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Colombia's discharge fee program: Incentives for polluters or regulators?☆

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Abstract

Colombia's discharge fee system for water effluents is often held up as a model of a well-functioning, economic incentive pollution control program in a developing country. Yet few objective evaluations of the program have appeared. Based on a variety of primary and secondary data, this paper finds that in its first 5 years, the program was beset by a number of serious problems including limited implementation in many regions, widespread noncompliance by municipal sewerage authorities, and a confused relationship between discharge fees and emissions standards. Nevertheless, in some watersheds, pollution loads dropped significantly after the program was introduced. While proponents claim the incentives that discharge fees created for polluters to cut emissions in a cost-effective manner were responsible, this paper argues that the incentives they created for regulatory authorities to improve permitting, monitoring, and enforcement were at least as important.

Keywords: Environment; Economic incentives; Market-based instruments; Discharge fees; Water pollution; Latin America; Colombia

1. Introduction

Over the past two decades, a robust debate has emerged among policymakers and academics about the advantages and disadvantages of using economic incentive (EI) policies instead of – or alongside – command-and-control (CAC) policies to control pollution in developing and transition countries (Lyon, 1989; Panayotou, 1994; Barde, 1994; Serôa da Motta et al., 1999; Blackman and Harrington, 2000; Bell, 2003; Meléndez and Uribe, 2003; Wolverton and West, 2005). The workhorse of environmental regulatory regimes worldwide, CAC policies typically require polluting facilities to use specified abatement devices and/or to cap emissions at specified levels. By contrast, newer EI policies – also known as market-based policies – provide financial incentives for facilities to cut pollution without actually dictating how or how much they should cut. The two EI policies that have received the most recent attention are discharge fee programs, which charge plants for each unit of pollution emitted, and marketable permit programs, which assign plants' emissions allowances that they may trade with other plants. In theory, these EI instruments are more cost effective than CAC policies, that is, they reduce the social cost of meeting pollution control targets. Some have argued that this property, among others, makes them particularly well-suited to developing countries, where public and private resources available for pollution control are relatively scarce. For example, Panayotou (1993) writes:

> Economic incentives as instruments of environmental management in developing countries have many advantages over command-and-control regulation. First, they can achieve the desired effect at the least possible cost, which is vital to developing countries with limited resources and

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> a dire need to maintain their competitiveness in world markets. (p. 21)

But others have pointed out that discharge fee and marketable permit programs are difficult to implement in developing countries for a variety of reasons, including a scarcity of requisite administrative and regulatory capabilities. For example, Bell and Russell (2002) write:

> Most [developing and transition] nations lack the infrastructure and expertise necessary to implement the market-based strategies… (p. 63)

Empirical evidence is increasingly available to test these arguments because a growing number of developing countries are experimenting with EI instruments. Some of the experiments, particularly marketable permit programs for air emissions, have had mixed or minimal success (e.g., O'Ryan, 2002; Anderson, 2002; Bell, 2003). Some discharge fee programs have received positive reviews, however (e.g., Wang and Wheeler, 2005). Among the latter, perhaps the best known is Colombia's wastewater discharge fee program, which began operation in 1997. Evaluations commissioned or conducted by a variety of organizations – including the World Bank, Colombia's Ministry of the Environment (*Ministerio del Medio Ambiente* – MMA), the UN Economic Commission for Latin America, and research institutes in Colombia – tend to portray it as a success story (e.g., World Bank, 1999; Castro et al., 2001; Acquatella, 2001; MMA, 1998, 2002b; CAEMA various years).[1] For example World Bank (1999) concludes that:

> Overall, although it is new, the Colombian experience provides support for the argument that a … pollution charge system can work well in developing countries. (p. 41)

Yet this and other existing evaluations of the Colombia's discharge fee program were based on preliminary data from the first year or two of the program. Also, the authors or sponsors of some of these evaluations were involved in the program's design or implementation. Few more recent third-party evaluations have appeared. This paper purports to fill this gap.

Focusing on the first 5 years of the discharge fee program (1997–2002) before reforms in 2003 and 2004 modified key design elements, we address two questions.[2] First, to what extent did the program encounter problems highlighted in the empirical literature on the use of discharge fees in developing and transition countries? Second, how successful was the program in controlling water pollution, and what factors were responsible? The present analysis relies on both primary and secondary evidence including data provided by Colombian regulatory authorities, interviews with representatives of industry and regulatory institutions, and evaluations conducted by Colombian and international research and policy organizations.

With regard to our first focus question, we find that Colombia's discharge fee program was beset by a number of serious problems including limited implementation in many regions, widespread noncompliance by municipal sewerage authorities, and a confused relationship between discharge fees and emissions standards.

With regard to our second focus question, we find that despite these problems, in some watersheds, pollution loads dropped significantly after the program was introduced. Most existing evaluations of the Colombian program suggest a direct causal link between discharge fees and these emissions' reductions. We argue that the link is actually more complex. Specifically, we contend that by enhancing transparency and accountability, and by introducing new financial incentives for enforcement (fee revenues), the discharge fee program spurred local regulators in some watersheds to remedy glaring deficiencies in permitting, monitoring, and enforcement of water pollution regulations. These efforts boosted the effectiveness of pre-existing CAC emissions standards as well as the new discharge fees. Hence, while most existing evaluations attribute reductions in emissions that coincided with the new program to the incentives the program created for polluters to cut their emissions, we argue that the incentives it created for regulatory authorities to improve permitting, monitoring, and enforcement were probably at least as important.

2. Literature

This section briefly summarizes the debate on the advantages and disadvantages of discharge fees compared to conventional CAC in developing countries.

2.1. Theoretical advantages of discharge fees

The literature on the advantages of discharge fees focuses on their efficiency, flexibility, and revenue-generating properties (see, e.g., Bohm and Russell, 1985; Sterner, 2003).

2.1.1. Efficiency

The literature distinguishes between static and dynamic efficiency. The former refers to the per-unit cost of aggregate emissions reductions attributable to a regulatory instrument in the short run when abatement technologies are fixed. Theory suggests that discharge fees enhance static efficiency compared to CAC instruments for two reasons. First, they leave each regulated plant free to choose the least expensive means of cutting pollution. By contrast, CAC technology standards more or less dictate that groups of plants use approved abatement technologies which are very unlikely to be cost minimizing for all of the plants in these groups. The same is true of CAC

[1] In 2003, MMA was merged with the Ministry of Development and the Ministry of Housing to create the Ministry of Environment, Development, and Housing (*Ministerio del Ambiente, Vivienda y Desarrollo Territorial*). To avoid confusion, we will refer to the ministry as MMA throughout this paper regardless of the time frame.

[2] Decree 3100 of 2003 and Decree 3340 of 2004 changed critical elements of the program's design (see Section 6 for details). Data on the program from the post-2003 period are relatively scarce. Much of the data presented in this paper were compiled by various research organizations in order to evaluate the program's success in meeting its first set of 5-year pollution-reduction targets.

emissions standards to the extent they are "technology forcing."[3] Second, discharge fees shift the burden of cutting aggregate emissions from plants with high marginal abatement costs to plants with low marginal abatement costs. Plants with marginal abatement costs lower than the discharge fee have a financial incentive to cut emissions to avoid paying the fee while plants with higher marginal abatement costs have an incentive to pay the fee rather than cutting emissions. In theory, as long as all plants pay the same discharge fee, their abatement costs will eventually be equated at the margin, a necessary condition for minimizing aggregate abatement costs. This result will be obtained even when regulators have no information about plants' abatement costs.[4] For a CAC policy to achieve this result, the regulator must know the marginal abatement costs of every plant and must set plant-specific standards, which is extremely unlikely in practice.

Dynamic efficiency refers to the per-unit cost of aggregate emissions reductions attributable to a regulatory instrument in the long run when innovation in abatement technology is possible. Discharge fee programs are said to enhance dynamic efficiency compared to CAC policies because plants that pay discharge fees have a continuing financial incentive to develop inexpensive ways to cut their emissions. By contrast, in a CAC regime, incentives to innovate are often dampened by enforcement risks associated with using a nonapproved technology.

2.1.2. Flexibility

Compared to CAC, discharge fees are said to more easily accommodate change. In a CAC system, the regulator usually sets different rules for different types of plants. Collectively, these rules, which may be quite complex, imply an environmental quality standard. To change the environmental quality standard, or to facilitate the adoption of a new abatement technology, the regulator may have to change the various rules. By contrast, in a discharge fee system, the regulator typically sets a single fee that applies to all plants. Plants retain control over complex abatement and technology adoption decisions. In principle, to change the environmental quality standard, the regulator only needs to change the discharge fee.

2.1.3. Revenue

Finally, unlike CAC policies, discharge fees generate revenue. This revenue may be earmarked for environmental expenditures. Although it has costs in terms of allocative efficiency, earmarking is popular because it makes discharge fees more politically palatable by returning revenue to those who pay the fees, and because it is seen as a means of correcting market failures that prevent firms from obtaining the investment credit.

