | | | | 69 | 11 |
| Corpocesar | | | | | | | | | | | 544.1 | 1 | 544.1 | 1 |
| utilities | | | | | | | | | | | | 20 | | 20 |
| Corpochivor | | | | | | | | | | | 52.6 | 38 | 52.6 | 38 |
| utilities | | | | | | | | | | | | | | |
| Corpoguajira | | | | | | | | | | | | | NC | |
| utilities | | | | | | | | | | | | | | |
| Corpoguavio | | | | | | | | | | | | | NC | |
| utilities | | | | | | | | | | | | | | |
| Corpomojana | | | | | | | | | | | 133.8 | 6 | 133.8 | 6 |
| utilities | | | | | | | | | | | 0 | 0 | 0 | 0 |
| Corponariño | | | | | | | | | | | | | NC | |
| utilities | | | | | | | | | | | | | | |
| Corponor | | | | | 749.2 | 15 | 1,547.30 | 18 | 1,656.60 | 20 | 1,695.20 | 14 | 5,648.30 | 17 |

| Entity | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | Total | Entity | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | R (%) | I | R (%) | I | R (%) | I | R (%) | I | R (%) | I | R (%) | I | R (%) |
| utilities | | | | | | 0 | | | | | | | | |
| Corporinoquía | | | | | | | | | | | | | NC | |
| utilities | | | | | | | | | | | | | | |
| Corpourabá | | | 124.9 | | 867.5 | 13 | 1,143.80 | 29 | 1,530.50 | 21 | 1,070.30 | 15 | 4,737.00 | 20 |
| utilities | | | 0 | | 0 | 0 | 193 | 140 | 0 | 0 | 133 | 130 | 77 | 72 |
| Cortolima | | | | | | | 1,416.40 | 70 | 1,744.30 | 63 | 1,599.40 | 42 | 5,187.40 | 53 |
| utilities | | | | | | | 76 | 70 | 90 | 94 | 91 | 79 | 86 | 82 |
| CRA | | | | | | | | | | | | | NC | |
| utilities | | | | | | | | | | | | | | |
| CRC | - | | 177.2 | 47 | 945.6 | 38 | 1,473.30 | 36 | 2,014.50 | 8 | 114.2 | 92 | 5,724.80 | 22 |
| utilities | | | | 64 | | 15 | | 34 | | 17 | | 155 | | 53 |
| CRQ | | | | | | | | | 360.6 | 15 | 1,163.00 | 13 | 1,523.60 | 13 |
| utilities | | | | | | | | | | 94 | | 95 | | 94 |
| CSB | | | | | | | | | | | | | NC | |
| utilities | | | | | | | | | | | | | | |
| CVC | | | 2,936.60 | 11 | 6,237.50 | 8 | 15,436.20 | 15 | 10,829.40 | 13 | 12,193.20 | 23 | 47,629.90 | 15 |
| utilities | | | 0 | 0 | | 0 | | 47 | | 27 | | 42 | | 38 |
| CVS | | | | | | | | | 587.4 | 4 | 2,592.30 | 4 | 3,179.70 | 4 |
| utilities | | | | | | | | | | 0 | | 0 | | 0 |
| **Total** | 309 | 69 | 4,790.70 | 30 | 14,100.30 | 27 | 32,239.10 | 27 | 32,263.40 | 25 | 33,854.50 | 27 | 117,557.00 | 27 |
| utilities | 35 | 0 | 22 | 39 | 32 | 14 | 31 | 51 | 38 | 51 | 36 | 60 | **34** | **52** |

Source: Self-reported by CARs as reported in Contraloría (2003).

NR: Does not report information

NC: Has not charged

NF: Has not invoiced

* Data are internally inconsistent.

Considerable attention has focused on the role that noncompliant municipal sewage authorities play in the discharge fee program. Municipal sewage authorities often argue that they simply do not have the means to either pay discharge fees or invest in treatment plants that would enable them to avoid the fees.

As discussed in Section 4.2.3, financing and developing wastewater treatment plants and sewer networks in Colombia are an admittedly difficult task. Considerable evidence suggests that discharge fees may have aggravated the situation. Some stakeholders interviewed for this study commented that municipalities are now reluctant to develop treatment plants or assume ownership of plants that have already been built because the discharge fees associated with the plant would make operating it unprofitable. Grigg et al. (2004) reaches the same conclusion. According to this report, "The fee structure for wastewater permits while meant to be an incentive to provide treatment, has actually created a disincentive to construct treatment facilities or to apply for a permit.…the increase in fees every six months…has resulted in many municipalities incurring fee debts that are so high, that they have no hope of paying them let alone financing water treatment facilities."

Unfortunately, a similar rationale applies to municipalities' incentives to build new sewer lines. For Colombia's many municipalities without adequate wastewater treatment facilities, building sewer lines that connect new pollution sources to the system increases the system's total pollution load and thus the total fees charged to the municipality. Hence, the discharge fees act as a financial disincentive to invest in new sewer networks.

Regardless of the reasons that many municipal sewage authorities are unable to pay discharge fees or invest in treatment plants that would reduce their discharges, municipal sewage authorities have been a major barrier—if not the chief hindrance—to the successful implementation of the program. First, when noncompliant sewage authorities do not pay their discharge fees, water users in industry and agriculture complain bitterly. In some cases, they undoubtedly feel justified in withholding payment themselves. Noncompliance by the leading and most visible dischargers breeds noncompliance among lesser players.

Second, the professed inability of the leading dischargers to cut their wastes prevents dischargers in water basins from meeting five-year total pollution load reduction targets established by CARS' boards of directors. As per Decree 901 of 1997, this had led to continual annual increases in fees rates. Table 4.17 shows the dramatic increase in fee rates mandated by Decree 901 of 1997 for a water basin that missed its compliance targets. Note that the fee rate began with the fee rate established for 2003.

**Table 4.17. Increments in Fee Rates Mandated by Decree 901 of 1997 for Failure to Meet Annual Reduction Targets**

| Regional factor | Fee ($/kg) | |
|---|---|---|
| | **BOD** | **TSS** |
| 1 | 74.24 | 31.75 |
| 1.5 | 111.36 | 47.625 |
| 2 | 148.48 | 63.5 |
| 2.5 | 185.6 | 79.375 |
| 3 | 222.72 | 95.25 |
| 3.5 | 259.84 | 111.125 |
| 4 | 296.96 | 127 |
| 4.5 | 334.08 | 142.875 |
| 5 | 371.2 | 158.75 |

Given this burden, industrial dischargers have complained repeatedly that they are being made to pay for the failure of municipal sewage authorities to control their discharges.

Finally, fees charged to municipal wastewater authorities have led these authorities to increase the fees they charge their customers. This problem has been especially severe in smaller cities, where the utilities are not able to spread the new costs over a large number of customers. Table 4.18 presents data on sewage fee increases due to discharge fees in a sample of 114 municipalities of varying sizes. Although discharge fees raised sewage bills by an average 6% across all the municipalities, the increase was 31% in municipalities with fewer than 2,500 persons and 21% in municipalities with 2,500–12,000 people.

**Table 4.18. Effect of Discharge Fees on Average Sewage Bill by Size of Municipality, 1999**

| Population | Municipalities with tariff (12/99) | Mmunicipalities with discharge fee | Mean sewage bill ($/user/mo.) | Discharge fee total cost ($/user/mo.) | Effect of fee on average sewage bill (percentage increase) |
|---|---|---|---|---|---|
| <2,500 | 82 | 15 | 1,528 | 483 | 31.6 |
| 2,500–12,000 | 138 | 53 | 2,871 | 614 | 21.4 |
| 12,000–30,000 | 26 | 17 | 3,856 | 640 | 16.6 |
| 30,000–70,000 | 21 | 14 | 4,861 | 602 | 12.4 |
| >70,000 | 17 | 5 | 8,672 | 843 | 9.7 |
| Department capitals | 22 | 10 | 10,235 | 610 | 6.0 |
| TOTAL | 306 | 114 | 9,645 | 619 | 6.4 |

Source: Ministry of Development (2002).

Because discharge fees have been passed on to customers in the form of higher sewage fees, and because these fees are do not vary significantly across income classes within cities, the fees are regressive—that is, they consume a larger proportion of the income of poorer customers (Enríquez 2004). Furthermore, according to Enríquez (2004), this undesirable effect has been magnified by recent regulatory changes that reduce subsidies to water utilities and allow them to charge user fees that enable them to fully recover costs.

***The relationship between discharge fees and discharge standards***

As discussed in Section 4.3.1.6 above, Article 24 of Decree 901 mandates that paying discharge fees does not exempt users from complying with discharge standards established under Decree 1594 of 1984. In theory, then—that is, assuming that the user is in compliance—discharge fees apply only to those discharges that exceed the standards. For example, for facilities required to remove 80% of BOD from their waste streams, discharge fees apply only to the remaining 20%.

The obvious problem with this regulation, however, is that, as discussed in Section 4.5 above, noncompliance with discharge standards is rampant in some CARs. In these CARs, the situation created considerable controversy when the discharge fee program was first implemented. Industry lobbyists predictably argued that regardless of a facility's compliance, discharge fees should be charged only on those emissions that would remain if the discharge standard were met (Castro et al. 2001). Clearly, such a policy would dramatically dampen the incentives that discharge fees create for pollution control.

The Ministry of Environment resolved the situation by issuing guidance stating that for a facility not in compliance with discharge standards, the CAR or AAU should negotiate a "compliance plan." The plan would specify a schedule of activities and investments designed to bring the facility into compliance. At a maximum, facilities would have five years to complete these plans. Until the plan was completed and discharge standards were met, discharge fees would cover all of the facility's BOD and TSS discharges.

Despite that guidance, according to Castro et al. (2001), some CARs and AAUs continue to invoice firms that are not meeting discharge standards only for those emissions that would remain if the discharge standard were met.

#### 4.6.2. Impacts on Water Quality

Most of the evidence reviewed for this report suggests that despite the implementation issues discussed above, the discharge fee program is having a significant, positive impact on water quality.

***National-level data on total pollution loads***

According to a 2002 evaluation of the discharge fees program conducted by the Economic Analysis Group of MMA (summarized in Gomez-Torres 2003), in the jurisdictions where discharge fees are being implemented, their effectiveness in reducing discharges of BOD and TSS has been significant. Total BOD discharges have fallen 27%, from 117,000 tons per semester to 85,000 tons per semester. Total TSS discharges have fallen 45%, from 162,000 tones per semester to 88,000 tones.

***Self-reported data on 2002 total pollution loads***

Table 4.19 presents self-reported CAR-level data on the performance of the discharge fee program—specifically, 2002 reductions in total BOD and TSS discharges versus the 2002 annual targets established as part of the five-year target. The average percentage of the annual goals met is quite high: 180% for BOD—that is, CARs exceeded this target by 80%—and 84% for TSS. However, averages mask several features. First, 5 CARs (CAR, CAS, Coralina, Corpocaldas, Corporuba, and CVC) reported having exceeded their BOD goals, but 12 achieved 0% of their goals. Note that Coralina reported having exceeded its goal by 2000%. As for TSS, 7 CARs (CAS, Coralina, Corpocaldas, Corpouraba, CRC, CRQ, and CVC) reported having exceeded their TSS goals, but 12 achieved 0% of their goals.

**Table 4.19. Discharge Fee Program Performance by CAR, 2002 (data self-reported to MAVDT)**

| Entity | Baseload BOD (ton/yr.) | 5-year BOD reduction goal (ton/yr.) | Reduction BOD loads (ton/yr.) | Percentage BOD goal achieved | Base load SST (ton/yr.) | 5-year TSS reduction goal (ton/yr.) | Reduction TSS loads (ton/yr.) | Percentage TSS goal achieved |
|---|---|---|---|---|---|---|---|---|
| CAM | 8,460 | 0 | 212 | 0 | 7,084 | 0 | 158 | 0 |
| CAR | 110,495 | 108,794 | 14,170 | 768 | 596,582 | 10,697 | 48,191 | 22 |
| CARDER | 48,676 | 4,212 | 32,245 | 13 | 46,794 | 11,231 | 24,975 | 45 |
| CARDIQUE | 24,198 | 272 | 0 | 0 | 25,470 | 80 | 0 | 0 |
| CARSUCRE | 1,528 | 229 | 0 | 0 | 1,278 | 192 | 0 | 0 |
| CAS | 5,308 | 1,372 | 740 | 185 | 6,320 | 1,504 | 886 | 170 |
| CDA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CDMB | 9,592 | 724 | 486 | 149 | 110,156 | 3,635 | 86,578 | 4 |
| CODECHOCO | 778 | 388 | 0 | 0 | 1,612 | 806 | 0 | 0 |
| CORALINA | 774 | 346 | 18 | 1922 | 858 | 472 | 100 | 472 |
| CORANTIOQUIA | 6,661 | 0 | 5,508 | 0 | 6,600 | 0 | 5,918 | -- |
| CORMACARENA | 408 | 133 | 0 | 0 | 486 | 112 | 0 | 0 |
| CORNARE | 2,595 | 95 | 422 | 23 | 4,910 | 112 | 150 | 75 |
| CORPAMAG | 2,586 | 10 | 733 | 1 | 3,857 | 10 | 2,290 | 0 |
| CORPOAMAZONIA | 1,735 | 1,735 | 0 | 0 | 2,210 | 2,210 | 0 | 0 |
| CORPOBOYACA | 11,258 | 940 | 0 | 0 | 7,138 | 589 | 0 | 0 |
| CORPOCALDAS | 111,282 | 10,238 | 1,698 | 603 | 105,324 | 9,372 | 2,636 | 356 |
| CORPOCESAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CORPOCHIVOR | 1,080 | 52 | 76 | 68 | 1,043 | 54 | 94 | 57 |
| CORPOGUAJIRA | 3,550 | 0 | 2,840 | 0 | 3,522 | 0 | 2,817 | 0 |
| CORPOGUAVIO | 0 | 323 | 0 | 0 | 0 | 353 | 0 | 0 |
| CORPOMAG | | | | | | | | |
| CORPOMOJANA | 1,011 | 131 | 0 | 0 | 1,243 | 161 | 0 | 0 |
| CORPONARIÑO | 174 | 97 | 0 | 0 | 376 | 74 | 0 | 0 |
| CORPONOR | 17,806 | 0 | 0 | 0 | 11,102 | 0 | 0 | 0 |
| CORPORINOQUIA | 6,332 | 126 | 0 | 0 | 6,384 | 128 | 0 | 0 |
| CORPOURABA | 6,814 | 545 | 58 | 940 | 6,636 | 398 | 74 | 538 |

| Entity | Baseload BOD (ton/yr.) | 5-year BOD reduction goal (ton/yr.) | Reduction BOD loads (ton/yr.) | Percentage BOD goal achieved | Base load SST (ton/yr.) | 5-year TSS reduction goal (ton/yr.) | Reduction TSS loads (ton/yr.) | Percentage TSS goal achieved |
|---|---|---|---|---|---|---|---|---|
| CORTOLIMA | 17,598 | 1,530 | 4,668 | 33 | 20,163 | 2,234 | 5,621 | 40 |
| CRA | 19,360 | 580 | 0 | 0 | 19,028 | 570 | 0 | 0 |
| CRC | 8,157 | 10,108 | 6,563 | 154 | 6,974 | 8,910 | 5,698 | 156 |
| CRQ | 17,816 | 1,953 | 1,038 | 188 | 12,650 | 2,219 | 1,027 | 216 |
| CSB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CVC | 66,598 | 45,360 | 5,064 | 896 | 53,458 | 26,122 | 4,274 | 611 |
| CVS | 4,943 | 344 | 0 | 0 | 6,895 | 247 | 0 | 0 |
| **AVERAGE** | 15,684 | 5,777 | 2,319 | 180 | 32,611 | 2,500 | 5,803 | 84 |

Source: Self-reported by CARs to MAVDT.

***2001 CEPAL study***

Using a case-study approach, Castro et al. (2001) evaluated the discharge fee program on discharges, revenues, investments, and administrative costs. The study examines three jurisdictions: CVC, Cornare, and DADIMA (the AAU for Barranquilla), using data from the first semester of 1997 through the second semester of 2000. Although each jurisdiction is different and DADIMA is especially different from the two CARs, in each case, Castro et al. find that the discharge fee program was responsible for significant reductions in BOD and TSS. It is probably worth noting that the first author of the report, Luis Fernando Castro, is the former director of Cornare.

CVC. Created in 1954, CVC is Colombia's oldest CARs. It is widely recognized as a relatively strong CAR in terms of regulatory capacity, particularly with regard to management of water resources. Indeed, it was created in the image of the Tennessee Valley Authority as a regional water authority. Its discharge fee program for the Río Cauca predated Decree 901 of 1997. According to Castro et al. (2001), prior to its discharge fee program, CVC's program of permitting, and monitoring and enforcement of discharge standards was quite stringent and rates of compliance were high. Therefore, discharge fees were charged only on BOD and TSS emissions not covered by discharge standards.

According to data presented in Castro et al. (2001), in the three years between 1998 and 2000, total pollution load generated by dischargers participating in the CVC discharge fee program fell 32% for DBO5 and 69% for TSS. The report argue that reductions in discharges from sugar processing plants and the paper industry due to implementation of pollution prevention measures and clean technologies (versus end-of-pipe treatment) contributed to these results.

Cornare. Cornare is also recognized as one of the stronger CARs. Its one of the oldest CARs in the country and its jurisdiction covers an areas that generates 30% of Colombia's hydro-power, and under Law 99, the CAR obtains significant revenue from these operations. According to Castro et al. (2001), like the CVC, Cornare strictly enforced discharge standards before it began setting up its program for the Río Negro in late 1997 and before it began invoicing in 2000. Therefore, in Cornare as well, discharge fees were principally charged on emissions not covered by discharge standards. According to Castro et al. (2001), between 1997 and 2000 pollution loads fell by 62% for BOD and 90% for TSS.

The report takes care to mention that these reductions can not with certainly be attributed solely to the new discharge fee program. The reason is that CRONARE implemented a series of clean production agreements with water dischargers immediately before beginning the discharge fee program. These agreements and related efforts to promote clean production undoubtedly contributed to the reductions.

DADIMA. DADIMA, Barranquilla's AAU, is quite different from CVC and Cornare. It was created by Law 99 of 1993 and has relatively limited institutional strength and regulatory capacity. In these regards, it is probably more representative of many CARs. According to Castro et al. (2001), before it began to implement a discharge fee program for a section of the Río Magdalena in 1998, DADIMA did not enforce discharge standards and the majority of polluters had not invested in treatment plants. Therefore, in implementing its program, DADIMA negotiated fulfilment plants with discharging facilities and applied pollution fees to all of their discharges.

According to Castro et al. (2001), the impact of the discharge fee in the industrial sector in the jurisdiction of the DADIMA has been notable. In two years, the program resulted in a 47% decrease in total loads of BOD and a 62% decrease in total loads of TSS.

#### 4.6.3. Revenue Generation

***Contribution to total revenue***

Table 4.20 presents data on the percentage contribution of revenue from discharge fees to self-generated revenue and total revenue, and it shows how revenue from discharge fees compares with revenue from national contributions. For all CARs, revenue from discharge fees contributes 1% of all revenue and 1% of self-generated revenue, and it represents 12% of revenue from national contributions. All of these are relatively modest percentages. For CAS, Corpoboyoca, and Cortolima, however, revenue generated by discharge fees is significant compared with national contributions.

**Table 4.20. Contribution of 2002 Discharge Fees to Total 2002 Revenue, by CAR and Type (thousands of pesos)**

| Entity | Fee revenue | | Revenue | | Revenue | | Revenue | |
|---|---|---|---|---|---|---|---|---|
| | Invoiced | Recovered | Nat. contrib. | Fee revenue as % of nat. contrib. | Self-generated | Fee revenue as % of self generated | Total | Fee revenue as % of total |
| CAM | 401.3 | 23.5 | 1,482 | 2 | 6,352 | 0 | 7,834 | 0 |
| CAR | 175.9 | NR | 0 | NR | 94,394 | NR | 94,394 | NR |
| Carder | 427.5 | 37 | 1,563 | 2 | 10,745 | 0 | 12,308 | 0 |
| Cardique | 195.8 | 0 | 1,097 | 0 | 8,654 | 0 | 9,752 | 0 |
| Carsucre | 108.3 | 1.1 | 1,932 | 0 | 1,963 | 0 | 3,896 | 0 |
| CAS | 1224.8 | 234.5 | 1,097 | 21 | 7,168 | 3 | 8,265 | 3 |
| CDA | 0 | 0 | 2,027 | 0 | 197 | 0 | 2,224 | 0 |
| CDMB | 2875.3 | 2555.4 | 0 | -- | 34,782 | 7 | 34,782 | 7 |
| Codechocó | 0 | NR | 1,724 | NR | 2,014 | NR | 3,738 | NR |
| Coralina | 208.1 | 19 | 2,025 | 1 | 1,643 | 1 | 3,667 | 1 |
| Corantioquía | 22.7 | NR | 3,452 | NR | 41,949 | NR | 45,401 | NR |
| Cormacarena | NR | NR | 261 | NR | 317 | NR | 578 | NR |
| Cornare | 363.8 | | 0 | 0 | 15,339 | | 15,339 | |
| Corpamag | 521.1 | 0 | 2,872 | 0 | 3,743 | 0 | 6,615 | 0 |
| Corpoamazonía | 58.9 | 0.3 | 1,696 | 0 | 5,118 | 0 | 6,814 | 0 |
| Corpoboyacá | 874.5 | 331.3 | 1,012 | 33 | 7,388 | 4 | 8,400 | 4 |
| Corpocaldas | 0 | 6.1 | 1,735 | 0 | 7,801 | 0 | 9,536 | 0 |
| Corpocesar | NR | 1.5 | 1,526 | 0 | 1,830 | 0 | 3,356 | 0 |
| Corpochivor | NR | NR | 1,378 | | 5,174 | | 6,552 | |
| Corpoguajira | | | 0 | | 12,661 | 0 | 12,661 | 0 |
| Corpoguavio | | | 0 | | 8,958 | 0 | 8,958 | 0 |
| Corpomojana | 0 | 0 | 1,993 | 0 | 152 | 0 | 2,145 | 0 |
| Corponariño | | | 1,828 | 0 | 5,841 | 0 | 7,669 | 0 |
| Corponor | NR | NR | 1,351 | NR | 7,685 | NR | 9,036 | NR |
| Corporinoquía | | | 1,108 | 0 | 6,058 | 0 | 7,166 | 0 |
| Corpourabá | 1428.8 | 202.3 | 2,276 | 9 | 2,525 | 8 | 4,800 | 4 |
| Cortolima | 1454.1 | 532.3 | 1,031 | 52 | 16,850 | 3 | 17,881 | 3 |
| CRA | | | 896 | | 15,999 | | 16,895 | |
| CRC | NR | 162.7 | 2,663 | 6 | 17,240 | 1 | 19,903 | 1 |
| CRQ | NR | 143 | 2,785 | 5 | 4,061 | 4 | 6,847 | 2 |
| CSB | | | 2,292 | | 5,289 | | 7,581 | |
| CVC | NR | 1167 | 0 | | 82,503 | 1 | 82,503 | 1 |
| CVS | NR | 0 | 105 | 0 | 13,267 | 0 | 13,371 | 0 |
| Total | 12307.9 | 5429.9 | 45,207 | 12 | 455,661 | 1 | 500,869 | 1 |

Source: MAVDT and Contraloría (2003).

***Regional funds for wastewater treatment***

Data on the uses of discharge fee revenues are difficult to obtain. Apparently, for many CARs, these revenues are absorbed into general revenues. MAVDT, however, encourages CARs to devote the revenue to regional funds for wastewater treatment meant to promote joint financing of wastewater treatment infrastructure and activities among CARs, municipalities and departments. In 1999, the Ministry of Environment issued guidance on the establishment and operation of these funds. It mandates that the funds be spent as follows: 50% to finance master plans for municipal wastewater treatment, 30% for industrial environmental management, 10% for science and technology projects, and 10% for administration of the discharge program. According to MMA, 15 CARs established such funds (Enríquez 2004).

## 4.7. Analysis

This section discusses the design and implementation of the three major water pollution control policies that are the focus of this chapter: permitting, discharge standards, and discharge fees.

### 4.7.1. Permitting and Discharge Standards

***The serious problem of enforcement***

Sections 4.2, 4.4, and 4.5 makes clear that in many CARs and AAUs, Colombia's system of permitting and discharge standards has not been effective in controlling water pollution. Is policy design at fault? The design of Colombia's system of permitting and discharge standards is quite conventional: the environmental authority identifies polluters and issues permits; polluters must abide by a set of discharge standards; environmental authorities monitor compliance with the standards through a mixed system of self-reports and random verifications; and environmental authorities impose sanctions for noncompliance, including closures and fines. Command-and-control water quality regimes all over the world have these same basic features, and many are very effective. As discussed below, some of elements of the design of Colombia's system of permitting and discharge standards clearly contribute to its poor performance. But the basic features of the system are sound.

The evidence presented here suggests that, notwithstanding some important policy design problems, poor implementation explains why Colombia's permitting and discharge system has, failed to protect water quality in many instances. To reiterate the main points findings of Sections 4.4. and 4.5: most environmental regulatory authorities do not have accurate inventories of dischargers, a problem compounded by the prevalence of informal and small-scale polluters; permitting in many CARs, even relatively strong ones, appears to be incomplete, slow, and haphazard; and perhaps most important, monitoring and enforcement of discharge standards are often lax and often do not cover all of the pollutants regulated in Decree 1594 of 1984.

The reasons for the poor enforcement of discharge standards are manifold. First, as discussed in Blackman et al. (2004b), regulatory capacity varies markedly across CARs. Some have much less technical expertise, less financing, and worse management than others. Thus, in some CARs, command-and-control water quality programs are poorly administered, as are many other programs, projects, and responsibilities.

Second, in many CARs, regulatory authorities have not succeeded in building a "culture of compliance." Students of environmental regulation—both lawyers and economists—have argued persuasively that such a culture is the key to the widespread, successful implementation of any environmental policy (Bell 1997; Russell et al. 1986). Agents comply because they believe others are doing the same, and furthermore, they believe that noncompliance will be identified and punished expeditiously and consistently.

The failure of many CARs to develop a culture of compliance is partly due to the problems with municipal wastewater treatment discussed in Section 4.2.3. Although a detailed analysis of the causes and manifestations of this problem is beyond the scope of this study, the major elements include a glaring lack of well-operating infrastructure; high costs of developing this infrastructure; and lack of clear, realistic plans for developing it. Whatever the roots of the problem, the result is that most municipal sewage authorities—the leading source of urban water pollution in most areas—are not able to comply with discharge standards. This has enormous negative repercussions for the viability of the discharge standard system for water pollution. Private-sector polluters understandably balk at the prospect of investing in pollution abatement when they know that the leading polluters are uncontrolled and are often owned and operated by the same public sector that enforces the discharge standards. Moreover, these private-sector polluters know that there is no real prospect of remedying the situation in the short- to medium-term.

***Industry-specific discharge standards***

As noted above, several features of Colombia's permitting and discharge system could be improved. First, Colombia discharge standards are not industry specific: facilities in all economic sectors are held to the same standards. This has the advantage of administrative simplicity—there is no lack of clarity about what standards polluters must meet. However, it has the important disadvantage that the standards are far more costly to meet for some types of facilities than for others. For example, leather tanneries discharge considerable amounts of chrome. It is probably far more expensive for them to meet discharge standards for chrome than, say, textile plants that use little or no chrome.

This is not simply industry's problem, for at least two reasons. First, economic theory suggests that industry-specific discharge standards are more likely to maximize social welfare than a uniform standard. In theory, social welfare is maximized by setting standards for each facility separately such that the marginal cost of further pollution abatement is equal to the marginal benefit. Assuming, for the sake of argument, that marginal benefits are constant, in setting facility-specific discharge standards, the standard would less stringent for facilities with greater marginal abatement costs, and vice versa.  In practice, of course, it is far too difficult and expensive for regulatory authorities to set discharge standards for individual facilities. It is possible, however, to differentiate standards by industrial sector. In theory—abstracting from the costs of setting and enforcing the differentiated standards—this would yield lower social benefits than facility-specific standards, but higher social benefits than uniform standards.

The second argument for differentiated standards involves the culture of compliance, discussed above. Uniform discharge standards lead to chronic noncompliance in sectors with high marginal abatement costs, making it impossible to build a culture of compliance. The most important sector in this case is municipal wastewater treatment: most of Colombia's municipalities are not able to comply with discharge standards.

For those reasons, many countries promulgate industry-specific discharge standards. They generally require facilities in each economic sector to meet discharge standards that are implied by the best available technology (BAT) or best practicable abatement technology (BPAT). Such standards can be complex and politically contentious. They are also difficult to compile and require periodic updates.

***Industry-specific technical guidance on pollution abatement***

Colombia lacks clear industry guidance on different methods of complying with discharge standards—particularly those for nonconventional industrial pollutants—in some economic sectors. Such gaps imply that emissions standards are unrealistic for firms that lack the technical information (or other types of resources) needed to purchase and operate abatement devices or to adopt clean technologies and pollution prevention. Informational barriers to pollution abatement are a common problem in countries where pollution abatement is limited (Blackman et al. 2004a). The reasons are fairly straightforward. When enforcement of environmental regulations is lax, polluters' demand for abatement technologies and information is limited. As a result, public- and private-sector supply of such goods and services is limited.

In many countries, the remedy for this problem is to provide industry-specific guidance on pollution abatement requirements. For example, in the United States, discharge standards are developed with reference to industry-specific abatement technologies (BATs and BPATs) for all nonconventional pollutants. Continually updated information on these technologies is made publicly available.

To some extent, Colombia's environmental guides *(guias ambientales)* serve to disseminate technical information about abatement. They detail options for improving environmental performance in specific sectors and typically focus on pollution prevention rather than end-of-pipe abatement strategies. Environmental guides have their origin in the national Cleaner Production Policy, a policy paper issued by the National Environmental Council *(Consejo Nacional Ambiental).* Fifty-seven environmental guides have been published covering approximately 60% of all productive sectors. The guides have been written for sectors where licensing is mandatory, and also for sectors where licensing is not required, such as livestock production. However, as discussed at length in Blackman et al. (2004b), the purpose and legal status of these guides are not clear. Also, to our knowledge, there is no system in place for continually updating the guides.

It is important to note that technical guidance on pollution abatement can have negative impacts. To the extent it becomes mandatory, it can preclude alternative abatement strategies that would be the most cost-effective strategies for some firms. For example, mandates for end-of-pipe wastewater treatment may crowd out low-cost pollution prevention measures.

One solution is simply to develop technical guidance on pollution control that is purely voluntary and retain standards that do not mandate any particular approach to abatement. Unfortunately, however, even when the technical guidance is not mandatory, in practice, it often become the standard for judging compliance. As a result, it become less than semimandatory in practice. For example, in the United States, emissions standards on point sources administered under the Clean Water Act (e.g., effluent guidelines) are developed with reference to the abatement capabilities of specific technologies. Firms adopt the technologies underlying the standards to minimize their risk of being found in violation. The risk of paying a high penalty for using alternative approaches turns a *de jure* emissions standard into a *de facto* technology standard. Hence, even discharge standards that do not appear to mandate particular standards can be "technology forcing." Of course, this danger can be mitigated by careful regulatory design—for example, explicitly designating technical guidance as nonmandatory.

Thus, in providing technical guidance, there may be a trade-off between the benefits of improved compliance and the costs—here, less flexibility to chose least-cost strategies. Although a full assessment of these benefits and costs is beyond the scope of this study, on the face of it, in situations where rates of compliance are low and environmental damages are extensive, the benefits of improved compliance would appear to outweigh the costs of higher abatement costs.

***Differential standards for discharging into sewer systems with centralized treatment facilities***

The discharge standards contained in Decree 1594 of 1984 are at least as stringent for polluters discharging into sewer systems as for those discharging directly into water bodies. In cases where sewage is treated, this can be inefficient. Wastewater treatment generally involves economies of scale—that is, average costs fall as the quantity treated increases. Therefore, requiring water users to pretreat their effluents using small-scale plants can be inefficient. This problem could be mitigated by relaxing discharge standards for water users discharging into systems with municipal treatment. As Roesner (2004) points out, these users could pay fees in lieu of treatment to the local sanitation authority.

***Pollutant coverage***

Colombia's discharge standards have not been revised since Decree 1594 of 1984 was passed more than two decades ago. They do not cover some pollutants that have important impacts on human health including coliforms.

***Nonpoint source water pollution***

The data reviewed for this report suggest that for some pollutants such as BOD, nonpoint sources of water pollution in Colombia—including agriculture and livestock in rural areas and runoff in urban and suburban areas—are at least as important as point sources of pollution. Conventional wisdom suggests that urban runoff is high in toxics, and agricultural nonpoint sources can have serious impacts on fish and wildlife and on human health if they affect drinking water or work their way into the food chain. In addition, small-scale and informal mining is sometimes considered a nonpoint source and typically generates heavy metal pollution. Nonpoint source pollution is a notoriously difficult problem to mitigate. Nevertheless, the attention devoted to it in Colombia appears to be relatively limited.

### 4.7.2. Discharge Fees

#### *Overall evaluation*

Colombia's discharge fee system has received considerable positive attention in publications put out by high-profile international development institutions, such the World Bank and CEPAL (World Bank 1999; Castro et al. 2001; Acquatella 2001), the academic literature (Sterner 2003), and the gray literature (CAEMA various years). The evidence reviewed for this report suggests that in many respects, these positive evaluations are warranted. The most important reason is that (according to self-reported statistics) in a significant number of CARs and AAUs, pollution loads dropped dramatically following the introduction of discharge fees. In addition, the fees have generated significant new revenue for environmental management.

That said, there have been at least three serious problems in implementing discharge fees. These have received less attention than the program's successes. First, as with other environmental responsibilities, some CARs are doing a far better job implementing discharge fees than others. Eight years after Decree 901 of 1997, some CARs have yet to establish functional programs, and others have programs that are barely functional. Second, in some CARs that do have functioning programs, collection rates are low. This is a particular problem for the leading sources of discharges in the program—municipal sanitation authorities. Rampant noncompliance by these large, highly visible, mostly public-sector sources inhibits the development of a culture of compliance, a necessary condition for the effectiveness of all regulatory instruments. In addition, by saddling sanitation authorities with sizable new debts, the fee program appears to have exacerbated the larger problem of the scarcity of wastewater treatment plants and sewer network coverage. Third, in some CARs, coverage of the discharge fee program is incomplete, as is coverage of permitting.

#### *Theoretical advantages of discharge fees*

Why have discharge fees succeeded in cutting pollution loads while permitting and discharge standards have largely failed? According to some proponents (e.g., Castro et al. 2001), the reasons have to do with the well-known theoretical advantages of economic incentive instruments compared with command-and-control instruments. Specifically, emissions fees are more cost-effective than command-and-control instruments, and for that reason, polluters have been more willing to comply with this program than with discharge standards. Briefly, there are two theoretical reasons that emissions fees are considered more cost-effective than command-and-control instruments (see e.g., Bohm and Russell 1985; Blackman and Harrington 2000): static efficiency and dynamic efficiency.[57]

Static efficiency. The static efficiency advantages of discharge fees stem from two properties. First, they leave firms free to choose abatement strategies that minimize costs given their individual circumstances. By contrast, under a command-and-control technology standard, the regulator more or less dictates that whole classes of firms choose certain technologies. The same is true of discharge standards to the extent they are "technology forcing," as discussed above. Second, and more important, emissions fees create incentives for individual firms to choose levels of abatement that minimize the aggregate costs of achieving a given level of environmental quality. The reason is that firms with low abatement costs are driven to undertake more abatement than those with higher abatement costs. Firms whose marginal abatement costs are lower than the fee will abate, while those whose marginal abatement costs are higher than the fee will not abate; they will pay the emissions fee instead. In theory, in an emissions fee system the marginal abatement costs of all firms are eventually equated because each source abates to the point where the marginal cost of further abatement equals either the fee or the permit price. The equalization of marginal costs is a necessary condition, in the standard theoretical model, for least-cost emissions reductions. For a command-and-control policy to achieve the same result, as noted above the regulator must know the marginal abatement cost of every polluter and set facility specific standards, which is extremely unlikely in practice.

[57] It is worth noting that a third theoretical advantage of emissions fees over command-and-control approaches is flexibility, although this advantage has not received attention as a driver of the success of Colombia's program. Emissions fees more easily accommodate change, whether of environmental quality standards, economic conditions, or abatement technologies. In a command-and-control system, the regulator must formulate and promulgate rules concerning different types of polluters. By contrast, with discharge fees, firms retain control over facility-specific abatement decisions while the regulator simply sets fees or permit quantities to achieve an environmental quality standard. As a result, changes in response to new technologies and economic conditions are spontaneous and decentralized—the regulator need take no action at all. Changing the environmental quality standard is also relatively simple: it involves changing only the level of emissions fees.

Dynamic efficiency. Although advocates of emissions fees and other economic incentive instruments generally focus on static efficiency arguments, the advantages of dynamic efficiency may be of greater long-run importance. Because firms in emissions fees programs can always increase profits by reducing emissions, such programs provide continuing incentives for emissions-reducing innovation. By contrast, in a command-and-control system, incentives to innovate are often dampened by the risks associated with using a nonapproved technology.

The efficiency properties of emissions fees are said to have improved compliance, but some proponents of the program also contend that Colombia's discharge fees have been successful in achieving emissions reductions in CARs that already have high rates of compliance (e.g., Cornare and CVS) because five-year targets for discharge reductions have been set well below the total loads implied by compliance with discharge standards. In other words, the discharge fee program has made it possible for well-functioning CARs and AAUs to obtain discharge reductions above and beyond those mandated by discharge standards.

***The principal drivers of success: More stringent monitoring and enforcement?***

We agree with the proponents of Colombia's emissions fees program that it almost certainly exhibits the static and dynamic efficiency properties described above. Also, the discharge fees program may have enabled well-functioning CARs and AAUs to obtain discharge reductions above and beyond those mandated by discharge standards. However, in our view it is not reasonable to infer that the total reductions in pollution loads from all CARs can be principally attributed to the discharge fee program.

