THE U.S.-MEXICAN border environment:

Improving Transboundary Air Quality with Binational Emission Reduction Credit Trading

by
Christopher A. Erickson
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Southwest Consortium for Environmental Research and Policy

The U.S.-Mexican Border Environment

Improving Transboundary Air Quality with Binational Emission Reduction Credit Trading

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A series edited by Paul Ganster

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The Southwest Consortium for Environmental Research and Policy (SCERP) is a consortium of U.S. and Mexican universities dedicated to addressing environmental issues of the U.S.-Mexican border region through applied research, outreach, and regional capacity building.

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The views of the authors contained herein are not necessarily the views of SCERP, the U.S. Environmental Protection Agency, the Secretaría de Medio Ambiente y Recursos Naturales, or the tribal nations involved. They are presented in the interest of providing a wide range of policy recommendations to prompt discussion and action in the U.S.-Mexican border region.

Contents

Foreword

"If an idea's worth having once, it's worth having twice."
–Tom Stoppard

Ideas need time and space to develop and mature. The first discussions about harnessing the forces of the market to address environmental quality culminated in a report from Harvard University in 1988. Called "Project 88" by its principal authors, Professor Robert Stavins and Senators John Heinz (R-Pennsylvania) and Tim Wirth (D-Colorado), the report contained a number of innovative ideas. Trading of pollution reduction credits was one of the more promising concepts that flourished. It proposed that relatively affordable technologies and strategies to reduce pollution by one source could be credited to that polluter, who might then choose to sell that credit to another source unable to reduce its emissions for the same investment, thus providing a cleaner environment and improved public environmental health conditions at a reduced cost. Cynics first criticized the concept as a permit to pollute. Since then, though, policy specialists throughout academia, in Washington, D.C., in state capitols, and at individual agencies have come to understand and appreciate the overall value and specific benefits of emissions trading, as it is now called.

When the idea of emission reduction credit trading was introduced to the U.S.-Mexican border region, people doubted its wisdom, challenged the U.S. origins of the concept, and criticized the mechanics of such trades. But a consortium of universities from both sides of the border—the Southwest Consortium for Environmental Research and Policy (SCERP)—persisted, and through a series of workshops explained the economic, environmental, and health benefits of trades. Today, progress has been significant:

- A number of potential sellers and buyers have been informed and are discussing options

- Several community activists and stakeholders acknowledge the value to their local conditions
- Advocates such as Environmental Defense and Resources for the Future are developing actual trading rules and structures
- A trade has been accomplished

It is SCERP's role to plant these seeds and allow them to grow in the transboundary context. As academics who can move freely across political, geographic, disciplinary, and societal boundaries, SCERP is able to incubate ideas, address negative perceptions, and provide the long-term funding to facilitate discussions.

To say merely that borders have been marginalized is to trivialize the environmental, infrastructure, and health issues found at the frontiers of many nations. Because countries focus efforts to maximize return on their investments and because of all the external influences in border regions, these areas tend to be ignored, suffer unplanned development, have economies that remain unmodernized, and make do with inadequate infrastructure.

The U.S.-Mexican border is no exception to marginalization, but it is unusual in that it joins a highly developed nation with a nation in the process of modernization and development. It also has accelerating assembly manufacturing and trade, and has been bolstered in the post-September 11 security setting. Legal and illegal immigration, smuggling, and corruption exist, as does transboundary pollution. Criteria air pollutants, contaminated surface water and groundwater, and hazardous materials and waste find their way across the border.

Because of the economic asymmetry across the border, tapping the financial resources of private industry has the potential for immense return. That is, what may be difficult, expensive, arduous, and time-consuming to accomplish on one side may be done more beneficially on the other. This works both ways with pollution. In the past, industries worldwide seeking affordable land and labor, a shorter environmental permitting process, and freedom from ambient air pollution ceilings may have investigated and sought to locate industrial sites in Mexico.

But the trend for the future offers economic savings, environmental quality benefits, and human health improvements. Trades of emission reduction credits, as this volume demonstrates, allow industries an opportunity to conduct business more cost effectively while emitting less overall pollution in perpetuity, thus benefiting citizens by reducing health risks associated with hazardous air pollutants.