2.2. Design and implementation issues

The literature includes a growing number of case studies of discharge fee systems in developing and transitioning countries. These case studies highlight three common problems with discharge fee systems outside of the industrialized West.[5]

2.2.1. Weak enforcement

In many of the developing and transitioning countries that have experimented with discharge fees, enforcement has been weak. Sources avoid paying fees by simply failing to pay invoices, misrepresenting emissions data, or flying below the regulatory radar. The key underlying problem is typically a lack or regulatory capacity stemming from a lack of finances, expertise, political will, and data. For example, Zinnes (1997) writes of Romania's experience with discharge fees[6,7]:

> The basic truth about the system … is that it is simply not enforced. … Local environmental protection agencies are grossly understaffed, underequipped, and underpaid for the work they are required to carry out. In 1993 in Romania, revenues collected amounted to about a quarter of fines levied (p. 240).

2.2.2. Low fee levels

To create incentives for significant pollution abatement, discharge fees must be set at levels that approximate marginal abatement costs. However, discharge fees in developing and transition countries are usually set well below abatement costs and have mainly served as a means of raising revenue rather than cutting pollution. For example, in the Czech Republic in the early 1990s, fees for sulfur dioxide and nitrogen oxide air pollution were at least an order of magnitude smaller than marginal abatement costs for most polluters (Stepanek, 1997). Similarly, in Poland, fees are set at levels that are politically acceptable and that meet revenue requirements, not at levels high enough to create incentive effects (Lehoczki and Sleszynski, 2000).

[3] 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 these technologies to minimize the risk of being found in violation of the standards. Hence, *de jure* emissions standards amount to *de facto* technology standards.

[4] Without information about marginal abatement costs, however, regulators cannot know how high fees need to be set in order to achieve a desired level of aggregate abatement. As discussed in Section 4.1, Baumol (1972) and Baumol and Oates (1975) suggest that regulators solve this problem by trial and error, a strategy adopted by the designers of Colombia's discharge fee program.

[5] For a review of the European experience with discharge fees for water pollution, see Kraemer et al. (2003).

[6] Similarly, in Poland in the early 1990s, over half of water polluters registered with the environmental regulatory agency were effectively exempted from the discharge fee program because they were operating without a permit, and only about 20% of fines charged were ultimately collected (Anderson and Zylicz, 1996). In reviewing the experiences with economic incentive instruments of 11 Latin American and Caribbean countries, Serôa da Motta et al. (1999) conclude a strong institutional base is a prerequisite to successful implementation.

[7] Regulators in industrialized countries also need to have the capacity to monitor and enforce in order for EI – or CAC – regulation to be effective. See, e.g., Jordan et al. (2003).

2.2.3. Two-tiered systems

Most discharge fee systems in developing and transitioning countries complement CAC emissions standards. Typically, polluters pay one fee – in some cases zero – for discharges below the standard and a second, higher fee for discharges above it. For example, in much of the former Soviet Union and China, polluters pay no fees on emissions below a legal standard (Bluffstone and Larson, 1997; Yang et al., 1997); in Korea, they only pay fees on emissions that exceed 30% of the legal standard (O'Connor, 1998); and in Poland and Malaysia, they pay a much lower fee on emissions below the standard than on those below it (Anderson and Zylicz, 1996; O'Connor, 1998). Two-tiered systems are typically used to mitigate the financial burden borne by polluters in a uniform fee system.[8] Notwithstanding their benefits, two-tiered systems have an important disadvantage: they dampen the static efficiency. Because some polluters pay a lower fee than others, polluters' abatement costs are not equated at the margin, an outcome that implies reallocating abatement across polluters could reduce aggregate abatement costs.[9]

3. Background

3.1. Water pollution in Colombia

Many of Colombia's most important rivers – including the Bogotá, Cali, Cauca, Medellín, de Oro, and Lebrija – are severely polluted (IDEAM, 2002a). Among point sources, the domestic sector, not the industrial sector, is the leading contributor to water pollution.[10] In 1999, the domestic sector generated over three-quarters of the total biochemical oxygen demand (BOD) discharged from all point sources (IDEAM, 2002a).[11] The domestic wastewater problem has several dimensions. First, a significant percentage of this wastewater is not collected into municipal sewer systems. For example, a quarter of Colombia's urban population – which comprises three-quarters of its total population – does not have access to sewer systems (Blackman, 2006). Second, many municipalities lack any type of wastewater treatment. As of 1999, only 16% of Colombia's 1089 municipalities had operating treatment plants. Nationwide, less than 1% of municipal wastewater is treated (Contraloría, 2000). Third, many of Colombia's wastewater treatment plants operate poorly. The Ministry of Development found that in a sample of 40 municipal wastewater treatment plants, 60% were not in compliance with emissions standards. Cost is a fourth component of Colombia's urban wastewater treatment problem. MMA estimated that $US 2.5 billion would be needed for municipal wastewater treatment between 2001 and 2010 (IDEAM, 2002b).

Like Colombia's domestic wastewater, most of the country's industrial wastewater is not treated. According to IDEAM (2002b), a report on the state of environmental quality in Colombia's urban areas, in two-thirds of 66 cities studied, not one industrial plant treated its wastewater, and in almost a quarter of the cities, less than half did. Among industrial activities, the leading sources of water pollution include manufacturers of beverages and alcohol, industrial chemicals, and paper products (Carrasquilla and Morillo, 1992)

3.2. Command-and-control policies

Colombia has a decentralized environmental management system. At the national level, MMA is the principal environmental regulatory authority. Its responsibilities include formulating, managing, and coordinating water-quality policies and programs. The principal regional environmental authorities are 33 Regional Autonomous Corporations (*Corporaciónes Autónomas Regionales* – CARs) along with five Urban Environmental Authorities (*Autoridades Ambientales Urbanas* – AAUs) in Colombia's most populous cities. Endowed with considerable fiscal and policy autonomy meant to insulate them from interest-group pressures, the CARs and AAUs are the front line of pollution control in Colombia – they are responsible for implementing and enforcing MMA programs and policies. By all accounts, a key problem with Colombia's environmental regulatory system is that some CARs and AAUs are quite weak. As a result, the system exhibits tremendous disparities in monitoring and enforcement across jurisdictions (Blackman et al., 2005, 2006; Meléndez and Uribe, 2003; Gómez Torres, 2003).

Colombian CAC water-quality regulation is conventional. All dischargers of liquid wastes are required to register with and obtain a permit from their regional environmental authorities. Permits must be renewed every 5 years. Most are essentially permissions to discharge and do not specify pollution abatement methods, equipment, or strategies. In addition, all dischargers are subject to 1984 effluent concentration standards for 22 organic and inorganic substances. Dischargers that began operating after 1984 are required to remove at least 80% of total suspended solids (TSS) and at least 80% of BOD from their waste streams. Older facilities are allowed to adhere to slightly less stringent requirements. None of Colombia's emissions standards are industry-specific. CARs and AAUs are responsible for enforcing the emissions standards. In doing so, they may inspect discharging facilities at any time to sample their effluents and check their equipment.[12]

[8] In uniform fee systems, the total value of the fees polluters pay can exceed the total value of damages that their pollution generates, a result that raises concerns about equity (Larson and Bluffstone, 1997).

[9] For a detailed graphical exposition of the theoretical properties of two-tiered fees, see Larson and Bluffstone (1997).

[10] In Colombia – as in most countries with significant agricultural sectors – nonpoint sources are responsible for the majority of certain types of water pollution. Unfortunately, nonpoint sources are particularly difficult to control. As a result, policymakers tend to focus on point sources.

[11] The largest sources of BOD are the cities of Bogotá, Barranquilla, Bucaramanga, Cali, Cartagena, Manizales, and Medellín (IDEAM, 2002a).

[12] A final component of Colombian CAC water-quality policy is a set of requirements for environmental licenses. Prior to construction, polluting facilities in certain sectors are required to obtain licenses from either their regional environmental authority or from MMA, which specify how discharges will be controlled. To obtain licenses, the facilities may have to conduct environmental impact assessments and hold public hearings.

3.3. The performance of command-and-control policies

Historically, CAC discharge permit policies have performed quite poorly in most of Colombia's CARs and AAUs. Three problems have been common. First, inventories of dischargers have often been inadequate. Since Colombia does not have a national-level database of water discharges, CARs and AAUs have been the principal repositories of such information. Yet, as late as 2001, 40% of CARs did not have an inventory of wastewater discharges (Contraloría, 2002). Among the 60% that did, most inventories were outdated and incomplete (Blackman, 2006). Second, permitting has not been comprehensive. In 2002, CARs had issued permits to less than a third of those plants that, in theory, were required to obtain them. Finally, permitting has been inefficient. It has been characterized by copious red tape and long delays; requirements that are not consistent across CARs; and in some cases, corruption (Blackman, 2006; Blackman et al., 2006).

Just as permitting in many jurisdictions has been incomplete, so too has monitoring and enforcement of emissions standards. As noted above, the lion's share of both municipal and industrial wastewater violates emissions standards. In the early 1990s, even in relatively well-functioning CARs and AAUs, less than half of polluting facilities were inspected (Sánchez Triana and Medina, 1994). The situation persists. For example, the 2003 goal of the AAU for Bogotá – widely considered a strong institution – was to monitor and control just 30% of registered industrial emissions sources in its jurisdiction (IDEAM y Alcada Mayor de Bogotá, 2002).[13] Furthermore, CARs lack the personnel and equipment needed to monitor compliance with emissions standards. Forty percent of the country's CARs do not have functioning environmental laboratories (Contraloría, 2002).