The reason is simply that before the discharge fee program was set up, as discussed in Sections 4.4 and 4.5, in many CARs and AAUs, permitting was woefully inconsistent and monitoring and enforcement were virtually negligible; these responsibilities improved dramatically during the implementation of the new instrument. Hence, a comparison before and after the1997 discharge fee program is not an "all other things equal" proposition, and as a result, one cannot be certain whether the post-1997 reductions in discharges were due to (i) the properties of fee program, or (ii) improved permitting, monitoring, and enforcement.

The data and evidence needed to disentangle these two factors would be difficult if not impossible to muster. Certainly, this task is outside the scope of this study. On the face of it, however, our view is that improvements in permitting, monitoring, and enforcement were a very important contributor to—if not the leading driver of—the environmental quality benefits that have been attributed to the emissions fee program. As detailed in Section 4.2.1.7, the specific steps needed to implement the discharge fee program included, among other items:

- developing a complete inventory of dischargers;
- registering all dischargers;
- creating an information management system;
- characterizing discharges from participating water users;
- calculating facilities' pollution loads; and
- developing a system of monitoring.

Note that each of those capabilities is also a necessary condition for effective implementation of a discharge standard system. Yet in many CARs and AAUs, they were developed for the first time only after 1997.

Why were permitting, monitoring, and enforcement bolstered for the discharge fee system? Several factors appear to have been at play. First, implementation of the discharge fee system was accompanied by considerable publicity and controversy. Extensive vertical (top-down) and horizontal (CAR-to-CAR) programs were created to help CARs and AAUs implement discharge fees. To our knowledge, this type of effort was never devoted to promoting discharge standards.

Second, the discharge fee program entailed far more transparency and accountability for regulatory authorities than did the discharge standards program. CARs and AAUs were required to report both to their boards of directors and to MAVDT their progress on program implementation, pollution reduction targets, pollution loads, invoices, and collections. As a result, for the first time, CARs and AAUs were themselves held to "performance standards" for water pollution control by their boards and by MAVDT. Prior to the discharge fee program, few CARs and AAUs consistently kept records of the discharges of water users in their jurisdictions and in any case were infrequently held accountable for their activities.

Finally, the discharge fee program created an important economic incentive for CARs and AAUs to enforce their water pollution control laws—these authorities were allowed to keep the revenues from these fees. As discussed in Section 4.6.2, the revenues are significant for some CARs and AAUs.

To sum up, proponents of Colombia's emissions fees programs believe that the incentives that discharge fees created for polluters—namely, continuing, significant financial incentives to cut emissions in a cost-effective manner—have been responsible for their success in improving environmental quality. To some extent this may be true. However, in our view, the incentives that the fees created for CARs and AAUs to enforce their pollution control laws—both by enhancing accountability and by creating financial incentives—have been at least as important.

***Hybrid fee-standard program***

Colombia's discharge fee program is actually a hybrid between a discharge standard program and a discharge fee program. As discussed in Section 4.3.1.6, polluters who are complying with discharge standards pay fees only on those emissions not covered by the discharge standard, but polluters who are not complying with discharge standards are supposed to negotiate compliance plans with the environmental authority and pay fees on all of their discharges during the term of the plan (which can last as long as five years).

Hybrid fee-standard programs are relatively common in developing countries, and the literature includes analyses of their economic properties (Bluffstone and Larson 1997). That not all facilities in the same water basin pay the same fee (again, because those that comply with discharge standards do not pay a fee) undermines the "equi-marginal" property that would minimize total social costs. In other words, the programs are not able to completely shift the burden of pollution abatement from polluters with high marginal abatement costs to those with lower marginal abatement costs, at least not to the extent that a pure fee program would.

***Pollutant coverage***

Although Colombian regulation allows MAVDT to expand its coverage, currently, the emissions fee program covers only two pollutants: BOD and TSS. Environmental regulatory authorities may have wanted to limit the scope of the program until it was well established. Nevertheless, the (qualified) success of the program begs the question of whether expanded coverage is appropriate. If an overarching goal of the project is to protect human health, then expanding coverage to toxic pollutants and coliforms would be justified. According to Enríquez (2004), however, the fact that the discharge fee program covers only BOD and TSS is not the result of a reasoned strategy. Rather, it is a historical artifact of the national fee system for the CVC program of the 1970s, which was intended to recover costs for the Salvajina hydroelectric dam project. However, Espino (1996) states that coverage is limited to BOD and TSS because these pollutants are relatively easy to measure.

***Goal setting***

The CAR and AAU boards of directors set pollution load reduction targets for water basins. This target-setting strategy has a number of attractive features. First, it relies on established institutions to set targets and therefore avoids having to create and legitimize new institutions. Second, the target-setting process is decentralized. In theory, this allows it take into account heterogeneity in marginal benefits and costs of abatement across water basins. Third, it helps legitimize the pollution reduction targets in the eyes of local polluters.

That said, it is not clear that CAR and AAU boards of directors are unbiased in setting pollution reduction targets. The boards purport to represent all elements of civil society. But as discussed in detail in Blackman et al. (2004b), considerable evidence suggests that civil society is underrepresented on boards of directors relative to industry. Environmental NGOs are supposed to be the principal representatives of civil society on the boards, but in many CARs, they are quite weak. This context, along with the dramatic variation in pollution reduction targets across CARs evident from Table 4.6.1, raises the question of whether target setting in some water basins may have been unduly influenced by industry lobbies.

***Fee calculation***

Several features of the method for calculating and readjusting fees established in Decree 901 of 1997 are of concern. First, in theory, the fees could increase indefinitely, a particular problem in the many water basins lacking municipal wastewater treatment plants and the capacity to build them. This problem with fee calculation was remedied by a MAVDT resolution establishing a maximum of 5.5 for the regional factor, a resolution that was later codified in Decree 3100 of 2003. Second, for facilities in water basins where total pollution loads exceed the targets established by CAR or AAU boards of directors, fee rates can increase every six months. This creates considerable financial uncertainty for those obligated to pay the fee.

## 4.8. Recommendations

**1. Develop realistic, phased plans for both building and regulating municipal wastewater treatment plants.**

Nationwide, municipal wastewater treatment plants are the leading point source of water pollution and are also a leading contributor to chronic noncompliance with water pollution regulation. To improve water quality and build a culture of compliance, it is essential that regulatory authorities develop a realistic, phased plan for financing and building missing municipal wastewater sewage and treatment infrastructure. The plan should take into account regional heterogeneity in fiscal resources and management capabilities. It may rely on cooperative efforts, such as regional funds for wastewater treatment, where possible. It may also rely on low-technology, low-cost solutions—including lagoons, anaerobic processes, anaerobic filters, and seasonal stabilization reservoirs for agricultural reuse—instead of conventional water treatment plants.

Just as important, a process for regulating municipal sewage authorities' discharges should be developed that avoids chronic noncompliance by, for example, creating new, less stringent standards that apply to municipalities, perhaps during well-defined grace periods that correspond to the timeline for infrastructure development. Such relaxed discharge standards would also mitigate the perverse incentives that discharge fees generate for municipalities to avoid investing in wastewater treatment facilities and new sewer networks. They would also mitigate concerns about the regressivity of discharge fees—that is, their disproportionate impact on poor water utility customers.

**2. Strengthen regulations, programs, and investments focused on nonpoint source water pollution.**

Given that nonpoint water pollution sources account for the lion's share of some types of pollution, MAVDT should strengthen SINA's efforts to control them. These efforts might include stronger mandatory regulation, voluntary regulation, information dissemination, and financing or cofinancing for infrastructure. Specific measures promoted might include such instruments as riparian buffers, cattle fencing, pesticide taxes, wetlands protection and promotion in rural and suburban areas, and expanded greenspace and riverfront parks in urban areas.

**3. Continue to strengthen permitting, monitoring, and enforcement.**

Stringent permitting, monitoring, and enforcement are a necessary condition for the effectiveness of most pollution control regulatory instruments—including both discharge standards and discharge fees. In many CARs and AAUs, implementation of the discharge fee system appears to have greatly strengthened permitting, monitoring, and enforcement by enhancing transparency and accountability and providing economic incentives (fee revenue) for doing good management. The CARs should use this momentum to continue to strengthen permitting and enforcement.

**4. Investigate costs and benefits of industry-specific discharge standards.**

Although easy to administer, uniform discharge standards do not take into account variations in marginal abatement costs across economic sectors. Uniform standards thus impose exorbitant compliance costs on some economic sectors—that is, they mandate emissions reductions for which marginal costs exceed benefits. In addition, in such sectors, uniform standards create chronic noncompliance, a problem that has negative spillovers on enforcement in other sectors. To mitigate these problems, MAVDT should study the benefits and costs of promulgating industry-specific standards, a common feature of command-and-control regulation in other countries. To ease the administrative burden, the standards need not be as complex or finely differentiated as those in more industrialized countries.

**5. Expand, rationalize, and update industry-specific technical guidance on pollution abatement.**

Compliance with discharge standards can be improved by issuing industry-specific technical guidance on pollution abatement. In doing so, care should be taken to ensure that discharge standards remain performance standards and do not evolve into *de facto* technology standards. Colombia's voluntary environmental guides may serve as a starting point for this effort. If they do, their legal status should be clarified. In any case, technical guidance should be periodically updated to ensure that compliance costs are kept as low as possible.

**6. Explore the practicality of issuing different standards for discharges into sewer systems with wastewater treatment infrastructure.**

MAVDT should investigate the practicality of differentiating discharge standards for emissions into sewer systems that have wastewater treatment infrastructure. Differentiating standards in this way could enable polluters to take advantage of economies of scale in wastewater treatment and could thereby lower total private costs of wastewater treatment. Facilities that discharge into sewers without treating their wastewater could pay a fee to municipal wastewater treatment authorities for the services they provide.

**7. Study the costs and benefits of expanding pollutant coverage of the discharge standard system.**

MAVDT should study the costs and benefits of promulgating and enforcing discharge standards on a wider array of pollutants that affect human health, including coliforms.

**8. Continue to build and expand the discharge fee program.**

Although imperfect, the discharge fee program appears to have had unprecedented success in reducing discharges of BOD and TSS. The proponents of this program often argue that its success is due to the incentives it creates for polluters to abate. In actuality, however, this success may have more to do with the incentives the program creates for CARs and AAUs to improve permitting, monitoring, and enforcement. In any case, the program should continue to be promoted, not only as a mechanism for improving permitting monitoring and enforcement, but also as a means of promoting cost-effective pollution abatement and generating revenue for pollution control.

After the institutional structure and regulatory capacity for fees becomes better established, MAVDT should consider replacing the hybrid fee-standard system with a pure fee system, at least for a limited number of pollutants, such as BOD and TSS. Such a system would mitigate the disadvantages of the hybrid system discussed above. In theory, this evolution would not impose a greater fee burden on polluters. Water users that are already complying with discharge standards would continue to pay fees only on those discharges over and above the limits established by the standards. For example, a facility that has made investments and process changes to cut BOD emissions from 100 units to 20 units to comply with discharge standards currently pays discharge fees only on the 20 remaining units. This would still be the case in a pure fee system. Under MAVDT guidance, water users that are not currently complying with discharge standards presumably now pay fees on all of their discharges (although in some jurisdictions, this is apparently not the case).

**9. Improve the credibility of the monitoring system for discharge standards and fees.**

To ensure the integrity of discharge standards and fee systems, MAVDT should consider instituting a program to ensure that CARs and AAUs are verifying industry self-reports. The program could entail random auditing and sampling by MAVDT or the control organizations, the Contraloría and Procuraduría.

**10. Reduce uncertainty surrounding fee adjustment.**

Semiannual adjustments of emissions fees based on whether total pollution loads in a water basin meet five-year reduction targets create considerable financial uncertainty for regulated firms. Options to reduce this uncertainty include annual rather than semiannual adjustments, and mandating a lag between the adjustment of the fee and actual implementation.

**11. Improve and standardize data management systems.**

Reliable, accurate, up-to-date environmental quality data on surface water and groundwater in Colombia are needed for planning, prioritizing, and general policy formulation. MAVDT, CARs, and AAUs should ensure that monitoring is expanded and that data collection and management are improved and standardized.

## Appendix 4.1: Decree 1594 of 1984: Substances Considered of "Sanitary Interest"

| | | |
|---|---|---|
| Arsenic Lead | Haloethers (different from others in the list) | Vinil Chloride (Chloroethylene) |
| Barium Selenium | 4 – Chlorophenylphenylether | Pesticides and metabolites |
| Cadmium Acenaphthene | 4 - Bromophenylphenylether | Aldrín |
| Cyanide Acrolein | Bis (2 – Chloroisopropyl) ether | Dieldrín |
| Copper Acrylonitrile | Bis (2 – Chloroetoxy) methane | Chlordane |
| Chrome Benzene | Halomethane (different from other in the list) | DDT and metabolites |
| Mercury Bencidine | Methyl Chloride (Dichloromethane) | 4,4 '-DDT |
| Carbon Nickel Tetrachloride (Tetrachloromethane) | Methyl Chloride (Chloromethane) | 4,4 '-DDE (p, p '-DDX) |
| Chlorobenzenes different from dichlorobenzenes | Methyl Bromide (Bromomethane) | 4,4 '-DDD (p, p '-TDE) |
| Chloro Benzene | Bromoform (Tribromide Methane) | Endosulfan and metabolites |
| 1,2,4 – Trichlorobenzene | Dichlorobromomethane | Endrin |
| Hexachlorobenzene | Trichlorofluoromethano | Endrin aldehyde |
| Chloroethane | Dichlorodifluoromethane | Heptachloroepóxido |
| 1,2 – Dichloroethane | Chlorodibromomethane | Hexachlorocyclohexane (all its isomers) |
| 1,1,1 – Trichloroethane | Hexachlorocyclopentadiene | a - BHC - Alpha |
| Hexachloroethane | Isophoron Naphthalene | b - BHC - Beta |
| 1,1 – Dichloroethane | Nitrobenzene | r - BHC (lindane) - Gamma |
| 1,1,2 – Trichloroethane | Nitrophenols | g - BHC Delta |
| 1,1,2,2 – Tetrachloroethane | 2 - Nitrophenol | Biphenyl polychlorinates |
| Chloroethane | 4 - Nitrophenol | PCB-1242 (Arochlorine 1242) |
| Chloroalkilethers | 2,4 – Dinitrophenol | PCB - 1254 (Arochlorine 1254) |
| Bis (chloromethyl) ether | 4,6 - Dinitro - **o** - Cresol | PCB - 1221 (Arochlorine 1221) |
| Bis (2-chloroethyl) ether | Nitrosamines | PCB - 1232 (Arochlorine 1232) |
| 2 – chloroethyl vinyl (mixed) ether | N – Nitrosdiphenylamine | PCB - 1260 (Arochlorine 1260) |
| Chloride Naphthalenes | N - Nitroso - n - Propilamine | PCB - 1016 (Arochlorine 1016) |
| 2 – Chloronaphthalene | Pentachlorophenol | Toxaphenol |
| Chloride Phenols different from others of the list, including chloride cresols | Phenol | Antimony |
| 2,4,6 – Trichlorophenol | N - Nitrosodimethylamine | Asbestos (fibers) |

| | | |
|---|---|---|
| Parachloromecresol | Phthalate esther | Beryllium |
| Chloroform (Trichloromethane) | Bis (2 - ethylhexyl) Phthalate | Zinc |
| 2 - Clorophenol | Butyl benzyl phthalate | 2,3,7,8 - Tetrachlorodibenzene - p - dioxin (TCDD) |
| Dichlorobenzene | Di - n - butyl phthalate | Additional compounds |
| 1,2 - Dichlorobenzene | Di - n - octyl phthalate | Abietic Acid |
| 1,3 - Dichlorobenzene | Diethyl phthalate | Dehydroabietic acid |
| 1,4 - Dichlorobenzene | Dimethyl phthalate | Isopymaric Acid |
| Dichlorobenzidine | Aromatic polynuclear hydrocarbons | Acid pymaric |
| 3,3 '- Dichlorobenzidine | Benz (a) anthracene (1,2 – benzantraceno) | Oleic Acid |
| Dichloroethylenes | Benz (a) pyrene (3, 4 - benzopyrene) | Linoleic Acid |
| 1,1 – Dichloroethylene | 3,4 - benzofluoranthene | Linolenic Acid |
| 1,2 - Trans-Dichloroethylene | Benz (k) fluoranthene (11, 12 - benzofluoranthene) | 9, 10 - Epoxistearic Acid |
| 2,4 – Dichlorophenol | Chrysene | 9, 10 - Dichloroestearic Acid |
| Dichloropropane and Dichloropropene | Acenaphthylene | Monochlorodehydroabietic Acid |
| 1,2 - Dichloropropane | Anthracene | Acid dichlorohydroabietic |
| 1,2 - Dichloropropylen (1, 3 - Dichloropropene) | Benz (gi) perilene (1,12 - benzoperilene) | 3,4,5 - Trichloroguayacolate |
| 2,4 - Dimethylphenol | Fluorine | Tetrachloroguayacolate |
| Dinitrotoluene | Fenantrene | Carbamates |
| 2,4 - Dinitrotoluene | Dibenz (to, h) Anthracene (1,2,5,5 - dibenzanthracene) | Phenolic Compounds |
| 2,6 - Dinitrotoluene | Indene (1,2,3 - of) pyrene (2,3 - or-phenyl enepyrene) | Biphenyl polychlorinated |
| 1,2 - Diphenylhydracine | Pyrene Tetrachloroethylene | Substances of explosive, radioactive, pathogenic character. |
| Ethylbenzene | Toluen | |
| Fluoranthene | Trichloroethylene | |

## *Appendix 4.2: Decree 1594 of 1984: Ambient Water Quality Standards for Different Types of Uses*

**1. Human and domestic use**

a. Criteria that indicate that only conventional treatment is needed to make water potable:

| Pollutant/characteristic | Maximum permissible value (mg./l. except where noted) |
|---|---|
| Ammonia N | 1.0 |
| Arsenic As | 0.05 |
| Barium Ba | 1.0 |
| Cadmium CD | 0.01 |
| Cyanide CN- | 0.2 |
| Zinc Zn | 15.0 |
| Chlorides Cl- | 250.0 |
| Copper Cu | 1.0 |
| Color | Real color 75 units, scale |
| Platinum - cobalt | |
| Phenolic Compounds - Phenol | 0.002 |
| Chrome Cr | + 6 0.05 |
| Diphenyl Polichlorinates | Concentration of active non-detectable agent |
| Mercury Hg | 0.002 |
| Nitrates N | 10.0 |
| Nitrites N | 10.0 |
| PH Units | 5.0 - 9.0 units |
| Silver Ag | 0.05 |
| Lead Pb | 0.05 |
| Selenium | 0.01 |
| Sulfates SO | 4 400.0 |
| Tenso-actives, methylene blue reactive substances | 0.5 |
| Total Coliforms NMP | 20.000 Microorganisms /100 ml. |
| Fecal Coliforms NMP | 2.000 Microorganisms /100 ml. |

Visible layers of fats and floating oils, floating materials, radioisotopes, and other substances that cannot be removed by conventional treatment and can affect human health will not be accepted.

b. Criteria that indicate that only disinfection is needed to make water potable:

| Pollutant/characteritic | Maximum permissible value (mg./l. except where noted) |
|---|---|
| Ammonia N | 1.0 |
| Arsenic As | 0.05 |
| Barium Ba | 1.0 |
| Cadmium CD | 0.01 |
| Cyanide CN- | 0.2 |
| Zinc Zn | 15.0 |
| Chlorides Cl- | 250.0 |
| Copper Cu | 1.0 |
| Color | Real color 20 units, scale |
| Platinum - cobalt | |
| Phenolic compounds - Phenol | 0.002 |
| Chrome Cr | + 6 0.05 |
| Diphenyl Polichlorinates | Concentration of active not detectable agent |
| Mercury Hg | 0.002 |
| Nitrates N | 10.0 |
| Nitrites N | 10.0 |
| PH Units | 6.5 - 8.5 units |
| Silver Ag | 0.05 |
| Lead Pb | 0.05 |
| Selenium | 0.01 |
| Sulfates SO = | 4 400.0 |
| Tenso-actives, methylene blue reactive substances | 0.5 |
| Turbidity, UJT. | 10 Jackson units of turbidity, UJT |
| Total coliforms NMP | 1.000 microorganisms/100 ml. |

Visible layers of fats and floating oils, floating materials generated from human activity, radioisotopes and other substances that can not be removed by disinfection and can affect human health will not be accepted.

**2. Agricultural use**

| Pollutant/characteritic | Maximum permissible value (mg./l. except where noted) |
|---|---|
| Aluminium Al | 5.0 |
| Arsenic As | 0.1 |
| Beryllium Be | 0.1 |
| Cadmium CD | 0.01 |
| Zinc Zn | 2.0 |
| Cobalt Co | 0.05 |
| Copper Cu | 0.2 |
| Chrome Cr | + 6 0.1 |
| Fluorine F | 1.0 |
| Iron Fe | 5.0 |

| | |
|---|---|
| Lithium Li | 2.5 |
| Manganese Mn | 0.2 |
| Molybdenum Mo | 0.01 |
| Nickel Ni | 0.2 |
| PH Units | 4.5 - 9.0 units |
| Lead Pb | 5.0 |
| Selenium | 0.02 |
| Vanadium V | 0.1 |
| Boron B | 0.3 And 4.0 mg/L depending on the type of soil and on the crops |
| NMP of total coliforms | Máx. 5.000 when it is used for irrigation of fruits that are consumed without removing the skin and for vegetables of short stem |
| NMP of fecal coliforms | 1.000 when it is used for irrigation of fruits that are consumed without removing the skin and for vegetables of short stem. |

In addition, measurements on the following characteristics must be taken:

a. conductivity.

b. relation of absorption of sodium (RAS);

c. percentage of possible sodium (PSP);

d. effective and potential salinity;

e. carbonate of residual sodium; and

f. radionucleids.

**3. Use by cattle**

| **Pollutant/characteritic** | **Maximum permissible value (mg./l. except where noted)** |
|---|---|
| Aluminium Al | 5.0 |
| Arsenic As | 0.2 |
| Boron B | 5.0 |
| Cadmium CD | 0.05 |
| Zinc Zn | 25.0 |
| Copper Cu | 0.5 |
| Chrome Cr | + 6 1.0 |
| Mercury Hg | 0.01 |
| Nitrates + Nitrites N | 100.0 |
| Nitrite N | 10.0 |
| Lead Pb | 0.1 |
| Content of salts | Total weight 3.000 |

**4. Recreation as a primary use**

| Pollutant/characteritic | Maximum permissible value (mg/l. except where noted) |
|---|---|
| Fecal coliforms NMP | 200 microorganisms/100 ml. |
| Total coliforms NMP | 1.000 microorganisms/100 ml. |
| Phenolic compounds – Phenol | 0.002 |
| Dissolved oxygen | 70% saturation concentration |
| PH units | 5.0 - 9.0 units |
| Tenso-actives, methylene blue reactive substances | 0.5 |

Visible layers of fats and floating oils, floating materials generated from human activity, toxic or irritating substances that act by contact, ingestion, or inhalation and produce adverse reactions on the human health will not be accepted.

**5. Recreation as a secondary use**

| Pollutant/characteritic | Maximum permissible value (mg./l. except where noted) |
|---|---|
| Total coliforms NMP | 5.000 microorganisms/100 ml. |
| Dissolved oxygen | 70% saturation concentration |
| PH units | 5.0 - 9.0 units |
| Tenso-actives, methylene blue reactive substances | 0.5 |

**6. Aesthetic use**

| |
|---|
| Absence of floating material and foam that come from human activity. |
| Absence of fats and oils that form visible layers. |
| Absence of substances that generate smells. |

**7. Use in preserving flora and fauna in fresh, cold, or hot waters and in marine or estuary waters**

| Pollutant/characteritic | Maximum permissible value (mg./l. except where noted) | | |
|---|---|---|---|
| | Cold fresh water | Hot fresh Water | Marine - Estuary Water |
| Chlorophenols-Chlorophenol | 0.5 | 0.5 | 0.5 |
| Diphenyl-concentration of active agent | 0.0001 | 0.0001 | 0.0001 |
| Dissolved oxygen | 5.0 | 4.0 | 4.0 |
| PH Units | 6.5 - 9.0 | 4.5 - 9.0 | 6.5 - 8.5 |
| Sulphur of ionized Hydrogen H2S | 0.0002 | 0.0002 | 0.0002 |
| Ammonia NH3 | 0.1 CL9650 | 0.1 CL9650 | 0.1 CL9650 |
| Arsenic As | 0.1 CL9650 | 0.1 CL9650 | 0.1 CL9650 |
| Barium Ba | 0.1 CL9650 | 0.1 CL9650 | 0.1 CL9650 |
| Beryllium Be | 0.1 CL9650 | CL9650 0.1 | 0.1 CL9650 |

| | | | |
|---|---|---|---|
| Cadmium CD 0. | 0.01 CL9650 | 01 CL9650 | 0.01 CL9650 |
| Cyanide free CN- | 0.05 CL9650 | 0.05 CL9650 | 0.05 CL9650 |
| Zinc Zn | 0.01 CL9650 | CL9650 0.01 | 0.01 CL9650 |
| Total residual chlorine Cl2 | 0.1 CL9650 | 0.1 CL9650 | 0.1 CL9650 |
| Copper Cu | 0.1 CL9650 | 0.1 CL9650 | 0.1 CL9650 |
| Hexavalent Chrome Cr +6 | 0.01 CL9650 | 0.01 CL9650 | 0.01 CL9650 |
| Monowater phenols-Phenols | 1.0 CL9650 | 1.0 CL9650 | 1.0 CL9650 |
| Fats and oils, fats as percentage of dry solids | 0.01 CL9650 | 0.01 CL9650 | 0.01 CL9650 |
| Iron Fe | 0.1 CL9650 | 0.1 CL9650 | 0.1 CL9650 |
| Manganese Mn | 0.1 CL9650 | 0.1 CL9650 | 0.1 CL9650 |
| Mercury Hg | 0.01 CL9650 | 0.01 CL9650 | 0.01 CL9650 |
| Nickel Ni | 0.01 CL9650 | 0.01 CL9650 | 0.01 CL9650 |
| Pesticides organochlorides concentration of (every variety) active agent | 0.001 CL9650 | 0.001 CL9650 | 0.001 CL9650 |
| Pesticides organophosphorates concentration of (every variety) active agent | 0.05 CL9650 | 0.05 CL9650 | 0.05 CL9650 |
| Silver Ag | 0.01 CL9650 | 0.01 CL9650 | 0.01 CL9650 |
| Lead Pb | 0.01 CL9650 | 0.01 CL9650 | 0.01 CL9650 |
| Selenium | 0.01 CL9650 | 0.01 CL9650 | 0.01 CL9650 |
| Tenso-actives, methylene blue reactive substances | 0.143 CL9650 | 0.143 CL9650 | 0.143 CL9650 |

Additionally, substances that create odors or tastes in the tissues of aquatic organisms or cause turbidity or color that interferes with photosynthesis must not be present.

The entity in charge of the management and administration of the resource (EMAR) is to make bio-tests that establish the values of the CL9650 of the parameters previously listed, as well as the NMP of total coliforms for aquaculture and the temperature values in various situations.

**8. Uses relating to transport, dilution, and assimilation:** quality criteria are not established, without prejudice to the corresponding discharge control.

**9. Industrial use:** quality criteria are not established, except for activities related to exploitation of riverbeds, beaches, and seabeds, for which the criteria on toxic or irritating substances, pH, fats and floating oils, floating material that come from human activity, and total coliforms must be considered.

## Appendix 4.3: Decree 1594 of 1984: Standards for Wastewater Discharges

**1. Discharges into a water body**

| Pollutant/characteritic/CMP | Existing User | New User |
|---|---|---|
| pH | 5 to 9 units | 5 to 9 units |
| Temperature | < 40°C | < 40°C |
| Floating material | | Absent |
| Fats and oils | Removal > 80 % in load | Removal > 80% in load |
| Domestic or industrial suspended Solids | Removal > 50 % in load | Removal > 80% in load |
| Biochemical demand of oxygen:<br>For domestic residues<br>For industrial residues | Removal > 30 % in load<br>Removal > 20 % in load | Removal > 80% in load<br>Removal > 80% in load |
| Maximum permissible load (CMP) | According to what is established in articles 74 and 75 of the present Decree | |

**2. Discharge into a public sewage system**

| Pollutant/characteritic/CMP | Value |
|---|---|
| pH | 5 a 9 units |
| Temperature | < 40°C |
| Acids, bases or acid or basic solutions that could cause pollution; explosive or inflammable substances. | Absent |
| Solids that can sediment | 10 ml/l |
| Substance soluble in hexane | 100 mg/l |

| Pollutant/characteritic/CMP | Existing user | New User |
|---|---|---|
| Suspended solids for domestic and industrial tailing | Removal > 50% in the load | Removal > 80% in the load |
| Biochemical oxygen demand:<br>For domestic residues<br>For industrial residues | Removal > 30% in the load<br>Removal > 20% in the load | Removal > 80% in the load<br>Removal > 80% in the load |
| Maximum flow | 1.5 Times the average hourly flow | |
| Maximum permissible load (CMP) | According to what is established in articles 74 and 75 of the present Decree | |

**3. Load concentration control**

| Substance | Concentration (mg./l.) |
|---|---|
| Arsenic As | 0.5 |
| Barium Ba | 5.0 |
| Cadmium CD | 0.1 |
| Copper Cu | 3.0 |
| Chrome Cr+6 | 0.5 |
| Phenolic compounds-Phenol | 0.2 |
| Mercury Hg | 0.02 |
| Nickel Ni | 2.0 |
| Silver Ag | 0.5 |
| Lead Pb | 0.5 |
| Selenium | 0.5 |
| Cyanide CN | 1.0 |
| Diphenyl polychlorates concentration of active agent | Not detectable |
| Organic mercury Hg | Not detectable |
| Trichloroethylene | 1.0 |
| Extract coal chloroform (ECC) | 1.0 |
| Tetrachloride of carbon | 1.0 |
| Dichloroethylene | 1.0 |
| Carbon Sulphur | 1.0 |
| Other organochloride compounds, concentration of every variety active agent | 0.05 |
| Organophosphorate compounds, concentration of every active agent variety | 0.1 |
| Carbamates | 0.1 |

The maximum permissible load (CMP – *carga máxima permitida*) of the substances listed in the tables above are to be calculated as follows. The CMP is the smaller of the following two values,

A = Q*CDC*0.0864
B = Q*CV*0.0864

where

A = load control (kg/day)
Q = average effluent flow (l/sec)
CDC = concentration control (mg/l) (concentration of pollutant in mg, per liter of effluent)

B = loads in the effluent ( kg/day)
CV = concentration in discharges (mg/l) (concentration of pollutant in mg, per liter of water discharges)

The decree stipulates that wastewater must undergo special treatment if it comes from hospitals, laundries, laboratories, clinics, slaughterhouses, and agrochemicals or pesticides production.

## Appendix 4.4: Decree 1594 of 1984: Methods of analysis and sample collection

The following methods of analysis are officially accepted.

| Reference | Methods |
|---|---|
| **1) Color** | - Visual comparison |
| | - Spectrophotometric |
| | - Tristimulus filter |
| Solids that sediment | - ImHoff cone |
| Turbidity | - Nephelometric |
| | - Visual |
| Saltiness | - Conductivity |
| | - Argentometric |
| | - Hydrometric |
| Solids in suspension | - Crisol Gooch filtration |
| **2) Inorganic nonmetal constituents** | |
| Bore | - Cucurmine |
| | - Carminic acid |
| Chloride | - Argentometric |
| | - Mercury nitrate |
| | - Potenciometric |
| Cyanide | - Titulation |
| | - Colorimetric |
| | - Potenciometric |
| Ammoniac | - Nessler |
| | - Phenate |
| | - Titulation |
| | - Specific electrode |
| Nitrate | - Ultraviolet spectrophotometry |
| | - Specific electrode |
| | - Cadmium reduction |
| | - Chromotropic acid |
| Oxygen | - Iodometric |
| | - Modified acid |
| | - Modified permanganate |
| | - Specific electrode |
| pH | - Potentiometric |
| Phosphate | - Vanadiomolibdophosphoric acid |
| | - Stannous chloride |
| | - Ascorbic acid |
| Fluorine | - Specific electrode |
| | - Spadns |
| | - Alizarine |
| Total residual chloride | - Lodometric |
| | - Amperometric |

| Reference | Methods |
|---|---|
| Sulphate | - Gravimetric |
| | - Turbidimetric |
| Sulphur | - Methylene Blue |
| | - Iodometric |
| **3) Organic constituents** | |
| Fats and oils | - Soxhlet extraction |
| Phenols | - Chloroform extraction |
| | - Fotometric direct |
| | - Chromatographic |
| Total organic carbon | - Oxidation |
| Tensoactives | - Methylene blue |
| | - Gas chromatography |
| Chemical oxygen demand | - Dichromate reflux |
| Biochemical oxygen demand | - Incubation |
| **4) Metals** | |
| Aluminium | - Atomic absorption |
| | - Cianine eriochrome |
| Arsenic | - Atomic absorption |
| | - Silver diethyldithiocarbamate |
| | - Mercuric-stanose bromide |
| Barium | - Atomic absorption |
| Beryllium | - Atomic absorption |
| | - Aluminon |
| Cadmium | - Atomic absorption |
| | - Ditizone |
| | - Polarographic |
| Chrome | - Atomic absorption |
| | - Colorimetric |
| Iron | - Atomic absorption |
| | - Phenanthroline |
| Lead | - Atomic absorption |
| | - Ditizone |
| Lithium | - Atomic absorption |
| | - Flame photometry |
| Mercury | - Atomic absorption |
| | - Ditizone |
| Nyquil | - Atomic absorption |
| | - Dimethylglioxime |
| | - Dimethylglioxime |
| Selenium | - Atomic absorption |
| | - Diaminobenzidine |
| Silver | - Atomic absorption |
| | - Ditizone |
| Vanadium | - Atomic absorption |
| | - Galic acid |
| Zinc | - Atomic absorption |
| | - Ditizone |

| Reference | Methods |
| --- | --- |
| | - Zincon |
| Manganese | - Atomic absorption |
| | - Persulphate |
| Molybdenum | - Atomic absorption |
| Cobalt | - Atomic absorption |
| **5) Biological constituents** | |
| Total fecal coliform group | - Multiple tube fermentation |
| | - Membrane filter |
| | - Dimethylglioxime |
| Selenium | - Atomic absorption |
| | - Diaminobenzidine |
| Silver | - Atomic absorption |
| | - Ditizone |
| Vanadium | - Atomic absorption |
| | - Galic acid |
| Zinc | - Atomic absorption |
| | - Ditizone |
| | - Zincon |
| Manganese | - Atomic absorption |
| | - Persulphate |
| Molybdenum | - Atomic absorption |
| Cobalt | - Atomic absorption |

# 5. Land Degredation

## 5.1. Introduction

Land degradation has a variety of causes, including depletion of soil nutrients, invasion of salts (salinization), agrochemical pollution, soil erosion, and vegetative degradation as a result of overgrazing. All of these processes result in a decline in potential agricultural yields. To compensate, farmers may increase fertilizer application, leave land fallow, or convert to land uses that are less demanding of soil quality. Reduced agricultural productivity aside, land degradation can also have negative off-site consequences, including siltation of low-lying dams and irrigation infrastructure, contamination of drinking water by agrochemicals, and loss of biodiversity and ecosystem health. Recent global studies of land degradation suggest that 22% of all cropland, pasture, forest, and woodland has been degraded in the past 50 years. Most of the degradation is due to wind and water erosion. Approximately 4% of this land has been so severely degraded that the problem is virtually irreversible. Latin America, along with Africa, has the highest proportion of degraded agricultural land. Although the economic impacts of soil erosion have been hotly debated, cumulative crop productivity loss from soil degradation over the past 50 years is estimated to be about 13%, and for pasture lands 4% (Scherr and Yadav 1996).

This chapter discusses land degradation in Colombia and policies designed to prevent, control, and mitigate it. To make the analysis feasible given the resources available for this study, and to ensure that it comports with a complementary MAVDT-administered study of the economic cost of land degradation, we focus on two specific types of degradation: salinization and soil erosion, defined as "physical loss of topsoil, reduction in rooting depth, removal of plant nutrients, and loss of water" (Lal 1990).

The remainder of the chapter is organized as follows. Section 5.2 discusses the magnitude and dimensions of the problem, including existing studies of soil erosion and salinization, the costs generated by these problems, and their causes. Section 5.3 summarizes the legal and regulatory framework that underpins policies focused on soil erosion and salinization. Section 5.4 discusses the availability of data on implementation of such policies. Finally, Section 5.5 offers a summary and policy recommendations.

## 5.2. Magnitude and Dimensions of the Problem

### 5.2.1. Overview

According to IGAC (1988), the main contributors to soil degradation in Colombia at a national level include both natural factors, such as geologic erosion, earthquakes, land slides, and weather changes, and anthropogenic factors, such as agricultural activities, urban expansion, mining, road construction, and logging. Of these, the anthropogenic factors are particularly important from a policy perspective because typically they can be more easily prevented by governmental initiatives.

As discussed in detail below, salinization and different types of soil erosion are more severe in some parts of the country than in others. Salinization is mainly due to irrigation and is most common in the Caribbean, Andean, and Pacific regions. Hydraulic erosion (due to water) is most severe in the Andean and Caribbean regions. Eolic erosion (due to wind) is most common in the Caribbean region.