While such international trades exist in several places around the world, none existed in the U.S.-Mexican border region when SCERP began its work early in 2000. Modeled after trades of acid rain precursors between Michigan and Ottawa, SCERP began a number of inquiries into the feasibility and practical concerns of dealing with an exchange. SCERP was in the position to facilitate such discussions after a decade of performing binational air quality research and outreach along the 10-state U.S.-Mexican border, and because of its well-established role as an organization of academic researchers.

Because of SCERP's work, one pollution reduction credit trade exists today and several others are possible. While they are not perfect, they do hold the promise of permanently cleaning the environment and clearing the air that people breathe.

D. Rick Van Schoik, Managing Director, SCERP
San Diego, California
July 2004

Prefacio

"Si vale la pena tener una idea una vez, vale la pena tenerla dos."
-Tom Stoppard

Las ideas requieren de tiempo y espacio para desarrollarse y madurar. Las primeras discusiones acerca del aprovechamiento de las fuerzas del mercado para abordar la calidad del medio ambiente culminaron en un reporte de la Universidad de Harvard realizado en 1988. Dicho reporte fue titulado "Proyecto 88" por sus principales autores, el Profesor Robert Stavins y los Senadores John Heinz (R-Pennsylvania) y Tim Wirth (D-Colorado) y contuvo una serie de ideas innovadoras.

El intercambio de créditos para reducir la contaminación fue uno de los conceptos más prometedores que surgieron a raíz de este reporte. Este concepto propuso la forma en que tecnologías económicamente accesibles y estrategias para reducir la contaminación proveniente de una sola fuente podrían ser acreditadas a ese contaminador, quien a su vez podría optar por vender ese crédito a otra fuente incapaz de reducir sus emisiones por la misma inversión, ofreciendo por lo tanto un medio ambiente más limpio y mejoras a las condiciones de salud ambiental pública, a un costo reducido.

En un principio el concepto fue visto por sus críticos como un permiso para contaminar. Sin embargo, a partir de entonces, especialistas en políticas a lo largo del medio académico, en Washington, D.C., en capitales estatales y en agencias individuales, han venido a comprender y a apreciar el valor general y los beneficios específicos que propicia hoy en día el llamado intercambio de emisiones.

Cuando la idea del intercambio de créditos para reducir la contaminación fue introducida a la región fronteriza México-Estados Unidos, la gente dudó su sabiduría, retó el concepto de su origen desde los Estados Unidos y criticó los mecanismos de dichos intercambios. Pero un consorcio de universidades de ambos lados de la frontera–el Consorcio de Investigación y Política Ambiental del Suroeste, (CIPAS)–persistió, y a través de una serie de talleres explicó los beneficios económicos, ambientales y de salud que ofrecen los intercambios. Hoy en día, su progreso ha sido significativo:

- Un número de compradores y vendedores potenciales han sido informados y están discutiendo opciones
- Diversos activistas comunitarios y personas interesadas reconocen el valor para sus condiciones locales
- Defensores como Defensa Ambiental y Recursos para el Futuro están desarrollando reglas y estructuras vigentes de intercambios
- Finalmente, se ha logrado un intercambio

Es el papel del CIPAS plantar estas semillas y dejarlas crecer en el contexto transfronterizo. Como académicos que pueden moverse libremente a través de las fronteras políticas, geográficas, disciplinarias y sociales, el CIPAS es capaz de incubar ideas, tratar percepciones negativas y proporcionar el financiamiento a largo plazo para facilitar discusiones.

Decir meramente que las fronteras han sido marginadas es trivializar los factores ambientales, de infraestructura y de salud encontrados en las fronteras de muchas naciones. Debido a que los países enfocan sus esfuerzos para maximizar el resultado de sus inversiones, y debido a las influencias externas en las regiones fronterizas, estas áreas tienden a ser ignoradas, a sufrir desarrollos no planificados, a tener economías que se mantienen sin modernización y a tener que salir adelante con infraestructura inadecuada.

La frontera México-Estados Unidos no es una excepción a la marginación, pero es peculiar, ya que une a un país altamente desarrollado con otro en proceso de modernización y desarrollo. Tiene también una agrupación acelerada de manufactura e intercambio comercial y ha sido fortificada en el ambiente de seguridad posterior al 11 de Septiembre.