4. The discharge fee program

4.1. Legal foundation

Law 99 of 1993, Colombia's second major comprehensive environmental law, established the legal foundation for a national discharge fee program.[14] Article 42 mandates that CARs and AAUs charge retributive charges (*tasas retributivas*) for water effluents. Decree 901 of 1997 regulates Article 42. The design of the fee system set forth in this Decree draws heavily on seminal environmental economics literature on how regulatory authorities should set fees when they lack plant-level information on the marginal costs of pollution abatement and environmental damages (Baumol, 1972; Baumol and Oates, 1975). The basic idea is to first set pollution-reduction goals in each watershed and then use trial and error to adjust fees until the goals are met. Political constraints dictate that regulators start with relatively low fees and ratchet them up over time. Although not welfare maximizing, such a strategy theoretically ensures that the pollution-reduction goals are met at the least cost. It also appears to ensure that regulatory authorities avoid one of the most common implementation problems in discharge fee programs in developing countries: setting fees too low to have an incentive effect. Accordingly, Decree 901 includes the following key provisions:

- *Discharge inventory and baseline*. CARs and AAUs are to develop comprehensive inventories of all facilities discharging BOD and TSS and to establish baseline discharge levels for each pollutant.[15]
- *Pollution-reduction targets*. CARs and AAUs are to identify and map water basins in their jurisdictions and set 5-year pollution-reduction goals for aggregate discharges into each basin. The goals are to be set by the board of directors of each CAR or AAU. Each board comprises a variety of stakeholders including representatives of national and local governments, key productive sectors, and environmental nongovernmental organizations. The pollution-reduction goals are to take into account the environmental and social damages generated by pollutants as well as differences across regions in pollution assimilation capacity, socioeconomic conditions, and the opportunity costs of resources.
- *Fee setting*. MMA is to establish a minimum discharge fee for all facilities in the entire country. This fee can be adjusted upwards – but not downwards – in each water basin based on a specified formula (see Appendix 1 for details). In essence, the formula automatically adjusts the fee upwards by a multiplicative factor of 1.5 for each semester (6-month period) that the pollution-reduction target is not met.

[13] Given constraints on regulatory resources, targeting certain plants for enforcement – namely, those responsible for the most pollution – while more or less ignoring other plants, may be a sensible strategy for maximizing environmental benefits per-unit of regulatory effort expended. See, for example, the discussion of targeted enforcement in Brazil in World Bank (1999). I'm grateful to an anonymous reviewer for this point. We have no evidence that CARs and AAUs as a group have, or have not, adopted this strategy, however.

[14] Law 2811 of 1974, Colombia's first comprehensive environmental law, also provided for discharge fees. This law and the two main Decrees regulating it (Decree 1541 of 1978 and Decree 1594 of 1984) contained provisions that allow regulatory authorities to charge fees to for-profit operations to cover the administrative cost of mitigating any damages they inflict on natural resources. However, these provisions were rarely used until Law 99 of 1993 was passed (for a discussion of an early experience, see Sánchez Triana and Ortolano, 2005). The provisions in Law 99 differed from those in Law 2811 in that they allow fees to be charged to both for-profit and nonprofit facilities. In addition, in determining the level of the fees, regulatory authorities are supposed to take into account a broad range of factors, not just administrative costs.

[15] Actually, Decree 901 does not specify which pollutants would be covered by the fees. It only states that MMA is to make this determination. Subsequent to the Decree, MMA selected BOD and TSS. The decision to limit the program to these two pollutants has attracted some criticism (see, e.g., Enríquez, 2004). To develop user inventories, the MMA implementation manual suggested the CARs and AAUs start with their lists of sources issued permits, even though, as discussed above, they were often incomplete. The next step was to use data from a variety of sources to identify additional users including that from licenses, concessions, the National Statistical Administration Department (DANE), chambers of commerce, the Secretariat of Mines, economic unions, offices of Departmental and Municipal Planning, and Metropolitan Areas (Guerrero, 1997).

- *Monitoring and invoicing*. CARs and AAUs are to monitor facilities' discharges every 6 months relying on facility-generated self-reports (based on approved sampling methods) verified by random checks. Invoices and payments are to be made monthly.
- *Relationship between discharge permits and fees*. Paying discharge fees does not exonerate facilities from the responsibility of complying with emissions standards. In theory – that is, assuming that dischargers are complying with emissions standards – discharge fees only apply to those discharges below the emissions standard. For example, for facilities established after 1984 that are required to remove 80% of BOD from their waste streams, discharge fees only apply to the remaining 20% of BOD.
- *Reporting*. Each semester, CAR and AAU directors are obliged to present a report detailing pollution loads, invoicing and collections to both their board of directors and MMA. Such reporting was not required under the pre-existing CAC regime. Therefore, Decree 901 significantly enhanced transparency and accountability in water pollution regulation.

4.2. Technical assistance for implementation

Decree 901 of 1997 assigned most of the responsibility for implementing discharge fees to CARs and AAUs. MMA's responsibilities were to set minimum national fees and to provide technical assistance and oversight. In the spring of 1997 and again a year later, MMA set minimum national fees (Table 1). Resolution 0372 of 1998 mandated an automatic annual adjustment for inflation instead of an annual discretionary adjustment.

Also in 1997, the Office of Economic Analysis (OEA) in MMA initiated a technical assistance program (MMA, 1997). The program aimed at helping CARs and AAUs accomplish a series of 13 tasks seen as pre-conditions for a successful discharge fee program. The tasks included compiling an inventory of dischargers, registering dischargers, creating system rules and guidance, building an information management system, measuring discharges, calculating pollution loads, identifying receiving water bodies and water body sections, setting total pollution load goals for each water body or section, communicating the pollution load targets, establishing systems for charging and collecting fees, managing fee revenue, developing a monitoring system, and establishing a system to evaluate whether pollution load goals are met. Note that many of these tasks – for example, compiling an accurate emissions inventory and registering dischargers – are also pre-conditions for a successful emissions standard program. Therefore, as noted in the introduction, OEA's discharge fee technical assistance program helped to improve the effectiveness of existing CAC emissions regulations.

The OEA's technical assistance program comprised several thrusts. Specifically, OEA: developed a detailed implementation plan with input from the World Bank; met with both the administrators of regional environmental authorities and private- and public-sector water polluters to provide technical assistance; promoted implementation in the most capable regional environmental authorities in hopes of generating early successes; catalogued best practices and lessons learned from such successes; organized expert groups to provide solutions to implementation problems[16]; presented regional workshops in Barranquilla, Rio Negro, Cali, and Bogotá aimed at disseminating technical information and best practices, as well as obtaining feedback from CARs and AAUs; and, with World Bank assistance and support, held a series of workshops and meetings at national chambers of commerce that represented key private-sector program participants.[17]

In addition to OEA's vertical, top-down technical assistance program, in 1998, MMA also created a horizontal, peer-to-peer system in which the three CARs with the most successful discharge fee programs – CVC, Cornare, and Carder – mentored other regional authorities. The program organized number of workshops in the summer and fall of 1998.[18]

5. Program implementation

5.1. Problems

Implementation of the discharge fee program between 1997 and 2002 was marred by the following six problems.

5.1.1. Slow or limited implementation in some regional environmental authorities

Some regional environmental authorities initiated discharge fee programs earlier than others and some made far more progress in implementation than others. Table 2 details when each CAR began actually invoicing and collecting fees.[19] In 1997, the year of Decree 901, only one CAR did so. After that, 4–6 more CARs each year began invoicing. Collection

[16] For example, at the time the program was established, guidance on self-monitoring of BOD and TSS was lacking, despite the fact that 1984 emissions standards required such monitoring. Therefore, an expert group was formed to create the requisite guidance.

[17] For example, workshops were held at the National Federation of Coffee Growers (*Federación Nacional de Cafeteros de Colombia* – FEDECAFE), the National Association of Public Utilities (*Asociación Nacional de Empresas de Servicios Públicos Domiciliarios y Actividades Complementarias e Inherentes* – ANDESCO), and the National Chamber of Commerce (*Asociación Nacional de Empresarios de Colombia* – ANDI).

[18] MMA also promulgated guidance on how fee revenue ought to be spent. Law 99 of 1993 allows CARs to determine how to use their self-generated revenue, including that from discharge fees. Nevertheless, in late 1998, responding to charges that CARs and AAUs were misusing program revenue, MMA issued voluntary guidelines recommending that CARs use the discharge fee revenue to create regional funds to co-finance wastewater treatment infrastructure. The MMA recommended that 50% of fee revenue be allocated for financing 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 of the 33 CARs have established regional funds (Enríquez, 2004).

[19] Unfortunately, existing data collection systems for regional environmental authorities typically exclude AAUs.

Table 1
MMA resolutions regarding minimum fee rate

Resolution	Period	BOD (pesos/kg)	TSS (pesos/kg)	Adjustment	Source
0273 of April 1997	4/1/97–5/5/98	39.50	16.90	n/a	n/a
0372 of May 1998	5/5/98–12/31/98	46.50	19.90	17.68	DANE – IPC97[a]
0372 of May 1998	1/1/99–12/31/99	54.26	23.22	16.70	DANE – IPC98
0372 of May 1998	1/1/00–12/31/00	59.27	25.36	9.23	DANE – IPC99
0372 of May 1998	1/1/01–12/31/01	64.46	27.58	8.75	DANE – IPC00
0372 of May 1998	1/1/02–12/31/02	69.39	29.68	7.65	DANE – IPC00

Source: MAVDT (2005).
[a] Adjusted for inflation using Departamento Administrativo Nacional de Estadística Indice de Precios al Consumidor (National Statistical Administration Department Consumer Price Index).

lagged behind invoicing. In 2002, 24 CARs invoiced and 21 collected.