### 5.2.2. Soil Erosion

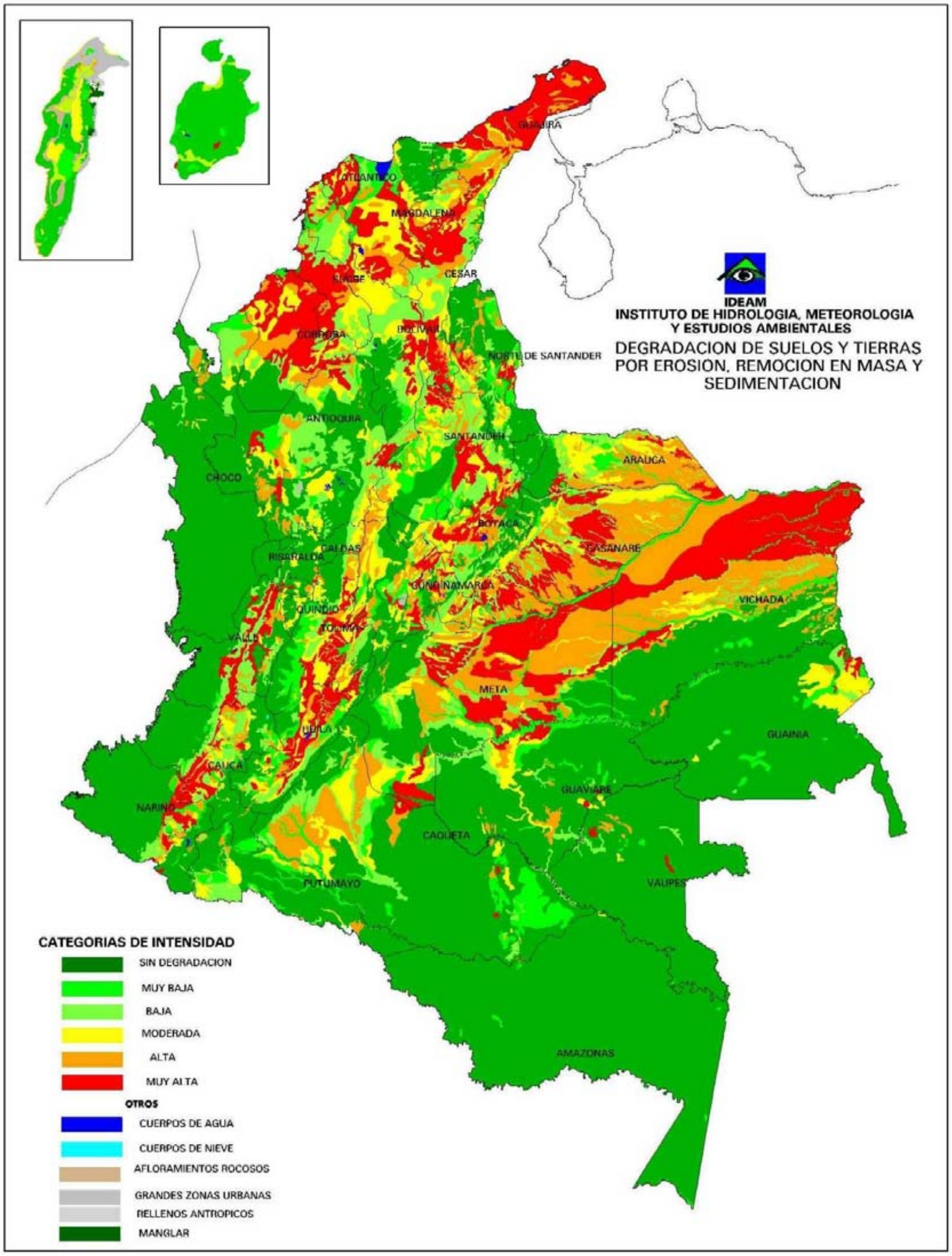
Few national-level studies of soil erosion exist. To our knowledge, in the past 25 years, only three national erosion maps have been constructed: IDEAM (2004b), IGAC (1988), and IGAC (2000).[58] However, these maps have not been constructed in a consistent manner. For example, landslides and sedimentation are included as causes of erosion in two maps but not all three. According to IDEAM (2002), the two most recent erosion maps were generated using remote sensing techniques but yielded significantly different results. The discrepancy was due to differences in the type of images used, the season in which the images were obtained, and the methodology used to interpret them. Such discrepancies make the evolution of soil erosion over time difficult to assess. The next three subsections consider each of the aforementioned national-level soil erosion studies.

[58] Future studies of soil degradation are planned. According to an employee at its Agrology Section, IGAC is establishing an agreement with the Ministry of Environment to design studies evaluating the current state of erosion and salinization in the country.

***IDEAM (2004b)***

The IDEAM (2004b) soil map considers land degradation caused by erosion, mass removal, and sedimentation. It uses a six-category scale to measure erosion: "very severe," "severe," "moderate," "mild," "very mild," and "without" erosion (Figure 5.1).

**Figure 5.1. Land Degradation in Colombia**




Source: IDEAM (2004).

The next several tables present information derived from the IDEAM (2004b) map. Table 1 lists land area by department that suffers from "very high" or "high" levels of erosion. In seven departments (Atlántico, Casanare, Cesar Cordoba, Guajira, Meta, and Sucre) more than half of total land area falls into these two categories. In approximately one-third of departments, more than 30% of the area falls into these categories. These departments include some of the most populated and productive areas of the country (Table 5.1).

**Table 5.1. Area with "High" or "Very High" Levels of Soil Erosion by Department**

| Department | Area ($km^2$) | Area (ha.) | Percentage of total area with "high" or "very high" soil erosion |
|---|---|---|---|
| Amazonas | 110,213 | 11,021,300 | 0 |
| Antioquia | 63,307 | 6,330,700 | 12 |
| Arauca | 23,784 | 2,378,400 | 48 |
| Atlantico | 3,324 | 332,400 | 73 |
| Bogotá | 1,642 | 164,200 | 8 |
| Bolivar | 26,644 | 2,664,400 | 17 |
| Boyacá | 23,076 | 2,307,600 | 29 |
| Caldas | 7,444 | 744,400 | 6 |
| Caquetá | 89,645 | 8,964,500 | 13 |
| Casanare | 44,435 | 4,443,500 | 66 |
| Cauca | 29,883 | 2,988,300 | 16 |
| Cesar | 22,614 | 2,261,400 | 50 |
| Cordoba | 25,061 | 2,506,100 | 55 |
| Cundinamarca | 22,490 | 2,249,000 | 32 |
| Chocó | 47,321 | 4,732,100 | 1 |
| Guainía | 70,679 | 7,067,900 | 1 |
| Guaviare | 55,080 | 5,508,000 | 5 |
| Huila | 19,240 | 1,924,000 | 32 |
| La Guajira | 20,506 | 2,050,600 | 81 |
| Magdalena | 23,076 | 2,307,600 | 33 |
| Meta | 86,047 | 8,604,700 | 50 |
| Nariño | 30,832 | 3,083,200 | 9 |
| Norte de Santander | 21,995 | 2,199,500 | 15 |
| Putumayo | 26,011 | 2,601,100 | 4 |
| Quindío | 1,948 | 194,800 | 3 |
| Risaralda | 3,599 | 359,900 | 7 |
| Santander | 30,475 | 3,047,500 | 20 |

| Department | Area (km²) | Area (ha.) | Percentage of total area with "high" or "very high" soil erosion |
|---|---|---|---|
| Sucre | 10,719 | 1,071,900 | 54 |
| Tolima | 24,061 | 2,406,100 | 24 |
| Valle del Cauca | 21,277 | 2,127,700 | 23 |
| Vaupes | 53,546 | 5,354,600 | 1 |
| Vichada | 99,874 | 9,987,400 | 41 |
| *Total* | 1,139,848 | 113,984,800 | 23 |

Source: Larsen (2004) based on IDEAM (2004b).

***IGAC (1988)***

The Agustín Codazzi Geographical Institute (*Instituto Geográfico Agustín Codazzi,* IGAC) issued a report on soil degradation in Colombia in 1988. This study used criteria established by the U.S. Department of Agriculture in 1981 that provide a qualitative determination of the damage inflicted by hydraulic and eolic erosion, salinization, sodification, and compaction. IGAC (1988) found that approximately half of the country suffered from erosion ranging in severity from "very mild" to "very severe" (Table 5.2). More specifically, the study characterized 23% of the area of the country as having "moderate" to "very severe" erosion. IGAC (1988) stated that "moderate" and "mild" erosion levels could still be controlled with soil and water conservation procedures. However, lands affected by "severe" and "very severe" erosion would be impossible or very expensive to recover.

**Table 5.2. Soil Erosion in Colombia by Level of Severity**

| Level | Hectares affected | Percentage of country affected |
|---|---|---|
| Very severe | 829,575 | 0.73 |
| Severe | 8,875,575 | 7.79 |
| Moderate | 14,706,795 | 12.9 |
| Mild | 26,337,546 | 23.11 |
| Very mild | 5,657,950 | 4.96 |
| No erosion | 55,508,310 | 48.53 |
| Other areas | 2,259,049 | 1.98 |
| *Total* | 114,174,800 | |

Source: IGAC (1988).

IGAC (1988) found "very high" erosion in regions with dry climate, characterized by a low annual precipitation concentrated in a few months. These areas include the most populated and economically active regions of the country. "Very high" erosion principally affects the Caribbean and Andean regions (Table 5.3).

**Table 5.3. Area with "Very High" Erosion**

| Region | Hectares affected | Percentage of region affected |
|---|---|---|
| Caribbean | 625,725 | 6.2 |
| Andean | 203,850 | 0.6 |
| *Total* | 29,575 | |

Source: IGAC (1988)

IGAC (1988) found "high" levels of erosion in the Caribbean, Orinoquía, and Andean regions, in areas where rains are intense and irregularly distributed (Table 5.4).

**Table 5.4. Area with "High" Erosion**

| Region | Affected area (ha) | Percentage of region affected |
|---|---|---|
| Caribbean | 844,175 | 8.33 |
| Andean | 3,206,275 | 9.26 |
| Orinoquía | 4,825,125 | 20.89 |
| *Total* | 8,875,575 | |

Source: IGAC (1988).

As for less severe categories of erosion, IGAC (1988) found "moderate" erosion on 14,706,795 hectares distributed in different regions of the country. (Annex 1 contains detailed information on the areas with "moderate," "mild," "very mild," and "no" erosion.) The Andean and Amazon regions suffer from the highest levels of this type of erosion, with 10,432,575 and 1,669,875 hectares, respectively. The weather, the incline of the terrain, and human activities—particularly landslides resulting from civil engineering works, such as roads, dams, and human settlements—have been key drivers of this type of erosion. IGAC (1988) found "mild" erosion in many colonization areas. The Andean region contained 14,019,075 hectares affected by such erosion, followed by the Amazon with 4,907,700 hectares, and Orinoquía with 4,094,775 hectares. IGAC (1988) found "very mild" erosion in the Orinoquía region with 3,947,175 affected hectares, followed by the Andean region with 1,209,275 hectares. Finally, IGAC (1988) found "no erosion" in areas where the climate and topography are not favorable to hydraulic and eolic erosion. The Amazon and Pacific regions the biggest areas in this category. In the Andean region, where most of the Colombian population lives, only 13.5% the total area falls into this category.

***IGAC (2000)***

Based on landscape satellite images, IGAC (2000) found that a total of 4,364,038 hectares (approximately 3.8% of the national territory) is characterized by "high" or "very high" levels of erosion (Table 5.5). This figure is much lower than that generated by other studies: IGAC (1988) placed 9,705,150 hectares (8.5% of the national territory) in this category, and IDEAM (2004) placed 113,984,800 hectares (23% of the national territory) in this category. This discrepancy could be the result of inconsistencies between the three studies and/or it could be due to rapid growth in serious land degradation.

**Table 5.5. Soil Erosion in Colombia by Level of Severity**

| Level | Hectares affected | Percentage of country affected |
|---|---|---|
| Without Erosion | 16,602,050 | 14.7 |
| Not apparent* | 50,863,505 | 44.9 |
| Mild | 22,132,483 | 19.5 |
| Moderate | 18,851,787 | 11.3 |
| Severe | 3,748,585 | 3.3 |
| Very severe | 615,453 | 0.5 |
| Areas of active sedimentation | 2,258,549 | 2.0 |
| Rocky outcrops | 1,405,984 | 1.2 |

*Not apparent according to landscape satellite images, but empirically identified in field.

Source: IGAC (2000).

***Time trends***

Even though the 1988 and the 2004 data summarized above are not necessarily comparable, they provide some indication of how erosion has changed throughout the past 16 years, including the 1993–2003 study period of the present report. Table 5.6 provides a comparison between the indicators provided by the two studies.

**Table 5.6. Evolution of Area Classified as Having "High" and "Very High" Erosion, 1988–2004**

| Region | Total area | IGAC 1988 (ha) | IDEAM 2004 (ha) | Δ (ha) | IGAC 1988 (%) | IDEAM 2004 (%) | Δ (%) |
|---|---|---|---|---|---|---|---|
| Amazon | 18,977,000 | 0 | 157,590 | 157,590 | 0.00 | 0.83 | 0.83 |
| Andean | 21,927,700 | 3,410,125 | 4,369,974 | 959,849 | 15.55 | 19.93 | 4.38 |
| Caribbean | 13,194,400 | 1,469,900 | 6,205,975 | 4,736,075 | 11.14 | 47.03 | 35.89 |
| Orinoquía | 46,954,400 | 4,825,125 | 13,982,990 | 9,157,865 | 10.28 | 29.78 | 19.50 |
| Pacific | 12,931,300 | 0 | 1,292,308 | 1,292,308 | 0.00 | 9.99 | 9.99 |
| *Total* | 113,984,800 | 9,705,150 | 26,008,837 | 16,303,687 | 8.51 | 22.82 | 14.30 |

Sources: IGAC (1988); IDEAM (2004).

This exercise suggests that areas characterized by "high" or "very high" erosion in Colombia have expanded significantly between 1988 and 2004. The total such area increased by more than 16 million hectares (14% of the area of the country). This statistic suggests that existing soil degradation policies are inadequate.

It would be particularly useful to devote more attention to the Caribbean and Orinoquía regions, which appear to have experienced the biggest increase in the affected areas. It would be interesting to consider the Andean and Pacific regions as well, as they have a considerable importance for the country: the Andean region because it is the most populated and economically active region of the country, and the Pacific region because it serves as a natural resources and biodiversity reservoir.

### 5.2.3. Salinization

As noted above, soil salinization is principally due to irrigation. Like soil erosion, soil salinization has a variety of adverse economic and ecological consequences. Yet salinization has received less attention from Colombian policymakers than soil erosion. In fact, it is difficult to find studies, policies, plans, or activities that directly mention salinization prevention or control.

An IGAC (1983) soil map indicates that 9% of the country's land is "susceptible" to salinization. These areas are mainly the dry ecosystems: the InterAndean valleys, the Bogotá savannah, and the Caribbean.

According to IDEAM (2004), approximately 10% of the national territory suffers from "high" or "moderate" levels of salinity—that is, levels that can affect crops and rangeland. Problem areas are basically located in the Caribbean region (Atlántico, Bolivar, Cesar, Cordoba, Guajira Magdalena, and Sucre). In addition, salinization is a problem in Cundinamarca Huila Tolima and Valle (Tables 5.7 and 5.8).

**Table 5.7. Area with "High" or "Moderate" Levels of Salinization, by Department**

| Department | Area (km2) | Area (ha) | Percentage of total area with high or moderate salinity |
|---|---|---|---|
| Amazonas | 110,213 | 11,021,300 | 0 |
| Antioquia | 63,307 | 6,330,700 | 10 |
| Arauca | 23,784 | 2,378,400 | 0 |
| Atlantico | 3,324 | 332,400 | 74 |
| Bogotá | 1,642 | 164,200 | 0 |
| Bolivar | 26,644 | 2,664,400 | 45 |
| Boyacá | 23,076 | 2,307,600 | 5 |
| Caldas | 7,444 | 744,400 | 13 |
| Caquetá | 89,645 | 8,964,500 | 0 |
| Casanare | 44,435 | 4,443,500 | 0 |
| Cauca | 29,883 | 2,988,300 | 2 |
| Cesar | 22,614 | 2,261,400 | 63 |
| Cordoba | 25,061 | 2,506,100 | 44 |
| Cundinamarca | 22,490 | 2,249,000 | 16 |
| Chocó | 47,321 | 4,732,100 | 2 |
| Guainía | 70,679 | 7,067,900 | 0 |
| Guaviare | 55,080 | 5,508,000 | 0 |
| Huila | 19,240 | 1,924,000 | 20 |
| La Guajira | 20,506 | 2,050,600 | 79 |
| Magdalena | 23,076 | 2,307,600 | 84 |
| Meta | 86,047 | 8,604,700 | 0 |
| Nariño | 30,832 | 3,083,200 | 3 |
| Norte de Santander | 21,995 | 2,199,500 | 6 |
| Putumayo | 26,011 | 2,601,100 | 0 |
| Quindío | 1,948 | 194,800 | 0 |
| Risaralda | 3,599 | 359,900 | 5 |
| Santander | 30,475 | 3,047,500 | 8 |
| Sucre | 10,719 | 1,071,900 | 80 |
| Tolima | 24,061 | 2,406,100 | 32 |
| Valle del Cauca | 21,277 | 2,127,700 | 18 |
| Vaupes | 53,546 | 5,354,600 | 0 |
| Vichada | 99,874 | 9,987,400 | 0 |
| *Total* | 1,139,848 | 113,984,800 | 10 |

Source: Larsen (2004) based on IDEAM (2004).

**Table 5.8. Area with "High" or "Moderate" Levels of Salinization, by Region**

| Region | Area ($km^2$) | Area (ha) | Percentage of total area with high or moderate salinity |
|---|---|---|---|
| Amazon | 18,977,000 | 0 | 0.00 |
| Andean | 21,927,700 | 2,753,579 | 12.56 |
| Caribbean | 13,194,400 | 8,388,200 | 63.57 |
| Orinoquía | 46,954,400 | 0 | 0.00 |
| Pacific | 12,931,300 | 629,890 | 4.87 |
| *Total* | 113,984,800 | 11,771,669 | 10.33 |

Source: Larsen (2004) based on IDEAM (2004).

Tables 5.9, 5.10, and 5.11 present the results of regional studies done for the Atlantic Coast (2002), the Cauca Valley (CVC 2002), and the Bogotá savannah (CAR 1982, 1983).

**Table 5.9. Total Area Affected by Salinization in Three Colombian Regions (ha.)**

| Region | Area |
|---|---|
| Atlantic Coast[1] | 2,500,000 |
| Valley of Cauca[2] | 120,000 |
| Savannah of Bogota[3] | 5,060 |

[1] Universidad del Valle (2002).

[2] Alvaro Garcia (2004).

[3] CAR (1982–1983).

**Table 5.10. Area in the Cauca Valley Affected by Salinization**

| Area | Salinity alone | | Study area | | Salinity and other problems | |
|---|---|---|---|---|---|---|
| **Municipality** | **Area (ha)** | **Percentage** | **Area (ha)** | **Percentage** | **Area (ha)** | **Percentage** |
| Candelaria | 2,027.50 | 6.76 | 30,000.00 | 100.00 | 2,832.50 | 9.44 |
| Palmira | 13,153.00 | 31.92 | 41,200.00 | 100.00 | 20,830.00 | 50.56 |
| Cerrito | 2,853.00 | 19.25 | 14,818.00 | 100.00 | 3,880.00 | 26.18 |
| Guacari | 280.00 | 4.63 | 6,048.00 | 100.00 | 610.00 | 10.09 |
| Buga | 1,022.00 | 12.31 | 8,303.00 | 100.00 | 2,159.00 | 26.00 |
| Buga-San Pedro | 1,268.00 | 12.69 | 9,990.00 | 100.00 | 2,519.00 | 25.22 |
| San Pedro-Tulua | 1,300.00 | 9.85 | 13,200.00 | 100.00 | 1,623.00 | 12.30 |
| Roldanillo-La Union-Toro | 2,351.00 | 23.51 | 10,000.00 | 100.00 | 3,872.00 | 38.72 |
| Tulua-Andalucia-Bugalagrande | 845.00 | 5.90 | 14,331.00 | 100.00 | 1,382.00 | 9.64 |
| Bugalagrande-Zarzal | 2,126.00 | 21.06 | 10,094.00 | 100.00 | 2,982.00 | 29.54 |
| Zarzal-La Victoria | 4,744.00 | 33.01 | 14,370.00 | 100.00 | 4,984.00 | 34.68 |
| Obando-Cartago | 8,407.00 | 33.45 | 25,130.00 | 100.00 | 8,932.00 | 35.54 |
| *Total* | 40,376.50 | 20.45 | 197,484.00 | 100.00 | 56,605.50 | 28.66 |

Source : CVC (2002)

**Table 5.11. Area Affected by Salinization in Areas Surrounding Bogotá (Cundinamarca)**

| Municipality | Class | Area (ha ) | Percentage |
|---|---|---|---|
| Mosquera (*La Ramada* irrigation district) | Slightly saline soils | 2,739.0 | 43.5 |
| | Slightly saline soils and slightly to moderately sodaic | 464.4 | 7.3 |
| | Slightly to moderately saline soils and slightly sodaic | 764.6 | 12 |
| | Moderately saline soils and moderately sodaic to sodaic | 11.6 | 0.2 |
| | Very strongly saline soils and moderately sodaic to sodaic | 4.0 | 0.1 |
| Cota-Zipaquira (Bogota River watershed) | Slightly saline soils | 180.0 | 3.5 |
| | Slightly saline soils and slightly sodaic | 553.7 | 10.9 |
| | Slightly saline soils and slightly to moderately sodaic | 340.9 | 6.7 |

Source: CAR (1982 and 1983).

***Cost of soil degradation***

Soil erosion generates very significant economic costs. Larsen (2004) estimates the mean annual costs of soil degradation (erosion and salinization) due to lost crop productivity at 1,440 billion Colombian pesos. Larsen attributes 60% of annual costs of soil degradation (805 billion to 965 billion pesos) to erosion and the remaining 40% (505 billion to 605 billion pesos) to salinization. These estimates are conservative: they include lost productivity of only agricultural cropland, not pastures and rangeland—an important consideration, since the area used for pastures and livestock production represents around 88% of the total agricultural land in Colombia. Even so, in Larsen's study, the costs of land degradation are the highest of any type of environmental problem (including water sanitation) for rural areas.

Corpoica (2000) estimates the costs of soil erosion for four departments—Caquetá, Meta, Santander, and Tolima (Table 5.12). The results suggest considerable variation in the cost per hectare of eroded land across departments.

**Table 5.12. Estimated Erosion Costs (using the hedonic pricing methods) for Three Departments**

| Department | Average cost of erosion ($/ha) |
|---|---|
| Caqueta | 638,673 |
| Tolima | 978,440 |
| Santander | 178,593 |

Source: Baquero et al. (2000).

### 5.2.4. Causes of Soil Degradation

As noted, above, the human causes of soil erosion are particularly important from a policy perspective. Human causes typically stem from use of land for purposes that do not comport with the land's natural characteristics.

Derived from MAVDT (2003), Table 5.13 provides aggregate national information on whether total land used for different purposes exceeds the amount of land naturally suited to these purposes. The table makes clear that, in certain cases, the answer is yes. For example, the amount of land being used for cattle ranching is more than twice the amount suitable for this use. Cattle ranching mainly displaces agriculture and forestry. It is associated with soil compaction and erosion and can sometimes (depending on other parallel land management issues like irrigation and drainage) be associated with salinization.

**Table 5.13. Potential and Actual Use of Land in Colombia (1,000 ha)**

| Activity | Potential use | Actual use in 1997 | Actual use in 1999 |
|---|---|---|---|
| Agriculture | 14,363 | 5,318 | 4,445 |
| Cattle raising | 19,251 | 40,083 | 41,223 |
| Forest | 78,301 | 58,854 | 63,052 |
| Water and urban | 2,259 | 1,430 | 3,156 |
| Without use | | 8,490 | 2,298 |

Source: MAVDT (2003).

Table 5.14, which is derived from IGAC (2002), presents similar data on land use conflicts. The table indicates that 17% of the country's land is being overused, that is, the current use is above capacity.

**Table 5.14. Suitable Land Use and Land Use Conflicts**

| Type of conflict | Intensity | Description | Area (ha) | Percentage |
|---|---|---|---|---|
| None | | Current use is compatible with capacity | 22,669,659 | 19.9 |
| Underuse | mild | Current use is near its productive capacity. | 5,192,717 | 4.6 |
| | moderate | Current use is below its productive capacity. | 7,829,533 | 6.9 |
| | severe | Current use is considerably below its productive capacity. | 4,767,866 | 4.2 |
| *Total underuse* | | | 17,790,116 | 15.7 |
| Overuse | mild | Current use is near its capacity | 6,303,463 | 5.5 |
| | moderate | Current use is above its capacity; productive processes unsustainable. | 5,635,580 | 4.9 |
| | severe | Current use is considerably above its capacity; cause of accelerated soil degradation. | 7,713,598 | 6.8 |
| *Total overuse* | | | 19,652,641 | 17.2 |
| Soils in conservation | | Natural forests, vegetation of moors, mangroves, etc. | 65,538,892 | 47.2 |
| *Total national* | | | 125,651,308 | 100.0 |

Source: IGAC, Ministry of Agriculture, and Corpocia (2002).

Table 5.15 presents the main agricultural uses since 1980. Total area devoted to agriculture has increased by about 2% since 1980. Note that the total area under irrigation, a major contributor to salinization, has increased by more than 100% during that time.

**Table 5.15. Land Use and Irrigated Areas in Colombia by Year (1000 ha)**

| Land use | 1980 | 1990 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|
| Arable land (1) | 3,712 | 3,305 | 2,536 | 2,818 | 2,516 |
| Permanent crops (2) | 1,480 | 1,695 | 1,828 | 1,727 | 1,733 |
| Arable and permanent crops (1+2) | 5,192 | 5,000 | 4,364 | 4,545 | 4,249 |
| Permanent pasture (3) | 40,100 | 40,083 | 41,304 | 40,920 | 41,800 |
| Total agricultural area (1+2+3) | 45,292 | 45,083 | 45,668 | 45,465 | 46,049 |
| Irrigated area | 400 | 650 | 850 | 900 | 900 |

Source: FAO (various years).

Deforestation is also a major contributor to soil degradation. Table 5.16, which is derived from MMA (1997b), provides data on the most common activities that result in deforestation. It shows that deforestation in Colombia is mainly due to expansion of the agricultural area (mostly for livestock production) and colonization (for cattle raising as well as small-scale agricultural activities).

**Table 5.16. Causes of Deforestation in Colombia**

| Causes | Percentage of total deforestation |
|---|---|
| Expansion of the agricultural area and colonization | 73 |
| Lumber production | 12 |
| Firewood consumption | 11 |
| Forest fires | 2 |
| Illegal crops | 2 |

Source: MMA (1997).

## 5.3. Policy Design

This section summarizes the legal and regulatory framework for policies designed to prevent, control, and mitigate soil erosion and salinization. These problems affect a variety of economic and policy sectors. Therefore, we review laws and regulations in three areas: environment, land use planning, and forestry and agriculture. As the discussion makes clear, the relevant legal and regulatory framework is quite limited: few laws and regulations in any of these areas deal explicitly with these problems.

### 5.3.1. Environmental Regulation

Neither Law 99 of 1993 nor Decree 2811 of 1974—two of the pillars of environmental law in Colombia—covers soil erosion or salinization in detail. They simply state that soil erosion and salinization are environmental problems and pubic authorities should be in charge of addressing them. However, no mechanisms or specific responsibilities are mentioned.

#### *Decree 2811 of 1974*

Decree 2811 states that soil erosion and salinization, among other factors, degrade the environment. It also states that public authorities should endeavor to mitigate these problems.

***Decree 1594 of 1978***

Decree 1594 regulates the water sector. It states that water users who are granted concessions for agricultural water must build and maintain drainage systems to prevent soil erosion and salinization.

***Law 99 of 1993***

Soil erosion and salinization appear in Law 99 of 1993 only in lists of topics that various environmental regulatory authorities are charged with addressing. The Ministry of Environment is charged with regulating the environmental matters associated with land use, and the CARs are charged with preventing natural disasters by, among other things, controlling soil erosion. In urban areas, this responsibility may be carried out in concert with municipal environmental authorities. Finally, Law 99 establishes that IDEAM must obtain, analyze, study, and process information regarding, among other things, land degradation.

**5.3.2. Land Use Planning**

Law 388 of 1997 is Colombia's primary land use planning law. However, the relationships between land use and land degradation are not clearly defined. Land use plans are supposed to ensure that land is used only for purposes compatible with the land's natural characteristics. Hence, a good land use plan should prevent erosion and salinization. Nevertheless, no such requirement is explicitly established either by the regulation itself or by subsequent clarifications promulgated by different environmental authorities—a limitation that may be due to the fact that these regulations were written by the development sector, not the environmental sector.

***Law 388 of 1997***

The objective of the land use plan proposed in Law 388 of 1997 is to rationalize the development and exploitation of land. According to the law, municipalities must formulate land use plans (*planes de ordenamiento territorial,* POT) in both urban and rural areas. With regard to conservation and protection of land and the environment, Law 388 establishes that all POTs should consider the territory's characteristics and potentials when defining permissible land uses, and it establishes that municipalities should consider long-run consequences of this use, including the impacts on natural resources.

***Decree 879 of 1998***

Decree 879 regulates Law 388 of 1997 and establishes specific guidelines for POTs. It mandates that all municipalities with more than 30,000 inhabitants should prepare a POT, which must have two basic components: rural and urban. The POTs are required to ensure a harmonious interaction between the designated land use and the environment, conserve and protect the environment and natural resources, prevent natural disasters, and designate certain areas for conservation and protection. Although several other issues (mostly operational) are covered by the decree, these are the only ones relevant to soil degradation and salinization.

### 5.3.3. Forestry and Agriculture

Forestry and agricultural legislation and policies barely mention soil erosion and salinization explicitly. Here we discuss some of the laws and regulation that are tangentially related to these two problems.

***Decree 2202 of 1939***

This decree regulates the use and exploitation of forests and oil-nut palms, establishing a prohibition on the destruction of oil-nut palms when these are located in natural forests. Exceptions to this prohibition have to be approved by the Ministry of Economy. The decree also establishes that any grass burn, destruction of the forest, or other action that attempts to use forest resources for private gain (in private or public areas) is illegal. All such illegal actions are subject to an economic fine (between COP $1 and $100) or prison.

***Decree 2151 of 1979***

This decree establishes that INDERENA (MMA's predecessor) is responsible for granting permission to exploit and use public forests. For areas smaller than 20,000 hectares, such permissions are assigned for a maximum of 10 years. To obtain such permissions, the agent must undertake an environmental impact assessment. For areas larger than 20,000 hectares, the assignation of this right must be done by public competition.

***Decree 2787 of 1980***

By law, all agents that exploit public forests have to restore the resource. This decree establishes that all the reforestation programs have to be approved by the responsible local authority. This does not include forest developed in untilled, uncultivated, or inappropriate land by private agents that have complete ownership of the forest.

***Decree 1135 of 1983***

This decree creates economic incentives for the conservation of water and land on the upper Magdalena River basin.[59] The lump-sum, one-time economic incentive is to be given to individuals or groups of farmers who invest in agricultural improvements, including labor practices (crop rotation, intercropping, planting on alternate rows), reforestation, pasture improvement, and the use of natural resources as living barriers, and mechanical practices for erosion control and water conservation. The decree also establishes that the incentives will be prioritized in following order: (i) establishment of new farms; (ii) maintenance of new farms; and (iii) erosion control.

***Decree 900 of 1997***

This decree establishes a forest conservation certificate (*certificado de incentivo forestal,* CIF) to be given to private owners of forest areas that are virtually undisturbed, in recognition and compensation for the costs of protecting the forest. The National Council for Economic and Social Policy (*Consejo Nacional de Política Económica y Social,* CONPES) is responsible for assigning these financial resources. Eligible to receive the incentive are forests over 2,500 meters above sea level, those near water sources, those in natural parks, and those in areas that provide water resources to municipalities. The local environmental authority is to monitor and evaluate the use of the forest. The economic incentive is equivalent to seven minimum wages per hectare in the first year; in subsequent years it is adapted using the following equation:

$$VA = VB + FAR$$

where:

VA = is the adjusted value every year

VB = is the base value established by the environmental authority

FAR = Is the regional factor

Further,

[59] Essentially, the area surrounding the Combeima River in the Departments of Huila and Tolima.

FAR = FTP * FPT

where

FTP is an altitude factor assigned as per the following table:

| Altitude | FTP |
|---|---|
| Less than 1,000 meters | 0.63 |
| 1,001 to 2,000 meters | 0.77 |
| 2,001 to 2,500 meters | 0.89 |
| More than 2,500 meters | 1.00 |

FPT is an area factor assigned as per the following table:

| Area | FPT |
|---|---|
| Less than 3 hectares. | 2.0 |
| 3 to 10 hectares | 1.6 |
| 11 to 20 hectares | 1.4 |
| 20 to 30 hectares | 1.2 |
| More than 30 hectares | 1.0 |

## 5.4. Policy Implementation

### 5.4.1. Data Availability

Unfortunately, assessment of the performance of soil degradation policies is difficult for two reasons. First, as noted above, environmental law and regulation in Colombia do not contain specific goals and/or objectives regarding soil erosion and salinization. Control and prevention of soil erosion are frequently mentioned in various planning documents, including those for environmental, disaster control, and economic development plans. For example, soil erosion is frequently mentioned in CARs' regional environmental management plans (*planes de gestión ambiental regional,* PGARs) and three-year action plans (*planes de acción trianual,* PATs). However, these plans almost always lack specific and quantifiable goals and indicators. Second, implementing institutions typically do not generate performance indicators. For example, in the management reports (*informs de gestión*) for the years covered in the plan, performance indicators typically focus on the amount of money invested in different areas, not on the actual results or effects of these investments.[60]

### 5.4.2. Investment Data

***How much have CARs invested in soil conservation?***

Canal (2004) presents data on total investment in land quality by CARs. Total investment in land quality by all CARs represented just 2.8% of all CAR investments in environmental activities (Tables 5.17 and 5.18). Such activities represented 58.8% of all CAR expenditures during this period. Hence, investment in land quality accounted for just 1.8% of total CAR expenditures. Note, however, that the information presented by Canal has important gaps—data for many CARs are not available, and the data omit investments by farmers and other public and private entities, which may overshadow CARs' investments in land quality. Notwithstanding the limitations, the data indicate that land quality is not an investment priority for most CARs.

**Table 5.17. CARs' Investments in Land Quality by Year, 1995–2000 (1,000 COP)**

| CAR | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Cam | 168,446 | 292,141 | N.A. | 168,255 | 186,726 | 310,826 | 207,612 | 126,300 | 120,000 | 1,580,306 |
| Car | 54,672 | 48,815 | 47,002 | 3,261,005 | 3,097,518 | 3,681,623 | 3,197,924 | 1,395,615 | 543,000 | 15,327,174 |
| Carder | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Cardique | 10,262 | 49,781 | 19,861 | N.A. | N.A. | 181,063 | N.A. | N.A. | N.A. | 260,968 |
| Carsucre | 179,406 | 511,929 | 442,144 | N.A. | N.A. | N.A. | 360,859 | 384,583 | 397,510 | 2,276,432 |
| Cas | 18,639 | 43,909 | 50,770 | N.A. | 147,170 | 350,056 | N.A. | N.A. | N.A. | 610,543 |
| Cda | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Cdmb | 3,586,902 | 3,192,086 | 2,744,274 | 4,216,555 | 4,149,980 | 4,473,975 | 4,050,197 | 4,767,598 | 4,878,167 | 36,059,734 |
| Codechoco | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Coralina | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Corantioquia | 252,006 | 367,338 | 333,691 | 877,893 | N.A. | N.A. | 1,509,607 | 1,545,912 | 1,586,304 | 6,472,750 |
| Cormacarena | 2,394 | 3,598 | 6,838 | N.A. | N.A. | N.A. | 24,920 | N.A. | N.A. | 37,750 |
| Cornare | 713,119 | 813,587 | 870,408 | 657,256 | 583,590 | 523,073 | 159,100 | 150,858 | 143,334 | 4,614,326 |
| Corpamag | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Corpoamazonia | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Corpoboyaca | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Corpocaldas | 7,588 | 10,989 | 9,845 | 60,670 | 107,740 | 120,709 | N.A. | N.A. | N.A. | 317,541 |
| Corpochivor | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Corpoguajira | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |

[60] This is likely to change under the new PAT formulation methodology adopted by the government and CARs in 2004.

| CAR | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Corpoguavio | 11,186 | 66,375 | 58,766 | 91,005 | 134,675 | 96,567 | N.A. | N.A. | N.A. | 458,574 |
| Corpomojana | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Corponariño | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Corponor | 144,330 | 117,410 | 77,280 | 151,675 | 130,723 | 211,241 | N.A. | N.A. | N.A. | 832,658 |
| Corporinoquia | 4,354 | 20,266 | 20,987 | 30,335 | N.A. | N.A. | N.A. | N.A. | N.A. | 75,942 |
| Corpouraba | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Cortolima | 376,622 | 472,591 | 1,678,147 | N.A. | 363,172 | 362,127 | 178,095 | 105,250 | 100,000 | 3,636,004 |
| Cra | 12,000 | 17,782 | 15,556 | N.A. | N.A. | N.A. | N.A. | 73,675 | 75,320 | 194,332 |
| Crc | 158,198 | 132,112 | 245,683 | N.A. | N.A. | N.A. | 774,783 | 210,500 | 200,000 | 1,721,276 |
| Crq | 597,053 | 719,408 | 763,701 | N.A. | 1,149,528 | 3,118,153 | 901,518 | N.A. | N.A. | 7,249,360 |
| Csb | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Cvc | 619,439 | 372,349 | 831,258 | 2,009,082 | 848,181 | 697,698 | 1,529,975 | 1,450,713 | 1,378,350 | 9,737,045 |
| Cvs | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| **Total** | **6,916,616** | **7,252,466** | **8,216,211** | **11,523,730** | **10,899,003** | **14,127,109** | **12,894,589** | **10,211,003** | **9,421,985** | **91,462,714** |

N.A.: Not available.

Source: Canal (2004).