Así como abundan la migración de personas documentadas e indocumentadas, el contrabando y la corrupción, también es abundante la contaminación transfronteriza. Los contaminantes del aire, el agua contaminada de la superficie y del subsuelo, los materiales peligrosos y los desechos, también logran cruzar la frontera.

Debido a la asimetría económica a lo largo de la frontera, tener acceso a los recursos financieros del mercado de la industria privada tiene potencial para ganancias inmensas. Esto es, lo que en un lado pudiera ser difícil, costoso, arduo y que requiriera mucho tiempo para ser logrado, pudiera ser hecho en condiciones más favorables en otro. Esto funciona en ambas vías con la contaminación. En el pasado, industrias en el mundo a la búsqueda de mano de obra y tierra barata, de un proceso más corto para obtener permisos ambientales, y de libertad de límites de contaminación ambiental del aire, pudieran haber investigado y buscado establecer sus industrias en México.

Pero la tendencia hacia el futuro ofrece ahorros económicos, beneficios para la calidad ambiental y mejoras a la salud humana. Como se demuestra en este volumen, los intercambios de créditos para reducir la contaminación le ofrecen a las industrias una oportunidad para llevar a cabo sus negocios con un mejor costo-beneficio, emitiendo, además, menor contaminación en perpetuidad y beneficiando, por lo tanto, a esos ciudadanos al reducir los riesgos de salud asociados con los contaminantes peligrosos del aire.

Mientras este tipo de intercambios internacionales existen en diversas partes del mundo, ninguno existía en la región fronteriza México-Estados Unidos cuando el CIPAS comenzó su trabajo, a principios del 2000. Tomando como modelo los precursores de intercambios por lluvia ácida entre Michigan y Ottawa, el CIPAS inició una serie de investigaciones sobre la factibilidad y practicalidad de un intercambio. El CIPAS se encontró en la posición de facilitar estas discusiones después de una década de llevar a cabo investigación y extensión binacional sobre la calidad del aire a lo largo de los 10 Estados colindantes en la frontera México-Estados Unidos, así como por su posición bien establecida como una organización de investigadores académicos.

A raíz del trabajo realizado por el CIPAS, hoy en día existe un intercambio de crédito para reducir la contaminación y varios otros son factibles. Aunque no son perfectos, conllevan la promesa de limpiar permanentemente el medio ambiente, así como el aire que respira la gente.

D. Rick Van Schoik, Director Aministrativo, CIPAS
San Diego, California
Julio de 2004

Preface

The border region is experiencing rapid economic and population growth that is currently not sustainable. Without rapid action, air quality can be expected to deteriorate. At the same time, many of the twin cities on the U.S.-Mexican border share a common geographical air basin. The daily airflows across the border make these air basins international, thus requiring binational solutions to air quality problems. Officials on both sides of the border have increasingly come to recognize this and are attempting to develop a response. Developing solutions to border air quality problems requires a binational dialog that must involve federal and local officials, non-governmental organizations (NGOs), and the private sector.

Such a dialog is beginning to develop. Starting with the La Paz Agreement in 1983 and continuing through the Border XXI and Border 2012 programs of the U.S. Environmental Protection Agency (EPA) and Mexico's Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT), the conversation about border environmental issues has proceeded with increasing effectiveness. But much work remains. The process will continue and will require a sustained effort by both the United States and Mexico. As a small part of the binational dialog, the authors held a series of workshops on emissions trading, sponsored by the Southwest Consortium for Environmental Research and Policy (SCERP). Workshops were held in Mexicali, Nuevo Laredo, Reynosa, Matamoros, and Ciudad Juárez. Participants were from Canada, the United States, and Mexico; from state and federal governments; and from NGOs, academia, and the business community. Overall, more than 200 people participated in the five workshops.

During the workshops, it became clear that there was considerable confusion about the air quality problems of the U.S.-Mexican border region and emissions trading. This monograph is a response to that confusion. It documents the environmental problems that face the border stemming from air quality problems, and shows that emissions trading is an important option for solving those problems. The essence of our research begins on page 121 in the section titled "Emissions Trading on the U.S.-Mexican Border." Academics and government officials will find information of interest within this monograph, but it is especially hoped that the general public will find it useful. To this end, care is taken to explain the issues in non-technical terms and with minimal use of jargon. The most important contribution of this monograph is the juxtaposition of information about air quality problems on the U.S.-Mexican border with information about emissions trading. The social, economic, and legal issues unique to emissions trading on the border are explored and explained.