For the purposes of characterizing progress in implementing discharge fees, MMA (2002b) placed 28 CARs and four AAUs into three groups.[20] Group A comprised nine CARs and AAUs that had operated a discharge fee program for at least 18 months, had fulfilled all the key requirements of Decree 901, and had completed all of the implementation tasks listed in Section 4.2. Group B comprised 13 CARs and AAUs that were invoicing and collecting revenue, but that had implemented the program in an incomplete or inconsistent manner. Group C included 10 CARs and AAUs that had begun implementation but had yet to collect fees. MMA did not rank five CARs and one AAU, presumably because they did not have any sort of discharge program.

Some lags in implementation across administrative regions are natural and may even be desirable to the extent they facilitate learning-by-doing and build political momentum. However, virtually all evaluations of the discharge fee program – even those conducted by the MMA – agree that the lags in implementation in the first 5 years of the program were problematic. For example, Contraloría (2003), an evaluation conducted by the Comptroller General of Colombia states[21]:

> …only ten (sic) [CARs and AAUs] have adopted implementation projects, that is to say … only 26.3% have the possibility of fulfilling the objectives of the economic instrument of allowing the internalization of pollution damages and changing the behavior of the polluters. … Given these deficiencies … it is clear that, to date, one can conclude that the application of the discharge fees for water users is highly unsatisfactory (p. 52).

Such comments echo one of the main themes in the literature (summarized in Section 2.2) on the use of discharge fees in developing countries: they are not effective unless regulators have the capacity to monitor and enforce.

It is useful to identify the characteristics of CARs that were more successful in implementing discharge fees according to MMA (2002b). Towards that end, we develop a simple econometric model, the details of which are presented in Appendix 2. The results suggest that implementation was more successful in CARs that were relatively rich and relatively old.[22]

5.1.2. Significant differences in pollution-reduction goals

Table 3 presents 5-year goals established by each CAR for total reductions of BOD and TSS from point sources. Clearly, some goals were far more ambitious than others. For example, Cormacarena's BOD goal was 80% while Cardique's was 3%. As noted above, Decree 901 allows for heterogeneity in goal setting to account for, among other things, differences in abatement costs and the quality of receiving waters. Nevertheless, the tremendous disparity in goals has led some to charge that the goal setting process in some CARs was "captured" by wastewater dischargers, including both industry and municipal wastewater plants (e.g., Enríquez, 2004). As noted above, the CAR boards of directors that set pollution-reduction goals purport to represent all elements of society including the victims of water pollution. But considerable evidence suggests that dischargers have disproportionate influence. Environmental nongovernmental organizations are supposed to be the principal representative of the victims of pollution, but in many

[20] The three groups were comprised as follows: Group A: CVC, Cornare, CDMB, Cortolima, CRC, DADIMA, AMVA, Coralina and Corpourabá; Group B: DAMA, Carder, CAS, CAM, Codechoco, Corponor, Corantioquia, Corpoboyaca, Corpocaldas, Corporinoquía, Cormacarena, CRQ, and Cardique; Group C: CVS, CAR, Corpochivor, Corponariño, Carsucre, CRA, CSB, DAGMA, Corpamag, and Corpoguajira.

[21] Similarly, Guzmán Castro (2003, p. 63) writes, "In addition, the failure to impose the tax in all of the country's regions creates inequities and competitive disadvantages for firms situated within the jurisdiction of those environmental authorities that are actually collecting the tax." (pp. 64–65). Roesner (2004) makes the same argument. Also, MMA (2002b) lists the following as its first of 19 recommendations for improving the program, "The environmental authorities – especially those in groups B and C – need to improve the level of development of the program if discharge fees." (p. 19)

[22] The first result is likely due to factors that affected both the demand and the supply of water pollution control regulation. On the demand side, richer CARs likely had relatively high levels of industrial activity and therefore faced a stronger demand for effective water pollution control. On the supply side, richer CARs likely had more resources to devote to pollution control and therefore were better equipped to supply such water pollution regulation. The fact that older CARs were more likely to have successfully implemented discharge fees probably reflects a supply-side mechanism: presumably, older CARs had more time to develop effective water pollution control institutions and procedures.

Table 2
Invoicing and recovery of the discharge fees by CARs 1997–2002 (I = total invoiced million of 2002 pesos; R = % 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	2184.9	5
CAR											201.2	17	201.2	17
Carder											733.9	14	733.9	14
Cardique					987.7	NR	1407.6	NR	1442.4	NR	750.7	NR	4588.3	NR
Carsucre											115.1	1	115.1	1
CAS					883	8	1763.4	32	2260.0	42	2678.1	39	7584.4	34
CDA													NC	NR
CDMB			584.7	100	1496.6	100	2096.8	98	2572.9	97	3366.6	87	10117.7	95
Codechocó			191.6	NR	275.3	7	343.5	48	372.9	9	-		1183.3	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	1176.9	85	1739.0	55	1980.7	42	829.7	31	6784.6	54
Corpamag							385.9	3	434.3	5	442.1	19	1262.3	9
Corpoamazonía											58.9	1	58.9	1
Corpoboyacá									895.2	12	1591.2	2	2486.5	6
Corpocaldas							2546.7	9	2018.1	NR	-		4564.9	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
Corponor					749.2	15	1547.3	18	1656.6	20	1695.2	14	5648.3	17
Corporinoquía													NC	NR
Corpourabá			124.9	NR	867.5	13	1143.8	29	1530.5	21	1070.3	15	4737.0	20
Cortolima					427.3	NR	1416.4	70	1744.3	63	1599.4	42	5187.4	53
CRA													NC	NR
CRC	-		177.2	47	945.6	38	1473.3	36	2014.5	8	114.2	92	5724.8	22
CRQ									360.6	15	1163.0	13	1523.6	13
CSB													NC	NR
CVC			2936.6	11	6237.5	8	15436.2	15	10829.4	13	12193.2	23	47629.9	15
CVS									587.4	4	2592.3	4	3179.7	4
Total	309	69	4790.7	30	14100.3	27	32239.1	27	32263.4	25	33854.5	27	117557.0	27
No. of invoicing	1		7		11		15		20		24			
No. of collecting		1		6		8		14		16		21		

Source: Contraloría (2003).
NR: Does not report information; NC: Has not charged.

CARs, they are quite weak or altogether nonexistent (Blackman et al., 2006).

5.1.3. Incomplete coverage of dischargers

Not all dischargers that should participate in the fee program actually did. Table 4 presents CAR-level data on the percentage of dischargers covered by the discharge fee system that were actually invoiced. The percentage ranged from 100% reported by four CARs to 0% reported by four other CARs (that 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 had low participation rates.

Because dischargers cannot be charged fees unless they have been issued permits, coverage of the discharge fee system depends critically on permitting. While permitting remains incomplete nationwide, according to a number of sources, permitting in some CARs and AAUs, improved significantly as a result of implementation of the discharge fee program. For example, Guzmán Castro (2003) writes that[23]:

> … the most significant benefits of the environmental tax [i.e., discharge fee] system, according to the various studies and analyses of its application in Colombia, are: updating of inventories of users that generate direct discharges into bodies of water; developing updated information on the state of water resources in regard to organic pollution and suspended solids; identification of users and their discharges [as a result of] using statement forms for users; [and] use of information that had been on file but had not been used. (p. 69)

[23] See also MMA (2002b) and Castro et al. (2001).

Table 3
CAR 5-year total BOD and TSS reduction goals as of 2001

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	N.I.	N.I.	N.I.
CAS	N.I.	N.I.	N.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	8.4%	8.5%	Apr/99
Corpocaldas	N.I.	N.I.	N.I.
Corpocesar	N.I.	N.I.	N.I.
Corpochivor	N.I.	N.I.	N.I.
Corpoguajira	N.I.	N.I.	N.I.
Corpoguavio	–	–	Mar/00
Corpomojana	N.I.	N.I.	N.I.
Corponariño[b] (kg/day)	163	279	N.I.
Corponor	16%	16%	Dec/98
Corporinoquía	N.I.	N.I.	N.I.
Corpouraba[a]	10%	10%	Dec/98
Cortolima	23%	29%	Sept/99
CRA	N.I.	N.I.	N.I.
CRC	34.1%	31.7%	Nov/98
CRQ	25%	32.7%	Sept/98
CSB	N.I.	N.I.	N.I.
CVC (kg/semester)	31300	50700	Dec/97
CVS	–	–	Oct/00

Source: Contraloría (2001).
N.I.: Not implemented; –: no data available.
[a] Goal average for BOD and TSS.
[b] Estimated value.

Table 4
Participation in discharge fee programs by CAR as of 2002

Entity	No. of water users potentially covered by fee system	No. of users that are invoiced	% Potential payees that are invoiced
CAM	75	45	60
CAR	491	91	19
Carder	2900	632	22
Cardique	72	54	75
Carsucre	31	10	32
CAS	91	91	100
CDA	5418	1	0
CDMB	160	153	96
Codechocó	2000	70	4
Coralina	49	6	12
Corantioquia	2607	1825	70
Cormacarena	10	10	100
Cornare	218	218	100
Corpamag	60	59	98
Corpoamazonía	22	9	41
Corpoboyacá	150	104	69
Corpocaldas	2400	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	7500	300	4
CSB	24	0	0
CVC	20,000	259	1
CVS	53	16	30
Average	1383	162	48

Source: MMA (2002a).