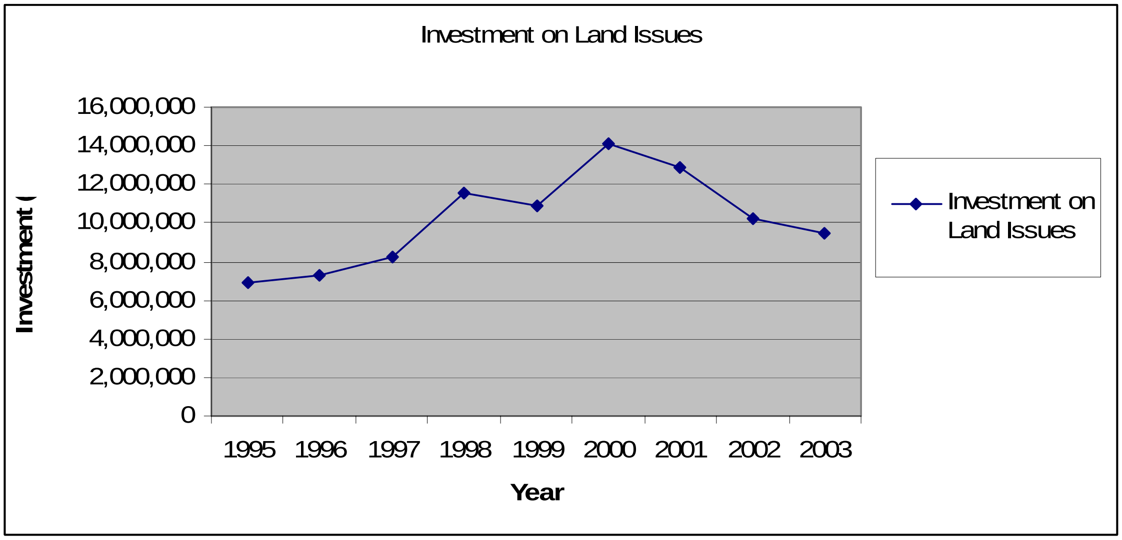
**Table 5.18. CARs' Investments in Land Quality, by Category (1,000 COP)**

| Year | Type of project | | | Total |
|---|---|---|---|---|
| | Studies and diagnoses | Erosion, salinization, landslide control | Other | |
| 1995 | 200,162 | 6,576,365 | 140,089 | 6,916,616 |
| 1996 | 276,311 | 6,766,484 | 209,671 | 7,252,466 |
| 1997 | 350,758 | 7,797,464 | 67,989 | 8,216,211 |
| 1998 | 91,005 | 11,321,420 | 111,306 | 11,523,730 |
| 1999 | 134,675 | 10,577,602 | 186,726 | 10,899,003 |
| 2000 | 277,631 | 13,538,653 | 310,826 | 14,127,109 |
| 2001 | 995,489 | 11,649,349 | 249,751 | 12,894,589 |
| 2002 | 435,033 | 9,539,158 | 236,812 | 10,211,003 |
| 2003 | 418,654 | 8,778,331 | 225,000 | 9,421,985 |
| *Total* | 3,179,718 | 86,544,826 | 1,738,171 | 91,462,714 |

Source: Canal (2004).

Figure 5.2 presents the time trend of total CAR investment in land quality from 1995 to 2003. There was an approximate 104% increase in the total investment in land issues between 1995 and 2000 and a 33% decline between 2000 and 2003.

**Figure 5.2. CARs' Investments in Land Issues**




Source: Canal (2004).

***Do individual CARs underinvest in soil conservation?***

Blackman et al. (2004b) analyzed 2001 CAR-level investment and (roughly concurrent) environmental quality data to determine whether individual CARs allocate their investment funds to the most pressing environmental problems. Soil degradation was among the six types of environmental risks considered in the analysis. We briefly recapitulate the soil degradation component of that analysis here.

For each CAR, Blackman et al. (2004b) compared (i) the severity of soil degradation risk with (ii) the extent to which the CAR focused its 2001 investment funds on this risk. If CARs were allocating investment spending rationally—that is, based on an assessment of the severity of different risks—then there should be a correlation between (i) and (ii). That is, CARs where soil degradation is relatively serious should be spending a relatively high percentage of their investment funds on soil conservation and vice versa.

It is important to note that this analysis is limited by the availability of appropriate data. Blackman et al. did not have data on soil degradation risk that exactly matched their categories of investment spending. Their proxy for the risk of soil degradation was the cost of salinzation and erosion for each CAR estimated by Larsen (2004), and their investment data included all types of soil conservation measures, not just those targeting erosion and salinzation. In addition, the categorization of spending was based on the names of investment projects reported by CARs and, therefore, was somewhat imprecise.

Blackman et al. used a simple method to compare the severity of different soil degradation risk in each CAR with the extent to which CARs focused their investment funds on this risks. They ranked the severity of the soil degradation risk posed in each CAR as "high," "medium," or "low" depending on whether the CAR ranked in the top, middle, or bottom trecile of the distribution of the soil degradation risks measure (economic costs) across all 33 CARs. They used a similar method for ranking the extent to which CARs focused their investment funds on soil degradation. They ranked the percentage of investment funds allocated to soil conservation in each CAR as "high," "medium," or "low" depending on whether the percentage of investment funds spent on that risk ranked in the top, middle, or bottom trecile of the distribution of these percentages across all 33 CARs.

Having ranked the severity of soil degradation risk and the extent to which CARs focused their investment funds on this risk, Blackman et al. compared these two rankings to determine whether CARs "overinvested" or "underinvested" in soil conservation. They said that a CAR has underinvested in soil conservation when the risk of degradation was ranked as either "high" or "medium" but the CAR investment spending was ranked as "low." Similarly, a CAR overinvested in soil conservation when the degradation risk was ranked as "low" but investment spending was ranked as "medium" or "high."

Blackman et al.'s measures of soil degradation risk and spending are detailed in Table 19. The first column presents a ranking of the risk of soil degradation in each CAR. The second column presents a ranking of the percentage of investment funds devoted to this risk in 2001. The last two rows of the third column indicate the percentage of all 33 CARs that underinvest and overinvest in that risk.

The data presented in Table 5.19 suggest that CARs' allocations of investment spending to soil conservation do not comport particularly well with the severity of this risk: 54% of CARs underinvest, and no CARs overinvest. Hence, CARs appear to systematically underinvest in soil conservation.

**Table 5.19. Severity of Soil Degradation Risk Versus Percentage of 2001 Total Investment**

| **CAR** | **Cost of soil degradation** (pesos) | **Percentage of total investment in soil conservation** |
|---|---|---|
| CAM | HIGH | LOW |
| CAR | HIGH | LOW |
| CARDER | LOW | LOW |
| CARDIQUE | LOW | LOW |
| CARSUCRE | LOW | LOW |
| CAS | HIGH | LOW |
| CDA | N/A | LOW |
| CDMB | MEDIUM | HIGH |
| CODECHOCO | N/A | LOW |
| CORALINA | N/A | LOW |
| CORANTIOQUIA | HIGH | HIGH |
| CORMACARENA | HIGH | LOW |
| CORNARE | HIGH | LOW |
| CORPAMAG | MEDIUM | LOW |
| CORPOAMAZONIA | N/A | LOW |
| CORPOBOYACA | HIGH | HIGH |
| CORPOCALDAS | MEDIUM | LOW |
| CORPOCESAR | LOW | LOW |
| CORPOCHIVOR | MEDIUM | LOW |
| CORPOGUAJIRA | LOW | LOW |
| CORPOGUAVIO | MEDIUM | LOW |
| CORPOMOJANA | LOW | LOW |
| CORPONARIÑO | MEDIUM | LOW |
| CORPONOR | N/A | LOW |
| CORPORINOQUIA | N/A | LOW |
| CORPOURABA | MEDIUM | LOW |
| CORTOLIMA | HIGH | LOW |
| CRA | N/A | LOW |
| CRC | MEDIUM | LOW |
| CRQ | LOW | LOW |
| CSB | LOW | LOW |
| CVC | HIGH | HIGH |
| CVS | N/A | LOW |
| **Percentage CARS UNDERinvest** | | 54 |
| **Percentage CARS OVERinvest** | | 0 |

### 5.4.3. Reforestation Data

Between 1991 and 2002, 180,000 hectares were reforested (Table 5.20). However, according to MAVDT (2003), approximately 15 million hectares that should be used for forests and forestry activities have been devoted to other uses. Thus, only approximately 1% of the "forest deficit" was reforested between 1991 and 2002.

**Table 5.20. Protective Reforestation in Colombia, 1991–2002**

| Year | Area planted (ha) |
|---|---:|
| 1991 | 1,100 |
| 1992 | 739 |
| 1993 | 105 |
| 1994 | 3,691 |
| 1995 | 17,951 |
| 1996 | 16,777 |
| 1997 | 21,277 |
| 1998 | 13,815 |
| 1999 | 7,204 |
| 2000 | 14,949 |
| 2001 | 19,109 |
| 2002 | 64,810 |
| Total | 181,527 |

Source: MMA (2002).

### 5.4.4. Planning Data

As noted in Section 5.3 above, by law, land use plans (POTs) are one of the principal tools policymakers are supposed to use to prevent soil degradation. Unfortunately, however, such plans are often not used to promote soil conservation and other environmental objectives. Table 21 presents self-reported information on the percentage of municipalities whose POTs contain an environmental component approved by their CAR. On average, 81% of the municipalities in each CAR have approved environmental components in their POTs. However, the existence of these components clearly does not guarantee that they are implemented or enforced.

Table 21 also presents information on the percentage of municipalities in each CAR that have basic soil zoning that would enable them to incorporate soil conservation considerations into their POTs. On average, only 60% of the municipalities in each CAR have such zoning.

**Table 5.21. Land Use Planning and Soil Zoning by CAR**

| CAR | Percentage of municipalities with environmental component of POT | Percentage of municipalities with soil zoning |
|---|---|---|
| CAM | 0.97 | 0.97 |
| CAR | 0.90 | 0.97 |
| CARDER | 1.00 | 1.00 |
| CARDIQUE | 0.81 | 0.48 |
| CARSUCRE | 0.79 | 0.72 |
| CAS | 0.58 | 0.00 |
| CDA | 0.63 | 0.00 |
| CDMB | 0.85 | 0.62 |
| CODECHOCO | 0.39 | 0.29 |
| CORALINA | 0.50 | 0.00 |
| CORANTIOQUI | 0.86 | 0.83 |
| CORMACAREN | 1.00 | 0.47 |
| CORNARE | 0.96 | 0.96 |
| CORPAMAG | 0.80 | 0.97 |
| CORPOAMAZO | 0.90 | 0.58 |
| CORPOBOYAC | 0.79 | 0.75 |
| CORPOCALDA | 0.89 | 0.81 |
| CORPOCESAR | 0.80 | 0.40 |
| CORPOCHIVOR | 0.96 | 0.72 |
| CORPOGUAJIR | 0.73 | 0.27 |
| CORPOGUAVI | 1.00 | 1.00 |
| CORPOMOJAN | 0.71 | 0.43 |
| CORPONARIÑ | 0.73 | 0.05 |
| CORPONOR | 0.85 | 0.63 |
| CORPORINOQ | 0.70 | 0.00 |
| CORPOURABA | 1.00 | 0.89 |
| CORTOLIMA | 0.53 | 0.64 |
| CRA | 0.91 | 0.87 |
| CRC | 0.56 | 0.02 |
| CRQ | 1.00 | 1.00 |
| CSB | 0.67 | 0.75 |
| CVC | 0.95 | 1.00 |
| CVS | 0.89 | 0.79 |
| **AVERAGE** | 0.81 | 0.60 |

Source: MMA (2002b); ASOCARs (2002).

## *5.5. Conclusion*

### 5.5.1. Summary

Data on soil erosion and salinization in Colombia are limited, and the studies that do exist differ in methodology, terminology, and coverage and are therefore not comparable. That said, data suggest that both erosion and salinization are significant problems. Soil in 4% to 23% of the national territory is seriously eroded, and the problem appears to have gown worse over the past 15 years. Soil erosion is worst in the Caribbean, Andean, and Orinoquia natural regions—

among the most populated and/or productive regions in the country. Existing studies of salinization suggest that soils in approximately 10% of national territory now have levels of salinity high enough to adversely affect cropland and rangeland productivity. Problem areas are basically in the Caribbean natural region.

Soil erosion and salinity generate significant economic costs. Larsen (2004) estimates the annual costs stemming solely from lost crop productivity are 1,440 billion Colombian pesos; he attributes 60% of these costs to erosion and the remaining 40% to salinization. In Colombia, salinization is mainly due to irrigation, and causes of erosion include the expansion of agricultural activities, particularly cattle ranching,

Despite the severity of land degradation in Colombia, few national laws or regulations specifically target soil erosion and salinization. Most of the existing legislation and regulation concerns broader problems, such as land use planning and deforestation, and do not explicitly contemplate the linkages between these issues and soil erosion and salinization. Not surprisingly, then, policies specifically targeting the problems are limited.

Given the scarcity of land degradation policy and the general lack of performance indicators for environmental regulation in Colombia, assessing this policy is problematic. That said, existing data suggest that present efforts to prevent, control, and mitigate land degradation by CARs are minimal. (Note, however, that entities other than CARs may account for the bulk of conservation investment.) CAR's investments in land quality between 1995 and 2003 were less than 2% of their total investments. A comparison across the 33 CARs of the severity of soil degradation risk with the extent to which they focus their investment funds on this risk suggests that CARs systematically underinvest in this risk. Reforestation activities between 1991 and 2002 took place on 180,000 hectares, far less than the number of hectares requiring reforestation. Finally, data on land use planning suggest that this mechanism for preventing soil degradation has significant limitations: 20% of municipalities do not have an environmental component in their POT, and 40% do not have soil zoning to ensure that their policies are effective in preventing soil degradation.

### 5.5.2. Recommendations

**1. Improve collection, management, and dissemination of data on soil degradation.**

Designing, implementing, and evaluating conservation policies requires reliable, consistent, user-friendly, time-series data on soil quality. MAVDT should establish clear mandates and protocols for collecting, managing, and disseminating such data.

**2. Mandate comparative risk assessment to inform land quality investments.**

The severity of soil degradation varies dramatically across departments in Colombia. Only jurisdictions where the problem is severe compared with other (environmental, natural resource, and economic) problems should consider mandating or promoting significant investments in prevention, control, and mitigation.

**3. Strengthen the legal and regulatory framework for land conservation at the national level.**

Executive authorities should expand laws and regulations that specifically address soil degradation. These laws and regulations could promote soil conservation activities where comparative risk assessments suggest they are appropriate. Examples of such activities include the following:

- intercropping and hedgerows;
- windbreaks;
- riparian buffer zones;
- contour plowing, terraces, and diversion ditches
- conservation tillage;
- small-scale irrigation;
- diversification into high-value perennial crops;
- agroforestry and community forestry;
- afforestation; and
- salt-tolerant varieties of crops, fodder species, and trees.

**4. Strengthen the soil conservation function of land-use planning.**

Closely related to the effort to bolster laws and regulations, the soil conservation function of land use planning should be strengthened. This can be done by mandating that POTs include specific soil erosion and salinization considerations in areas where soil degradation maps indicate significant problems. Incentives for implementing POTs should also be strengthened.

**5. Increase research and development, information dissemination, and technical assistance on land conservatio**n.

From the perspective of the individual land holder, fixed setup costs—both pecuniary costs and nonpecuniary transactions and information costs—are a significant barrier to adopting land conservation measures. This barrier can be mitigated by developing and demonstrating such conservation measures and providing information and technical assistance to help farmers adopt them.

**6. Strengthen and clarify linkages among various economic and policy sectors that have an interest in the problem, including agriculture, forestry, environmental management, and land use planning.**

To the extent possible, responsibilities for addressing soil erosion and salinization should be consolidated so that lines of authority and accountability are clear and direct.

**7. Minimize potential conflicts of interest in salinization policies.**

Salinization stems primarily from irrigation. Irrigation infrastructure is almost principally built by governmental entities. Hence, conflicts of interest can arise in developing and regulating irrigation infrastructure. Policymakers should institute mechanisms to minimize this potential conflict. Possibilities include establishing independent committees to review environmental aspects of irrigation and mandating enhanced transparency and accountability in irrigation administration.

**8. Weaken or eliminate market and policy incentives for land degradation in fragile areas.**

Perverse incentives might include tax breaks for conversion of land to agriculture or subsidies for inputs into and outputs from ranching and irrigation.

## *Appendix 5.1: Tables*

**Table 5.1.1. Area with Moderate Erosion, by Natural Region**

| Region | Affected area (ha) | Percentage of natural region affected |
|---|---|---|
| Caribbean | 1,299,825 | 12.83 |
| Andean | 10,432,575 | 30.13 |
| Orinoquía | 1,190,100 | 5.15 |
| Amazon | 1,669,875 | 4.19 |
| Pacific | 111,375 | 1.73 |
| Insular | 3,945 | 49.58 |
| **Total** | 14,706,795 | |

Source: IGAC (1988).

**Table 5.1.2. Area with Mild Erosion, by Natural Region**

| Region | Affected area (ha) | Percentage of natural region affected |
|---|---|---|
| Caribbean | 2,421,675 | 23.91 |
| Andean | 14,019,075 | 40.49 |
| Orinoquía | 4,094,775 | 17.73 |
| Amazon | 4,907,700 | 12.31 |
| Pacific | 891,225 | 13.83 |
| Insular | 3,096 | 50.42 |
| **Total** | 26,337,546 | |

Source: IGAC (1988).

**Table 5.1.3. Area with Very Mild Erosion, by Natural Region**

| Region | Affected area (ha) | Percentage of natural region affected |
|---|---|---|
| Caribbean | 139,372 | 1.38 |
| Andean | 1,209,275 | 3.49 |
| Orinoquía | 3,947,175 | 17.09 |
| Amazon | 222,750 | 0.56 |
| Pacific | 139,375 | 2.16 |
| **Total** | 5,657,950 | |

Source: IGAC (1988).

**Table 5.1.4. Area with No Erosion, by Natural Region**

| Region | Affected area (ha) | Percentage of natural region affected |
|---|---|---|
| Caribbean | 4,362,900 | 43.08 |
| Andean | 4,681,475 | 13.52 |
| Orinoquía | 8,784,925 | 38.04 |
| Amazon | 32,713,725 | 81.44 |
| Pacific | 4,965,285 | 77.06 |
| **Total** | 55,268,910 | |

Source: IGAC (1988).

# 6. Climate Change

## 6.1. Introduction

Concerns about future climate change have motivated international efforts to limit emissions of greenhouse gases (GHGs) for more than a decade. In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was adopted by Colombia and other members of the world community as a first step toward reducing global emissions. Under the convention, the industrial, or "Annex B," countries committed to mitigate their emissions, and every nation agreed to conduct an inventory of their contributions to global warming and an initial assessment of domestic vulnerabilities to climate change, as well as a preliminary examination of policy options for both adaptation and mitigation. The convention also established an ongoing process for developing and updating international commitments through regular Conference of the Parties assemblies. Although Colombia is not an Annex B nation—and thus not subject to specific GHG mitigation commitments—it has been an active participant in the international process since its inception.

At the third meeting of the Conference of the Parties (COP 3), 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 emissions targets for developed country signatories and several incentives for international cooperation to promote cost-effective GHG abatement in the developing world. Among the incentives is the Clean Development Mechanism (CDM), which is designed to generate both cost-effective GHG reductions and sustainable development benefits for developing countries.

For its part, Colombia signed the UNFCCC on June 13, 1992, and ratified it on March, 2, 1995. On November 30, 2004, Colombia ratified the Kyoto Protocol with an accession status.[61] Despite the withdrawal of the United States and Australia, the protocol was officially scheduled to enter into force as of February 2005.

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[61] "Accession" is the act whereby a state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states. It has the same legal effect as ratification. Accession usually occurs after the treaty has entered into force. The secretary-general of the United Nations, in his function as depositary, has also accepted accessions to some conventions before their entry into force. The conditions under which accession may occur and the procedure involved depend on the provisions of the treaty.

Pursuant to its obligations under the UNFCCC, Colombia issued its First National Communication in March 2002. This communication documented that Colombia's contribution to global GHG emissions was between 0.2% and 0.3%. It also identified potential vulnerabilities to climate change across the country, including coastal zones, water resources, high plateau zones, glaciers and other ecosystems, soils and land affected by desertification, vegetative cover, and agricultural and health impacts. Currently, the Second National Communication is nearing completion. Colombia has also taken steps to organize a range of domestic activities to address issues relating to both mitigation and adaptation. It has set up the Climate Change Mitigation Office, established bilateral agreements on climate change with a number of countries (including Canada, the Netherlands, and France), and it has established the Colombian Ministry of Environment, Housing and Territorial Development as the designated national authority for the CDM.

The second section of this chapter summarizes the information presented in Colombia's First National Communication, including basic data on the national inventory of GHG sources and sinks, actions undertaken to mitigate emissions (1994–2000), and the vulnerabilities and means of adaptation to the effects of climate change. The third section of this chapter presents available information on the activities underway to develop project-based activities potentially eligible for support under the CDM and related mechanisms. The final section of this chapter offers recommendations for future improvements.

## 6.2. First National Communication

Colombia's First National Communication to the UNFCCC, issued in March 2002, contains five major sections:

- national circumstances;
- national inventory of greenhouse gas sources and sinks, 1990 and 1994;
- actions to mitigate greenhouse gases;
- vulnerability and adaptation; and
- limitations, recommendations and needs.

### 6.2.1. National Circumstances

The initial section of the national communication describes the basic geographic, climatic, and ecological characteristics of the country. Also included are descriptions of water resources, population and development, economic development, and legislation, institutions, and policies.

With a population of 42 million, Colombia is the fourth-largest country in South America and the only one with both Caribbean and Pacific coasts. The five main natural regions on the mainland are Caribbean, Andean, Pacific, Orinoquia, and Amazonia. Most of the country enjoys an annual average temperature of 24–28 degrees C. Between 1970 and 2000, urban populations increased from 57% to 71% of the total. By 2050 urban areas are expected to contain 85% of the nation's population.  Currently, 90% of Colombia's population is under age 50.

In terms of water production, the Maddalena-Cauca basins and basins draining into the Caribbean represent 25% of the annual water production in the country. The Pacific region has an abundance of runoff in the range of 4,000–12,000 mm per year, with values higher than 14,000 mm per year in some areas. Other areas suffer from excessive deficits, at levels as much as 70–95% below the national average. Areas suffering from such deficits include Guajira, San Andres and Providencia islands, Cesar, and most critically, the Sabana de Bogota.

Despite widespread economic liberalization in the 1990s, the structure of the economy has been quite stable in recent years. Trade and service sectors account for about half of the nation's economic output; agriculture, livestock, and mining activities account for 22%; manufacturing accounts for 13%, and construction accounts for 4%. Per capita energy consumption is more than 20% below the average for Latin America. At the same time, automobile use is growing rapidly. In 1995 alone, more than 200,000 new vehicles were registered nationwide.

The national communication describes economic opportunities in a number of sectors.

In the forestry products sector, this includes the evolving market for $CO_2$ sequestration credits. The communication also indicates a capacity for expansion in relatively high value products, such as cocoa, exotic oils, flowers, processed food, and shrimp breeding.

### 6.2.2. National Inventory of Greenhouse Gas Sources and Sinks, 1990 and 1994

Following the guidelines of the Intergovernmental Panel on Climate Change, a national inventory of GHGs was drawn up for the years 1990 and 1994. Tables 6.1 and 6.2 display emissions estimates by gas and by sector.

**Table 6.1. Colombia's GHG Emissions by Gas and Sector (1990), in Carbon Dioxide Equivalents (Gg)**

| Sectors | $CO_2$ | $CH_4$ | $N_2O$ | Total |
|---|---|---|---|---|
| Energy | 46,886.1 | 5,3634.3 | 407.5 | 52.927.0 |
| Industrial proceses | 4,744.5 | 4,2 | 62.0 | 4.810.7 |
| Agriculture | | 31,862.0 | 23.557.8 | 55.419.9 |
| Land use change and forestry | 11,879.8 | 88,7 | 9.0 | 11.977.5 |
| Waste | | 3,651.9 | 580.6 | 4.232.5 |
| Total country (Gg) | 63,510.4 | 41,241.1 | 24,617.0 | 129,368.4 |

Source: IDEAM.

**Table 6.2. Colombia's GHG Emissions by Gas and Sector (1994), in Carbon Dioxide Equivalents (Gg)**

| Sectors | $CO_2$ | $CH_4$ | $N_2O$ | Total |
|---|---|---|---|---|
| Energy | 55,351.7 | 5,972.4 | 476.6 | 61,800.7 |
| Industrial proceses | 5,212.3 | 8.2 | 77.5 | 5,298.0 |
| Agriculture | | 34,319.5 | 27,126.6 | 61,445.1 |
| Land use change and forestry | 16,540.0 | 88.7 | 9.0 | 16,637.7 |
| Waste | | 4,601.4 | 625.0 | 4,686.4 |
| Total country (Gg) | 77,103.9 | 44,450.1 | 28,313.7 | 149,867.8 |

Source: IDEAM.

Overall, Colombia emitted 129.4 million gigagrams of GHGs (expressed as $CO_2$ equivalents) in 1990. In 1994, emissions rose to 149.9 million gigagrams (also expressed as $CO_2$ equivalents), an increase of about 16% over the four year period. In both 1990 and 1994, emissions from the energy and industrial process sectors accounted for almost 45% of total emissions, mostly in the form of $CO_2$. In 1990 emissions from the agriculture sector accounted for almost 43% of total emissions, in the form of methane ($CH_4$) and nitrous oxide ($N_2O$). In 1994 that proportion fell slightly to 41%. In 1990 the land use change and forestry sector accounted for 9.3% of total emissions, almost entirely in the form of $CO_2$. In 1994 that proportion rose to 11.1%. The waste sector accounted for the remaining 3% of emissions, in the form of methane and nitrous oxide. The aggregate balance of $CO_2$ emissions and capture (sequestration) is shown in Figure 6.1. Note that in 1994, the rate of capture was almost 40 times greater than the annual emissions.

**Figure 6.1.**

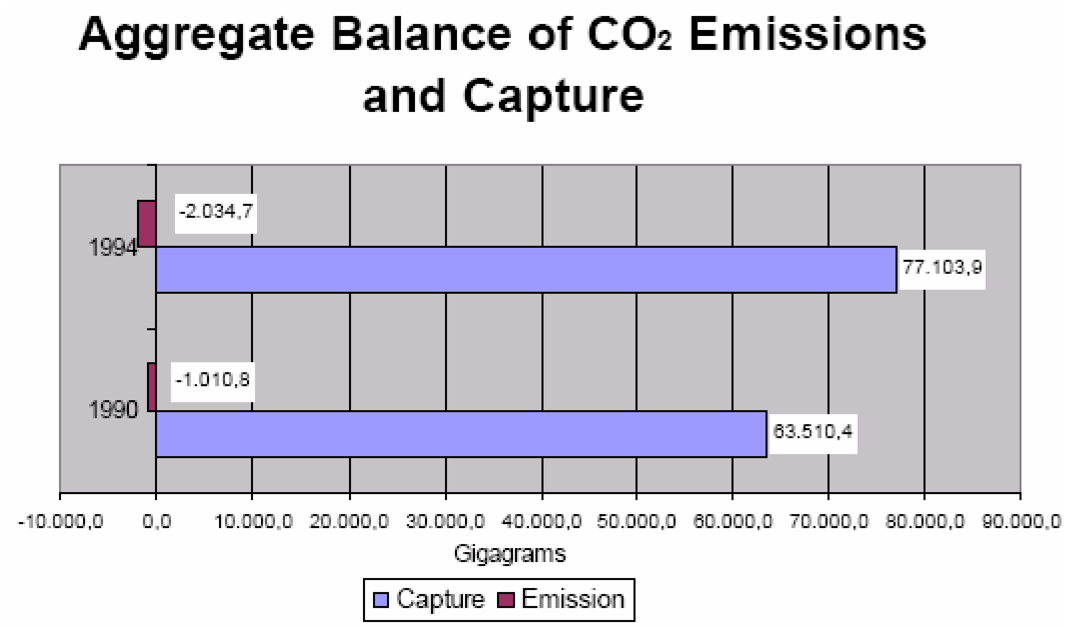
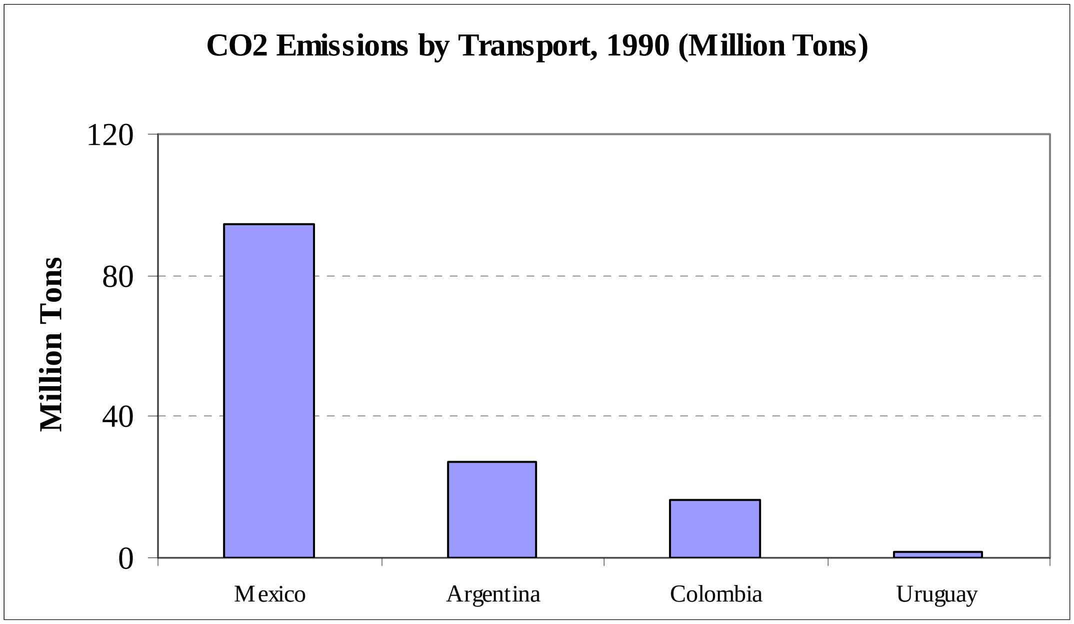


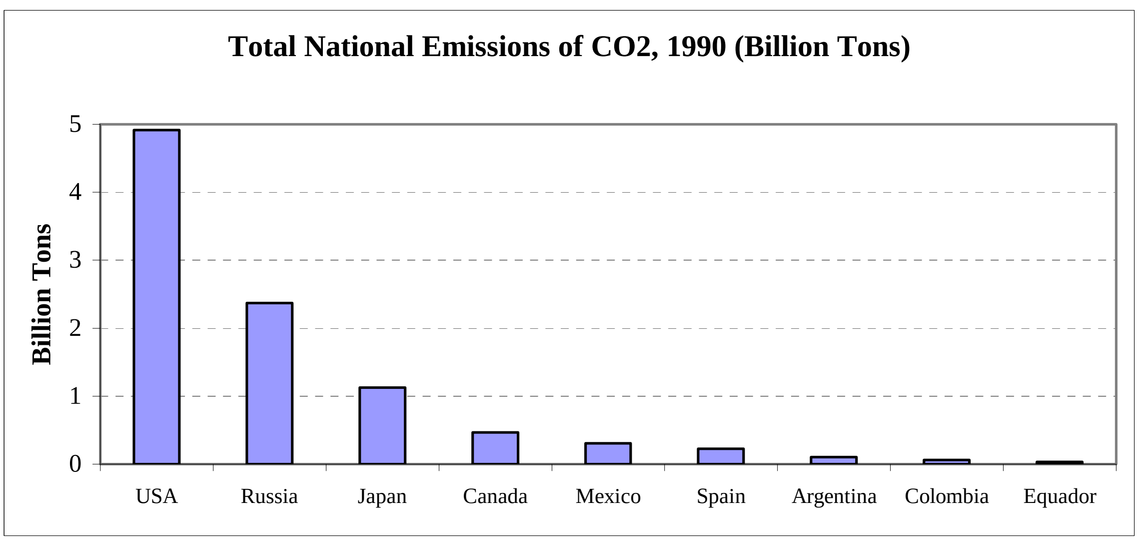

Figure 6.2 presents an international comparison of $CO_2$ emissions in the transport sector for Colombia and several other Latin American nations. As shown, $CO_2$ emissions in the transport sector are about one-fifth the comparable emissions from Mexico and about two-thirds those from Argentina. Figure 6.3 compares total $CO_2$ emissions in Colombia with those of selected developed and developing nations. As shown, Colombia is a relatively small emitter of $CO_2$. For example, Colombia's 1990 emissions are about 1% of the level of U.S. emissions and about 5% as much as those from Japan.

**Figure 6.2. $CO_2$ Emissions in the Transport Sector, 1990**




Source: Colombia's First National Communication to the UNFCCC.

**Figure 6.3. Total National Emisisons of $CO_2$**




Source: Colombia's First National Communication to the UNFCCC.

**6.2.3. Actions to Mitigate Greenhouse Gases**

Since 1994, Colombia has moved to reduce GHG emissions. With the exception of actions taken pursuant to the Clean Development Mechanism, most of these actions have been designed and introduced for reasons other than to combat climate change. The First National Communication identifies six areas in this category:

- energy
- transport
- industry
- agriculture
- land use changes and forestry
- waste disposal

The National Energy Plan was first formulated in 1994. It focused on the production and distribution of electricity. Specific policies include a reduction in the vulnerability of the system due to hydrological factors, an increase in the number of electricity generators, and the encouragement of competition among them. In the transport sector, major policies include gas-conversion programs; emissions controls, restrictions on the use of vehicles, and the implementation of mass transit systems, such as the Metro in Medellin and the TransMilenio in Bogota. In the industrial sector, the national "clean production" policy was adopted in 1997. In the agricultural sector, so-called ecological products have been introduced. In the land use change and forestry sector, the Forests Policy was introduced in 1996, the Strategic Plan to Restore and Establish Forests (Plan Verde) was introduced in 1998, and the National Forests Development Plan was introduced in 2000. The Integrated Waste Disposal Management Policy of 1997 regulates waste disposal practices.

In addition to the national policies, local agencies have also undertaken activities relevant to climate change Not surprisingly, these activities have focused on adaptation to potential vulnerabilities rather than GHG mitigation. Specific examples include the following:

- an integrated coastal management program that preserves wetlands and regulates land use and activities in zones threatened by flooding;

- guidelines that regulate land use in ecologically sensitive areas and limit social and economic activity so as to preserve biodiversity;
- agricultural programs that include evaluating land to determine whether it is suited for intensive farming, taking into account the impacts of irrigation and desertification; and
- research on human health issues with regard to dengue and malaria, including educational awareness programs on the relationship between malaria and stagnant water, which can serve as breeding grounds for mosquitoes.

**6.2.4. Vulnerability and Adaptation**

To assess the potential vulnerability of the nation to climate change as well as the opportunities for adaptation, Colombia has undertaken broad-ranging scientific, economic and engineering studies. Individual analyses focused on impacts associated with sea-level rise, desertification, the vulnerablity of the hydrological regime, the vulnerability of high mountain ecosystems, the impacts on agriculture, and the impacts on human health. This subsection highlights the important results of these studies.

The analyses of the effects of a potential rise in sea level relied largely on geomorphologic and morphodynamic indicators. The possible biophysical changes that may result were also addressed. According to the analysis, an increase of 1 meter in the sea level would result in the permanent flooding of 5,100 square kilometers and affect the economy and infrastructure of the 1.4 million people who live in the most vulnerable areas.

The agricultural sector on the Caribbean coast is particularly susceptible to the effects of rising sea levels. According to the analysis, 7.2 million hectares of banana and African palm crops would be directly affected by the flooding. In the industrial sector, 73.5% of manufacturing facilities in Barranquilla and 99.7% in Cartagena are considered especially vulnerable.

San Andres is a relatively small Caribbean island (27 square kilometers). According to the analysis, a rise in sea level of 1 meter would inundate 17% of the island, which includes the richest of the island's natural resources and most commercially developed tourist areas. The public service infrastructure on the island would also be affected, particularly the sewage system, water supplies, and roads.

On the Pacific coast, 13% of households were deemed to be highly vulnerable and an additional 62% were deemed to be moderately vulnerable. Buenaventura, the main commercial area on the coast, would be highly vulnerable, along with Tumaco and Satinga.

The proposed measures to cope with the impacts of climate change are designed to restore and strengthen the resilience mechanisms of the coastal regions so as to facilitate the natural adaptation of these areas to rising sea levels. These measures would be integrated with existing policies in coastal areas, such as the preservation of coastal wetlands, regulation of land use, and protection of zones, which serve vital socioeconomic interests.

Desertification was another issue examined in the First National Communication. Currently, 4.1% of the national territory is affected by desertification. Climate change has the potential to increase that amount to more than 7% of the national territory. The most affected areas include the Caribbean plains, Andean valleys, Cundinamarca-Boyaca plateau, and Narino.

Global climate change could affect the hydrological system. Runoff is expected to increase in some areas but decrease in others. Variability is also likely to change, with an increase in the frequency of maximum flows. Overall, it is estimated that the hydrological system in half the country could be affected to a high or very high degree by climate change. The most drastic changes are predicted to occur in the Amazon basin.

A study to determine the natural system dynamics, disturbances, and tension as a consequence of climate change was conducted for the following ecosystem types:

- humid tropical woodland;
- pedo-biomas and helo-biomas of humid tropical forest;
- dry tropical forest;
- flatlands (pedo-biomas or peino-biomas, depending on location);
- Andean mountain jungle;
- mainland water ecosystems; and
- agricultural ecosystems.

Guidelines for adaptation measures for the various ecosystems include land use regulations and the concept of principal ecological structure—a national planning system that takes into account the spatial distribution of natural and managed ecosystems and seeks a balance between the supply of natural resources and environmental services and the demands placed on it by the population. This is especially relevant to the management of Paramo ecosystems and agricultural land.

The potential changes to high mountain ecosystems are quite significant. Table 6.4 displays the results from a doubling of $CO_2$ concentration on three distinct ecosystems: Paramo, Superparamo, and Glacier. In all cases the predicted loss of ecosystems is large, ranging from 75% to 95% of the resource.

**Table 6.4. Vulnerability of the High Mountain Ecosystems**

| Vegetation | Present Climate | Difference between Present and Future Climates | |
|---|---|---|---|
| | Hectares | Hectares | Percentage |
| Paramo | 323,000 | –238,170 | –75 |
| Superparamo | 40,500 | –34,500 | –85 |
| Glacier zones | 45,500 | –43,700 | –95 |

Source: IDEAM.