The authors of this monograph believe that 20 years of successful emissions trading both in the United States and internationally are sufficient to demonstrate that emissions trading works. By allowing flexibility in how emission standards are to be met, an emissions trading program provides an efficient and cost-effective method for reducing air emissions to the benefit of the public, industry, and society as a whole. Some environmentalists are skeptical of emissions trading. They view capitalism and markets as the problem, not the solution. The authors show, however, that the evidence does not support this negative view. Indeed, many environmentalists have come to support emissions trading as one option for achieving environmental goals (see Daly 1996).

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I

Introduction

The View from El Paso

Looking down on the Paso del Norte from the Franklin Mountains, a cloud is often visible over Ciudad Juárez, Chihuahua, even though the border town is located in a desert not known for rain. The cloud consists of carbon monoxide, ozone, and dust. It obscures the skyline and hangs like a pall over the Mexican city. When the prevailing wind is from the south, the cloud crosses the Rio Grande to join the pollution already hovering over El Paso, Texas, choking the entire metroplex.

Unusual topography contributes to the problem. The Franklin Mountains to the north and west and the Juárez Mountains on the south hem in El Paso and Ciudad Juárez, thereby forming a single bowl and airshed. Occasionally, winter inversions trap emissions close to the ground. At these times, aircraft passengers looking out their windows can observe strata of pollution that bend and twist in response to air pressure variations in much the same way the rock strata of the Franklin Mountains bend and twist in response to geological pressure. At the western edge of El Paso is a gap in the mountains through which flows the Rio Grande. This is the Paso del Norte. Sometimes pollution spills through into the Mesilla Valley toward Las Cruces in New Mexico.

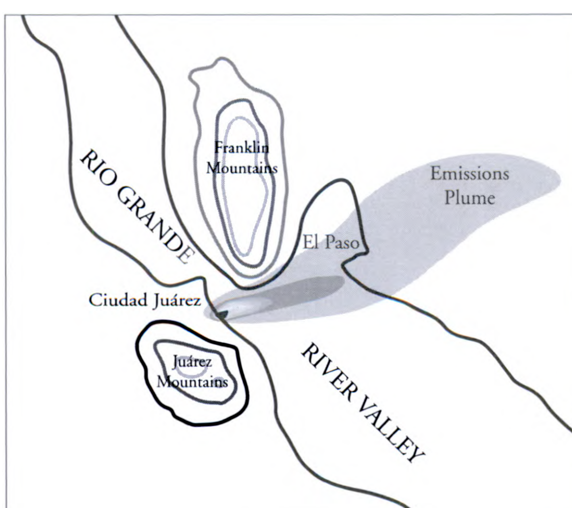
Like other twin cities along the border, El Paso and Ciudad Juárez are linked by cultural and economic ties that go back many generations. The border is crossed tens of thousands of times each day over the three bridges linking the cities. It is common for workers living in one city to commute daily to jobs in the other. The cities, as well as the corner of New Mexico that is also part of the area referred to collectively as the Paso del Norte, have been characterized by rapid industrialization and population growth. The result has been a deteriorating common environment. Since the 1990s, the U.S. Environmental Protection Agency (EPA) has classified El Paso as a nonattainment area for ozone, particulate matter, and carbon monoxide. Mexico does not formally designate areas as nonattainment, but evidence from monitoring stations in Ciudad Juárez indicates that the Mexican city is noncompliant with Mexican ambient air quality standards. Status as a nonattainment area means there are significant health risks for the residents of El Paso and, by implication, Ciudad Juárez. Exposure to ozone is believed to be a significant cause of lung disease. Ozone can also aggravate existing lung and heart disease. Particulate matter (PM) can exacerbate existing lung and heart disease, and even lead to premature death. Carbon monoxide can trigger angina. People with existing lung and heart disease, and those who work or play outside, are particularly at risk.