5.1.4. Fee collection rates in some CARs were low

Table 2 provides self-reported CAR-level data on invoicing and collection of discharge fees between 1997 and 2002. Several patterns are noteworthy. First, just 27% of all fees invoiced were actually collected. Collection rates varied 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 the 54% reported by Cornare. Second, in any given year, a small number of CARs were responsible for a large share of all charges collected. For example, in 2002, all participating CARs collected 9.1 billion pesos. However, three CARs – CAS, CDMB, and CVC – were responsible for roughly three-quarters of the total. Third, for most CARs, invoicing increased over time as their program was implemented and, presumably, more point sources were brought into the system. However, after the first few years, invoicing leveled off. CAR and AAU responses to nonpayment varied widely. While some made little or no attempt to collect, other took a hard line, applying fines, political pressure, and even seizing polluting facilities (Guzmán Castro, 2003; Kathuria, 2006).

5.1.5. Noncompliance by leading dischargers: municipal sewerage authorities

As in many developing countries, Colombia's municipal sewerage authorities are leading sources of BOD and TSS and also leading violators of water-quality regulations. Table 5 presents data on the role of municipal sewerage authorities in invoicing and collecting discharge fees between 1997 and 2002. Two patterns are notable. First, the sewerage authorities were the key players in the discharge fee program. They were invoiced for over one-third of all discharge fees. Second, collection rates for municipal sewerage authorities were low in absolute standards. Sewerage authorities paid only 40% of the total amount they were invoiced between 1997 and 2002.[24] Finally, however, recovery rates for utilities were

[24] This figure is derived from the data in the table, but is not included in it.

Table 5
Role of municipal sewerage authorities in invoicing and recovery of the discharge fees by CARs 1997–2002 (I = total invoiced million of 2002 pesos; R = % 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	2184.90	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		1407.60		1442.40		750.7		4588.30	
Utilities (%)					41		27		27		26		30	
Carsucre											115.1	1	115.1	1
Utilities (%)											94	79	94	79
CAS					883	8	1763.40	32	2260.00	42	2678.10	39	7584.40	34
Utilities (%)					73	0	56	14	58	29	46	23	55	23
CDA													NC	
Utilities (%)														
CDMB			584.7	100	1496.60	100	2096.80	98	2572.90	97	3366.60	87	10117.70	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	-		1183.30	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	1176.90	85	1739.00	55	1980.70	42	829.7	31	6784.60	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	1262.30	9
Utilities (%)							67	1083	97	0	118	0	95	118[a]
Corpoamazonía											58.9	1	58.9	1
Utilities (%)											100	100	100	100
Corpoboyacá									895.2	12	1591.20	2	2486.50	6
Utilities (%)									44	68	55	1119[a]	51	291[a]
Corpocaldas							2546.70	9	2018.10		-		4564.90	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	1547.30	18	1656.60	20	1695.20	14	5648.30	17
Utilities (%)						0								
Corporinoquía													NC	
Utilities (%)														
Corpourabá			124.9		867.5	13	1143.80	29	1530.50	21	1070.30	15	4737.00	20
Utilities (%)			0		0	0	193	140	0	0	133	130	77	72
Cortolima							1416.40	70	1744.30	63	1599.40	42	5187.40	53
Utilities (%)							76	70	90	94	91	79	86	82
CRA													NC	
Utilities (%)														
CRC	-		177.2	47	945.6	38	1473.30	36	2014.50	8	114.2	92	5724.80	22
Utilities (%)				64		15		34		17		155		53
CRQ									360.6	15	1163.00	13	1523.60	13
Utilities (%)										94		95		94

Table 5 (*continued*)

Entity	1997		1998		1999		2000		2001		2002		Total	
	I ($)	*R* (%)	*I* ($)	*R* (%)	*I* ($)	*R* (%)	*I* ($)	*R* (%)	*I* ($)	*R* (%)	*I* ($)	*R* (%)	*I* ($)	*R* (%)
CSB													NC	
Utilities (%)														
CVC			2936.60	11	6237.50	8	15436.20	15	10829.40	13	12193.20	23	47629.90	15
Utilities (%)			0	0		0		47		27		42		38
CVS									587.4	4	2592.30	4	3179.70	4
Utilities (%)										0		0		0
Total	309	69	4790.70	30	14100.30	27	32239.10	27	32263.40	25	33854.50	27	117557.00	27
Utilities (%)	35	0	22	39	32	14	31	51	38	51	36	60	34	52

Source: Contraloría (2003).
NC: has not charged.
[a] Data are internally inconsistent.

higher than for industry. Although sewerage authorities were invoiced for 34% of all wastewater fees between 1997 and 2002, they contributed 52% of all fees actually collected.

Nonpayment of fees by municipal sewerage authorities has stirred considerable controversy. According to the Colombian Comptroller General[25]:

> Even though the collection from the invoicing to the municipal sewerage authorities is better [than that for industry] … it is still a very low value. It is basically a laughable amount compared to their huge contribution to BOD and TSS loadings … (Contraloría, 2003, p. 52).

In their defense, the municipal sewerage authorities argued that in the short run they simply did not have the financial wherewithal to pay discharge fees or to invest in treatment plants that would enable them to avoid the fees.[26] ANDESCO, the national trade association for municipal sewerage authorities, lobbied against implementation of the discharge fee program and has initiated several lawsuits to derail it. Some regional environmental authorities took legal action in response to nonpayment. For example, DADIMA, the urban environmental authority for Barranquilla, at one point took control of the city's sewerage authority until it agreed to pay a 2.5 billion pesos fee debt (Guzmán Castro, 2003).

Noncompliance by municipal sewerage authorities was a key barrier to successful implementation of the program during its first 5 years. It generated three widely publicized problems. First, water polluters in industry and agriculture complained loudly about being made to pay fees when many of the largest and most visible polluters refused or failed to do so (Castro et al., 2001; Guzmán Castro, 2003). Some industrial polluters felt justified in withholding fee payment themselves. In general terms, the problem was that chronic noncompliance by a group of leading polluters undermined the ''culture of compliance'' needed to enforce the program.[27]

This contentious situation was greatly aggravated by the fact that noncompliance by municipal sewerage authorities prevented many water basins from meeting 5-year total pollution load reduction targets and, as mandated by Decree 901 of 1997, led to steep fee increases in these water basins. Fig. 1 shows the dramatic increase in fee rates for water basins that repeatedly missed their compliance targets. Given this burden, industrial dischargers argued that they were being punished for the failure of municipal sewerage authorities to control their discharges.

Second, some argued that discharge fee system had a regressive impact, that is, it imposed a disproportionate financial burden on the poor (e.g., Sánchez Triana, 2000; Enríquez, 2004). They pointed out that poorer customers often paid subsidized sewerage fees, used less water than richer customers, and therefore had lower monthly sewerage bills than richer customers. When municipal sewerage authorities passed on discharge fees by spreading them equally over all customers, the resulting percentage increase in monthly bills was much higher for poor customers than rich customers. For example, Enríquez (2004) projected that additional billing due to implementation of the discharge fee program in Bogotá – assuming, among other things, that aggregate pollution-reduction goals were not met so that the fees increased fivefold – represented a 94% increase

[25] See also MMA (2002b), which concludes, ''With some exceptions, the municipalities and the municipal sewerage authorities fail to fulfill the program norms and resist the legal requirement to pay their fees. The municipal sector is responsible for 70% of the contamination that is discharged without treatment … these discharges are particularly harmful because of their high concentration of pathogens, fecal coliforms, viruses and discharges of the industries connected to the sewerage systems. Although some [municipalities and the municipal sewerage authorities] are outstanding … the sector in general has responded more slowly the discharge fee program than the industrial sector. (p. 16)

[26] The MMA Office of Economic Analysis studied the projected impact of discharge fees on wastewater treatment in nine municipalities in the state of Cundinamarca before implementing discharge fees nationwide (MMA, 1997). It concluded that for most municipalities, discharge fees would exceed marginal abatement costs and would therefore cause municipalities to invest in abatement. However, this prediction has not been borne out for several reasons. First, the MMA study underestimated marginal abatement costs by assuming that the low-cost abatement technologies would be available to municipalities (Guzmán Castro, 2003). Also, in many municipalities, wastewater treatment plants have not been built and, therefore, the marginal cost of abatement amounts to the fixed costs of building a new facility, including the shadow costs of overcoming financing and siting constraints. Finally, and perhaps most important, for some municipalities, discharge fees are much lower than they appear since failure to pay fees is penalized lightly if at all.

[27] The literature suggests that polluters comply with environmental regulation when they believe that others are complying, and that noncompliance is punished expeditiously. Chronic noncompliance by some polluters breeds chronic noncompliance by others (Bell, 1997; Russell et al., 1986).