An evaluation of potential agricultural impacts of climate change concluded that 7% of Colombia's land area is well suited to intensive agriculture. According to the analysis conducted, a doubling of carbon dioxide levels would result in desertification of a significant portion of this land.

The measures to address climate change in the agricultural sector include the following:

- creation of an inventory of water resources;
- analyzing the climatic variability and yields for the main intensive crop using the temporal analogue method;
- characterization of soils and determination of the agricultural uses appropriate to this characterization; and
- strengthening the use of remote sensing information, identification, georeferencing, and characterization of specific crops.

In addition, it was recommended that efforts be made to restrict the spread of agricultural activities in high mountain areas.

Human health impacts represent a further area of vulnerability to climate change. The zones most vulnerable to malaria are defined in terms of temperature, rainfall, and relative humidity. Potentially affected areas include towns in Choco and Guaviare; some of Putumayo, Caqueta, Amazonas, Meta, Vichada, Vaupes, Guainia, and Arauca; the Pacific watersheds of the Departments of Nariño, Cauca, and Valle del Cauca; and the watershed of Uraba-Antioquia, southern Guajira, Catatumbo and the Lower Magdalena, Lower Cauca, Nechi, Alto San Jorge, and Alto Sinu. The most vulnerable areas for dengue are Santander, Norte de Santander, Tolima, Huila, Atlantico, and Valle del Cauca.

Measures to address the human health impacts of climate change are similar to those commonly used for malaria and dengue, including chemical controls to eliminate adult mosquitoes and larvae, and cleanup and awareness campaigns organized with the aid of community organizations and health workers. Health services of several types need to be strengthened in the areas identified as potentially vulnerable.

#### 6.2.5. Limitations and Recommendations Made by Colombia Regarding Preparation of the Inventory of Greenhouse Gases

In its First National Communication to the UNFCCC, the Colombian government raised technical issues relating to the calculations of gas emissions according to the 1996 guidelines of the Interngovernmental Panel on Climate Change (IPCC). Colombia is currently performing a review of the first communication with support from the World Bank, which was scheduled to be completed by April 2005. The review is expected to improve the analysis of gaseous emissions from stationary and mobile sources and the effect of agricultural activities. Further work is also underway on vulnerability and adaptation to climate change, including issues raised in a recent IPCC report.[62]

Even though Colombia has formulated a series of policies to address the effects of climate change, as per the guidelines of the UNFCCC, implementation appears to be hampered by a lack of effective coordination within SINA and across state entities. This lack of coordination

[62] See UNFCCC (2004), " Ten Years," which reports major regional and sectoral findings on vulnerability and adaptation.

and ineffectiveness of policy has been highlighted in a recent report of the General Comptroller[63].

## *6.3. Project-Related Activities Designed to Reduce Emissions and Increase Sequestration of Greenhouse Gases*

The Kyoto Protocol established the CDM as a means of generating cost-effective GHG reductions as well as sustainable development benefits for host developing countries. The principal goal of the CDM is to support project-based GHG reductions in developing nations to be transformed into certified emissions reductions (CERs). In turn, these CERs become available to countries or companies as credits that may be used as a means of meeting individual Kyoto emissions 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.

To begin the process of developing a pipeline of high-quality projects, the World Bank's Prototype Carbon Fund (PCF) and several other multilateral and bilateral entities have been established to purchase CER-eligible credits in advance of the full operation of the CDM. For its part, Colombia has established a Climate Change Mitigation Office within SINA with the goal of promoting the development of GHG emissions reduction and sequestration projects in a transparent and efficient manner. Three specific strategies have been identified to advance these objectives:

- develop tools and capacities for project evaluation and approval;
- identify and develop capacities to promote a portfolio of high-quality projects; and
- design, develop, and implement a marketing strategy for national projects for the international carbon market.

This section describes the evolving procedures and activities of the CDM at the international level, along with those of the PCF and other institutions established to promote development of GHG mitigation projects. It also outlines the initial project-based activities underway in Colombia. An appendix describes the results of a study commissioned by the Inter-American

[63] Contraloría General de la Republica," Estado de los Recursos Naturales y del Ambiente 2003–2004," 2004.

Development Bank on the challenges and opportunities for the CDM in Latin America, based on three detailed case studies conducted by Latin American experts.

### 6.3.1.The Clean Development Mechanism

Since GHG emissions contribute equally to climate change irrespective of their geographic location, the impact on the global environment of mitigation activities is the same as those undertaken anywhere else on earth. CERs can be generated through the joint activities of developed and developing nations. Developing countries, through their unilateral efforts, may also generate credits and make them available for sale on the open market.

Through the CDM, environmental gains, such as cleaner air and water, soil conservation, reduced deforestation, and biodiversity protection are likely occur, in addition to potential social benefits such as poverty alleviation, employment, and rural development. It is anticipated that, in most cases, these benefits will overlap with each other as well as with the less formal goals of developing countries. Thus, rather than conflicting with existing development priorities, the CDM has the potential to achieve gains on climate change *and* sustainable economic development.

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 emissions reductions (see Boxes 6.1 and 6.2).

**Box 6.1. Participants in CDM Projects**

**Executive Board:** Approves methodologies for baselines, monitoring plans and project boundaries; accepts operational entities; develops and maintains CDM registry.

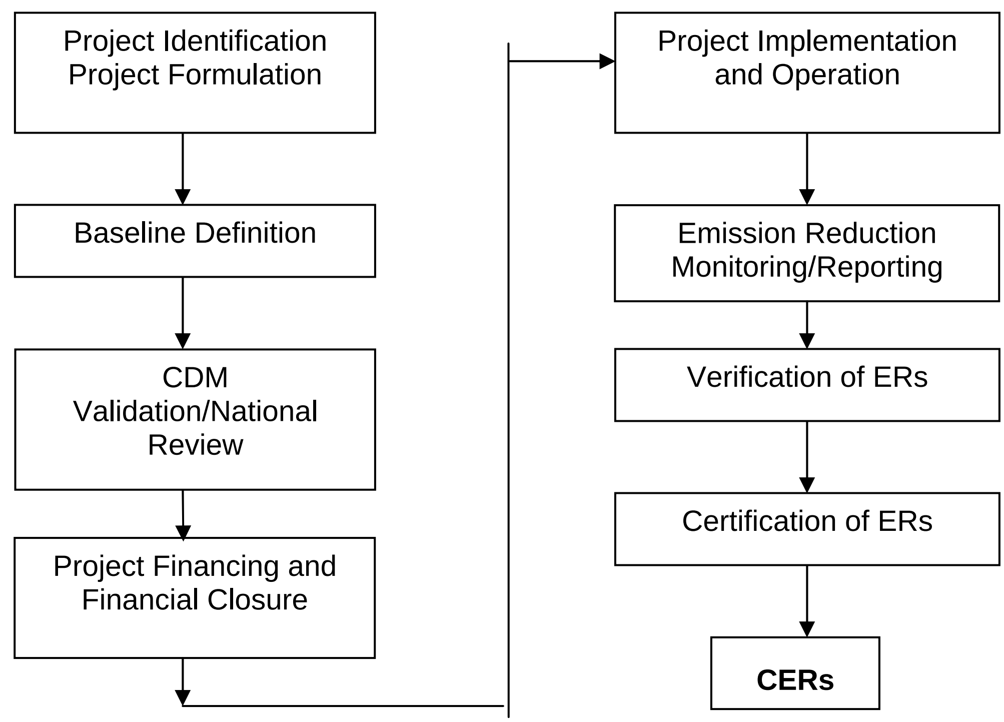
**Designated National Authority:** Provides government approval for individual projects to be submitted to the operational entities for validation.

**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 6.2. Key Steps for a CDM Project**



Major decisions regarding land use and forestry were made at COP 9, 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, nonpermanence 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.

The Kyoto Protocol requires CDM investments to be additional to other activities. Thus, 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, practical procedures must be developed to estimate the additional emissions reductions associated with a project. Box 6.3 presents a list of barriers that, according to the CDM Executive Board, are major factors in determining project additionality. The CDM has established a set of streamlined procedures and approved specific methodologies for "small-scale" CDM projects.[64] However, larger projects are governed by a set of general procedures and new case-by-case approved methodologies.

**Box 6.3. 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 nontraditional projects would have led to the adoption of traditional options with higher emissions.

[64] Small-scale projects are defined as renewable energy projects with a maximum output capacity of 15 MW or equivalent; energy efficiency projects with a maximum reduction in energy consumption on the 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.

***Box 6.3 con't***

7. *Managerial resources barrier:* without the project activity, limited managerial resources that abide by energy and emission standards would have led to noncompliance 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 increased emissions.

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 on 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 issues associated with project-level baselines as well, such as significant project cost increases and detailed government review, which may slow the approval process. As described below, baseline and additionality issues have arisen on funding decisions for several projects under development in Colombia.

Activities eligible for the CDM include a broad array of emissions reduction measures and efforts to expand carbon storage in forest sinks. Various institutions are being developed worldwide to support these efforts, including bilateral arrangements, such as the Netherlands Clean Development Facility, and multilateral initiatives. The World Bank's Prototype Carbon Fund is the largest of the multilateral initiatives. The World Bank has also set up a new, $100 million Community Development Carbon 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 Prototype Carbon Fund was established in 2000 to mobilize public and private investment to serve as a vehicle for creating a market for GHG reductions. 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. PCF has already committed more than $100 million to the support of projects in non-Annex B nations.

Because GHG mitigation projects are highly decentralized, it is difficult to gauge the full set of activities underway worldwide. Currently, data from PCF are the most comprehensive available on individual projects. These data are available for all major regions of the developing world and for all technologies. So far, PCF appears to be relatively bullish on Latin America and the Caribbean, as 40% of the reduction credits purchased for 2002–2003 and 27% of the credits purchased for 2003–2004 were from projects in the region (see Table 6.5). Despite the recent decline in the share of projects in Latin America and the Caribbean, and the concurrent rise in activities in Asia, Latin America is expected to continue as an important source of project-level activities.

Also of interest are the specific types of projects being undertaken. As shown in Table 6.6, landfill gas projects were the most popular in 2002–2003, representing 25% of the total tons. In 2003–2004, however, this proportion fell to 18%, and the share for $HFC_{23}$ destruction projects rose to 31% of the total. Biomass and hydro projects also make important contributions to the PCF portfolio of projects.

Despite the high expectations for international support of project-based activities in developing countries, certain factors have served to dampen expectations about CER prices in the near term. Current price estimates are in the range of \$3 to \$7 per ton of $CO_2$ for Kyoto precompliance credits. 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 as high as several hundred dollars per ton during the first budget period of the protocol (2008–2012). 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 and Australia from the protocol.

**Table 6.5. Location of Emissions Reduction Projects Supported by the Prototype Carbon Fund, 2002–2004**

| Region | 2002-2003 | 2003-2004 |
|---|---|---|
| Asia | 21% | 51% |
| Latin America | 40% | 27% |
| Transition Economies | 15% | 8% |
| Africa | 5% | 4% |
| OECD | 19% | 10% |

Source: *State and Trends of Carbon Market*, 2004, World Bank, Washington, D.C.

**Table 6.6. Technology Share of Emissions Reduction Projects Supported by the Prototype Carbon Fund, 2002–2004**

| Technology | 2002–2003 | 2003–2004 |
|---|---|---|
| **LFG** | 25% | 18% |
| **Hydro** | 13% | 11% |
| **Wind** | 8% | 6% |
| **Biomass** | 17% | 14% |
| **Fuel Switching** | 7% | 4% |
| **Energy Efficiency** | 4% | 6% |
| **LULUCF** | 6% | 4% |
| **HFC** | 10% | 31% |
| **Geological Sequestration** | 9% | 1% |
| **Other** | 1% | 5% |

Note: * denotes $N_2O$ projects

Source: *State and Trends of Carbon Market*, 2004, World Bank, Washington, D.C.

## 6.4. GHG Mitigation Projects in Colombia

In August 2003, MAVDT issued a formal document on the criteria and procedures for project developers to submit GHG mitigation projects for official approval by the Colombian government, as prescribed in the Kyoto Protocol. These criteria are applicable to several GHG mitigation and sequestration projects currently under development in Colombia. Unfortunately, the MAVDT document does not establish a formal clearinghouse for projects. Thus, it is difficult to obtain an up-to-date inventory of actual projects under development or in the planning phase. However, according to CDM Watch, an NGO that is tracking decisions by the CDM Executive Board, PCF, and other multilateral and bilateral project sponsors, four projects are well along in the development pipeline in Colombia: Jepirachi (wind power), Aqua Fresca (small hydro/renewables), La Vuelta and La Herradura (large hydro), and TransMilenio (transport). In addition to the projects reported by CDM watch, two others are also under development: Amoya (run-of-river hydro); and Furatena (energy efficiency). See Table 6.7.

**Table 6.7. Project-Level Activities Underway in Colombia**

| Project | Description | Participants | Gas reduced | GHG reductions claimed (in TCO2e)/CERs | Time period (years) | Remarks |
|---|---|---|---|---|---|---|
| TransMilenio urban transport project | A transport system in Bogotá incorporating high-capacity articulated buses running on trunk lines and lower-capacity buses operating on feeder routes | CAF-Netherlands CDM Facility | $CO_2$, methane ($CH_4$) and Nitrous oxide ($N_2O$) | 2,503,517/ 2,029,342 | 10 | Seeking baseline and monitoring methodology approval; public comment period closed May 6, 2004 |
| La Vuelta and La Herradura hydroelectric project | Construction of two linked subprojects: La Vuelta (11.7 MW) and La Herradura (19.8 MW) on the La Herradura River | Electric Power Development Company, Japan<br>Empresas Publicas de Medellin (EE.PP.M)<br>MGM | $CO_2$ | 1,559,984/ 535,793 | 21 | Seeking baseline and monitoring methodology approval; a new version of the methodology was submitted to the Meth Panel in February 2005 |
| Jepirachi wind project | Construction of 15 wind generators with a total capacity of 19.5 MW | Empresas Publicas de Medellin (EE.PP.M) | $CO_2$ | 1,168,000/ 406,905 | 21 | Prevalidation stakeholder comment period completed; project expected to commence in October 2003; currently seeking approval for its baseline and monitoring methodology; public comment period closed October 8, 2003 |
| Agua Fresca hydroelectric project | A small-scale project that aims to generate 208,000 CERs by 2012 through construction of a run-of-river project | Aguas de la Cabaña<br>Generadora Unión SA<br>Va Tech Bouvier Hydro<br>Empresas Publicas de Medellin (EE.PP.M) | $CO_2$ | 420,200/ 208,842 | 7 with option of renewal (reduction figure given is for the first two 7-year periods) | Unclear; not yet seeking validation |

**Table 6.7, Continued**

| Project | Participants | GHG Reduction Claimed (Million metric tons) | Time Period (Years) | Remarks |
|---|---|---|---|---|
| Amoya River run-of-river power generation facility | Generadora Union SA ESP and Hidroger SA ESP | 1.87 up to 2012<br>2.69 up to 2019 | 2007– 2012 (2019) | The project does not involve bank financing. Carbon revenues are estimated at EU 7.5 million up to 2012, and an additional conditional purchase of up to EU 10.76 from 2013 to 2019. |
| | | | | |
| Furatena Energy Efficiency Project<br><br>(Improving energy efficiency of panela farms and switching fuel to bagasse) | Sponsor: CORPOANDINA, Local NGO | .011946 after year 8<br>.127426 by year 14 | 2004– 2019 | Total project cost estimate: US$ 0.98 million<br>Grants for project preparation, socialization and one-fourth of initial investment are obtained.<br>- Farmers and the town will provide 20% equity<br>- The balance is to be secured by FINAGRO (rural financing bank)<br>Contribution sought from (Community Development Carbon Fund) CDCF: US$ 0.7 million with up front payment sought of US$ 0.175 million<br>A third-party project, the CDCF purchase will be implemented through an NGO with local experience and networks and through FINAGRO, a rural bank.. CDCF-Plus resources will be sought to assist with preparation and business costs. To scale-up, additional leverage and replicability will be sought. |

Source: Prototype Carbon Fund (PCF), World Bank, and the Community Development Carbon Fund (CDCF) documents.

### 6.4.1. Jepirachi Wind Farm

In December 2002, PCF signed an agreement with the utility Empresas Publicas de Medellin to purchase 800,000 tons of GHG emission reductions from the 19.5 MW Jepirachi Wind Power Project, located in the Wayuu Indigenous Territory in the Department of Guajira. This is the first project to be carried out in Colombia within the CDM framework. Once completed, it is expected that the 15 windmills will deliver 68.3 GW hours per year to the national grid. Over a 21-year period, the project will reduce emissions by 1.168 million tons. Jepirachi was used to propose a new baseline methodology based on least-cost analysis and optimization modeling for renewable energy capacity additions to existing power systems. It was also the basis for a new monitoring methodology for capacity expansion projects which replace electricity that would otherwise be generated and dispatched to the grid by other power plants.

The Jepirachi project is expected to contribute to the nation's sustainable development goals in several ways. First, it will demonstrate the potential for wind-based generation at the commercial level, thereby facilitating investments that will capture the relatively large wind-energy potential identified in the country. Second, it will increase the share of nonhydroelectric energy in the national grid, which is currently dominated by hydro and thermal generation. This is important for Colombia, as it will enhance reliability and help avoid the rationing experienced during the 1990s after severe droughts caused power shortages. Without carbon finance, the preferred option for capacity additions would be thermal energy, because of its low cost.

Further, the Jepirachi project will contribute to the development of the host indigenous community, which is among the poorest in the country, by financing a series of community-driven projects that go beyond the system of transfers mandated by Colombian law. By targeting water supply, education, and health services, the project addresses the priorities for social development identified by the host community. There is also an agreement between the project sponsor and the host community to review the program two years after initial implementation.

PCF has agreed to pay a premium of US$0.50 per ton of emissions reductions upon implementation of the plan. This purchase agreement contains a clause that lays out the conditions under which the premium will be paid—namely, upon delivery of the emissions reductions and upon verification that the social plan has been implemented.

### 6.4.2. La Vuelta and La Herradura

This project is designed to harness the capacity of La Herradura River by means of two subprojects, La Herradura and La Vuelta. With a total installed capacity of 31.5 MW, the project will improve electricity service in the west of Antioquia Department, contribute to regional development, improve security via distributed generation, and reduce $CO_2$ emissions. The Empresas Publicas de Medellin, E.S.P, is the developer (the same entity responsible for the Jepirachi Wind Project). According to CDM Watch, a Japanese firm is also involved in the project.

The project will generate revenues of about $200,000 per year for the municipalities in the area. These funds will be available for the implementation of municipal development plans, consistent with the framework of Law 99 of 1993. The focus of these plans will be basic sanitation and environmental protection programs. Run-of-river plants of this type have no regulating reservoirs, so the environmental impacts of the facilities themselves are minimal.

### 6.4.3.TransMilenio Urban Transport Project

This project will incorporate high-capacity articulated buses running on trunk lines and lower-capacity buses running on feeder routes into the existing TransMilenio transport system in Bogotá. Although initial GHG reductions are estimated to be small, the project sponsors have estimated that annual reductions will reach almost 500,000 tons of $CO_2$ equivalent by 2010. It is proposed that the national government contribute 70% of the infrastructure costs and the district government allocate 50% of fuel surcharges to fund construction of the system's lanes. International support is being sought from the CAF (Netherlands) and the CDM. Benefits of the system include improvement in urban air quality, improvement in the efficiency of the urban transit system, and reduction in transit times.

Although an extensive monitoring plan has been developed, questions have been raised by the CDM Executive Board about the calculation of the project baseline, the additional reductions to be contributed by the CDM-eligible portion of the project, and the overall transparency of the calculations of reductions. CDM Watch reports that the project has been rejected by Executive Board. It is anticipated that revisions will be made to the methodology and that the project will be resubmitted for review.

### 6.4.4. The Agua Fresca Hydroelectric Project

This small run-of-river generating facility would earn 420,200 CERs in the first seven years of operation. It is expected that 208,000 CERs will be generated by 2012. Participants include Aguas de la Cabana Generadora Union SA and Va Tech Bouvier Hydro Empresas Publicas de Medellin. The project is expected to generate annual revenues to support sustainable development plans in the area. The plant itself, which does not involve a regulating reservoir, will have minimal environmental impacts. Although further information on the funding and approval status of this project is not available, it was nominated by the Advisory Board of Carbon Market Insights as one of the top five projects in 2005.

### 6.4.5. Amoya River Run-of-River Power Generation Facility

This project involves construction of a 78 MW run-of-river facility on the Amoya River to replace existing generation sources. The project also seeks to protect and use, in a sustainable manner, the environmental services provided by the Páramo (a high alpine ecosystem unique to the Northern Andes) of Las Hermosas. The project developer is HIDROGER S.A. E.S.P., a subsidiary of Generadora Unión S.A. E.S.P. $CO_2$ mitigation is expected to be 1.87 million tons by 2012 and 2.69 million tons by 2019.

The Páramo of Las Hermosas, which encompasses the headwaters of the Amoya River, acts as a natural reservoir to provide the necessary water and kinetic energy for the project, and therefore no reservoir is required. Nearly all the works will be conducted underground, as opposed to open areas, to minimize possible environmental impacts from land use and to minimize impacts on the open landscape. The weir will be located downstream near the mouth of the Davis River, at 1,485 meters above sea level.

With anticipated changes in temperature associated with climate change, the highly hydrophilic vegetation of the Páramo may become vulnerable to changes in land use. Changes in the vegetation may result in an alteration of the water regulation regime of the Páramo. To prevent this, incentives will be generated through the project and in cooperation with local environmental authorities. The project will also have a strong social development component geared to maximizing benefits to the local population. A fraction of the revenues from the emissions trading will be channeled directly to a social development plan.

**6.4.6.Furatena Energy Efficiency Project**

The project will support improvements through the use of improved, high-efficiency burners at about 120 small family-owned plants, enabling them to process panela (raw sugarcane juice) to molasses. This improves energy efficiency and enables the communities to use bagasse (fibers from the crushed cane stalks) as fuel instead of old tires.. The project would give farmers a value-added product that enhances their net income potential. It also includes a social program in education, training and health services for the community and will support the adoption of organic practices in sugar cane production.

CORPOANDINA, the project developer, is a local NGO consisting of an association of local farmers. Created in 1999, the NGO has been working on sustainable development in the rural sector in Colombia with particular emphasis on the Unica region, the project site. CORPOANDINA has developed a general framework for finding new models for rural productive activities that benefit the poor and improve the living conditions of the community.

An estimated 84% of the surrounding rural population has unmeet basic needs, and 43.5% are below the extreme poverty line. In this context, the project would contribute to local community in a number of ways:

- increasing net income;
- training 800 people in improved sugar cane production practices;
- providing basic managerial training to 120 small farms;
- providing employment and job training; and
- working with farmers to develop a land use environmental plan.

Total project cost is estimated to be US$0.98 million. Farmers and the town will provide 20% of the equity. The balance is to be secured by FINAGRO (a rural financing bank). A contribution from the Community Development Carbon Fund is sought for about US$0.7 million over 14 years. Expected emissions reductions are approximately 127,000 tons of $CO_2$ equivalent.

Beyond the above projects, the Colombia Climate Change Office reports that eight additional projects for reduction and sequestration of GHGs were in the pipeline as of March 2004. As shown in Table 6.8, four projects are in the energy, transportation, and waste sectors, and the other four involve sequestration activities presumed to be in compliance with the criteria established at COP 7.

**Table 6.8. Additional Projects for Reduction and Capture of GHG Emissions**

| | Promoter | Category | Total Emissions Reductionor Capture | Accreditation Period | Emissions Reduction or Capture in Accreditation Period | Emissions Reduction or Capture in Compliance Period, 2008–2012 |
|---|---|---|---|---|---|---|
| **Emissions Reduction Projects** | Triple A ESP | Waste handling and disposal | 3,638,000 | 14 | 3,638,000 | 1,523,000 |
| | CDMB | Residues: supply of energy by cogeneration | 1,452,900 | 14 | 968,600 | 362,900 |
| | Metrocali | Transport | 2,000,000 | 10 | 800,000 | 400,000 |
| | Gas Natural | Energy demand: fuel switching | 300,000 | 10 | 300,000 | 150,000 |
| | Agua Fresca | Renewable energy | 700,000 | 14 | 241,425 | 86,225 |
| **Emissions Capture Projects** | Procuenca | Forestry activities in accordance with COP 7 | 1,586,100 | 10 | 584,925 | 372,225 |
| | Cornare | | 8,900,000 | 10 | 1,780,000 | 890,000 |
| | Corpornor | | 286,436 | 10 | 286,436 | 198,520 |
| | Umbrella Forestry Project | | 7,694,817 | 10 | 1,961,214 | 1,418,217 |

In addition to the specific project activities reported above, other activities are also underway to promote GHG abatement and sequestration. For example, a report issued by Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ) proposes a method for formulating CDM projects and preparing a generic portfolio of CDM-eligible projects for Colombia's energy sector.[65] Finally, we call attention to a recent report issued by the Inter-American Development Bank that reviews the findings of three case studies conducted in Latin America on the potential for CDM projects in the region.[66] The three projects involve capture and use of landfill gas in Chile, sequestration of carbon in Patagonian forests, and the modernization of the Santiago transport system to achieve further GHG reductions. The latter project has certain similarities to the TransMilenio project discussed earlier in this section. An appendix to this chapter excerpts portions of that report with a focus on the twin objectives of sustainable economic development and GHG mitigation.

## *6.5. Recommendations*

As chronicled in this chapter, Colombia has undertaken a diverse set of activities to address the issue of climate change. Colombia's Second National Communication is currently under preparation and is expected to be released soon. Undoubtedly, this document will update some of the data presented in this chapter on domestic activities in the areas of both adaptation and mitigation. Without access to the revised data, it is not possible to gain a full understanding of current activities. However, based on the information available at this writing, our principal recommendation is that the current efforts on the important, long-term problem of climate change be expanded.

One clear priority for adaptation activities in Colombia, as in many other nations, is to improve coordination among relevant government agencies at both the national and the local levels. By its very nature, climate change is a cross-cutting issue that involves many levels of government and many agencies. Because it is a long-term challenge, climate change is often not treated as a priority by environmental, agricultural, or resource development agencies. Additional capacity building and strong management direction at the national levels is needed to ensure the most

[65] Rodriguez, Humberto, and Fabio Gonzalez, "Colombian Project Portfolio in the Energy Sector Under CDM, Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ), undated.

[66] Morgenstern, Richard. 2004. "Policy Studies on Greenhouse gas Mitigation and Economic Development: Synergies and Challenges," Working Paper, Inter-American Development Bank, Sustainable Development Department, Environment Division. October.

effective and cost-effective management response. Specifically, we recommend the creation of a clearinghouse of information. Designating one national-level entity as the coordinating body is the first step. In this case, SINA already serves this function. However, there is a lack of coordination within SINA itself. A climate change impact mitigation division within SINA that would serve as a clearing house of information for all levels of government, including national, regional, and municipal authorities, would streamline the flow of information.

Many opportunities exist to advance the twin objectives of sustainable economic development and GHG mitigation in Colombia. The Climate Change Mitigation Office is already promoting the CDM and providing support to developers on specific projects. To accelerate activities in this area, it is recommended that enhanced support be offered to project developers. The recent positive experience with the Jepirachi Wind Project demonstrates that innovative design and methodology development can pay off. At the same time, experience with the TransMilenio project suggests that more refined analysis is essential for success. Overall, the Climate Change Mitigation Office should strengthen its capacity to support project developers, particularly for complex and/or innovative projects with potential for large sustainable development benefits.

## *Appendix 6.1: Excerpts from IADB-Sponsored Study, "Greenhouse Gas Mitigation and Economic Development: Synergies and Challenges"*

*(This appendix presents excepts from an Inter-American Development Bank report on the results of three case studies conducted by university-based experts and independent consultants from Latin America. Although none of the cases specifically involve Colombia, the lessons are potentially applicable across all of Latin America. The three cases involve landfills (Chile), forestry (Patagonia, Argentina), and urban transit (Santiago, Chile).* [67]

Although 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; each case has a focus on technically achievable, relatively low- or medium-cost mitigation options; and each one presents ancillary environmental benefits or other types of sustainable development advantages associated with the GHG abatement. None of the cases appear to present truly intractable problems from the political economy perspective. Table 6.1.1 summarizes the results of the three case studies according to 10 evaluation criteria: technical feasibility, quantity of CERs involved, estimated marginal abatement costs per ton of $CO_2$ abated, extent of identified environmental and economic benefits, presence of complex issues associated with baselines, legal and institutional context, monitoring and/or enforcement, and the local political economy.

[67] Morgenstern, Richard. 2004. "Policy Studies on Greenhouse gas Mitigation and Economic Development: Synergies and Challenges," Working Paper, Inter-American Development Bank, Sustainable Development Department, Environment Division. October, 37–43.

**Table 6.1.1. 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 and Institutional Issues | Yes | No | Some |
| Income Distribution Impacts | Favorable | Potentially Favorable | Potentially Favorable |
| Complex Monitoring and 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 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 IADB 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" reaction of many communities. Although the forestry methods in Patagonia are well established, the IADB analysis recognizes the need for more research and analysis on the potential for growing different species on 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, the IADB report does not 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 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 cases. However, 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 are sensitive to the type of cost analysis 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 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 PM10 and $NO_x$ generated by the redesigned transport system were also included, the net benefits would be even greater. As the IADB report notes, the inclusion of the monetized value of these ancillary environmental and congestion-reduction benefits raises 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 those for 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 attractive. At the same time, the case study identifies 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 at smaller sites. 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.

Although 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 PM10 reductions (7%) and $NO_x$ reductions (16%) that are significant by any measure, particularly in a city like Santiago that faces 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 IADB-sponsored study devotes less attention to quantification of these environmental benefits. In the case of Patagonian forestry, the extent of environmental benefits is 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 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 cases—Santiago transport reform and the capture and use of biogas at Chilean landfills.New policies that are currently being implemented create certain difficulties for developers who seek to gain eligibility for these CDM projects. In the case of the Santiago transport system, 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. For Chilean landfills, new policies are also relevant, although the details of the new policies have yet to be finalized.

In the Argentinean forestry case, 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 and pests, as well as various manmade damages, such as timber theft, poor 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 on 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 emissions reduction credits, particularly those generated by owners of private automobiles, remains open to debate. According to the IADB-sponsored case study, 57% of the estimated $CO_2$ reductions arise from the expected modal shift away from private automobiles as a more attractive and efficient bus system becomes available. A large portion of the incremental reductions in PM10 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 such 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 emissions reductions would need to be developed.

All the projects analyzed in the three IADB-sponsored case studies are likely to increase the economic well-being and overall income levels of the participating nations. At the same time, they are 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 instances. Among the three cases, the results of the Santiago transport case are clearest in this regard: 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 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, greater difficulties are likely to occur in the transport and the forestry cases 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 commuter automobiles. In the case of Patagonian forestry, considerable effort will be required to ensure that 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. In all likelihood, these groups would resist the adoption of the redesigned system. The "not in my backyard" issue is 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.

Arguably, the dual benefits of economic development and GHG mitigation are attractive goals for all countries. A challenge for the nations of Latin America and the Caribbean is how to encourage the expansion of policies that accelerate progress toward both goals. Steps have already been taken, such as reductions of subsidies, power sector and other regulatory reforms, regional market integration, and the general strengthening of capital markets. Similarly, there is clear 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 despite 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 ensure a continued balance between traditional economic development and environmental objectives, including GHG mitigation. Given the long-term nature of the projects, community support is a crucial 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.

- Although 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% of the emissions reductions contracted by 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, and 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% of the emissions reductions contracted by PCF for 2002–2003 involve landfill gas projects. Although the results of the single landfill case examined in this monograph should 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 so 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 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 forestry growth in large land areas (Patagonian forests). Since CERs must be verified, 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. The PCF experience highlights the need for skills strengthening in project preparation, marketing, and negotiating emissions reduction agreements. In the landfill case, the author notes that the local operators' lack of familiarity with advanced technologies, combined with local concerns about building power-generating facilities at 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. Although 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 the potential gains from CDM participation would be greater. Inevitably, this will be a problem for the CDM Executive Board. It may even be appropriate for international institutions like the IADB 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 many significant 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 the 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.

# 7. Natural Disasters

## *7.1. Introduction*

This chapter analyzes Colombian natural disaster policy. Section 7.2 presents background information on the frequency and costs of natural disasters. Section 7.3 describes the legal framework for natural disaster policy. Section 7.4 presents data on implementation of this policy, and Section 7.5 analyzes its design and implementation. Finally, Section 7.6 presents recommendations.

A few preliminary notes on terminology should prove useful. Colombia's National Disaster Prevention and Management Plan (*Plan Nacional para la Prevención y Atención de Desastres,* PNPAD), described below, defines key terms as follows. A "disaster" is a situation caused by a natural, technological, or human-caused phenomenon that implies intense alteration in people, goods, services, or the environment. "Prevention" is a set of measures taken to avoid or reduce an anticipated event's impacts on people, goods, services, and the environment. Finally, "mitigation" consists of measures intended to reduce or diminish risk to an "acceptable" level when it is not possible to eliminate it completely.

## *7.2. Frequency and Costs of Natural Disasters*

Colombia is extremely vulnerable to natural disasters. The country's climate, topography, and hydrology imply a high risk of floods and landslides—risks that are greatly exacerbated by deforestation and unsustainable agricultural techniques. Furthermore, much of Colombia is located on the Andean fault line (where several tectonic plates meet) and therefore is at high risk of earthquakes, volcanic eruptions, and tsunamis. Finally, the country is affected by the El Niño southern oscillation, which periodically causes severe droughts and flooding. Major natural disasters in recent history include earthquakes in Cúcuta (1875), Caldas (1979), Popayán (1983), Atrato (1992), Tauramena, Pereira, and Pasto (1995), and Armenia (1999); repeated activities associated with the Nevado del Ruiz and Galeras volcanoes; and tsunamis in Tumaco (1906 and 1979).

Table 7.1 from Charvériat (2000) presents information on the incidence of natural disasters and their costs in Central and South America between 1970 and 1999. During this period, Colombia averaged 2.97 natural disasters per year, the second-highest annual rate of natural disasters among the 19 countries in both regions. Charvériat (2000) estimates that these natural disaster caused 30,000 deaths.

**Table 7.1. Disaster Exposure Indicators, Central and South America, 1970–1999**

| Country | Disaster occurrence | | | Fatalities | | Economic losses | |
|---|---|---|---|---|---|---|---|
| | Total | Per year | Per km² | Total deaths | Deaths per 1,000 inhabitants | Losses (1998 millions $US) | Loss/1995 (percentage) |
| *Central America* | | | | | | | |
| Belize | 6 | 0.2 | 0.3 | 5 | 0.02 | 33.8 | 5.4 |
| Costa Rica | 33 | 1.1 | 0.7 | 287 | 0.08 | 1,117.5 | 13.4 |
| El Salvador | 16 | 0.5 | 0.8 | 2,880 | 0.50 | 2,713.9 | 22.9 |
| Guatemala | 28 | 0.9 | 0.06 | 24,139 | 2.20 | 3,062.5 | 17.3 |
| Honduras | 28 | 0.9 | 0.3 | 17,347 | 2.90 | 4,239.5 | 82 |
| Mexico | 117 | 3.9 | 0.06 | 15,594 | 0.20 | 13,822.5 | 3.60 |
| Nicaragua | 26 | 0.9 | 0.2 | 13,067 | 2.90 | 5,780.5 | 338.4 |
| Panama | 15 | 0.5 | 0.2 | 152 | 0.06 | 170.0 | 1.8 |
| *South America* | | | | | | | |
| Argentina | 48 | 1.60 | 0.02 | 685 | 0.02 | 11,201.0 | 3.8 |
| Bolivia | 31 | 1.03 | 0.03 | 787 | 0.10 | 4,919.9 | 21.0 |
| Brazil | 102 | 3.40 | 0.01 | 4,462 | 0.03 | 1,756.7 | 2.2 |
| Chile | 47 | 1.57 | 0.06 | 997 | 0.07 | 16,238.1 | 6.3 |
| Colombia | 89 | 2.97 | 0.09 | 29,857 | 0.80 | 4,457.8 | 11.5 |
| Ecuador | 46 | 1.53 | 0.20 | 7,091 | 0.61 | 6,824.5 | 42.5 |
| Guyana | 5 | 0.17 | 0.10 | 0 | 0.00 | 29.8 | 4.6 |
| Paraguay | 16 | 0.53 | 0.04 | 109 | 0.02 | 116.1 | 1.4 |
| Peru | 78 | 2.60 | 0.06 | 72,475 | 2.98 | 5,988.7 | 10.3 |
| Uruguay | 7 | 0.20 | 0.04 | 2 | 0.00 | 30.0 | 0.2 |
| Venezuela | 19 | 0.63 | 0.02 | 30,446 | 1.40 | 2,055.2 | 2.2 |
| AVERAGE | 40 | 1.32 | 0.17 | 11,599 | 0.78 | 4,450 | 31 |

Source: Charvériat (2000).

Tables 7.2 and 7.3 from Larsen (2004) present further data on the impacts from natural disasters between 1999 and 2003. On average during this period, 142 persons per year were killed by natural disasters, 533,000 people per year were affected in some way, and 18,000 houses per year were affected in some way.

**Table 7.2. Impacts of Natural Disasters, 1999–2003**

| Impact | 2003 | 2002 | 2001 | 2000 | 1999* |
|---|---|---|---|---|---|
| Deaths | 122 | 142 | 74 | 96 | 276 |
| Injured persons | 420 | 39 | 379 | 111 | 351 |
| Missing persons | 18 | 52 | 28 | 15 | 60 |
| Persons affected (000) | 436 | 343 | 205 | 468 | 1,214 |
| Families affected (000) | 88 | 67 | 40 | 94 | 240 |
| Houses destroyed (000) | 2.1 | 1.3 | 1.6 | 2.5 | 5.5 |
| Houses damaged (000) | 16.8 | 10.2 | 14.5 | 10.9 | 26.2 |
| Roads damaged | 31 | 83 | 66 | 135 | 375 |
| Bridges damaged | 8 | 13 | 14 | 61 | 123 |
| Pedestrian overpasses, bridges damaged | 10 | 22 | 20 | 57 | 126 |
| Water supply systems affected | 6 | 119 | 21 | 91 | 136 |
| Sewage systems affected | 1 | 1 | 1 | 5 | 30 |
| Health centers affected | 6 | 8 | 8 | 11 | 7 |
| Schools, education centers affected | 45 | 65 | 64 | 76 | 89 |
| Community centers affected | 31 | 62 | 40 | 31 | 62 |

Source: Larsen (2004) derived from DGPAD database.