Status as a nonattainment area has triggered increased enforcement measures in El Paso (TNRCC 2000). Industrial permits have been restricted. A new vehicle inspection program requires that vehicles pass an annual tailpipe emissions test. El Pasoans are required to use less evaporative gas in the summer and oxygenated fuel in the winter, thus increasing fuel costs. These regulations have put a damper on some sectors of the El Paso economy. Unemployment remains high, even by border standards, and El Paso per capita income is consistently in the bottom 10 among U.S. urban areas.

The Paso del Norte's air quality problem is an international one. Figure 1 displays a typical pattern for ozone concentrations. It shows a high concentration in Ciudad Juárez with a plume extending across the border into El Paso, illustrating the binational nature of the pollution problem in the Paso del Norte region. Achieving air quality standards will require cooperation. In 2000, the Texas Natural

Resource Conservation Commission (TNRCC), now the Texas Commission on Environmental Quality (TCEQ), certified that El Paso was in compliance for pollution sources within the city; nevertheless, El Paso continues to be a nonattainment area. The cause of continuing nonattainment, according to TCEQ, should be attributed to sources in Ciudad Juárez, where the burning of old tires, wood, and trash for fuel is common, and monitoring and enforcement at industrial sites is weak or nonexistent. It is not that Juárezenses' attitudes toward the environment differ from U.S. attitudes (Ghosh and Molina 2002), rather, the problem is a lack of resources to devote to monitoring and enforcing air quality standards. The fact remains, however, that Ciudad Juárez and El Paso share a common airshed and until air pollution is controlled in Ciudad Juárez, El Paso will likely remain a nonattainment area, with the restrictions on economic growth that this implies. Clearly, the solution to El Paso air quality problems lies in developing a coordinated binational policy. And if the policy is to be successful, greater resources will have to be made available to the Mexican side of the border.

Figure 1. An Ozone Plume Originating in Ciudad Juárez and Extending into El Paso



Source: Los Alamos National Laboratory

Policy Options for the Control of Pollution

Environmental degradation, like that evident in the Paso del Norte, reduces quality of life and adversely affects public health. Yet at the same time, it is neither possible nor financially plausible to eliminate pollution altogether since doing so would impose onerous restrictions on human activity. An optimal policy will balance benefits gained from improved quality of life and public health against the benefits from pollution-generating human activities. Achieving this balance requires that each potential abatement project be considered individually. In particular, if a potential abatement project results in an environmental benefit that exceeds the cost of the project, the project should be undertaken. Conversely, if the benefit from the abatement project is less valuable than the cost of executing the project, the project should not be undertaken. It follows that abatement activity should continue up to the point at which the benefit from the last or incremental abatement project equals the cost of that project. That is, incremental benefit should equal incremental cost.

One possible policy to adopt in response to air pollution is *laissez faire*, in which the level of emissions is determined by the market. Unfortunately, *laissez faire* is not optimal; unregulated markets will result in inadequate abatement and excessive pollution. Pollution is created as a byproduct from the production of desired commodities. Because the pollution is released into the collective environment without charge to the emitter, the price of the desired commodity does not reflect the cost of pollution to society. Thus, the price is set too low, consumption of the commodity is too high, and excessive pollution is emitted. Moreover, emitters have an inadequate incentive to undertake abatement activity. Because the environment is the collective property of society, if society fails to limit its use, there will be exploitation and excess pollution. This is an example of the "problem of the commons" (Halvey 2002). Markets inadequately price the environment and the consequence is excessive pollution. Given the failure of markets in providing correct incentives, government intervention through the regulatory process has been appropriate. In this regard, there are three basic regulatory approaches to correcting this market failure—command-and-control, corrective taxes and subsidies, and marketable emission permits (Dhanda 1999).