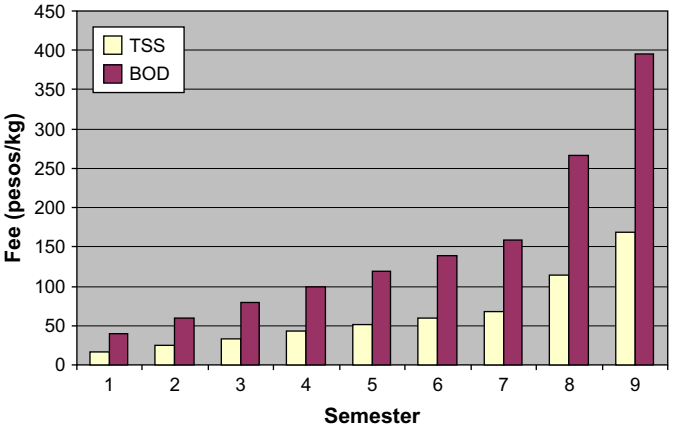

Fig. 1. Automatic increases in fee rates mandated by Decree 901 of 1997 due to failure to meet targets for reducing total pollution loads.

for service customers in the lowest income category versus 11% for those in the highest income category (Table 6).

Finally, some have argued that the difficulties experienced by some municipal sewerage authorities in paying discharge fees exacerbated the severe shortage of sewerage and wastewater treatment infrastructure by making it difficult for municipalities to finance new investment (Roesner, 2004; Enríquez, 2004). In the short run, municipalities without treatment facilities were not able to reduce fee payments by bringing new treatment facilities on line. In addition, some claimed that they did not have the legal authority to pass on fee increases to customers. Therefore, in the short run, the fees' main effect in some watersheds was to saddle some municipalities with significant debts. Moreover these debts mounted as fees were ratcheted up for noncompliance with aggregate emissions goals. Evidently, these "fee debts" made it difficult for municipalities to finance new investments in wastewater treatment.[28] According to Roesner (2004):

> The discharge fees are a disincentive to constructing … wastewater facilities. The 'polluter pays' fee structure ascribed to wastewater discharges, in particular, the increase in fee every 6 months that a waste discharge is out of compliance, has resulted in many municipalities incurring fee debts that are so high, they have no hope of paying the fee, let alone financing the construction of a wastewater treatment facility (A-66).

5.1.6. The relationship between discharge fees and emissions standards

As discussed in Section 4, Decree 901 of 1997 explicitly states that paying discharge fees did not exonerate users from the responsibility of complying with emissions standards. As a result, in theory (that is, assuming that polluters were complying with emissions standards) discharge fees only applied to those discharges remaining *after* the emissions standard have been met, i.e., those discharges below the standard. The obvious difficulty with this regulation, however, is that, as discussed in Section 3.3, noncompliance with emissions standards was rampant in some CARs and AAUs. This situation created two problems.

First, uncertainty about which emissions were subject to a fee generated significant controversy. Industry lobbyists predictably argued that regardless of whether a plant was in compliance with discharge standards, discharge fees could only be charged on those emissions falling below the standard (Castro et al., 2001). Clearly, such a policy would dampen the incentives that discharge fees create for pollution control. MMA attempted to resolve this problem by issuing guidance stating that in cases where a facility is not in compliance with emissions standards, the CAR or AAU should negotiate a plan with the facility that specifies a schedule of activities and investments designed to bring the facility into compliance. At a maximum, facilities would have 5 years to complete the plan. In the interim, fees would be charged on all of the facility's emissions. Despite this guidance, some CARs and AAUs continued to charge noncompliant firms only for those emissions below the emissions standard (Castro et al., 2001).

A second problem was that the discharge fee program was prone to the allocative efficiency problems associated with two-tiered fees (see Section 2.2). Although the Colombian discharge fee program was supposed to be uniform, in some jurisdictions it was effectively two-tiered because sources that failed to comply with emissions standards paid no fees on emissions above the standard.

5.2. Fee revenue

Law 99 of 1993, which created Colombia's decentralized environmental management system provides CARs (but not AAUs) with a number of mechanisms for self-financing, including energy fees, resource use taxes, discharge fees, and a claim to a share of municipal property taxes. For virtually all CARs, property taxes are the most important source of revenue (Blackman et al., 2006). Table 7 presents data on the revenue that discharge fees generated in 2002 and the contribution of this revenue to total revenue from all sources. For all CARs, discharge fees contributed 1% of total revenue. Note, however, that if collection rates were improved, discharge fees could contribute far more: invoices for discharge fees amounted to 4% of total revenue. Although even this average is modest, for some CARs, total invoices were quite sizable. For example, invoices accounted for 30% of Corpourabá's total revenue. Hence, discharge fees created financial incentives for at least some CARs and AAUs to enforce water pollution regulations.

5.3. Impacts on pollution loadings

Unfortunately, comprehensive, independently verified data on BOD and TSS discharges from sources covered in the discharge fee program do not exist. To account for possible bias in the data that do exist, we review several different types of data, taking care to note potential problems with each. On the whole, this evidence suggests that the performance of

[28] A similar rationale may apply to municipalities' incentives to build new sewer lines. For Colombia's many municipalities without adequate wastewater treatment facilities, building new sewer lines that connect new pollution sources to the system would increase the system's total pollution load and, therefore, would increase total fees charged to the municipality.

Table 6
Predicted effect of discharge fees on average sewerage bills in Bogotá by income class

Income class[a]	No. of users	Average sewerage tariff ('03 pesos/m^3)	Mean sewerage bill ('03 pesos/user/mo.)	Discharge fee total cost[b] ('03 pesos/user/mo.)	Effect of discharge fee on the avg. sewerage bill (%)
Strata 1	60,706	342	4335.15	743.45	94
Strata 2	347,810	547	7292.37	743.45	56
Strata 3	491,965	873	11446.87	743.45	36
Strata 4	158,870	980	13069.16	743.45	31
Strata 5	58,494	1485	23194.89	743.45	18
Strata 6	47,796	2113	38717.28	743.45	11

Source: Enríquez (2004).
[a] Strata 1 = lowest income class and Strata 6 = highest income class.
[b] Assumes regional factor = 5.5; discharge fees passed onto customers in full; municipal discharges are perfectly elastic. For additional assumptions see source.

the discharge fee system varied dramatically across CARs and that good performance was limited to a few CARs.

5.3.1. Aggregate emissions reductions from 1997–2002

According to a MMA (2002b), an evaluation of the discharge fees program conducted by the MMA's OEA, discharge fees were effective in reducing BOD and TSS in the first 5 years of the program in nine (of 38) CARs and AAUs that "adequately implemented the program" – the same nine CARs and AAUs that MMA assigned to implementation group A discussed in Section 5.1.1. In these nine CARs and AAUs, total BOD discharges from point sources covered in the program fell 27%, while total TSS discharges from point sources covered in the program fell 45%. MMA (2002b) reports that reductions in discharges from CARs and AAUs that did not implement the program adequately – those in implementation Group B – were significantly less, while discharges from those in Group C continued to increase during the course of the program.

These statistics – as well as those reported in Section 5.3.2 – are subject to two caveats. First, MMA (2002b) is based on data that are self-reported by dischargers, the only available data on pollution loadings from sources covered by the discharge fee system.[29] Second, as discussed in detail below, the reductions in BOD and TSS are not necessarily due solely to economic incentives generated by the discharge fees – they also reflect the impact of CAC and voluntary pollution-prevention programs. Despite these caveats, however, the size of the measured reductions in BOD and TSS in the nine CARs and AAUs in group A are so large that is unlikely that the program did not have a significant impact in some CARs.

5.3.2. Emissions reductions by CAR in 2002

Table 8 presents self-reported CAR-level data on the performance of the discharge fee program, specifically, the 2002 reductions in total BOD and TSS discharges versus the 2002 annual targets established in conjunction with 5-year targets. The average percent of the annual goals met is 42% for BOD and 158% for TSS. However, these averages mask several features. Twelve CARs reported having achieved some portion of their BOD reduction goals, including several that had a goal of zero reductions, while 16 CARs achieved 0% of their goals. Only one CAR, Cornare, reported having overmet its BOD goal, and it did this by 721%. If Cornare is excluded from the sample, then on average, the 33 CARs only met 13% of their BOD goals. As for TSS, 12 CARs reported having met some portion of their TSS goals, while 16 achieved 0% of their goals. Only two CARs, Cornare and CDMB reported having overmet their goals and each did this by over 1000%. If these two CARs are excluded from the sample, then on average, the 33 CARs met only 10% of their TSS goals. Thus, overall these data also demonstrate that good performance was limited to a few CARs.

5.3.3. 2001 CEPAL Study

Castro et al. (2001) evaluated the impact of the fee program on discharges in three jurisdictions – CVC, Cornare, and DADIMA (Barranquilla's AAU) – using data from the first semester of 1997 through second semester of 2000. In each case, Castro et al. find that the discharge fee program was responsible for significant reductions in BOD and TSS. It is important to note that one of the authors of the report is a former director of Cornare. Also, the data for the three environmental authorities are self-reported.

5.3.3.1. CVC. Created in 1954 in the image of the Tennessee Valley Authority, CVC is Colombia's oldest CAR and is widely recognized as a relatively capable institution, particularly with regard to water resources management. Prior to its discharge fee program, CVC made significant efforts to enforce CAC emissions standards and compliance rates were high. Therefore, discharge fees were charged only on BOD and TSS emissions below emissions standards. Between 1998 and 2000, total BOD discharged by point sources participating in the fee program fell 32% while TSS discharges fell 69%. The report acknowledges 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.