*Not including the Armenia earthquake.

**Table 7.3. Annual Average Impacts of Natural Disasters, 1999–2003**

| Impact | 1999–2003 |
|---|---|
| Deaths | 142 |
| Persons affected (000) | 533 |
| Houses affected (000) | 18 |

Source: Larsen (2004) derived from DGPAD database.

*Not including the Armenia earthquake.

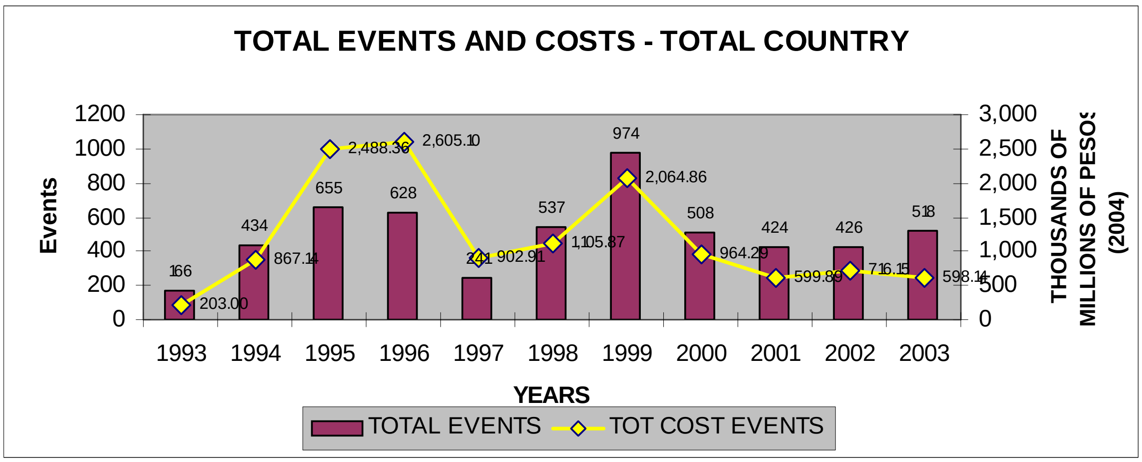
### *7.2.1. Economic Damages*

Economic damages from natural disasters are significant. The cost of the Nevado del Ruiz volcano in 1986 was estimated at US$211 million, the El Niño in 1997 and 1998 at US$564 million, and the 1999 Eje Cafetero earthquakes at US$1.5 billion (Pollner 2002). Charvériat (2000) estimated the economic costs of natural disasters in Colombia between 1970 and 1999 at US$4.5

billion, a sum that represents 11.5% of Colombia's 1995 GDP. Larsen (2004) estimates that the mean *annual* cost of natural disasters is COP $1,759 billion.[68]

Figure 7.1 presents the Colombian government's data on the frequency and costs of natural disasters and emergency events from 1993 to 2003, along with estimates from Larsen (2004) of the costs these disasters generated. We omit the 1999 Armenia earthquake because the costs it generated far exceed those of other disasters.

**Figure 7.1.**




The imperfect correlation between frequency and cost of disasters demonstrates that the total cost of disasters in any given year depends not only on the number of disasters but also on the location and type of the disaster: disasters in urban areas have much more severe impacts than those in rural areas because they affect many more people.

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[68] Larsen's estimates are based on a simple formula that assigns fixed per unit costs to various types of damaged infrastructure (Table 7.4). The costs include only material damages and do not take into account human morbidity or mortality.

**Table 7.4. Unit Costs Used to Estimate Costs of Natural Disasters**

| Infrastructure type | Unit cost (million pesos 2003) |
|---|---|
| Houses destroyed | 33.2 |
| Houses damaged | 16.8 |
| Furniture and equipment damaged or destroyed (per house) | 8.1 |
| Roads and bridges damaged | 1,990 |
| Water supply and sewage systems damaged | 1,300 |
| Health centers damaged | 13,650 |
| Education and community centers damaged | 1,065 |

Source: Larsen (2004).

### 7.2.1. Types and Timing

Table 7.5 presents information on natural disasters between 1999 and 2003 broken down by type of disaster. Floods affected the greatest number of people. However, earthquakes appear to have inflicted more severe damages. They accounted for majority of deaths, injuries, and houses destroyed.

**Table 7.5. Percentage of Disaster Impacts by Type of Disaster, 1999–2003**

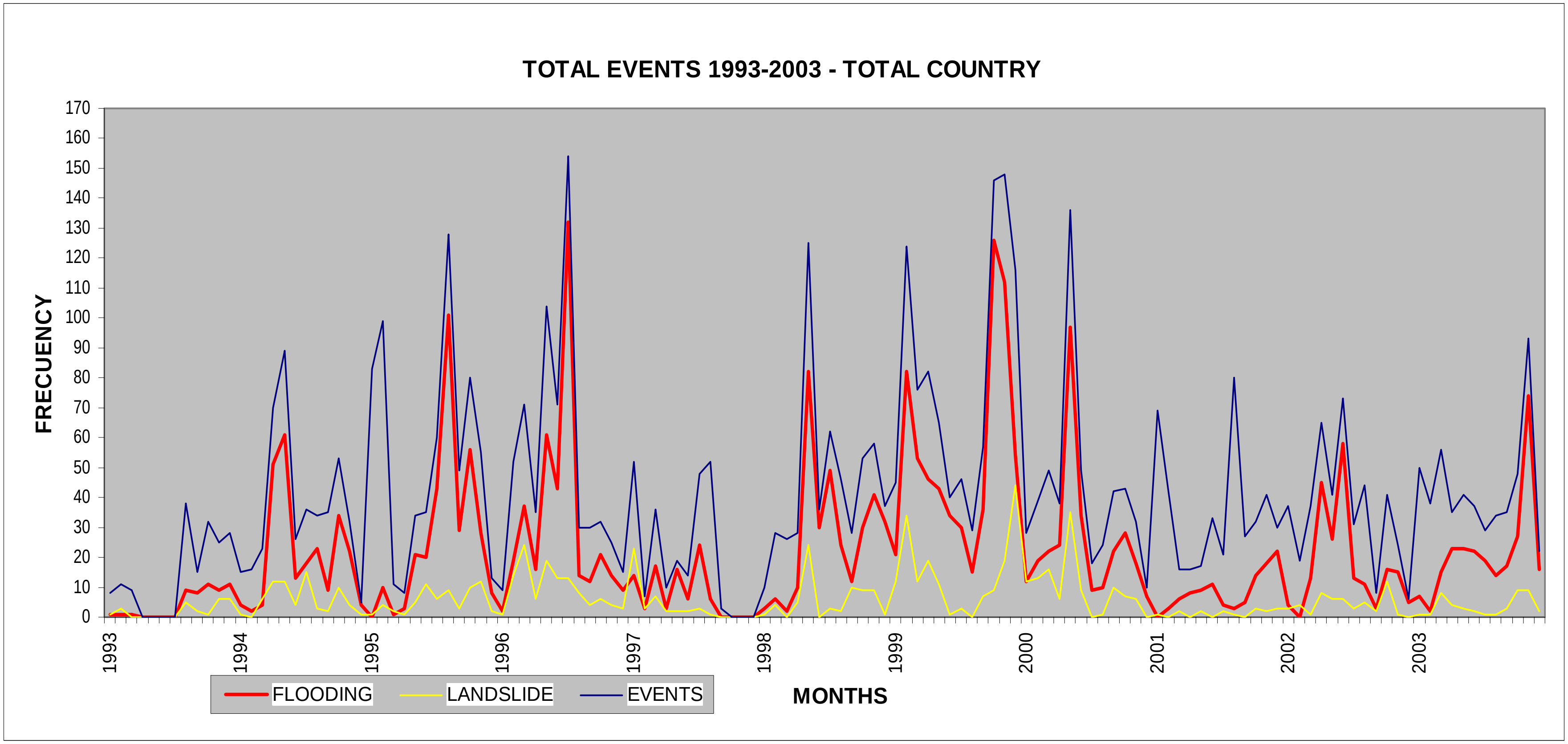
| Event | Deaths | Injured persons | Persons affected | Houses destroyed | Houses damaged |
|---|---|---|---|---|---|
| Landslides | 18% | 6% | 3% | 6% | 5% |
| Floods | 8 | 3 | 71 | 20 | 35 |
| Storms | 0 | 5 | 7 | 5 | 25 |
| Droughts | 0 | 0 | 3 | 0 | 0 |
| Structural fires | 1 | 2 | 0 | 8 | 0 |
| Forest fires | 0 | 0 | 1 | 0 | 0 |
| Avalanches | 3 | 1 | 1 | 4 | 2 |
| Earthquakes | 63 | 76 | 13 | 56 | 32 |
| Contamination | 0 | 4 | 0 | 0 | 0 |
| Other | 6 | 2 | 1 | 0 | 1 |
| | | | | | |
| Total | 100 | 100 | 100 | 100 | 100 |

Source: Larsen (2004) derived from DGPAD database.

*Not including the Armenia earthquake.

Figure 7.2 presents the monthly frequency of floods and landslides, along with the total number of disasters. The graph shows that these events mainly occur during the rainy months of May–June and October–November. Fortunately, this cyclic pattern is predictable, a characteristic that in principal facilitates disaster planning and prevention.

**Figure 7.2.**


TOTAL EVENTS 1993-2003 - TOTAL COUNTRY
FRECUENCY
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
FLOODING
LANDSLIDE
EVENTS
MONTHS

## *7.3. Legal Framework*

This section is organized as follows. Section 7.3.2 discusses the principal natural disaster laws and regulations including: Law 9 of 1979, Law 46 of 1988, Decree-Law 919 of 1989, and Decree 93 of 1998. Section 7.3.3 summarizes relevant provisions of the 1991 constitution, and Section 7.3.4 summarizes relevant provisions of land use planning law. Section 7.3.5 discusses the links between the National System for the Prevention and Management of Disasters (*Sistema Nacional para la Prevención y Atención de Desastres,* SNPAD) and the National Environmental System (*Sistema Nacional Ambiental,* SINA). Section 7.3.6 covers legal provisions for funding SNPAD. Finally, Section 7.3.7 presents a synopsis of the Colombian natural disaster policy.

A few preliminary notes on Colombian law—specifically, the hierarchy of legal instruments and the relationship between old and new laws—may prove useful. The penultimate legal authority in Colombia is the Constitution: all other legal instruments must comport with its general principles and specific details. Laws are next in the hierarchy: they create institutions and contain general dictates. Finally, presidential decrees flesh out laws: they provide specific details and procedures needed to implement them. In general, regional environmental authorities, including CARs and AAUs, can pass laws that are more restrictive than national laws, but not less. In other words, national laws set a floor for the stringency of local laws. New laws and regulations completely supersede old ones only when the new law explicitly states that they do. But this is rare—typically, new laws include language to the effect that "this law overrules all regulations that contradict it." In such cases, some provisions of old laws remain in place.

### 7.3.1. Natural Disaster Law

#### *Law 9 of 1979*

Law 9 of 1979 created Emergency Management Committees and establishes disaster prevention and management procedures. This was one of the first general integrated laws covering public health in Colombia. Its broad aim was to create procedures that would preserve or improve sanitary conditions—defined as those that ensure the well-being of the population and public health—including disaster prevention and management measures. Only Title VIII of Law 9 dealt exclusively with disasters. It covered prevention as well as management.

Emergency committees. Law 9 created national, regional, and local disaster management institutions. At the national level, the National Emergencies Committee (*Comité Nacional de Emergencias,* CNE) was responsible for declaring the beginning and end of an emergency situation and for coordinating disaster response activities. Regional and local emergency committees—one in each department and municipality—had similar functions. CNE, along with national and regional emergency committees, were to acquire the information systems and equipment needed to diagnose and mitigate disaster risks. CNE was also assigned responsibility for specifying and approving disaster alarm systems.

Disaster preparedness. Law 9 required local emergency committees to prepare a contingency plan for each type of disaster that threatened their communities. These plans were to be presented to CNE, which in turn would present them to the Ministry of Health for approval. The Ministry of Health was to coordinate training programs needed to facilitate the contingency plans.

The contingency plans were to be based upon a vulnerability assessment and a disaster planning exercise. Title VII required all public and private entities in charge of managing utilities to analyze their facilities' vulnerability to disasters. CNE was charged with specifying other cases in which vulnerability assessments would be needed and with identifying the minimum protective requirements that facilities should have.

The second input into contingency plans was planning exercises led by national and local emergency committees. Every entity that could provide shelter (according to criteria to be established by the emergency committee) was to be involved. The planning operation was to consider a variety of disasters and for each type was to identify responsible authorities, the functions of these authorities, supplies and their location, and places that could be used during the period of the disaster.

Disaster management. Law 9 included several provisions regarding disaster response. It mandated that the authority in charge of the alarm system was the only entity allowed to provide news regarding emergencies. The same authority was to validate the existence of the disaster and provide immediate assistance. The regional emergencies committee would then assess the disaster in order to determine its magnitude, its area of influence, and whether federal or regional assistance would be needed. Emergencies committees were also responsible for providing first aid, leading rescue activities, removing debris, establishing shelters to lodge victims and prevent epidemics, and reconstruction and rehabilitation of disaster areas. The Ministry of Health was to provide attention to wounded people, manage corpses, and handle waste disposal and other sanitary measures. CNE was responsible for requesting foreign assistance for disasters. The Ministry of Health would also certify that minimum sanitary conditions had been met so that CNE could declare a situation "back to normal."

***Decree 3489***

Decree 3489 of 1982 implements the disaster provisions of Law 9 of 1979. Decree 3489 of 1982 contains detailed regulations that implemented the disaster provisions of Law 9 of 1979. For example, it specified the functions of CNE, established criteria for declaring an emergency; detailed procedures that both CNE and other governmental institutions were to follow in various emergencies, and established emergency operations centers. Most of the provisions of this decree were superseded by subsequent decrees, which are described below.

***Law 46***

Law 46 of 1988 created the National Disaster Prevention and Management System. Two severe natural disasters in the early 1980s—the 1983 Popayán earthquake and the 1985 Nevado del Ruiz volcano and avalanche—raised grave concerns regarding disaster planning and management. As a result, Congress passed Law 46 of 1988. The president received special powers from Congress to promulgate this law. Law 46 supersedes several provisions of Law 9 of 1979 and—along with Decree 919 from 1989—constitutes the country's most important national disaster regulation.

SNPAD. The main purpose of Law 46 was to create the National Disaster Prevention and Management System (*Sistema Nacional para la Prevención y Atención de Desastres,* SNPAD). Law 46 charged this new set of disaster prevention and management institutions with (i) defining the responsibilities and functions of all public and private institutions related to disaster prevention and management; (ii) integrating public and private efforts for disaster prevention and management; and (iii) guaranteeing timely and efficient management of the human, technical, administrative, and economic resources necessary for preventing and managing disaster situations. Law 46 did not specify the exact composition of SNPAD; this was left to Decree-Law 919 of 1989 discussed below.

CNPAD and DGPAD. At the national level, the two most important institutions in SNPAD are the National Disaster Prevention and Management Committee (*Comité Nacional para la Prevención y Atención de Desastres,* CNPAD) and the National Disaster Prevention and Management Office (*Oficina Nacional para la Prevención y Atención de Desastres,* ONPAD) which is today known as the *Dirección General para la Atención y Prevención de Desastres* (DGPAD) and is located in the Ministry of Interior and Justice.[69] CNPAD is a high-level committee to that heads SNPAD and coordinates its activities through DGPAD. It comprises (i) the president, who presides over it; (ii) the ministers of Government, Finance, Defense, Health, Communications, and Transportation (and later Environment); (iii) the chief of the Department of National Planning; (iv) the national directors of Civil Defense and the Red Cross; (v) the director of DGPAD; and (vi) two representatives of industry, professional, or community associations.[70] DGPAD's function is to coordinate day-to-day disaster planning and management. Its director is appointed and removed by the president. Funding for DGPAD is provided by the National Calamity Fund (*Fondo Nacional de Calamidades,* FNC), which is discussed below.

<u>PNPAD</u>. Law 46 charges DGPAD with promulgating (by presidential decree) the National Disaster Prevention and Management Plan (*Plan Nacional para la Prevención y Atención de Desastres,* PNPAD; see discussion below of Decree 93 of 1998). Law 46 requires that PNPAD cover a wide range of issues, including (i) disaster prevention, immediate management, and reconstruction; (ii) all relevant technical, scientific, economic, funding, community, judiciary, and institutional topics; (iii) educational and participatory issues; (iii) integrated information and communication systems; (iv) the role of mass media; (v) interinstitutional and intersectoral coordination; and (vi) the need for research or technical studies. These issues are to be addressed by every national, regional, and local planning office.

<u>Integrated disaster information system</u>. Using PNPAD as a guide, DGPAD is to organize integrated information system that facilitates the identification of disaster risks.

<u>CREPAD and COLPAD</u>. Law 46 creates two types of regional and local disaster prevention and management institutions: the Regional Disaster Prevention and Management Committee (*Comité Regional para la Prevención y Atención de Desastres,* CREPAD) and the Regional Disaster Prevention and Management Committee (*Comité Local para la Prevención y Atención de Desastres,* COLPAD). Each department is to have a CREPAD and each municipality a COLPAD. These institutions comprise (i) the governor or mayor, who presides; (ii) the highest military

[69] ONPAD was originally located in the Administrative Department of the Presidency of the Republic. It was moved to the Ministry of Government by Decree 1680 of 1991. Decree 2035 of 1991 and Decree 372 of 1996 changed the Ministry of Government into the Ministry of Interior, and Decree 2546 of 1999 merged the Ministry of Interior with the Ministry of Justice to create the Ministry of Interior and Justice.

[70] Subsequently, when the Ministry of Environment was created by Law 99 of 1993, the minister of Environment was to be a part of this CNPAD.

commander in the area; (iii) the director of the Health Sectional Service (for CREPADs) or unit (for COLPADs); (iv) the police commander; (v) a representative of Civil Defense and the Red Cross; (vi) two representatives chosen from the region's CAR and productive, professional or community associations; and (vii) for CREPADs, the mayor of the capital city of the department.

Declarations of disaster. Law 46 mandated that the president, as head of CNPAD, be in charge of declaring—through a decree or resolution—the existence of a disaster situation, along with its magnitude. The magnitude of disasters can be classified as national, departmental, district, or municipal. The president is also charged with declaring resumption of total or partial normalcy. Declarations of disaster are to specify the responsibilities of all public and private entities that might be involved with the disaster.

Specific disaster response action plan. After a disaster has been declared, DGPAD—and CREPAD or COLPAD in the case of regional or local disasters—is responsible for producing a specific disaster response action plan, which becomes a mandatory document for all public and private entities involved. Required disaster response activities are to be coordinated by DGPAD (for national disasters), CREPADs (departmental disasters), or COLPADs (municipal disasters).

***Decree-Law 919***

Decree-Law 919 of 1989 implements provisions of Law 46 of 1988. Its main objective is to identify the members of SNPAD and define their responsibilities and functions. The decree purports to do this in a way that integrates these organizations' efforts. The decree also proposes some general guidelines for managing disaster situations as well as the procedures to be followed by each institution for both prevention and management of potential and actual disasters.

Composition of SNPAD. The decree establishes that the members of SNPAD are as follows: (i) CNPAD; (ii) CREPADs and COLPADs; (iii) DGPAD; (iv) the National Technical Committee for the Prevention and Management of Disasters, a committee created by the decree; (v) the Operational Committee for the Management of Disasters, a committee created by the decree; (vi) the ministries and administrative departments with disaster-related responsibilities, specifically the ministries of Government, National Defense, Health, Public Works and Transportation, Education, Agriculture, Communications, and the National Department of Planning (and later the Environment Ministry); (vii) the national decentralized entities: INGEOMINAS, Civil Defense, HIMAT, Telecom, SENA, IGAC, ICT, INDERENA, the CARs, and the Fiduciary Society La Previsora;[71] (viii) the territorial entities (including departments and municipalities) affected by the disaster; (ix) the Colombian Red Cross; and (x) the entities and persons concerned with the management and prevention of disasters and calamities.

The decree specifies the members of the committees at the national, regional and local levels, together with their functions and responsibilities. (For details regarding the members and submembers of SNPAD, see Annex 2.) It also establishes the functions of the territorial entities, such as departments and municipalities.

<u>Planning</u>. Decree 919 requires that the recommendations of PNPAD be included in any land use plan. It also mandates the prioritization of risk mitigation activities in major economic sectors.

<u>National Disaster Information System</u>. Decree 919 mandates creation of the National Disaster Information System—a repository of data on risks and vulnerabilities as well as guidance on disaster prevention and risk mitigation measures.

<u>Definition of disaster</u>. Decree 919 clarifies the criteria for declaring and terminating a state of emergency. In the cases where the situation does not qualify as a state of emergency, it is to be considered a "public calamity" and is eligible to be upgraded to a state of emergency during the first three months after the event.

<u>Use and demolition of private property</u>. Decree 919 establishes guidelines for public use of private property in a disaster situation. It specifies that municipalities are responsible for identifying locations to be used as temporary housing and care facilities in the event of a disaster. When disaster actually strikes, the mayor's office is required to publish a request for the temporary (up to one year) occupation of these locations. These locations can be purchased or even expropriated by force if need be. However, this occupation must be accompanied by written notification, may not exceed the minimum necessary space and time (up to one year), and should cause the least possible damage to the private property. The owners must be compensated for any damage resulting from the occupation. Decree 919 also establishes guidelines for the demolition of buildings and relocation of people in high-risk areas.

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[71] INGEOMINAS (*Instituto Colombiano de Geología y Minería*) is the Colombian Institute of Geology and Mining; the HIMAT (Instituto Hidrología, Meteorología y Adecuación de Tierras )was a natural resources data collection institute that was eventually replaced by IDEAM; SENA (*Servicio Nacional de Aprendizaje*) is the National Learning Institute; IGAC (*Instituto Geográfico Agustin Codazzi*) is the Geographical Institute; ICT (*Instituto de Crédito Territorial*) is the Territorial Credit Institute; and INDERENA (*Instituto de Hidrología, Meteorología y Adecuación de Tierras*) was an environmental and natural resources agency affiliated with the Department of Agriculture that was superseded by MMA and then MAVDT.

Demolition must be accompanied by an official order, and relocation must be accompanied by a study. The acquisition of new land for resettlement can be done either by direct negotiation or by expropriation, using the "public utility" or "social interest" provisions contained in the legislation.

Financing. Decree 919 mandates that the debts that victims of disasters owe to public entities are to be refinanced without interest or penalties. Furthermore, any legal process for debt collection underway is to be postponed or suspended. Decree 919 leaves it to future regulation to define athe actual mechanism by which the credit renegotiation should be done. The decree mandates that donations to the government for disaster victims are to be used for the intended purpose and allocated according to the specific action plan. These funds are to be managed by the National Calamity Fund (discussed below) with the collaboration of the regional or local disaster management offices. The disaster-related expenses of the government and other entities will be subject to fiscal control only when the "back to normal" situation has been declared.

***Decree 93***

Decree 93 of 1998 establishes the National Disaster Prevention and Management Plan (PNPAD). As noted above, Law 46 of 1988 mandated that the newly created DGPAD prepare a National Plan for the Prevention and Management of Disasters (PNPAD). A PNPAD was not approved for 10 years, however, until the promulgation of Decree 93 of 1998. This delay had the advantage of enabling PNPAD to take into account all of the natural disaster-related entities and policies created between 1988 and 1998 by: the Constitution of 1991, Law 99 of 1993 (including CARs, research institutes and the MMA) and Law 388 of 1997 on land use planning. Decree 93 of 1988 states that the main goal of PNPAD is to guide the actions of government and civil society to prevent and mitigate disaster risks and to attend to and restore areas that have suffered a disaster.

Decentralization. The decree states that PNPAD is to operate in a decentralized manner that allows the regional and local governments to carry out their functions.[72]

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[72] The decree mandates that PNPAD must observe the "concurrence," "complementarity," and "subsidiarity" principles in Colombian law that are meant to ensure both interinstitutional coordination and public participation.According to Law 152 of 1994: (i) the Concurrence Principle states that when two or more planning authorities that have different power levels must develop joint activities toward a common goal, their performance should respect each other's competence and be opportune and efficient; (ii) the Complementarity Principle establishes that each authority will proceed within its competences

Programs. Decree 93 stipulates that research and an understanding of risks should be the basis of the decisionmaking and planning processes. Toward that end, SNPAD is to carry create programs in four areas:

- identifying and characterizing sources of risk;
- incorporating risk reduction and prevention in planning mechanisms;
- strengthening SNPAD institutions; and
- information disclosure programs.

The decree lists specific activities meant to further these programs: installing a surveillance, detection, and alert network; developing a risk and threats inventory; including disaster prevention criteria in development plans; conducting inventories of settlements in high-risk areas; supporting relocation activities; defining housing standards; preparing a communications network for SNPAD institutions; strengthening CREPADs, COLPADs, Civil Defense, the Red Cross, and other SNPAD institutions; preparing contingency plans for the rehabilitation of utilities; establishing temporary management facilities for social housing and infrastructure reconstruction and relocation; designing an integrated information system and a documentation center network; and developing a national capacity-building system for government employees and community leaders.

Coordination between SINA and SNPAD. Decree 93 states that SINA and SNPAD need to coordinate their activities in areas such as (i) vulnerability, threats, and risks at national, regional, and local levels; (ii) the inclusion of risk mitigation and disaster prevention in environmental impact assessments and environmental management plans; and (iii) including risk as a trigger for the prohibition of certain land uses.

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and will collaborate with other authorities so that the development of their planning activities is efficient; and (iii)

the Subsidiary Principle states that the planning authority at the highest level must support those that lack technical capacity for the preparation of their own plans.

### *Presidential Directive 5 of 2001*[73]

Presidential directives do not have the power of law or decrees. They serve to highlight and prioritize issues, signaling that they are considered important by the office of the president. The purpose of Presidential Directive 5 of 2001 was to strengthen SNPAD to ensure a coordinated response in the case of a natural disaster of national scale. Although the directive does not specify any new features for SNPAD, it reemphasizes the importance of following the procedures, requirements, and proposals of Law 46 of 1988, Decree 919 of 1989, and Decree 93 of 1998. It also lists the efforts needed to define the representation of sectoral institutions at the departmental and municipal level and reiterates that national emergency response activities can be requested only through the governors' or mayors' offices and their regional or local committees. Finally, it requests that SNPAD members follow the directions of DGPAD.

## 7.3.2. States of Emergency

Article 215 of the Constitution of 1991 states that the president can declare a state of emergency in event of an actual or potential severe disturbance to the economic, social, or ecological order of the country. Declarations of emergency must be signed by all the ministers and approved by the constitutional court. The term of emergencies is limited to 30 days but can be extended to a maximum of 90 days per year. During this period, the president can issue decrees intended to control the crisis that have the strength of a law. For example, the president can issue decrees mandating new temporary taxes.[74] The decrees issued during this period must be approved by the constitutional court.

## 7.3.3. Land Use Planning and Disaster Management

### *Law 9 of 1989*

Law 9 of 1989 regulates municipal development plans, purchasing, sales, and expropriations. Although the main purpose of Law 9 of 1989 is to establish the basic regulation for urban development in Colombia, several provisions relate to disaster prevention and management,

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[73] A presidential directive is an "instructional memo" written by the president and addressed to specific parties. Although it can include specific mandates, it does not have the strength of a decree. Presidential Directive 5 of 2001 was addressed by the president to the ministers, directors of administrative departments, directors and managers of national decentralized entities, governors and mayors.

[74] Such taxes can last only until the end of the current fiscal year, unless Congress passes a law to make them permanent.

notably those that regard the expropriation of land for the purpose of relocating people in high-risk areas. Specifically, Article 56 of Law 9 states that the mayor of every municipality should identify and report every housing complex located in high-risk areas. The houses and land of those being relocated can also be expropriated and used as partial payment for the land to which they will be moved. Article 56 establishes fines for not complying with this law, the revenue from which is to be used for the relocation activities.

***Decree 1424***

Decree 1424 of 1989 regulates Article 56 of Law 9 of 1989. It stipulates that mayors should send an inventory of housing complexes in high-risk areas to the governor or to the Ministry of Government. These inventories should provide location (including boundaries), a census of the permanent residents, and an analysis justifying its classification as a high-risk area.

***Law 2 of 1991***

Law 2 of 1991 modifies Law 9 of 1989. It states that mayors are to make inventories of housing complexes in high-risk areas jointly or in consultation with the municipal or departmental planning office. It also stipulates that the people living in such housing complexes must be relocated. Finally, it states that if people remain in high-risk areas within the municipality, then any and all areas in the municipality expropriated by the mayor's office—including land that is declared "of public use" or of "social interest" or that is expropriated from criminals—can be used only to relocate these people, and not for any other uses.[75] Law 2 also states that any citizen can request the local government to include a piece of land in the high-risk inventory, whereupon the government is required to make a determination of whether to do so.

***Law 3 of 1991***

Law 3 of 1991 also modifies Law 9 of 1989. It creates the National Social Interest Housing and Urban Reform Institute (*Instituto Nacional de Vivienda de Interés Social y Reforma Urbana,* INURBE), which is charged with providing housing subsidies to low-income families. Most of this fund's functions are not particularly relevant to natural disasters. However, the fund is responsible for the acquisition (voluntarily or by expropriation) of any land at high risk for disasters. Once INURBE has acquired this land, it is responsible for relocating the families that

[75] In Colombia, land (as well as companies or any other properties) proven to have been bought with money from illegal sources (i.e., drug dealing) can be expropriated by the government.

used to live there and stabilizing the terrain to mitigate risk. This law also reforms the Territorial Credit Institute.

***Decree 4 of 1993***

Decree 4 of 1993 implements Law 3 of 1991 and charges INURBE with prioritizing the allocation of and distributing relocation subsidies to households in disaster and calamity areas. Also, land and houses in the high-risk areas that are being evacuated can be expropriated and used as partial payment for the land and houses to which the family is being relocated.

***Law 388 of 1997***

Law 388 of 1997 modifies Law 9 of 1989 and Law 3 of 1991 and, among other things, addresses municipal land planning issues related to disaster prevention. It stipulates that land use plans (*planes de ordenamiento territorial,* POTs), which are required of every municipality in the country, must contain an assessment of the factors related to risks and natural disasters. Specifically, POTs must include policies, directives and regulations regarding the prevention of natural disasters, the location of human settlements in risk areas, and management strategies for zones in high-risk areas. The law is particularly emphatic in requiring that municipalities identify high-risk areas so that settlement there can be limited. Once identified, these areas are to be managed jointly by the municipality and the CAR in which it is located.

***Decree 879 of 1998***

Decree 879 of 1998 stipulates the contents of land use plans and standardizes their components. The decree states that all the priorities contained in the POTs must be set by the municipal development plan and other regulations of higher hierarchy, including those related to the prevention of threats and natural risks. POTs must have (i) a general component that covers the entire municipality's territory and indicates the mid- and long-term land use objectives and strategies; (ii) an urban component that deals with land management for urban areas and the expansion of those areas, and (iii) a rural component that facilitates adequate interaction between rural and urban areas and the supply of basic utilities to the rural population. All three components of POTs must identify high-risk areas, as well as those to be used for relocation of households currently in high-risk zones.

***Decree 932 of 2002***

Decree 932 of 2002 implements Law 388 of 1997 and states that prior to its expiration, a POT can be modified only under special circumstances. The decree was intended to prevent changes in POTs that serve private interests. It stipulates that a POT can be modified prior to expiry only when a disaster or public calamity has been declared or when the results of detailed technical studies on threats, risks, and vulnerability require revising the POT's high-risk designations. The decree states that the mayor is to request and initiate reviews of POTs. The CAR of the region in which the municipality is located also has to approve the POT's modification.

### 7.3.4. The National Environmental System and the National Disaster Prevention and Management System

Law 99 established a National Environmental System (*Sistema Nacional Ambiental,* SINA) headed by a newly created Ministry of Environment (*Ministerio del Medio Ambiente,* MMA). Several provisions of Law 99 concern disaster prevention and management. One of the law's basic principles is that disaster prevention and management are matters of collective interest, and as a result, SINA is required to promote them. In addition, among the many functions assigned to MMA are the evaluation, followup, and control of natural disaster risks. Law 99 directs MMA to coordinate the actions intended to anticipate and prevent emergencies. Finally, Law 99 requests that the Ministry of Government and MMA coordinate the activities of SINA and SNPAD in an effective manner.

Law 99 assigns CARs—SINA's regional authorities—principal responsibility for implementing a wide range of environmental and natural resource policies, including disaster prevention and management. The law establishes that one of the functions of CARs is to organize activities for the analysis, followup, prevention, and control of disasters, in coordination with other competent authorities. It also stipulates that CARs are assist these institutions in the environmental aspects of disaster prevention and management. The specific responsibilities of CARs include working jointly with the local and regional institutions to improve the security of urban areas located in high-risk zones.

### 7.3.5. Funding for the National Disaster Prevention and Management System (SNPAD)

As discussed above, SNPAD comprises a variety of institutions. Most have responsibilities other than disaster prevention and management, obtain funding from a variety of sources, and allocate only part of their funding to this task. An exception is DGPAD, an office within the

Ministry of Interior and Justice that focuses solely on disaster prevention and mitigation and is allocated a budget from general revenues.

***Decree 1547***

Decree 1547 of 1983 creates the National Calamity Fund (*Fondo Nacional de Calamidades,* FNC) as a national account with administrative, accounting, and statistical independence. The decree stipulates that FNC's funds are to be used to (i) provide financial support for dealing with disasters; (ii) control the effects of catastrophes, especially those involving epidemics; (iii) support rehabilitation and restructuring of basic sanitation facilities; (iv) finance information systems and other equipment necessary to diagnose and manage catastrophic situations; and (v) take actions to prevent or mitigate the effect of disasters.

Decree 1547 mandates that FNC be established with the following resources: (i) a minimum of 500 million pesos from the national budget; (ii) special funds provided by the national government; (iii) loans; (iv) internal debt bonds; and (v) grants.

Allocation of FNC's resources is to be managed by a consulting board comprising (i) the minster of Government, who presides; (ii) the minster of Finance; (iii) the minister of Health; (iv) the minister of Transportation; (v) the minister of Agriculture; (vi) the banking superintendent; (vii) the director of Civil Defense; and (viii) two representatives of the president who are experts in insurance. In addition, since Law 99 of 1993, the consulting board includes the minister of Environment.

***Law 60 of 1993***

Law 60 of 1993 concerns the distribution of financial resources among regional entities. Article 21 of this law provides more specificity regarding the allocation of financial resources among municipalities discussed in Article 357 of the Constitution. It states that in addition to education, health, housing, and utilities, these resources are to be used for stabilizing high-risk zones, relocating households at risk, and preventing and managing disasters.

***Law 715 of 2001***

Law 715 of 2001 replaces Law 60 of 1993. In modifying the Constitution of 1993, Legislative Act 1 of 2001 necessitated revisions to several laws. Law 715 of 2001 replaces Law 60 of 1993 and creates the General Participations System (*Sistema General de Participaciones*). The municipalities are to use this system to promote, fund, or cofund projects of municipal interest, including those related to natural disasters. Law 715 establishes that the municipalities along with the national government and the departments are to cofinance projects to prevent and manage natural disasters within their jurisdiction including by relocating households in high-risk zones.

### 7.3.6. Synopsis of Natural Disaster Policy

Like Colombia's National Environmental System (SINA), the country's National Disaster Prevention and Management System (SNPAD) is an all-encompassing set of institutions—spanning both the public and private sectors and the national and regional levels—within which some relationships are somewhat vague. The functions and relationships among the principal actors within SNPAD are relatively well defined, however.

#### *National-level institutions*

The principal national-level institutions within SNPAD are listed in Appendix 7.2.

CNPAD. An executive body that comprises the most important disaster-related authorities and institutions in the Colombia, CNPAD is the highest authority in SNPAD. Its principal responsibilities are to define broad policy directions for SNPAD and to declare emergencies. It reviews policy documents, emergency declarations and regulations prepared by DGPAD, and decides whether to approve them. If approved, these documents are passed to the president, who can sign decrees making them mandatory. CNPAD was also responsible for approving the National Disaster Prevention and Management Plan (PNPAD) and for defining the main mechanisms for its execution, followup, and evaluation.

DGPAD. Housed in the Ministry of Interior and Justice, DGPAD handles the day-to-day operation of SNPAD with the assistance of the National Operations Committee and the National Technical Committee. One of its principal charges is supporting the regional and local disaster management committees (CREPADs and COLPADs). DGPAD is also in charge of preventive activities at the sectoral level—for example, for health care, water utilities, transportation, and energy. In the event of an actual disaster of national magnitude, one of DGPAD's principal responsibilities is to prepare a specific disaster management action plan, which becomes a mandatory document for all public and private entities involved.

National Operations Committee. The National Operations Committee provides assistance in the case of actual disasters. It is supervises three national advisory commissions and four national services (see Annex 2). Among its specific responsibilities are conducting initial damage assessment, providing temporary housing, distributing aid, reestablishing safe environmental conditions, and operating disaster alarms.

National Technical Committee. The National Technical Committee mainly helps DGPAD—as well as CREPADs, and COLPADs—identify risks and promote disaster prevention. It provides technical and scientific input on specific disaster-related issues to national-level institutions and can assume some of the functions of CNPAD. It is also responsible for establishing the group that coordinates firefighting operations. The National Technical Committee, like the Operations Committee, supervises 15 national advisory commissions and 7 national services (see Annex 2), including groups that specialize in technical issues such as housing, seismic activities and observatories, tsunamis, and forest fires.

National Calamity Fund. A fifth national-level institution within SNPAD is the National Calamity Fund (FNC). FNC funds are mainly used for restoration activities and support of communities affected by a disaster. FNC is run by a consulting board that includes the ministers with disaster-related functions, a representative of the president, and members of Civil Defense. Notwithstanding FNC funds, every entity at the national, regional, or local level is responsible for allocating resources from their annual budgets for disaster prevention and management.