Command-and-control involves traditional regulatory action in which the quantity of pollution emitted into the general environment is directly controlled. It is the most commonly used approach in both the United States and Mexico. There are a number of different variations on command-and-control. Policymakers might require polluters to meet a uniform design standard, referred to as the "best available control technology" (BACT). Alternatively, pollution controls may be directly applied to an emitter, thus limiting the quantity of a certain pollutant per unit of time or per unit of production (Dhanda 1999). A third approach to command-and-control is to establish a minimum ambient air quality standard for a pollutant. If the standard is exceeded, limits are placed on the actions of all emitters, even to the point of forcing an emitter to cease production. The main problem with command-and-control policies is that they limit flexibility, thereby increasing abatement costs. There is no guarantee that the measures mandated by regulators are the least-cost method for achieving a given level of air quality. "One-size-fits-all" policies may result in society incurring a higher cost than necessary. Implementation regulations require that existing facilities be retrofitted or that they be replaced with new facilities. However, retrofitting is likely to be expensive and replacing existing facilities means mothballing otherwise productive capacity, which is a waste of capital. Recognizing this, regulators commonly grandfather existing facilities, thus exempting them from new regulations. However, grandfathering is also likely to be inefficient because polluters may extend the life of a grandfathered facility precisely to avoid complying with new regulations.

Specific command-and-control polices have problems. BACT requires that regulators identify exactly which technology is best, a prospect that can be problematic during periods of rapid technological change. Moreover, BACT can inhibit research and development of new technologies when adoption requires a lengthy and uncertain regulatory approval process.

Imposing limits on emissions per unit of time or per unit of production can also increase abatement costs. Facilities with high abatement costs will have to meet the same standards as facilities with low abatement costs. The result will be that high-cost abatement projects will have to be undertaken at facilities where meeting standards are difficult. Moreover, since firms have no incentive to reduce emissions below the regulatory standard, even when doing so is a low-cost alternative, some low-cost abatement projects (i.e., low-cost projects at facilities already meeting emission standards) will not be undertaken.

Enforcing air quality standards by restricting the activities of polluters introduces a potential "free-rider" problem. The facilities most heavily regulated are the firms most likely to have their activities restricted should air quality standards not be met. They are also most likely to have already undertaken aggressive abatement activities. Facilities operating under fewer regulations, which are thus less likely to face regulatory action, have less incentive to undertake abatement projects, yet it is these facilities that contribute most to the failure of a region to meet pollution standards. This is exactly the situation facing the Paso del Norte. Regulated U.S. facilities have faced restrictions on activities while major sources of pollution continue unabated on the Mexican side of the border (TNRCC 2000). Such an anomaly raises fairness issues.

Of course, regulators are well aware of the drawbacks of command-and-control regulation. They understand that the blind application of simplistic rules can result in perverse outcomes. With this in mind, regulators have developed detailed rules with the hope of overcoming the limitations of command-and-control. But, this rule-making process in and of itself can introduce new inefficiencies. To the extent that complex rules are difficult to understand and enforce, they can become burdensome.

The second approach to regulation is the use of corrective taxes and subsidies. This approach usually involves levying a tax on pollution emissions, typically on each unit of pollution emitted above a baseline level. Alternatively, rather than impose a tax, a subsidy can be paid for each unit of pollution reduction below the baseline. Corrective taxes and subsidies allow for decentralized decision-making in that the emitter determines the level of pollution released into the environment. If an emitter finds that the tax incurred from polluting is greater than the abatement costs, it will reduce its pollution releases. If the opposite is true, so that the cost of abatement is greater than the tax, the emitter will not undertake the abatement project and emissions will be greater. The overall cost of abatement is reduced since emitters with lower abatement costs will reduce pollution more than those with higher abatement costs. Both taxes and subsidies should be used in designing an efficient policy, otherwise an asymmetry occurs at the baseline pollution level. If only taxes are imposed, some low-cost abatement projects may not be undertaken if they are located at facilities that have already obtained baseline emissions. If only subsidies are used, low-cost abatement projects at facilities above the baseline will not be undertaken because abatement projects at such facilities are not eligible for subsidies.

The third approach to regulation—emission trading—involves the trading of emission reduction credits, which are sometimes referred to as permits, that give legal permission to emit a certain quantity of a pollutant. There are two basic trading regimes—cap-and-trade, and baseline-and-trade (Rosenzweig, et al. 2002). In a cap-and-trade system, the regulator sets a cap for the maximum level of emissions that can be released from a source. Regulators then issue a permit to the source specifying how much can be emitted. The permits are freely transferable so they can be bought or sold. The control authority issues the number of permits needed to produce the desired aggregate emission level. Under a baseline-and-credit system, a baseline is determined for each participant against which its performance is measured. If an action is taken to reduce emissions, the difference between the baseline and the actual emissions creates an emissions reduction credit (ERC), which can be traded. Under either system, emitters are allowed flexibility in determining how to meet air quality standards—either by reducing pollution on site or by purchasing credits. Emitters with low abatement costs will choose to reduce emissions and sell excess permits; high abatement cost emitters will choose to buy permits, thereby avoiding abatement costs. Thus, the overall cost of achieving any given emission target will be reduced.