5.3.3.2. Cornare. Cornare is also recognized as one of Colombia's stronger CARs. Like CVC, Cornare enforced

[29] Although these data are subject to verification (by CARs and AAUs, MMA, and the Contraloría), the effectiveness of the verification process varies across CARs. It is worth noting that these data often do not reflect favorably on the CARs and AAUs that collect them. See, for example, the participation rates in Table 4, the invoicing and recovery rates in Table 5, and the benchmarking data in Table 8. This suggests that, for some CARs at least, self-reporting is somewhat objective.

Table 7
Contribution of 2002 revenue from discharge fee to 2002 revenue by CAR and type (thousands of pesos)

Entity	Fee revenue		Other revenue		Total	Fee revenue as % of total	
	Invoiced	Recovered	National contribution	Self-generated		Recovered	Invoiced
CAM	401.3	23.5	1482	6352	7834	0	5
CAR	175.9	NR	0	94,394	94,394	NR	0
Carder	427.5	37	1563	10,745	12,308	0	3
Cardique	195.8	0	1097	8654	9752	0	2
Carsucre	108.3	1.1	1932	1963	3896	0	3
CAS	1224.8	234.5	1097	7168	8265	3	15
CDA	0	0	2027	197	2224	0	0
CDMB	2875.3	2555.4	0	34,782	34,782	7	8
Codechocó	0	NR	1724	2014	3738	NR	0
Coralina	208.1	19	2025	1643	3667	1	6
Corantioquía	22.7	NR	3452	41,949	45,401	NR	0
Cormacarena	NR	NR	261	317	578	NR	NR
Cornare	363.8		0	15,339	15,339	0	2
Corpamag	521.1	0	2872	3743	6615	0	8
Corpoamazonía	58.9	0.3	1696	5118	6814	0	1
Corpoboyacá	874.5	331.3	1012	7388	8400	4	10
Corpocaldas	0	6.1	1735	7801	9536	0	0
Corpocesar	NR	1.5	1526	1830	3356	0	NR
Corpochivor	NR	NR	1378	5174	6552	NR	NR
Corpoguajira			0	12,661	12,661	0	0
Corpoguavio			0	8958	8958	0	0
Corpomojana	0	0	1993	152	2145	0	0
Corponariño			1828	5841	7669	0	0
Corponor	NR	NR	1351	7685	9036	NR	NR
Corporinoquía			1108	6058	7166	0	0
Corpourabá	1428.8	202.3	2276	2525	4800	4	30
Cortolima	1454.1	532.3	1031	16,850	17,881	3	8
CRA			896	15,999	16,895	0	0
CRC	NR	162.7	2663	17,240	19,903	1	NR
CRQ	NR	143	2785	4061	6847	2	NR
CSB			2292	5289	7581	0	0
CVC	NR	1167	0	82,503	82,503	1	NR
CVS	NR	0	105	13,267	13,371	0	NR
Total	10340.9	5417.0	45207.0	455660.0	500867.0	27	101.8
Average	544.3	270.9	1369.9	13807.9	15177.8	1	3.9

Sources: MMA (2002a), Contraloría (2003).

emissions standards before it began setting up its discharge fee program for the Negro River in late 1997. Therefore, as in CVC, fees were only charged on discharges below emissions standards. Between 1997 and 2000, total BOD discharged by point sources participating in the fee program fell 62% while TSS discharges fell 90%. The report takes care to mention that these reductions may have been partly due to a series of clean production agreements signed with water dischargers immediately before the discharge fee program began.

5.3.3.3. DADIMA. DADIMA is quite different from CVC and Cornare. It was created by Law 99 of 1993 and has relatively limited regulatory capacity. In this regard, it is probably more representative of the ''average'' regional environmental authority. Before it began to implement a discharge fee program for a section of the Magdalena River in 1998, DADIMA did not enforce emissions standards and the majority of polluters had not invested in treatment plants. Therefore, in implementing its program, DADIMA negotiated compliance plans with discharging facilities and applied discharge fees to all of their effluents. In 2 years, BOD loads fell by 47% and TSS loads fell by 62%.

6. Conclusion

This paper has sought to answer two questions about the first 5 years of the Colombian discharge fee program. The first was: to what extent did the program encounter problems highlighted in the empirical literature on the application of EI instruments in developing and transition countries? The evidence presented in Section 5.1 suggests that the program was beset by a number of serious problems including limited overall implementation in many CARs and AAUs; widespread noncompliance by municipal sewerage authorities; and a confused relationship between discharge fees and emissions standards.

Our second question was: how successful has the program been in controlling water pollution and what factors have been responsible? Our answer to the first part of this question is relatively straightforward: as discussed in Section 5.3, the weight of available evidence suggests that, in some CARs and AAUs – the

Table 8
Discharge fee program performance for the year 2002 by CAR (data self-reported to MMA)

Entity	BOD			TSS		
	Reduction goal (ton/year)	Actual reduction (ton/year)	% Goal achieved	Reduction goal (ton/year)	Actual reduction (ton/year)	% Goal achieved
CAM	535	212	40	450	158	35
CAR	0	10,697	GZ	0	10,879	GZ
Carder	13,737	0	0	24,065	0	0
Cardique	272	0	0	80	0	0
Carsucre	229	0	0	192	0	0
CAS	1372	740	54	1504	886	59
CDA	ND	ND	ND	ND	ND	ND
CDMB	724	486	67	3635	86,578	2382
Codechocó	388	0	0	806	0	0
Coralina	346	18	5	472	100	21
Corantioquia	0	5508	GZ	0	5918	GZ
Cormacarena	290	0	0	346	0	0
Cornare	804	5794	721	719	7372	1025
Corpamag	10	0	0	10	0	0
Corpoamazonía	ND	ND	ND	ND	ND	ND
Corpoboyacá	940	0	0	589	0	0
Corpocaldas	10,238	0	0	9372	0	0
Corpocesar	ND	ND	ND	ND	ND	ND
Corpochivor	0	0	0	0	0	
Corpoguajira	ND	ND	ND	ND	ND	ND
Corpoguavio	323	0	0	353	0	0
Corpomojana	13	0	0	13	0	0
Corponariño	97	0	0	74	0	0
Corponor	0	0	GZ	0	0	GZ
Corporinoquía	126	0	0	128	0	0
Corpourabá	0	58	GZ	0	74	GZ
Cortolima	16,070	4370	27	17,929	2953	16
CRA	126	0	0	78	0	0
CRC	10,108	3282	32	8910	2849	32
CRQ	1953	1038	53	2219	1027	46
CSB	ND	ND	ND	ND	ND	ND
CVC	45,360	5064	11	26,122	4274	16
CVS	1167	0	0	2505	0	0
Average	3758	1331	42	3592	4395	158

ND: no data; GZ: reduction goal was zero.
Source: MMA (2002a).

exact number is not clear but very likely less than a third – BOD and TSS discharges dropped significantly following the initiation of program in 1997. Our answer to the second part of this question about the drivers of these reductions is less straightforward.

Not surprisingly, proponents have attributed emissions reductions that followed the introduction of discharge fees to the fees themselves, and in particular to the efficiency advantages of the fees discussed in Section 2 that reputedly make them less burdensome to polluters than CAC emissions standards. Although these claims are not baseless, the whole truth is more complicated because implementation of the discharge fee program was accompanied by simultaneous and important improvements in permitting, monitoring, and enforcement that were needed to implement both discharge fees and emissions standards.

As discussed in Sections 3.3 and 4.2, prior to 1997 permitting, monitoring, and enforcement of water pollution regulation was inadequate in most CARs and AAUs. To set up discharge fee programs, CARs and AAUs had to remedy these deficiencies by, for example, developing a complete inventory of dischargers and creating information management and monitoring systems. As a result of this effort, in many jurisdictions emissions standards had a far greater impact after 1997 than before. Hence, one cannot be certain whether the reductions in emissions that occurred after 1997 were due to: (i) the economic incentive and efficiency properties of the new discharge fee program or to (ii) improved permitting, monitoring, and enforcement of both the new discharge fees and existing emissions standards.[30] Although these factors are virtually impossible to disentangle empirically, intuition alone suggests that the second factor was critical – again, reasonably effective permitting, monitoring, and enforcement constitute the foundation upon which effective CAC and EI pollution control systems must be built. In

[30] This is a common problem in environmental policy evaluation: successes – in both developing and industrialized countries – are typically the result of a combination of policies and *ex post* attribution of credit among them is difficult. See, e.g., Kathuria (2006) and Jordan et al. (2003).

addition, other evaluations of Colombia's discharge fee program have attributed a significant share of the reductions in emissions after 1997 to improved permitting, monitoring, and enforcement (Kathuria, 2006; Guzmán Castro, 2003).

Why did the advent of the discharge fee system bolster permitting, monitoring, and enforcement? At least three factors contributed. First, implementation of the discharge fee system was accompanied by considerable publicity, fanfare, and controversy. As discussed in Section 4.2, vertical (top-down) and horizontal (CAR-to-CAR) programs were created to help CARs and AAUs implement discharge fees. This type of concerted nationwide effort was never devoted to promoting emissions standards. Second, the new discharge fee program entailed more transparency and accountability for regulatory authorities than did the old emissions standards program. Prior to the discharge fee program, few CARs and AAUs consistently kept records of – and, in any case, were infrequently held accountable for – discharges by water users in their jurisdictions. Under the discharge fee program, CARs and AAUs were required to report to both their boards of directors and MMA about their progress on a number of fronts including program implementation, pollution-reduction targets, pollution loads, invoices and collections. Hence, when the program was initiated, CARs and AAUs were for the first time held to performance standards for water pollution control. Finally, the discharge fee program created an economic incentive for CARs and AAUs to enforce their water pollution control laws. They were allowed to keep the revenues from these fees which, as discussed in Section 5.2, were significant for some CARs and AAUs.