***Regional-level institutions***

Disaster management policy in Colombia is highly decentralized. The two primary regional and local institutions within SNPAD are Regional Committees for Disaster Prevention and Management (CREPADs), which operate at the department level, and Local Operative Committees for Disaster Prevention and Management (COLPADs), which operate at the municipal level. CREPADs and COLPADs support and assist CNPAD and DGPAD in executing the National Disaster Plan (PNPAD) and in ensuring that regional and local institutions comply with its provisions. Both types of committees are permanent and have considerable autonomy from the national government. CREPADs report to departmental governors; COLPADs report to municipal mayors. These regional and local committees are responsible for operating alarms in cases of disasters and for promoting and coordinating disaster prevention and community capacity-building programs. During a disaster that is not of national magnitude, they are responsible for declaring and terminating a state of emergency and for producing a specific disaster management action plan that defines the responsibilities of various institutions involved. More broadly, they are responsible for coordinating management of the situation.

***Policy***

The disaster prevention policies of SNPAD entail four types of activities: (i) developing information on disaster risks, (ii) incorporating disaster prevention and mitigation into planning activities and construction codes, (iii) strengthening SNPAD institutions; and (iv) promoting education on disaster prevention and mitigation.

<u>Developing information on disaster risks</u>. DGPAD is responsible for building an integrated disaster information system that includes data on risks and vulnerabilities as well as surveillance, detection, and alert networks. Many networks in the system are run by entities that specialize in related functions. For example, INGEOMINAS is responsible for the seismology and vulcanology network, IDEAM is responsible for the hydrometeorology network, and mayors' and governors' offices are responsible for the disaster alert networks. DGPAD, CREPADs, and COLPADs are responsible for building documentation centers that cover their management levels—national, departmental, and municipal, respectively.

Risk and threat inventories are a central component of the effort to build knowledge about disaster risks. Law 9 of 1989 originally mandated such inventories and gave the territorial entities responsibility for carrying them out. Subsequent decrees and policies spread responsibility for these inventories among various institutions with relevant expertise. For example, INGEOMINAS is charged with preparing seismology and vulcanology risk maps, and IDEAM is responsible for a hydrometeorology risk maps.

<u>Incorporating of disaster prevention into planning and construction</u>. According to Colombian law, disaster prevention and mitigation considerations are supposed to be incorporated into land use, contingency, and development planning as well as into construction codes.

*Land use planning*. Both municipalities and CARs share responsibility for incorporating disaster considerations into land use plans (POTs). Municipalities are responsible for including in their POTs detailed inventories of areas at high risk of natural disaster. CARs are responsible for verifying that high-risk areas are clearly identified in POTs.

Once an area has been classified as "high risk," either the mayor's office or the CAR can make a determination that the area is unfit for infrastructure or occupation. In such cases, households in these areas are supposed to be relocated to alternative areas identified by the municipality. National subsidies can finance some of the relocation. Prior to the Uribe administration, INURBE was responsible for relocation subsidies. Since then, however, MAVDT has assumed this responsibility.

In addition to identifying areas suitable for relocating households, municipalities are also responsible for identifying locations to be used as temporary housing and care facilities in the event of a disaster. When disaster actually strikes, the mayor's office is required to publish a request for the temporary (up to one year) occupation of these locations. These locations can be purchased or even expropriated by force if need be. The municipality is supposed to compensate the (public or private) owner.

*Contingency planning*. For national-level disaster risks, contingency plans are the responsibility of the National Technical Committee in association with DGPAD. For the regional and local risks, contingency plans are supposed to be prepared by CREPADs and COLPADs and approved by the governor's or mayor's office. In addition, municipalities are responsible for ensuring that public services companies (utilities) conduct a vulnerability assessment of the existing utilities and prepare contingency plans. Also, municipalities are required to request that any public service company planning to construct new facilities carry out an *a priori* risk and vulnerability assessment to prevent building in high-risk areas.

*Development planning*. A third means of incorporating prevention and mitigation considerations into planning activities concerns economic and social development planning at the national, departmental and municipal levels. The Department of National Planning is supposed to incorporate disaster prevention and management into its development plan.

*Construction codes*. A final planning-related mechanism for promoting disaster prevention concerns construction codes. The PNPAD assigned the responsibility for defining housing standards to the National Technical Committee, more specifically to the Colombian Construction Chamber of Commerce (*Cámara Colombiana de la Construcción,* CAMACOL), and to the Colombian Society of Construction Engineers, both of which are part of the Permanent Advisory Commission for Seismic Resistant Construction. Territorial entities are supposed to enforce compliance with these guidelines.

<u>Strengthening SNPAD institutions</u>. DGAPD and MAVDT share responsibility for strengthening SNPAD institutions at the national level. Strengthening of regional and local entities is to be carried out mainly by DGPAD and MAVDT together with CARs and territorial entities. Finally, for assistance institutions such as the Red Cross and Army, responsibility for capacity building is shared among the Ministry of Interior, the Army, the Police, and the Ministry of Health.

Education. Disseminating information about disaster prevention and management among public- and private- sector officials and the public at large is the responsibility of SENA, the ministries of Education and Environment, DGPAD, CREPAD, and COLPAD.

## 7.4. Evaluation of Natural Disaster Policies

This section presents data on the efficiency and effectiveness of SNPAD. Section 7.4.1 summarizes general evaluations of the overall performance of the system. Section 7.4.2 presents evaluative data on several SNPAD institutions—CNPAD, DGPAD, the National Technical Committee, the National Operations Committee, CREPADs, and COLPADS. Section 7.4.3 discusses SNPAD's funding. Section 7.5 discusses disaster planning. Finally, Section 7.6 discusses land use planning.

### 7.4.1. General Evaluations

All evaluative materials on SNPAD reviewed for this chapter—both interview data and written reports—share a theme: SNAPD's disaster prevention (versus management) efforts are inadequate. Closely related criticisms are that the generation, management, and dissemination of information on disaster risks are inadequate, and financing of prevention activities is insufficient.

***Inadequate attention to disaster prevention***

Stakeholders interviewed for this chapter stated that SNPAD's design is partly to blame for weak performance in disaster prevention (see list of interviews, Annex 3). They stated that, in the spirit of the 1991 Constitution, one of SNPAD's defining characteristics is decentralization. A related characteristic is that many of SNPAD's top institutions—including the National Technical Committee and the CREPADs and COLPADs—comprise preexisting institutions. These characteristics have had both advantages and disadvantages. Decentralization has enabled SNPAD to rely on local and regional resources in addition to those provided by the national government. Also, reliance upon existing institutions has made it possible to build SNPAD's institutions expeditiously. Because most of the members of important disaster committees work in other capacities, however, they often neglect their day-to-day disaster-related responsibilities within SNPAD. Evidently, this is particularly true of disaster prevention and risk mitigation. Stakeholders interviewed for this report repeatedly stated that disaster committees typically do not actively engage until an actual disaster strikes. This was consistently mentioned as one of the major overall weaknesses of SNPAD.

Pollner et al. (2002), CONPES (2001), and Freeman et al. (2003) all concur with our interviewees' opinion that SNPAD has failed to devote sufficient resources to disaster prevention. Pollner et al.'s (2002) main criticism of SNPAD is that it focuses disproportionately on disaster management instead of prevention. They write that the principal areas of SNPAD that need to be improved are its ability to (i) assess risks and vulnerabilities; (ii) build capacity for disaster management and prevention at the local level; and (iii) generate nonemergency financing. (We will return to the specifics of the latter two points in our sections on CREPADs and COLPADs and on funding, below). CONPES (2001) states that "Disaster management (versus prevention) is typically considered the main responsibility of the [national, regional and local] disaster committees…despite PNPAD and other norms that mandate prevention"(7). This report also concurs with the assessment of our interviewees that SNPAD's constituent members are typically not focused on natural disasters. It states, "The majority of national entities in SNPAD have not incorporated this participation into their programs and statutes, a fact that limits their commitment to it." (9) According to Freeman et al. (2003), "…mitigation activities tend to relate to reconstruction rather than to risk reduction and trying to avoid the perpetuation of vulnerability has been a challenge." (16)

***Poor information, communication, and coordination***

A second set of cross-cutting problems within SNPAD involves poor information on disaster risks, poor communication about these risks, and poor coordination among the system's many constituent members.

As noted above, Decree 919 of 1989 mandates that DGPAD create the National Disaster Information System. Unfortunately, however, by all accounts, this information system remains incomplete and inadequate. Several entities have good information that could be incorporated into the system. For example, DGPAD has information on past disasters, IDEAM has hydrometerological information, DIMAR has oceanographic information, and SPS and INS have sanitation information. However, these information systems are not linked or integrated. DGPAD personnel interviewed for this report stressed the need to gather together in one place all the disaster-related data contained in existing information systems, including those for environmental, hydrographic, sanitation, mining, and oceanographic data. A related concern repeatedly addressed by a variety of interviewees is the need for a improved system to allow for effective and timely communication among the members and levels of SNPAD.

According to Pollner et al. (2002), with some specific exceptions, Colombia's information on disaster risks and vulnerabilities is inadequate.[76] A number of factors contribute to this problem. First, funding for studies and scientific instruments is inadequate. Second, many of the studies that do exist often use inconsistent methodologies and are not technically rigorous. Those that contain reasonably good scientific and technical information sometimes do not use it effectively to assess risk and vulnerability. Finally, an integrated information system containing, for example, data on costs, death tolls, injuries, damages, and risks does not exist. The end result is that it is "difficult to mitigate future risks and take preventative actions." (464).

CONPES (2001) supports Pollner et al.'s overall negative assessment of SNPAD's information and systems. According to this report, at the national level, SNPAD has knowledge about disaster threats because it comprises several top scientific institutions. However, SNPAD has limited knowledge about physical, social, economic, and cultural vulnerabilities to these threats. For example, SNPAD may have good seismic maps but poor information about what these maps imply for populations living in earthquake-prone areas. As a result, modeling or quantifying the impact of potential disaster risks—an essential activity for disaster policy—is difficult if not impossible.

CONPES (2001) states that for the National Disaster Information System to be developed adequately, links among SNPAD, the National System of Science and Technology (SNCyT), and the National Environmental System (SINA) need to be strengthened. Specifically, the new system would need to integrate the following existing information systems:

- *Sistema de Información Ambiental para Colombia* (MAVDT);
- *Sistema Nacional de Información Oceanográfica* (Commisión Colombiano del Océano, CCO);
- *Sistema de Información de Agua Potable y Saneamiento Básico* (MDE);

[76] Pollner et al. (2002) list five areas where information on disaster risk is relatively strong. (i) Both detailed seismic maps and preliminary seismic vulnerability studies have been developed for Bogotá. (ii) The Normas de Diseno y Contrucción Seismo Resiste (NSR-98) mandated seismic studies aimed at identifying of zones across the country where the probability of a seismic incident is greater than 10% over the next 50 years. Accordingly, detailed seismic maps have been developed for Armenia, Bogotá, and Pereira. (iii) The cities of Manizales and Tumasco have incorporated risk mitigation into their political agendas. (iv) INURBE has commissioned evaluations of housing conditions that can be used to assess risk and vulnerability to natural disasters. (v) The Ministry of Development has developed maps of areas that are susceptible to floods, volcanoes, landslides, and earthquakes in 1,054 municipalities (with the help of IDEAM, INGEOMINAS, and IGAC).

- *Sistema de Potencialidades y Restricciones para el Desarrollo Minero- Energético* (MME);
- regional and local systems such as the *Sistema de Información para la Gestión de Riesgos y Atención de Emergencias* (SIRE) (Alcaldía de Bogotá e INGEOMINAS);
- information maintained by CARs; and
- the SNPAD information center.

Poor information aside, CONPES (2001) cites as a serious weakness SNPAD's lack of an integrated system of communication among far-flung constituent institutions as well as weak coordination among these members at the national, regional and local levels. (9) Among the most urgent communication issues is strengthening the natural disaster monitoring and alert systems (Pollner et al. 2002).

Finally, both CONPES (2001) and Pollner et al. (2002) fault SNPAD for failing to devote sufficient attention to public education on disaster risk mitigation. Although piecemeal education efforts exist, a national public education campaign strategy is lacking.

### 7.4.2. Primary Institutions

***CNPAD***

CNPAD is not a permanent institution—it meets whenever disasters or calamities strike to approve declarations of the emergencies, and otherwise meets only infrequently (every month or two) to vet documents prepared by DGPAD and other government bodies. Annex 4 presents all disaster and calamity declarations of the past decade.

***DGPAD***

As noted above, DGPAD carries out policies set by CNPAD and is responsible for the day-to-day operation of SNPAD. It has 32 full-time employees and is organized into six offices that reflect DGPAD's foci:

- education and information: disseminating plans and actions to CREPADs and COLPADs;
- national programs: designing policies and presenting draft laws and decrees;

- emergencies: receiving and directing petitions for declaration of emergencies and disasters;
- jurisdiction: executing agreements and contracts with entities that will manage disasters or emergencies;
- administration and finance: preparing budgets; and
- regions: providing technical support for prevention and management of disasters.

Several stakeholders interviewed for this study at both the national and the regional levels (see Annex 3) stated that of the many institutions represented in SNPAD, DGPAD has the best understanding of its role and the procedures to be followed during a disaster. Moreover, these interviewees suggested that DGPAD generally performs its functions adequately. One function that DGPAD evidently performs particularly well is building capacity in regional natural disaster institutions by, for example, offering short courses on contingency planning. That said, there is little hard evidence to support these opinions.

Notwithstanding those positive informal evaluations, according to CONPES (2001), DGPAD has faced obstacles in recent years. Specifically, it has been reformed and restructured repeatedly, a process that has generated considerable political, financial, and institutional instability. Also, DGPAD had significantly greater resources and autonomy when it was a part of the Administrative Department of the Presidency than it has today as part of the Ministry of Interior and Justice. DGPAD originally was allocated a budget from general national revenues. Today, its budget comes from the Ministry of Interior and Justice. The end result has been budget reductions and cuts in personnel that, according to CONPES (2001), have affected its performance.

***National Technical Committee***

The National Technical Committee comprises entities with considerable technical and scientific expertise. Nevertheless, according to CONPES (2001), committee members do not always have the most *appropriate* expertise, and sometimes have little influence.

***National Operations Committee***

As can be seen in the organizational chart attached as Annex 2, unlike the other national institutions that lead SNPAD, the National Operations Committee comprises institutions that focus primarily on natural disasters, emergencies, and calamities. Examples include Civil

Defense, the Red Cross, the Ministry of Health, and the National Firefighting Board. As a result, the members of the National Operations Committee are relatively well-trained to work on emergency and disaster contingency, prevention, and risk mitigation. That said, according to CONPES (2001), the National Operations Committee has severe financial difficulties because the entities assigned to it typically have minimal operating budgets. For example, the Red Cross and the National Firefighting Board have had difficulty establishing capacity-building projects, acquiring equipment, and maintaining vehicle fleets.

***CREPADs and COLPADs***

As noted above, Pollner et al. (2002) identify limited local-level capacity for risk prevention and mitigation as one of SNPAD's major deficiencies. Unfortunately, there is no centralized repository of information on CREPADs and COLPADs. In fact, according to CONPES (2001), no evaluation of the more than 900 CREPADs and COLPADs has ever been carried out. (9) Therefore, our performance data are derived primarily from interviews with stakeholders in selected areas, including coordinators of CREPADs in Valle del Cauca, San Andrés, and Cordoba (see Annex 3).

<u>Resources</u>. Funding for CREPADs and COLPADS, including salaries of support staff, comes directly from departments and municipalities, respectively. According to stakeholders interviewed for this report, unfortunately, these funds are almost always insufficient. Further detail on funding is included in the next section.

<u>Staffing</u>. As with many institutions in SNPAD, CREPADs and COLPADs consist of representatives of existing institutions related to natural disasters. This staffing strategy has important disadvantages. Perhaps most importantly, according to stakeholders interviewed for this report, local disaster committee members typically focus on responsibilities other than disaster prevention and management. For example, the CREPAD coordinators interviewed for this study were all persons with high-ranking positions in the governors' administration, including department secretaries and department planning secretaries. Although this ranking no doubt imbues disaster committee directors with more power and influence than they would otherwise have, it also implies that their day-to-day responsibilities tend to crowd out their disaster responsibilities.

Interviews with CREPAD directors conducted for this study confirmed stakeholders' comments about this disadvantage. The directors did not appear to be particularly well informed about disaster prevention—most did not have information on prevention activities or projects underway in their departments. Note, however, that this could simply reflect a paucity of ongoing prevention activities. Notwithstanding their poor knowledge of disaster prevention activities, the CREPAD directors interviewed for this study generally had good information on the resources allocated for the management of actual disasters.

Role of CARs. In principal, CARs should play a vital role in local disaster prevention and management—they are the principal repositories of knowledge about the natural, physical, geographical, climatological, and geological characteristics of the areas under their jurisdiction, and CAR representatives are members of CREPADs and COLPADs. Unfortunately, however, CARs' actual role in local disaster prevention and management appears to be limited. Many of the CAR staff interviewed for this chapter (from CVC, CAR and Coralina; see Annex 3) were not even aware that Law 99 charges them with responsibilities for disaster prevention and risk assessment.

Performance. According to stakeholders interviewed for this report, although there is sometimes a delay in convening CREPADs and COLPADs after an actual disaster, the committees then generally operate according to previously defined procedures. The governor of the department (the head of CREPAD) or mayor of the municipality (the head of COLPAD) coordinates prevention and management activities and institutions so that the emergency is managed expeditiously.

### 7.4.3. Funding

***Requirements***

The costs of natural disasters in Colombia are daunting. Table 7.6 presents estimates from Freeman et al. (2003) of economic losses due to natural disasters in Colombia and three other countries in Latin America, along with financing needs (assuming that countries must cover half the costs). They estimate that the cost to Colombia of each 20-year event at US$2 billion, each 50-year event at US$5 billion, and each 100-year event at US$8 billion. These figures are the highest of the four study countries; as discussed in Section 7.2, Colombia is exceptionally vulnerable to natural disasters.

**Table 7.6. Projected Economic Loss from Disasters and Government Financing Needs (million US$)**

| Country | 20-year event | 50-year event | 100-year event |
|---|---|---|---|
| *Projected loss* | | | |
| Bolivia | 200 | 600 | 1,000 |
| Colombia | 2,000 | 5,000 | 8,000 |
| Dominican Republic | 1,250 | 3,000 | 6,000 |
| El Salvador | 900 | 3,000 | 4,500 |
| *Financing needs (50% loss)* | | | |
| Bolivia | 100 | 300 | 500 |
| Colombia | 1,000 | 2,500 | 4,000 |
| Dominican Republic | 625 | 1,500 | 3,000 |
| El Salvador | 450 | 1,500 | 2,250 |

Source: Freeman et al. (2003).

Table 7.7 presents estimates from Freeman et al. (2003) of the annualized losses due to 20-year to 100-year natural disasters for the study countries. The annualized loss is the amount of money that the country would need to set aside each year to cover the cost of these disasters. For Colombia, the annualized loss is $85 million per year, a sum that represents 8% of GDP and 60% of annual government expenditures.

**Table 7.7. Expected Annualized Loss Due to 20-year to 100-year Natural Disasters**

| Country | **Annualized loss** (million US$) | Annualized loss/GDP | Annualized loss/ government expenditures |
|---|---|---|---|
| Bolivia | 10 | 0.12 | 0.4 |
| Colombia | 85 | 0.08 | 0.6 |
| Dominican Republic | 54 | 0.34 | 1.8 |
| El Salvador | 48 | 0.40 | 2.2 |

Freeman et al. (2003).

*Sources*

FNC is clearly the principal domestic source of disaster management funding (Table 7.8). Of the 49 million pesos spent on disaster management between 1993 and 2003, 93% was provided by FNC, 5% by COLPADs and CREPADs, 1% by other entities such municipalities and private foundations, and less than 1% by aid organizations, including the Red Cross, Civil Defense, and

Army. Note, however, that because COLPADs and CREPADs do not have their own resources, their contributions must come from the entities that constituite them.

**Table 7.8. Disaster Funding by Source and Year (million 2004 COP)**

| Year | FNC | COLPADs, CREPADs | Aid organizations | Mixed aid (CREPAD, COLPAD, FNC) | Other entities | Total |
|---|---|---|---|---|---|---|
| 1993 | 736.50 | 38.05 | 0.00 | 119.93 | 0.00 | 157.98 |
| 1994 | 1,511.35 | 824.88 | 1.91 | 14.17 | 75.09 | 916.05 |
| 1995 | 3,142.20 | 915.22 | 0.00 | 25.98 | 449.14 | 1,390.33 |
| 1996 | 2,455.75 | 470.88 | 21.37 | 148.77 | 0.00 | 641.02 |
| 1997 | 251.86 | 117.85 | 0.00 | 51.76 | 0.00 | 169.61 |
| 1998 | 6741.57 | 21.97 | 0.00 | 0.00 | 0.00 | 21.97 |
| 1999 | 14,065.28 | 0.00 | 0.00 | 22.92 | 0.00 | 22.92 |
| 2000 | 4,304.81 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2001 | 3,178.97 | 29.38 | 0.00 | 0.00 | 0.00 | 29.38 |
| 2002 | 2,902.32 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2003 | 6,273.31 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | 45,563.92 | 2418.23 | 23.28 | 383.52 | 524.23 | 48,913.18 |
| **Average percentage** | 93% | 5% | 0% | 1% | 1% | 100 |

Source: DGPAD.

*Reactive instead of proactive*

FNC was initially capitalized with direct appropriations from the national budget. As noted above, the intention was to create a reliable, stable reserve fund that could be used expeditiously in the event of a natural disaster. Recently, however, FNC's funding has changed. Instead of receiving regular funds to build up a reserve, FNC now obtains major infusions of funding only after a disaster has occurred. CONPES (2001) states that the new mode of funding generates sudden fiscal destabilizations and slows response time during major catastrophes. Pollner et al. (2002) agree, identifying "cyclical and sometimes politically driven funding" as one of SNPAD's major weaknesses.

Table 7.9 shows total budget allocations to FNC. Note that by far the largest allocation occurred in 1995 and 1999. But in 1995, roughly 50% of the total allocation was additional, and in 1999, roughly 95% was.

**Table 7.9. Initial, Additional, and Total Budget Allocation to FNC (million 2001 pesos)**

| Year | Initial percentage | Additional percentage* | Total |
|---|---|---|---|
| 1995 | 50 | 50 | 17,500 |
| 1996 | 90 | 10 | 7,000 |
| 1997 | 100 | 0 | 5,000 |
| 1998 | 80 | 20 | 5,000 |
| 1999 | 95 | 5 | 28,154 |
| 2000 | 100 | 0 | 15,000 |
| 2001 | -- | -- | 10,449 |
| 2002 | -- | -- | 12,500 |
| 2003 | -- | -- | no data |
| 2004 | -- | -- | 3,800 |
| AVERAGE | 86 | 14 | 11,600 |

*Following actual natural disasters, estimated.

Sources: CONPES (2001) and DGPAD (2004).

CONPES (2001), Pollner et al. (2002), and Freeman et al. (2003) all concur that one important potential source of funding—natural disaster insurance programs—have not been explored in sufficient depth. The main reason is that SNPAD's efforts have been focused on responding to emergencies.

***Inadequate funding for prevention***

SNPAD resources have been disproportionately focused on disaster management instead of prevention. According to CONPES (2001), of the total budget of FNC, roughly 80% is devoted to disaster management and only 20% to prevention. In 2001–2004, resources used for prevention totaled only roughly COP $250 million, less than 2% of the COP $12,850 million requested by DGPAD for the 2002 Disaster Prevention Program.[77] Pollner et al. (2002) decry the lack of funding for the development of disaster prevention and contingency planning. They write that funds are rarely designated for this purpose—especially at the local level—and even when they are, they are often diverted to emergencies.

The problem is partly structural. As noted above, one of the motivations for SNPAD's decentralized design was to give it access to resources from the general budget of the varied

[77] The request for this funding is contained in BPIN File # 0002-30072-0000 of 2001.

entities that constitute the system, including departments, municipalities and the Red Cross. Furthermore, disaster planning and management were to be "mainstreamed" into the normal planning and investment activities of SNPAD's constituent institutions. Unfortunately, however, this has not happened. SNPAD's decentralized resources have been devoted almost exclusively to disaster management, not prevention. For example, of the 187,412 million pesos of investment made by municipalities between 1997 and 2000, less than 1% was directed to disaster prevention and management (CONPES 2001).

### 7.4.4. Disaster Planning

Decree 93 of 1998—wich established the National Disaster Prevention and Management Plan (PNPAD)—mandates that both national and local institutions develop detailed disaster contingency plans.

***Sectoral contingency plans***

Several "sectoral" disaster plans—that is, plans, laws, or regulations covering specific economic sectors—have been adopted. Unfortunately, according to CONPES (2001), many have been problematic. For example,

- El Niño. Contingency plans for dealing with the impacts of El Niño were promulgated as CONPES Document 2948 of 1997. CONPES 2985 of 1998 critiques the implementation of this plan, concluding that it has not been developed or monitored adequately.
- Farm insurance. Farm insurance legislation was promulgated as Law 69 of 1993. According to CONPES (2001), considerable difficulties were encountered in implementing this law.
- Earthquake resistance. Legislation regarding earthquake resistance was promulgated as Law 400 of 1997. This law mandated vulnerability studies in various sectors. Unfortunately, implementation has been incomplete. For example, only 20% of health care institutions have completed these studies.
- Mining and energy. Decree 321 of 1999 established a National Contingency Plan for Discharges of Hydrocarbons and Dangerous Substances.
- Transportation. According to CONPES (2001), regulation of the transportation of hazardous substances is inadequate.

DGPAD has prepared an instruction manual and has taught short courses for companies in various sectors on contingency planning. Some assistance for sector and local planning has also been provided by the Regional Andean Program for the Prevention and Mitigation of Risk (*Programa Regional Andino para la Prevención y Mitigación de Riesgos,* PREANDINO), funded by the InterAmerican Development Bank, U.S. Office of Foreign Disaster Assistance, the European Union, and *Corporación Andina de Fomento* (CAF).

***Local contingency plans***

Development of local contingency plans has also been inadequate. By law, Territorial Development Plans (*Planes Desarrollo Territorial,* PDTs) are supposed to contain Emergency and Contingency Plans (*Planes Locales de Emergencia y Contingencias* - PLECs). Table 7.10 presents data (collected by DGPAD) on PLECs—specifically, the number of municipalities that have been offered capacity-building services by DGPAD for the development of PLECs, the number that have actually adopted these plans, and the number in the process of developing them. DGPAD has offered capacity-building services in all but 5 of Colombia's 32 departments. Nevertheless, few municipalities have adopted contingency plans. Of Colombia's 1,092 municipalities, 73 have developed written plans, 35 are in the process of developing plans, and 112 report that the plans have been developed by the local CREPAD. In total, only one-quarter of all municipalities had adopted plans or were in the process of doing so.

**Table 7.10. Implementation of PLECs, 1998–2004**

| Department | Year assistance offered | Munici-palities | PLECs | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | M | I | EP | CR | Total | Municipalities (percentage) |
| Amazonas | 2002 | 2 | | | 1 | | 1 | 50 |
| Antioquia | 1999 | 125 | 6 | | 6 | 39 | 51 | 41 |
| Arauca | 2002 | 7 | | | 1 | | 1 | 14 |
| Atlántico | 2002 | 23 | | | | | 0 | 0 |
| Bolivar | 1999, 2002 | 45 | 5 | | 1 | | 6 | 13 |
| Boyacá | 1998, 2000, 2002 | 123 | | 15 | 10 | | 25 | 20 |
| Caldas | 2002 | 27 | | | 10 | 4 | 14 | 52 |
| Caquetá | – | 16 | | | | 1 | 1 | 6 |
| Casanare | 2002 | 19 | | 1 | 1 | | 2 | 11 |
| Cauca | 2000 | 41 | 1 | | | | 1 | 2 |
| Cesar | 1998, 2001 | 25 | | | | 1 | 1 | 4 |
| Córdoba | 2001 | 28 | | | | | 0 | 0 |
| Cundinamarca | 1998 | 117 | | | | | 0 | 0 |
| Choco | 2001 | 26 | 1 | 1 | | 4 | 6 | 23 |
| Guajira | 1998, 2002 | 15 | | | | | 0 | 0 |
| Guaviare | – | 4 | | | | 4 | 4 | 100 |
| Guiania | 2001 | 1 | | | | | 0 | 0 |
| Huila | 2001 | 37 | | | | | 0 | 0 |
| Magdalena | 2002 | 30 | 17 | 10 | | | 27 | 90 |
| Meta | 2002 | 29 | 6 | | 2 | | 8 | 28 |
| Nariño | 2000 | 63 | | | | 37 | 37 | 59 |
| Nte de Santander | 2002 | 40 | 1 | | 1 | | 2 | 5 |
| Putumayo | 2001 | 13 | | | | 2 | 2 | 15 |
| Quindio | 2002 | 12 | | 5 | | 6 | 11 | 92 |
| Risaralda | 2000, 2002 | 14 | | 1 | | 13 | 14 | 100 |
| San Andrés | 2002 | 2 | | | 1 | | 1 | 50 |
| Santander | 1999 | 87 | | | | | 0 | 0 |
| Sucre | 2002 | 25 | 2 | | 1 | | 3 | 12 |
| Tolima | – | 47 | 1 | | | 1 | 2 | 4 |
| Valle del cauca | 1999 | 42 | | | | | 0 | 0 |
| Vaupes | – | 3 | | | | | 0 | 0 |
| Vichada | – | 4 | | | | | 0 | 0 |
| TOTAL | 18 | 1092 | 40 | 33 | 35 | 112 | 220 | 25 |

Source: DGPAD.

M: electronic version; I: paper version; EP: in process; CR: found in CREPAD

Table 7.11 also presents data on the adoption of PLECs by CARs. These data are self-reported by CARs to MAVDT. They do not comport with the data collected by DGPAD. According to these data, 36% of the municipalities in the country have adopted PLECs, not 25%. Both figures are quite low.

**Table 7.11. Implementation of PLECs by CAR and Municipality, 2002**

| Entity | Municipalities | Municipalities with PLEC | Municipalities with PLECs (percentage) |
|---|---|---|---|
| Cam | 37 | 0 | 0 |
| Car | 104 | 0 | 0 |
| Carder | 14 | 12 | 86 |
| Cardique | 21 | 0 | 0 |
| Carsucre | 19 | 3 | 16 |
| Cas | 74 | 0 | 0 |
| Cda | 8 | 8 | 100 |
| Cdmb | 13 | 11 | 85 |
| Codechoco | 31 | 0 | 0 |
| Coralina | 2 | 0 | 0 |
| Corantioquia | 80 | 80 | 100 |
| Cormacarena | 10 | 0 | 0 |
| Cornare | 26 | 0 | 0 |
| Corpamag | 30 | 33 | 110 |
| Corpoamazonia | 31 | 5 | 16 |
| Corpoboyaca | 87 | 0 | 0 |
| Corpocaldas | 27 | 27 | 100 |
| Corpocesar | 25 | 0 | 0 |
| Corpochivor | 25 | 0 | 0 |
| Corpoguajira | 15 | 0 | 0 |
| Corpoguavio | 8 | 7 | 88 |
| Corpomojana | 7 | 7 | 100 |
| Corponariño | 64 | 33 | 52 |
| Corponor | 40 | 40 | 100 |
| Corporinoquia | 64 | 0 | 0 |
| Corpouraba | 19 | 0 | 0 |
| Cortolima | 47 | 47 | 100 |
| Cra | 23 | 0 | 0 |
| Crc | 41 | 0 | 0 |
| Crq | 12 | 12 | 100 |
| Csb | 24 | 7 | 29 |
| Cvc | 42 | 0 | 0 |
| Cvs | 28 | 0 | 0 |
| TOTAL | 1098 | 605 | 36 |

Source: Self-reported by CARs to MAVDT.

### 7.4.5. Land Use Plans and Construction Standards

PLECs aside, Colombian law mandates that different municipal, regional, and national planning mechanisms incorporate disaster prevention and management. Chief among these are land use plans (POTs). As noted in Section 7.3, Decree 919 of 1989 and Law 388 of 1997 mandate that POTs include policies, directives, and regulations regarding the prevention of natural disasters, the location of human settlements in risk areas, and management strategies for high-risk areas. However, compliance is apparently limited. Among stakeholders interviewed for this report, a common view is that natural disaster planning is handled by CREPADs and COLPADs and is not in the purview of planning authorities. According to CONPES (2001), a preliminary analysis conducted by the DGPAD indicated that most of the municipalities incorporate some disaster planning in their POTs, but a high percentage "do so in a deficient way." Reasons include lack of capacity to deal with disaster issues among the staff responsible for POTs.

CAR staff are responsible for supervising municipal POTs. Among the CAR staff interviewed for this study, there was a consensus that disaster planning and management are not appropriately addressed in POTs. Often the POTs are guided more by political considerations than by technical ones. Moreover, even when POTs identify areas as high risk, households and business in these areas are rarely relocated. In some cases, the mayor's office has relocated some families living in high-risk areas—typically poor households that cannot buy property—but new families have moved into informal (unlicensed, substandard) dwellings in these high-risk areas. According to MAVDT staff, a percentage of the total budget is allocated to people affected by disasters. However, this percentage is small and is intended only for people who have already been affected by a disaster—not for relocating those in high-risk areas.

Finally, both CAMACOL and the Constructing Engineering Society have already produced basic earthquake-resistance standards for housing and infrastructure. Municipal offices that issue construction permits *(curadurías urbanas)* are charged with enforcing these standards. However, according to interviewees at DGPAD, little monitoring occurs after a license has been issued.

## 7.5. Analysis

As discussed in Section 7.2, natural disasters have significant impacts on human health, the environment, and the economy in Colombia. As discussed in Section 7.3, Colombian law creates a wide-ranging system of institutions—SNPAD—to prevent and manage disasters. Although this legal foundation is not without weaknesses, the most important deficiencies in Colombian natural disaster policy clearly arise more from poor implementation than from flaws in policy design.

### 7.5.1. Inadequate Disaster Prevention

Without exception, all the evidence reviewed for this report suggests that the most important general problem in implementing natural disaster policy is insufficient emphasis on disaster prevention, as opposed to disaster management. This problem has a number of causes and manifestations.

#### *Structural characteristics of SNPAD*

Three basic structural characteristics of SNPAD contribute to a lack of emphasis on disaster prevention. First, SNPAD has a decentralized organizational structure. The regional and local disaster committees—CREPADs and COLPADs—bear much if not most of the burden for actually implementing natural disaster policy. Inevitably, given regional disparities in overall levels of institutional capacity within Colombia, some CREPADs and COLPADs are less competent in carrying out their functions that others, and the low-functioning committees fail to give adequate attention to natural disaster issues except in the event of actual disasters. For example, they are unlikely to develop requisite disaster contingency plans, incorporate disaster considerations into land use plans, relocate households in high-risk areas, enforce construction codes mandating earthquake resistance, or help raise public awareness about disaster prevention.

Second, SNPAD is all encompassing. It comprises all of the institutions in Colombia at the national, regional, and local levels that have a bearing on natural disasters. This characteristic—along with decentralization—implies that communication and coordination between CREPADs and COLPADs and between these institutions and national-level SNPAD entities are costly. This too contributes to inadequate attention to disaster prevention.

Finally, the leading institutions in SNPAD—CNPAD, DGPAD the National Technical Committee, and the National Operation Committee at the national level; CREPADs at the departmental level; and COLPADs at the local level—comprise representatives of existing institutions. These representatives do not count disaster prevention and management as their principal responsibility and, apparently, prioritize their disaster responsibilities only in the event of an actual disaster. The end result is that SNPAD institutions tend to be reactive rather than proactive.

***Funding***

Historically, FNC has provided more than 90% of funding for disaster prevention and management. However, only 20% of this funding has been devoted to prevention. Although the original intention of the framers of FNC was to create a reserve fund with a stable level of funding, in practice, this reserve has been depleted and is replenished only when a disaster occurs. This mode of operation limits resources available for disaster prevention. An alternative to such reactive funding is to rely on insurance mechanisms. However, this strategy has received limited attention.

***Information***

Colombia's disaster law recognizes that sound, readily available information on disaster risks and vulnerabilities is essential to promoting disaster prevention. However, implementation of information-related mandates has been inadequate. By all accounts, pockets of information on various risks and vulnerabilities exist. Overall, however, the necessary data are incomplete, poorly managed and maintained, poorly integrated, and not readily available. In addition, the disaster alert and monitoring system is inadequate, as are efforts to disseminate information to key institutions (such as COLPADs and CREPADs) and to the public at large. In sum, Colombia lacks the integrated national disaster information system mandated by law.

***Planning***

One way to promote natural disaster prevention is to mandate the inclusion of natural disaster considerations into Colombia's extensive planning process. Municipalities must incorporate disaster contingency into the development plans as well as their land use plans. In addition, national authorities are charged with developing disaster contingency plans for major economic sectors, such as health care and transportation. Unfortunately, however, implementation of this strategy has been woefully incomplete.

### 7.5.2. Parallels between SNPAD and the National Environmental System (SINA)

In many respects, SNPAD and the National Environmental System (SINA) are cut from the same cloth. Both were created within three years of the 1991 Constitution, and both reflect its emphasis on inclusiveness, participation, and decentralization. More specifically, both SNPAD and SINA comprise a set of far-flung of institutions at the national, regional, and local levels. Each system is led by a set of national-level institutions that set policy; coordinate and monitor interactions of local institutions; allocate national funds; generate, manage, and disseminate scientific information; and attempt to raise public awareness. And in each system, semiautonomous regional and local instructions with their own sources of funding are principally responsible for policy implementation. In both systems, decentralization was in part an effort to relieve the national government of the financial and administrative burden associated with central control.