In theory, any of the three basic regulatory approaches can result in optimal pollution abatement. Command-and-control, however, requires that a single decision-maker—the regulator—have specific knowledge of conditions at each emission site. In practice, it is unlikely that regulators will have access to such detailed (and often proprietary) information, making it unlikely that an optimal policy will be implemented. By contrast, both corrective taxes and permit trading rely on decentralized decision-making. Polluters respond directly to market incentives by setting emission levels. Changes in market conditions change incentives, which result in individual decision-makers dynamically adjusting emissions over time. Such dynamic adjustment occurs only with a delay, if at all, under command-and-control because changes in regulations must be approved through a lengthy procedure.

Coordinating Policy on the Border

The Paso del Norte illustrates the problem faced by many twin cities along the U.S.-Mexican border: The environmental fates of border cities are not under their sole control, but rather depend upon the policies adopted by governments and implemented by industries in their twin city on the other side of the border. Circumstances—rapid industrialization, population growth, and unfavorable topography—conspire to make the problem more acute in El Paso-Ciudad Juárez, but the issues faced in the Paso del Norte region are the same issues that must be dealt with by other communities on the border. If air quality goals are to be met, there is a need for policy coordination between the United States and Mexico.

There are special difficulties in coordinating policy on the border that are not present in other venues. First are the language differences and other cultural misunderstandings that people communicating across the border must overcome. At the local level, this is a lesser problem than might be expected because the border has developed its own unique binational culture. Economic and social border criss-crossing is common. Both English and Spanish are commonly spoken. Binational sport leagues, philanthropic clubs, and other social organizations can be found (Barry 1994). It is usual for assembly plants located on the Mexican side of the border, called maquiladoras, to hire managers who commute across the border every day. However, at the state and national level, the potential for misunderstanding is more prevalent. Distance and lack of familiarity diminishes understanding. State and national government views of the border tend to be complicated by issues of nationalism, rather than what is best for border residents. On the U.S. side, the situation is exacerbated by poverty. The border poor, like the poor elsewhere, tend to be less politically powerful, and hence command less time from politicians. The border also often gets tied up in the public mind with issues related to illegal immigration. In the popular mind, more fences and other controls are needed, not greater transborder cooperation. The discussion is often tinged with racism. At best, the policy adopted by state and national governments can be characterized as benign neglect. Border residents often joke that they have more in common with their counterparts in their neighboring country than with their respective state and national governments.[1]

The second problem in policy coordination is the fact that the U.S. and Mexican economies are at fundamentally different levels of development. This means the two nations have different priorities. In Mexico, the major environmental problems involve the provision of potable water and sewage treatment. In the United States, these more basic environmental goals have been largely achieved. Indeed, potable water and sewage treatment are generally taken for granted. Other environmental goals—such as improvement in air quality—are now viewed as priorities in the United States. Such goals, however, are something only a developed country is likely to have sufficient resources to pursue. This is not to say that Mexico does not view air quality as important. Mexico has implemented a major effort to improve air quality in Mexico City. Oxygenated gasoline, catalytic converters, vehicle inspections, and greater industrial enforcement have all been implemented over the last 20 years in an attempt to improve air quality in the Mexican capital. The result has been a positive trend in air quality there. Lead, carbon monoxide, nitrogen oxide, and sulfur dioxide levels have fallen, although ozone remains a problem (Soto 2000). Along the border, a major environmental movement has developed, and the Paso del Norte leads it. The Joint Advisory Committee (JAC) on Air Quality

Improvement—comprised of local government, industry, and public representatives—was established to give environmental policy advice to environmental officials on both sides of the border. JAC has promoted a number of programs for improving air quality, including strengthening vehicle inspection, promoting dedicated commuter lanes, and the seasonal use of oxygenated gasoline (NEJAC 2003).