To sum up, proponents of Colombia's discharge fees program claim that the incentives that fees create for polluters – namely, continuing significant financial incentives to cut emissions in a cost-effective manner – were responsible for reductions in BOD and TSS loads. To some extent this may be true. However, the incentives that the fees created for CARs and AAUs to improve permitting, monitoring, and enforcement – by enhancing transparency and accountability and by creating financial incentives for strict enforcement – are likely to have been at least as important.

What are the implications of our case study for the administration of the Colombian discharge fee program? A key finding is that the program was successful in some CARs and AAUs at least partly because it enhanced information flows about water pollution control. This result suggests that further efforts to improve information flows – by, for example, standardizing CAR and AAU reports and requiring MMA to post them on the internet (see, e.g., MMA, 2002b) – will heighten this benefit.

A second finding is that chronic noncompliance by municipal sewerage authorities undermined the development of a culture of compliance needed to enforce the program. The root problem here has been a complete lack of wastewater treatment infrastructure in the vast majority of Colombia's municipalities. This is a national-level public finance problem, not one that most municipalities acting independently are apt to solve on their own. Hence, the advent of the emissions fee program saddled many municipalities with an untenable choice between constructing wastewater treatment plants, paying rapidly escalating emissions fees that they were unable (or unwilling) to pass on to their customers, or simply refusing to pay discharge fees. Although the ideal fix would be a comprehensive national plan to build wastewater treatment infrastructure, the reality is that the government has other budgetary priorities, including fighting a civil war. Pending resolution of this problem – which is unlikely to happen soon – the discharge fee program needs to accommodate it. The program could do this by negotiating site-specific agreements with municipal sewerage authorities that establish realistic timetables and strategies for eventual compliance; clarifying regulations to allow municipalities to pass on to water users some part of discharge fees; and strengthening guidelines that require some fee revenues to be used to finance wastewater treatment.

A third, closely related finding, is that automatic fee increases in watersheds that did not meet aggregate pollution-reduction goals had an unintended impact: while they were supposed to ensure that financial incentives for pollution control were strong enough to allow CARs and AAUs to meet aggregate pollution load targets, they appear to have helped weaken these incentives in watersheds where municipal sewerage authorities were unable or unwilling to pay fees. One way to mitigate this problem would be to continue to require municipalities to pay emissions fees but to condition automatic fee increases on the performance of industrial polluters only instead of on both industrial and domestic polluters. This arrangement would avoid penalizing industrial dischargers for municipalities' noncompliance.

Finally, we find weak regulatory capacity in some CARs and AAUs that resulted in very uneven implementation of the discharge fee program. Although we argue that setting up such a program may help to bolster regulatory capacity in poorly performing CARs and AAUs, it may not have much impact in the short run. So here again, the design of the fee program needs to accommodate a structural problem. Options include targeting particularly weak CARs and AAUs for subsidies and technical assistance, and reducing their regulatory burden by limiting program implementation to certain watersheds. Note that Decree 3100 of 2003 and Decree 3440 of 2004, which modified Decree 901 of 1997, addressed several of the issues outlined in the last three paragraphs.[31]

What are the implications of this case study for the debate about the use of EI instruments in developing countries? The most obvious – and also most superficial – conclusion is

[31] Decree 3100 of 2003 and Decree 3440 of 2004 cap automatic increases in the fee level due to failure to meet aggregate emissions standards at 5.5 times the initial level; make automatic increases inversely proportional to the percentage of the target achieved; exclude discharges from municipal sewerage authorities from the calculation of total pollution loadings; allow trading of discharge reductions among pollution sources; allow CARs to set site-specific goals for water utilities and large sources; and limit the purview of the discharge fee program to watersheds considered a priority based on the quality of its waters See Blackman, 2006 for details.

that discharge fees can indeed be successfully implemented to control pollution in developing countries. But other case studies have already demonstrated this point. More interesting conclusions concern the advantages and disadvantages of relying on discharge fees instead of – or in addition to – CAC instruments to control water pollution.

Discussions of the advantages of discharge fees in the existing literature have focused on the static and dynamic efficiency properties of fees, while discussions of the disadvantages have centered on the notion that they are more demanding of scarce regulatory resources than many CAC instruments. Yet, the evidence presented here suggests that other pros and cons of discharge fees may be equally important. As for advantages, the Colombian case study suggests that, as noted above, discharge fees create incentives for regulatory authorities to improve permitting, monitoring, and enforcement.

As for disadvantages, this case study suggests that inadequate municipal wastewater treatment infrastructure – a pervasive problem in many developing countries – is likely to be a key barrier to implementation of discharge fee programs. Among other things, the lack of such infrastructure can greatly hinder efforts to develop a culture of compliance in the discharge fee program, saddle municipal sewerage authorities with debts that further complicate plans for new wastewater treatment facilities, and increase utility fees for end users.

In addition, the Colombia experience suggests that the strategy of setting pollution-reduction goals for individual water basins and then ratcheting up fees until these goals are met is bound to be problematic when leading dischargers are unable and/or unwilling to undertake the pollution abatement investments required to meet these goals. In such cases, fees will increase continuously regardless of the investments made by lesser polluters, a politically untenable situation that is likely to damage the credibility of the program.

Appendix 1. Discharge fee formulae in Decree 901 of 1997

Decree 901 of 1997 regulates Law 99 provisions on retributive fees for water discharges. It mandates that the monthly fee for pollutant j (BOD5 or TSS), TR_j is calculated as

$$TR_j = \mathrm{Tr}_j \mathrm{Cc}_j T$$

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

Furthermore, Cc is calculated as

$$\mathrm{Cc} = Q_j C_j \times 0.0864(t/24)$$

where Q_j is the average flow (l/s); C_j is the concentration of the contaminating substance (mg/l); 0.0864 is a unit conversion factor; and t is hours per day of discharges (h) and Tr_j is calculated as

$$\mathrm{Tr}_j = \mathrm{Tm}_j \mathrm{Fr}_j$$

where Tm_j is the minimum rate ($/kg); and Fr_j is the regional factor.

Tm_j is established annually by MMA. The minimum regional factor is equal to 1. It increases by 0.5 each semester (6 months) that a pre-established target for total reductions of discharges by all sources is not met.

Appendix 2. CAR-level econometric model of implementation

We develop a simple econometric model to identify the characteristics of CARs that have been more successful in implementing discharge fees. The independent variable (GROUP_M) is a categorical variable that corresponds to the MMA (2002b) ranking of 28 CARs based on their performance in implementing discharge fees (group A = 3; group B = 2; group C = 1). Given the limited sample size ($n = 28$), we are only able to use a few explanatory variables. We use four that were constructed from data provided by the national association of CARs, and the Colombian national statistical agency: percent urban population (PERCURBAN); whether the CAR was established prior to 1993 (PRELAW99); per capita (GDP_CAP); and the natural log of population density (LN_POP_DENS). See Table A1. Presumably, PERCURBAN, GDP_CAP, and LN_POP_DENS proxy for the demand for water pollution regulation: one would expect that CARs with denser, more urbanized populations, and higher incomes to generate relatively high levels water pollution. GDP_CAP may also proxy for the supply of water pollution regulation in that it may be positively correlated with the availability of various resources for water pollution control. Presumably, PRELAW99 proxies for the supply of water pollution regulation. While some CARs date back to the 1950s, most were created by Law 99 of 1993. Generally, the CARs which pre-dated Law 99 of 1993 function relatively well compared to those created more recently (Blackman et al., 2006).

Table A1
Variables used in CAR-level econometric analysis of program implementation ($n = 28$)

Variable	Explanation	Source	Mean
GROUP_M	MMA rank categorical variable (A = 3; B = 2; C = 1)	MMA (2002b)[a]	1.93
PERCURBAN	Percent urban population	ASOCARS (2004)[b]	18.45
PRELAW99	CAR estab. before Law 99 of 1993?	Blackman et al. (2006)	0.61
GDP_CAP	GDP per capita	DANE (2004)[c]	1.28
LN_POP_DENS	Natural log of pop. density 2004	ASOCARS/DANE (2004)	4.31

[a] Ministerio del Medio Ambiente.
[b] Asociación de Corporaciones Autónomas Regionales.
[c] Departamento Administrativo Nacional de Estadística.

Results from an ordered probit regression are presented in Table A2. The estimated coefficients of two variables are significantly different from zero, both at the 1% level: GDP_CAP and PRELAW99. As expected, the signs of both variables are

positive. These results are robust to the specification of the regression. For example, both GDP_CAP and PRELAW99 remain significant when PERCURBAN and LN_POP_DENS are omitted, and PERCURBAN and LN_POP_DENS are insignificant when GDP_CAP and PRELAW99 are omitted.

Table A2
Ordered probit regression results: dependent variable = GROUP_M ($n = 28$)

Variable	Coefficient (s.e.)
PERCURBAN	0.0033 (0.0170)
PRELAW99	1.4457** (0.5838)
GDP_CAP	0.8196** (0.2451)
LN_POP_DENS	−0.0554 (0.2278)
Pseudo R^2	0.2502
Log likelihood	−22.5587

**Significant at 1% level.

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