Given those common characteristics, it should not be surprising that both SNPAD and SINA also share a number of weaknesses and problems. In both systems, capacity and performance vary markedly across autonomous regional and local institutions; coordination among the members of the system is inadequate; and generation, management, and dissemination of critical information are weak. Finally, in both systems, the potential strategies for solving these problems are similar. In both cases, collection of reliable indicators of institutional performance is a necessary condition for improved coordination and performance. Beyond this, possible strategies include both carrots and sticks—that is, the provision of inducements, such as national cofinancing, as well as more command-and-control and sanction-based policies, such as requiring municipalities to devote a fixed share of revenues to disaster prevention.

## 7.6. Recommendations

**1. Improve implementation of natural disaster prevention policies at the local and national levels.**

Many, if not most, of Colombia's COLPADs and CREPADs do an inadequate job of implementing disaster prevention mandates, such as developing contingency plans and incorporating disaster considerations into land use plans. The remedy begins with reliable, detailed, up-to-date information on this problem. Toward this end, DGPAD, one of Colombia's control organizations, and/or an independent research institute should conduct a study of the performance of CREPAD and COLPADs. Even more importantly, DGPAD should develop a permanent system of performance indicators for CREPADs and COLPADS. Local disaster committees would be required to report annually the data needed to operationalize this system. Self-reports should be subject to verification.

Given new performance data, several measures might be undertaken to improve implementation of natural disaster prevention policies at the local level. First, DGPAD can publicize the performance indicators described above. Recent case studies suggest that public disclosure of performance data by itself can create pressures for institutions to improve performance. Second, DGPAD, FNC, and other relevant institutions can provide funding—most likely matching funding—for disaster prevention projects. Allocations of funds should conform to priorities established by a risk assessment discussed below and should be subject to strict accountability and transparency conditions. Third, DGPAD can continue to help build capacity in disaster prevention at CREPADs and COLPADs by developing instructional materials and offering training and technical assistance. Fourth, Colombia's control organizations, which are charged with ensuring that government entities perform their assigned functions, can step up pressure on departments and municipalities to ensure that CREPADs and COLPADs are fulfilling disaster prevention mandates. Fifth, executive branch can investigate legal requirements that municipalities and departments spend a certain percentage of their tax revenue on disaster prevention. Finally, the executive branch can promulgate regulations that enable it to withhold transfers of national funds to departments and municipalities that are not fulfilling their obligations to implement natural disaster prevention policies.

Implementation of disaster prevention policies also needs to be enhanced at the national level. As discussed above, SNPAD comprises a large number of different types of institutions, a feature that makes communication and coordination difficult. One means of mitigating this problem would be to more clearly define (via new laws, decrees, regulations, or directives) the specific roles of each of the national-level members of SNPAD. Moreover, as with CREPADs and COLPADs, efforts could be made to develop data on how well national-level members of SNPAD are performing their functions, to publicize these data, and to use them to create incentives for more effective disaster prevention.

**2. Expedite completion of an integrated disaster information system.**

Colombian lawmakers have long recognized that reliable, up-to-date, readily available data on disaster risks and vulnerabilities, strategies for mitigating these risks, and strategies for managing disasters are absolutely essential for disaster policies to be effective. Despite specific mandates, however, Colombia still lacks a well-functioning integrated disaster information system. This gap needs to be filled as quickly as possible. The system should integrate oceanographic, hydrological, climatological, and seismographic data systems as well as others deemed appropriate. Data systems most relevant to areas deemed high priority by the risk assessment described above should be integrated first. To the extent possible, data in the system should be made available on the Internet. Subcomponents of the system should be made available as quickly as possible instead of waiting for the entire system to be completed. Adequate resources and effort should be provided to ensure that the system is well managed and maintained. Protocols should be developed to ensure the quality and standardization of data collection. Finally, user-friendly guidance documents on the interpretation, use, and application of the data should be made available.

**3. Mandate comparative risk assessments.**

Although SNPAD has developed detailed information on various disaster risks, to our knowledge, only limited efforts have been made to compare different types of risks in terms of their human and economic impacts. Given that resources available for disaster prevention are quite scarce, such comparative risk assessment is urgently needed to ensure that investments in disaster prevention have the greatest possible impact. Risk assessments are needed at the national, regional, and local levels. DGPAD can periodically perform national risk assessments, and CREPAD and COLPAD can periodically perform similar assessments of the disaster risks in their territory. DGPAD, departments, and municipalities should be required to use these comparative risk assessments to guide their allocations of financial, human, and technical resources. The DGPAD can take specific steps to make these requirements feasible. First, as discussed above, it can improve data collection and management. Second, it can develop a standard methodology for comparative risk assessments that is practical given CREPADs' and COLPADs' capacity for data collection and analysis in the medium term. Third, it can provide technical assistance and training in comparative risk assessment by, among other things, developing user-friendly training manuals and holding workshops. Finally, it can certify third parties to assist CREPADs and COLPADs in carrying out risk assessments.

**4. Integrate and strengthen the disaster monitoring and alert systems.**

Efforts to integrate and strengthen disaster alert and monitoring systems—including those for seismic activity, volcanoes, flooding, and tsunamis—should be expedited. The comparative risk assessment discussed above should be used to establish priorities for this project. Adequate resources and effort should be provided to ensure that the system is well managed and maintained.

**5. Enhance funding for disaster prevention.**

Lack of funding for disaster prevention at the national and local levels is an important—although by no means unique—barrier to adequate prevention. At the national level, it is critical that DGPAD and other national-level entities have a reliable source of nonemergency funding to support disaster prevention efforts. One option for achieving this goal would be to reinstate direct allocations to DGPAD from the national budget. This might entail repositioning DGPAD within the national-level bureaucracy. A second option would be to change the operating guidelines of FNC to ensure that it provides sufficient funding for prevention activities. A third option would be to mandate that the various members of SNPAD's national-level entities—e.g., ministries, and national services—guarantee funding for the participation of their representatives in SNPAD. Finally, DGPAD can be encouraged to make better use of the National Royalty Fund (*Fondo Nacional de Regalías,* FNR), international sources, and other sources of funding. If need be, the regulations governing FNR's allocations could be altered to facilitate funding for disaster prevention activities.

At the local level, CREPADs and COLPADs also must have the resources they need to meet regularly—that is, in nonemergency situations—and to undertake disaster prevention. A variety of measures can advance this goal. First, like DGPAD, CREPADs and COLPADs can be encouraged to make better use of FNR, international aid, and other sources of funding. DGPAD could provide guidance to CREPADs and COLPADs on how to raise funds for prevention activities. Second, the institutions that constitute CREPADs and COLPADs can be directed or encouraged to guarantee funding for the participation of their representatives in disaster committees.

**6. Investigate better use of insurance to provide disaster management financing.**

Colombia's use of insurance and other market instruments to finance disaster management is incipient. DGPAD should investigate the feasibility of making better use of such instruments at both local and national levels.

**7. Develop a prioritized agenda for scientific research on disaster risks and vulnerabilities, and promote priority research areas.**

The integrated disaster information system above will be only as good and useful as the scientific information it is based on. To ensure that requisite data are generated, DGPAD and/or an independent research organization should undertake a study to identify gaps and priorities for scientific research on disaster risks and vulnerabilities. The results from this study should be combined with those from the comparative risk assessment to develop a prioritized agenda for research. To promote the items on this agenda, targeted funding can be made available through existing funding channels (or new ones if these are deemed inadequate). In addition, the National System of Science and Technology (*Sistema Nacional de Ciencia y*

*Tecnologia,* SNCyT) can be better integrated into SNPAD. Finally, lines of communication between universities and other SNPAD intuitions can be strengthened.

**8. Improve coordination among CARs and regional disaster committees.**

Synergies between the important members of SNPAD—particularly CARs and regional disaster committees—are underexploited. To mitigate the problem, DGPAD, MAVDT, and the control organizations can strengthen enforcement of mandates that CARs participate in disaster planning and can create stronger incentives for inclusion of disaster considerations in environmental impact assessments and environmental licensing.

**9. Expedite sectoral contingency planning.**

DGPAD should commission a study of progress on sectoral contingency planning and use the results in combination with those from the comparative risk assessment discussed above to set a prioritized agenda for developing and strengthening sectoral disaster contingency plans. It should ensure that sufficient resources are made available, and sufficient incentives are provided so that planning in major sectors is expedited.

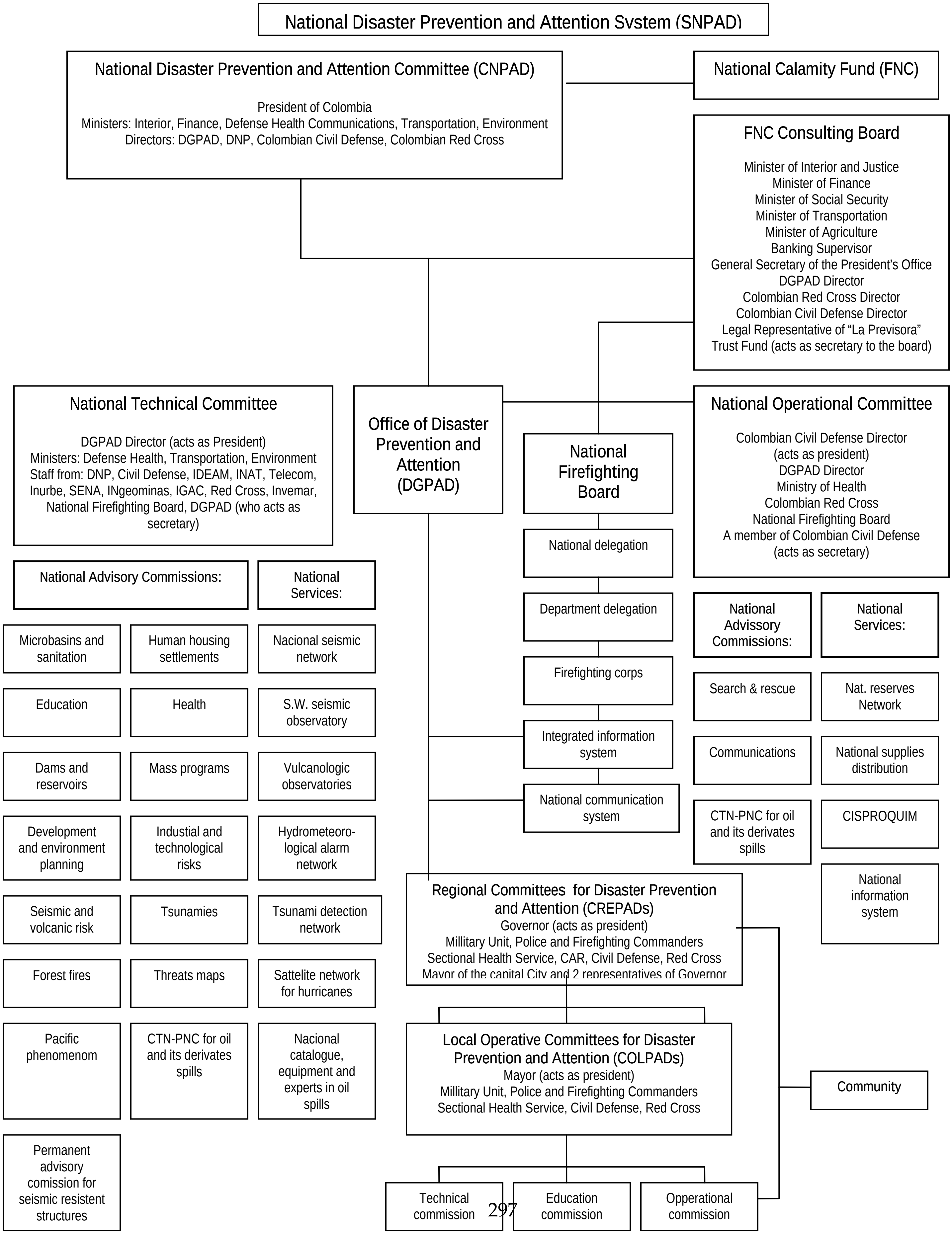
**10. Create stronger incentives for enforcing of construction codes.**

DGPAD should explore means of strengthening enforcement of disaster prevention provisions of construction codes.

**11. Raise public awareness about disaster prevention and management.**

Raising public awareness of disaster prevention will not only advance prevention directly, it can also generate the political will to pressure SNPAD to do this. Tools for achieving this goal include mass media campaigns and ensuring that disaster prevention and management are included in educational curricula.

## Appendix 7.1: National Disaster Prevention and Attention System


National Disaster Prevention and Attention System (SNPAD)
National Disaster Prevention and Attention Committee (CNPAD)
President of Colombia
Ministers: Interior, Finance, Defense Health Communications, Transportation, Environment
Directors: DGPAD, DNP, Colombian Civil Defense, Colombian Red Cross
National Calamity Fund (FNC)
FNC Consulting Board
Minister of Interior and Justice
Minister of Finance
Minister of Social Security
Minister of Transportation
Minister of Agriculture
Banking Supervisor
General Secretary of the President's Office
DGPAD Director
Colombian Red Cross Director
Colombian Civil Defense Director
Legal Representative of "La Previsora"
Trust Fund (acts as secretary to the board)
National Technical Committee
DGPAD Director (acts as President)
Ministers: Defense Health, Transportation, Environment
Staff from: DNP, Civil Defense, IDEAM, INAT, Telecom, Inurbe, SENA, INgeominas, IGAC, Red Cross, Invemar, National Firefighting Board, DGPAD (who acts as secretary)
Office of Disaster Prevention and Attention (DGPAD)
National Firefighting Board
National Operational Committee
Colombian Civil Defense Director
(acts as president)
DGPAD Director
Ministry of Health
Colombian Red Cross
National Firefighting Board
A member of Colombian Civil Defense
(acts as secretary)
National Advisory Commissions:
National Services:
Microbasins and sanitation
Human housing settlements
Nacional seismic network
Education
Health
S.W. seismic observatory
Dams and reservoirs
Mass programs
Vulcanologic observatories
Development and environment planning
Industial and technological risks
Hydrometeoro-logical alarm network
Seismic and volcanic risk
Tsunamies
Tsunami detection network
Forest fires
Threats maps
Sattelite network for hurricanes
Pacific phenomenom
CTN-PNC for oil and its derivates spills
Nacional catalogue, equipment and experts in oil spills
Permanent advisory comission for seismic resistent structures
National delegation
Department delegation
Firefighting corps
Integrated information system
National communication system
National Advisory Commissions:
National Services:
Search & rescue
Nat. reserves Network
Communications
National supplies distribution
CTN-PNC for oil and its derivates spills
CISPROQUIM
National information system
Regional Committees for Disaster Prevention and Attention (CREPADs)
Governor (acts as president)
Millitary Unit, Police and Firefighting Commanders
Sectional Health Service, CAR, Civil Defense, Red Cross
Mayor of the capital City and 2 representatives of Governor
Local Operative Committees for Disaster Prevention and Attention (COLPADs)
Mayor (acts as president)
Millitary Unit, Police and Firefighting Commanders
Sectional Health Service, Civil Defense, Red Cross
Community
Technical commission
Education commission
Opperational commission

## Appendix 7.2: CNPAD Declarations of Disaster and Calamity, 1993–2003

| Nº | Type | Resolution or Decree | Date | Departments - Municipalities | Event | Impacts |
|---|---|---|---|---|---|---|
| 1 | Severe calamity | 001 | 15/01/93 | Antioquia (Murindó, Urrao, Frontino, Mutatá, Vigía del Fuerte, Apartadó, Carepa, Chigorodó, Dabeiba, Cañasgordas, Caicedo y Medellín<br><br>Chocó (Bojayá, Riosucio) | Earthquake. October 17 and 18, 1992 | Intense damage to homes and infrastructure |
| 2 | Severe calamity | 002 | 02/07/93 | Andes - Antioquia | Landslide in the bed of River Tapartó | |
| 3 | Moderate | 003 | 02/07/93 | Bagadó - Chocó | Fire in capital municipality | Destruction of 100 homes |
| 4 | Severe calamity | 004 | 02/07/93 | Leticia and Puerto Nariño – Amazonas | Flooding | |
| 5 | Severe calamity | 005 | 10/08/93 | Department of Arauca (Puerto Rondón and Tame)<br>Departement of Casanare (Hato Corozal) | Earthquake | |
| 6 | Severe calamity | 006 | 20/12/93 | Dabeiba - Antioquia | Landslides and repressions | Destruction of homes |
| 7 | Severe calamity | 007 | 28/12/93 | Manizales - Caldas | Landslides | Destruction of homes, deaths |
| 8 | Severe calamity | 001 | 03/02/94 | Florida, Pradera and Tuluá – Valle del Cauca | Avalanche | Destruction of homes, deaths |
| 9 | Emergency due to grave public calamity | D-1178 | 09/06/94 | Cauca and Huila | Earthquake, fire, flooding, and avalanches | 15 calendar days starting June 9, 1994 |
| 10 | Disaster | D-2108 | 06/09/94 | Department of Cauca (Caldono, Inzá, Jambaló, Toribío, Caloto, Totró, Silvia, Páez and Santander de Quilichao)<br><br>Departement of Huila (La Plata, Paicol, Yaguará, Iquira, Tesalia and Nátaga) | Earthquake | Nasa Kiwe, direction, coordination and control |
| 11 | Severe calamity | 002 | 27/10/94 | Bagadó, Lloró, Bajo Baudó, Itsmina, Nóvita, Litoral del San Juan, Sipí and Quibdó - Chocó | Flooding | Damage to homes, agricultural sector |
| 12 | Severe calamity | 003 | 28/11/94 | Tibú, Tarra and Sardinata – Norte de Santander | Flooding | Damage to homes, agricultural sector |
| 13 | Severe calamity | 004 | 28/11/94 | Cáchira – Norte de Santander | Flooding | |
| 14 | Severe calamity | 001 | 21/01/95 | Departement of Boyacá (Garagoa, Miraflores, Páez, Campohermoso, San Luis de Gaceno)<br><br>Department of Casanare (Sabanalarga) | Earthquake | Damage to homes, infrastructure |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 | Severe calamity | 002 | 10/02/95 | Departement of Caldas (Palestina), Chocó (Quibdó and Sipi, Novita, Carmen de Atrato, San José del Palmar and Condoto)<br><br>Quindio (Armenia, Buenavista, Calarcá and Córdoba), Risaralda (Desquebradas, Pereira, La Virginia)<br><br>Valle del Cauca (Alcalá, Andalucia, Ansemanuevo, Argelia, Bolivar, Buenaventura, Buga, Bugalagrande, Caicedonia, Cali, Calima, Cartago, Dagua, El Aguila, El Cairo, Restrepo, Riofrío, Roldadillo, San Pedro, Sevilla, Toro, Trujillo, Tulúa, Ulloa, Versalles, Vijes, Yotoco, Zarzal) | Earthquake | Damage to homes, infrastructure |
| 16 | Severe calamity | 003 | 23/02/95 | Department of Boyacá (Aquitania, Berbeo, Boyacá, Cubará, Chinavita, Chitaraque, Chivor, Firavitoba, Guateque, Guayatá, La Capilla, Macanal, Mongua, Panqueba, Ramiriquí, Rondón, San Miguel, Santa María, Sogamoso, Somondoco, Tenza, Tibaná, Tópaga, Tota, Turmeque, Tuta, Villa de Leyva, Zetaquira)<br><br>Department of Casanare (Chámeza), department of Cundinamarca (Manta) | Earthquake | Recognize municipalities that were not included in declaratory Nº 001 21-01-95 |
| 17 | Severe calamity | 004 | 24/03/95 | San Juan de Pasto, Buesaco, La Florida y Chachagüí - Nariño | Earthquake | Damage to homes, infrastructure |
| 18 | Calamity | 005 | 10/04/95 | Neighbourhood Los Libertadores in the municipality of Neiva, Huila | Structural fire | Destruction of 33 homes |
| 19 | Severe calamity | 006 | 19/07/95 | Tibirita - Cundinamarca | Earthquake | Addition to resolutions Nº 002 and 003 |
| 20 | Severe calamity | 007 | 02/08/95 | Fredonia and Valdivia – Antioquia | Landslides | Destruction of homes, deaths |
| 21 | Severe calamity | 008 | 09/08/95 | Urban area of Barranquilla and Soledad - Atlántico | Flooding | Destruction of homes |
| 22 | Severe calamity | 009 | 19/09/95 | Department of Quindio (Armenia, Buenavista, Córdoba, Montenegro, Tebaida, Circasia, Salento, Génova, filandia, Pijao, Quimbaya)<br><br>Department of Caldas (Chinchiná, Riosucio, Risaralda), department of Chocó (Condoto), department of Risaralda (Dosquebradas, La Virginia, Balboa, Marsella, Santuario, Apía)<br><br>Department of Valle del Cauca (Alcalá, Andalucia, Ansemanuevo, Buenaventura, Buga, Bugalagrande, Caicedonia, Cartago, Dagua, El Dovio, Filprida, Guacarí, Jamundí, La Cumbre, Obando, Primavera, Restrepo, Roldadillo, San Pedro, Sevilla, Tuluá, Ulloa, Vijes, Yotoco, Yumbo, Zarzal) | Earthquake | Damage to homes, infrastructure and environment. Addition to resolution Nº 002/95 |
| 23 | Severe calamity | 010 | 07/11/95 | Atlántico (Baranoa, Candelaria, Galapa, Juan de Acosta, Luruaco, Malambo, Manatí, Palamar de Varela, Piojó, Plonuevo, Repelón, Sabanagrande, Sabanalarga, Santa Lucía, Santo Tomás, Usiacurí, | Flooding | Tourniquet plan, resolution Nº 011 of the 7-11-95 (Tourniquet plan intervention). Resolution Nº 012, |

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| | | | | Campo de la Cruz, Ponedera, Suan and Tubará)<br><br>Bolivar (Cartagena, Achí, Alto del Rosario, Barranco de la Loba, Calamar, Cicuco, Córdoba, El Carmen de Bolivar, Magangue, Maria La Baja, Mompox, Montecristi, Morales, Pinillos, Rio Viejo, San Martín de Loba, San Pablo, Santa Rosa Norte, Santa Rosa Sur, Soplaviento, Taligua, Tiquisio, San Estanislao, Zambrano, Hatillo de Loba, Villanueva, Clemencia, Arjona, Margarita, San Jacinto, Turbaco, San Juan Nepomuceno, Cantagallo, San Fernando, Turbará, Santa Catalina, Mahates and Simití) | | selection of interventionist |
| | | | | Cesar (Astrea, Bosconia, Chiriguaná, Curumaní, El Copey, El Paso, Gamarra, Chimichagua, La Gloria, Pailitas, Aguachica, Becerril, San Martín, Codazzi, Manaure, Rio de Oro, Tamalameque, Pelaya, Valledupar)<br><br>Córdoba (Montería, Lorica, Puerto Libertador, San Pelayo, Tierralta, Montelibano, Buenavista, Ayapel, Planeta Rica, Pueblo Nuevo, Valencia, Cereté, San Bernardo del Viento, Canalete, San Carlos, Moñitos, Purisima, Chimá, Momil, Puerto Escondido, Sahagún, Los Córdobas)<br><br>Magadalena (Aracataca, Ariguaní, Cerro San Antonio, El Banco, Fundación, Pedraza, Plato, Pueblo Viejo, Remolino, San Sebastián, San Zenón, Santa Ana, Ciénaga, El Piñón, Guamal, Sitio Nuevo, Tenerife, Pivijay, Salamina, Santa Marta)<br><br>Sucre (Sincelejo, Caimito, Coloso, Guaranda, Majagual, Sucre, Galeras, Sincé, Corozal, Morroa, Tolú, San Benito Abad, San Marcos)<br><br>Guajira (Riohacha, Maicao, Manaure, Fonseca, Barrancas, San Juan del Cesar, El Molino, Villanueva, Brumita, Urbilla) | | |
| 24 | Severe calamity | 001 | 15/01/96 | Neighbourhoods Santa Cruz, Villa los Alpes, La Aurora, Clarita Botero, Santa Bárbara, Ancón, Belencito, Alaska, Alaskita, 20 de Julio, San Diego, Calambao, 7 de Agosto, Augusto Medina, La Sofía, Pueblo Nuevo, La trinidad, Orquideas, from the municipality of Ibagué - Tolima | Landslides, avalanche | Damage to homes and infrastructure |
| 25 | Severe calamity | 002 | 15/01/96 | Tasco, Socha and Paz del Rio – Boyacá | Landslides | Damage to homes and infrastructure |
| 26 | Severe calamity | 003 | 08/04/96 | La Floresta, El Limonar, El Guadual, El Rosario, Ceballos, Yanancha, Cruz de Mayo, disticts of the municipality of Ancuya - Nariño | Landslides | Damage to homes and infrastructure |
| 27 | Severe calamity | 004 | 10/04/96 | Manizales - Caldas | Flooding and landslides | Damage to homes and infrastructure |
| 28 | Severe calamity | 006 | 24/05/96 | All the National Territory | Flooding, landslides, avalanches, gales | |

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| 29 | Clarifies and adds Resolution Nº010 30-10-95 | 007 | 28/09/96 | Archipelago of San Andrés, Providencia and Santa Catalina | Flooding | |
| 30 | Grave Calamity | 001 | 15/04/97 | Area of the San Jorge and Magdalena rivers, Departments of Antioquia, Córdoba, Sucre and Bolivar | Avalanche | |
| 31 | Severe calamity | 005 | 01/10/97 | All the National Territory | El Niño phenomenon | |
| 32 | National Disaster | D-182 | 26/01/99 | Quindio (Armenia, Calarcá, Córdoba, La Tebaida, Circasia, Filandia, Montenegro, Pijao, Quimbaya, Salento, Buenavista)<br><br>Risaralda (Pereira, Desquebradas, Santa Rosa de Cabal)<br><br>Valle del Cauca (Obando, Ulloa, Caicedonia, Alcalá)<br><br>Tolima (Cajamarca, Fresno) | Earthquake | |
| 33 | Severe calamity | 001 | 24/02/99 | All the National Territory | La Niña phenomenon | |
| 34 | Municipal Disaster | D-1516 | 13/08/99 | San Cayetano, Cundinamarca | Mass movement | |
| 35 | Public Calamity | D-182 | 23/03/00 | Departements of Cauca, Nariño and Valle del Cauca | Mass removal phenomenona | |
| 36 | Public Calamity | 001 | 27/04/00 | Municipality of La Sierra, Cauca | Mass removal phenomenona | 118 homes, 10 institutions, aqueduct, sewer and urban ways |
| 37 | Municipal Disaster | D-1563 | 15/08/00 | Municipality of La Sierra, Cauca | Mass removal phenomenona | |
| 38 | Public Calamity | 004 | 17/08/00 | Municipality of Medellín | Structural fire | |
| 39 | Public Calamity | 005 | 17/08/00 | Municipality of Bucaramanga | Mass removal phenomenona | Damage to homes in Villa Helena I, Mirador, Lizcano I and II, Esperanza I and II, Villa Rosa and José María Córdoba |
| 40 | Public Calamity | 006 | 07/11/00 | Municipality of López de Micay, Cauca | Structual fire | Destruction of homes of 30 families (213 persons), commercial buildings |
| 41 | Public Calamity | 007 | 27/12/00 | Monfort Inspection, municipality of El Calvario, Meta | Mass removal phenomenona | All the inspected residencies |
| 42 | Public Calamity | 001 | 06/03/01 | Municipality of Barbacoas, Nariño | Structural fire | Destruction of homes of 59 families (188 persons), commercial buildings |
| 43 | Public Calamity | 002 | 02/06/01 | Municipality of Soledad, Atlántico | Strong winds and torrential rains | Effects on 4,500 persons; 700 homes damaged and 100 destroyed (partial census) |
| 44 | Public Calamity | 003 | 04/06/01 | Municipality of Sampués, Sucre | Strong winds | Effects on 45,00 persons; 852 homes damaged, 58 destroyed; damage to 145 ha of crops |
| 45 | Public Calamity | 003 | 03/12/01 | Municipalities of Silvania and Ricaurte, (Cundinamarca) municipalities of Melgar, Icononzo and Carmen de Apicalá (Tolima) | River overflow, flooding | Damage to homes of 2,500 persons and infrastructure in Cundinamarca and Tolima. |

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| | | | | The municipality of Litoral del San Juan (Chocó) | | In Chocó 1,200 affected families |
| 46 | Public Calamity | 004 | 03/12/01 | 13 municipalities of the west zone of Nariño (Linares, San Lorenzo, La Andes Sotomayor, El Peñol, San Bernardo, San Pedro de Cartago, Arboleda, Cumbitara, El Rosario, Taminango, Leiva, Ricaurte and La Florida) | Forest fires and drought | Damage to homes and crops |
| 47 | Public Calamity | 005 | 07/03/02 | Municipalities of Nariño (El Tambo, Policarpa, Alban) Municipalities of Cauca (Patía, Bolivar, Florencia, Balboa, Mercaderes, Sucre and Argelia | Forest fires and drought | 1,865 families affected in Nariño and 1,598 families affected in Cauca; damage to homes and crops |
| 48 | Public Calamity | 006 | 23/04/02 | Municipality of El Carmén de Apicalá, Tolima | Flooding | 70 families affected, 38 homes destroyed, loss of property |
| 49 | Public Calamity | 013 | 31/07/02 | Municipality of Herrán, Norte de Santander | Mass removal | Structural damage in many buildings of the municipality |
| 50 | Public Calamity | 001 | 20/03/03 | Municipality of Medellín - Antioquia | Structural fire | Destruction of 650 residencies |
| 51 | Public Calamity | 004 | 06/05/03 | Municipality of Carepa, Antioquia | Gale | Damage to 1,115 homes, 8 schools, 12 wounded, loss of crops |
| 52 | Disaster of municipal character | D-1080 | 30/04/03 | Municipality of Manizales, Caldas | Landslides | Destruction of 713 homes, 3,031 persons affected, 32 wounded, 16 deaths, 3 missing persons, and damage to 7,500 homes in high-risk zone |
| 53 | Public Calamity | 009 | 21/07/03 | Municipality of Barranquilla, Atlántico | Erosion, flooding, landslides | Structural damage in the sectors of La Florida, Las Colinas, Me Quejo, via calle 81B, via carrera 38, Terrazas, El Rubí, Edén, Pastoral Social, Villas de las Colinas and Prados del Edén. |
| 54 | Public Calamity | 011 | 05/08/03 | Municipality of Puerto Asís, inspections of Puerto Vega, Cuembi and Teteyé, Putumayo | Fire and spillage of hydrocarbons | Damage to environment and population of the area |
| 55 | Public Calamity | 023 | 12/12/03 | Nazareth district, municipality of Colombia, Huila | Mass removal | Destruction of agricultural production infrastructure, residencies and services, 53 families affected |
| 56 | Public Calamity | 005 | 10/05/04 | Municipality of Puerto Santander, Norte de Santander | Flooding, river overflow | 70 homes destroyed, 150 damaged, 2,005 affected; 10,000 affected persons |

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## Report Appendix 1: RFF Stakeholder Interviews

Some of the interview evidence referred to in this report was collected for two RFF studies of SINA and the CARs commissioned by the World Bank in the winter of 2003–2004. This annex lists all interviews conducted in the course of all three RFF studies.

**A5.1. Interviews conducted for present MAVDT study, September–December 2004.**

*September and December 2004*

- Eduardo Jose Gonzalez, Director General DGPAD; Adriana Cuevas, Germán Jiménez and Gustavo Gutierrez, DGPAD staff (Bogotá)

*December 20, 2004*

- Julian Camilo Arias, Director General CVC; Maria Clemencia Sandoval, Luisa Marina Baena, Amparo Duque, Patricia Osorio Maria Cristina Collazos, Omar Alberto Chavez Ruben Rengifo , Alvaro Calero , Maria Amparo Duran, CVC staff (Cali)

*December 21, 2004*

- Beatriz Eugenia Ramirez, Director General DAGMA; Aris Molina, Fernando Medina, Fernando Estrada, Yolanda Otero, DAGMA staff (Cali)
- Julián Henao Cárdenas, Coordinator CREPAD Valle del Cauca
- Javier Parra, Planning Subdirector CORNARE; Carmen Elena Mejía, María Victoria Arias, Aura Elena Gómez, CREPAD staff (Medellín)

*December 22, 2004*

- Héctor Bermúdez, Planning Subdirector CORANTIOQIA and Carlos Nicolás Zuluag Liliana Gutierrez, CORANTIOQUIA staff (Medellín)
- Clara Gallego, Environmental Manager AMVA (Medellín)

*December 23, 2004*

- Fernando Sanclemente Superintendent, Superintendencia de Puertos y transporte, Alejandro Rueda Serbousek, Ports Delegate Superintendent, Luis Fernando García, General Secretary

- Mauricio Bayona, Subdirector CAR (Bogotá)
- Captain Camacho, Coastal Director DIMAR

*December 27, 2004*

- Elizabeth Taylor Jay, Director General CORALINA (San Andrés)

*December 28, 2004*

- Wanda Forbes James, Coordinator CREPAD San Andrés
- Juan Carlos Lemus Coordinador CREPAD Cordoba

**A5.2. Interviews conducted for World Bank CARs study, March 8–12, 2004**

*March 8, 2004*

- Camilo Santos, Office of the Environment, State of Cundinamarca (Bogotá)
- Francisco Canal, Executive Director, ASOCARs (Bogotá)
- Juan Carlos Iazza, Subdirector of Environmental Affairs, ASOCOLFLORES (Bogotá)

*March 9, 2004*

- Leonardo Muñoz, Director of Planning, Information and Regional Coordination
- MAVDT (Bogotá)
- Rosalba Ordoñez, Director of Planning, MAVDT (Bogotá)

*March 10, 2004*

- Francisco Zapata Ospino, Director General, CORANTIOQUIA (Medellin)
- Nicolas Alberio Echeverry, Office of the Environment, State of Antioquia (Medellin)
- Augustine Chavez, Director General, CARDIQUE (Cartegena)
- Edgar Mateus Hernandez, Director AAU (Cartegena)
- Evelyn Espita, Chemist and Sanitary Engineer, SINGENTA, S.A. (Cartegena)

- Roxana Segovia de Cabrales, Director Fundacion Mamonal, Board of Directors, CARDIQUE (Cartegena)

*March 11, 2004*

- Angela Peña Marin, Executive Director, GAIA (Medellin)
- Carlos Anibal Palacio, Director, Corporación Empresarial ProAburrá Norte (Medellin)
- Julio Maya and Herman Marain, Director and employee CELBA (Medellin)
- José Gomez, Plant Manager and Octavio Nieto, Quality Control Manager, INVESA (Medellin)
- Jorge Mario Gallego, Chief of Department of Industrial Security, ENKA de Colombia (Medellin)
- Sergio Bustamante Perez, Director of Area Metropolitan del Valle de Aburrá (Medellin)
- Lilliana Marie Castilla, Corporación CEA (Cartegena)
- Ana Verena Vargas, Chief of Environmental Quality, C.I., Oceanos S.A. (Cartegena)
- Dayro Banquez, Director de OKAWA Environmental Foundation (Cartegena)
- Antonio Berasteguil, Superintendent of the Environment, PETCO [Petrochemical Columbia] (Cartegena)

*March 12, 2004*

- Enrique Rozo, Funcionamio Especializado SIYP (Baranquilla)
- Hugues LaCouture and Armando Carmacho, Special Advisors to the chief, BAMA (Baranquilla)
- Ing. Mario René Bernal Poveda, Jefe de Ingeneria y Montages, COLCERAMICA (Cundinamarca)
- Juan Carlos Velasco, Subdirector, CRA (Bogotá)
- Ignacio de la Hoz, Assistant to the sub director CRA (Bogotá)

**A5. 3. Interviews conducted for World Bank SINA study, December 4–12, 2003 (all in Bogotá)**

*December 4, 2003*

- Carlos Costa, Director of Environmental Policy, National Planning Department (DNP)
- Juan Pablo Bonilla, Vice Minister of Environment, Ministry of Environment, Housing and Territorial Development (MAVDT)
- Pedro A. Chavarro, Office of the Vice-Minister of Environment, MAVDT
- Santiago Villegas, Director of Planning, MAVDT
- Mauricio Rivera, Office of Potable Water and Basic Sanitation, MAVDT
- Marcela Bonilla, Office of Sustainable Development, MAVDT

*December 5, 2003*

- Claudia Arias, Office of General Secretary, MAVDT
- Juan Carlos Riascos, Director, National Parks Unit
- Diana Gaviria, National Parks Unit
- Andrés Guerrero, National Parks Unit
- Fernando Gast, Director, Alexander von Humboldt Institute
- Carlos Costa, Director of Environmental Policy, DNP
- Luz Marina Arévalo, Subdirector of Planning and Regulation, DNP
- Jhon Berajano, Environmental Unit, DNP
- Elisa Moreno, Coordinating Office for State Reform, DNP

*December 9, 2003*

- Eduardo Uribe, Program Director, Environmental Economics, Universidad de los Andes.
- Sergio Barrera, Professor, School of Engineering, Universidad de los Andes.
- Gloria Sanclemente, Director of the Legal Office, MAVDT

*December 10, 2003*

- Gerardo Viña, Consultant, Former Director, Environmental Sector, MAVDT
- Fabio Arjona Hincapié, Director, Conservation International Colombia, and Former Vice-Minister, Ministry of Environment (MMA)
- Rafael Colmenares, Executive Director, ECOFONDO
- Julio Cesar del Valle, Secretary, Asociación Nacional de Empresas de Servicios Publicos Domiciliarios y Actividades Complementarias e Inherentes (ANDESCO)
- Mauricio López, Technical Secretary, ANDESCO.
- Carlos Herrera, Manager for Environmental Affairs, Asociación Nacional de Empresas de Colombia (ANDI)

*December 11, 2003*

- Julio Carrizosa Umaña, Professor, Universidad Nacional, and Former Director, INDERENA
- Elsa M. Escobar, Director, Fundación Natura.
- Álvaro Villate Supelano, Contralor Delegate for Environment, Contraloría
- Ricardo Botero Villegas, Director, Sectoral Studies, Contraloría
- Ernesto Guhl Nanetti, Consultant, Former Vice Minister of the Environment, MMA
- Manuel Rodríguez Becerra, Former Minister of the Environment (MMA)

*December 12, 2003*

- Adriana María Guillén, Environmental and Agrarian Issues, Procuraduría
- Claudia Sampedro, Attorney and Professor, Universidad Externado
- Carlos Rodríguez, Director, Tropenbos International, Colombia
- Leonardo Muñoz, Acting Director, CRA.