The efforts outlined above, while important at the local level, only address a minority of the air quality issues on the border or elsewhere in Mexico. An important point, which will be taken up in detail in subsequent chapters, is that U.S. and Mexican environmental standards are similar—there is little disagreement about what is desirable. But Mexico, a developing country, has not set the same priority on monitoring, enforcing, and therefore achieving air quality goals as the United States, nor is it reasonable to think it should. The reality is that Mexico does not have the resources to meet all of its environmental goals and has placed a higher priority on solving problems with potable water and sewers, believing that these will have a greater impact on public health and quality of life than improved air quality. Nevertheless, improved air quality is an important goal for border communities.

The question then is, How can policy coordination be achieved along the U.S.-Mexican border in an effort to improve air quality? The answer is that there is no single answer. In some circumstances command-and-control may be the best solution, in others it might be corrective taxes and subsidies that make the most sense. The authors argue that the best solution for the border often turns out to be emission reduction credit trading, and that is the focus of this monograph—using emissions trading as a policy coordination device on the U.S.-Mexican border. That is, this monograph is about how to design, construct, and administer emissions trading programs so that the shared goals of achieving good air quality can be met.

Emissions trading is an increasingly popular policy choice. The 1990 U.S. Clear Air Act and Amendments (CAAA) encouraged states to adopt market-based mechanisms, such as emissions trading, to assist in attaining and maintaining air quality standards (EPA 2002c). In the context of CAAA, concern centers on the criteria pollutants—carbon dioxide (CO_2), nitrogen oxide (NO_x), sulfur dioxide (SO_2), lead (Pb), ozone (O_3), and especially particulate matter

(PM_{10} and $PM_{2.5}$)—and volatile organic compounds (VOC). In 2003, EPA (2003b) reported that 70 market-based programs existed in 26 states. At least 17 states have emissions trading programs, including three located on the border (Texas, Arizona, and California). Emissions trading has also been used successfully to reduce acid rain in the eastern United States (see box, page 12).

A number of international emissions trading programs aimed at coordinating environmental policy between developed and developing countries already exist, most famously the United Nations Convention on Climate Change (UNCCC). The Kyoto Accord, reached under UNCCC, allows for joint implementation (JI), under which reductions in greenhouse gases in developing countries can be used as offsets for greenhouse gases emitted in developed countries. Parties to the protocol recognize that JIs allow developed countries to finance environmentally beneficial projects in developing countries, thereby achieving global greenhouse gas emission standards more efficiently. In essence, JI projects allow the "low-hanging fruit" in developing countries to be picked first, while the cost is borne by developed countries. Given the limited resources available in developing countries, these projects might not be undertaken in the absence of JIs. This illustrates the general principal that in coordination of environmental policy between developed and less-developed economies, emissions trading has the additional benefit of allowing the developed country to provide additional resources to the developing country, in effect, paying for the enforcement of agreed-upon environmental standards without regard to where the remediation is undertaken. That is, emissions trading can facilitate the transfers of resources to places where those resources can be used most efficiently. Citizens of the developing country obtain funds to finance environmental remediation and benefit from lower-cost abatement. Both countries benefit from improved environmental quality. This is obviously an advantage for the border, where resources are especially limited.

Some object to emissions trading on the grounds that it is unethical. Commentators who hold this point of view argue that it is unethical to allow a source to pollute to the detriment of the collective environment just because the source has purchased a permit.[2] These commentators argue that this is an immoral usurpation of a

Acid Rain and SO_2 Trading

The largest, most ambitious, and best studied[1] emissions trading scheme is the U.S. Acid Rain Program. Acid rain is a major problem in the eastern United States. It has been blamed for declines in eastern forests, acidification of lakes and streams (resulting in fish deaths), and damage to structures and buildings. Controlling sulfur dioxide (SO_2) emissions is an important step in reducing acid rain because SO_2 is a precursor for it. A major source of SO_2 emissions is power plants that burn coal and petroleum.

In an effort to address the acid rain problem, the U.S. Environmental Protection Agency (EPA) established a cap-and-trade program under which a fixed number of "allowances" are distributed to power plants. Each allowance represents permission to emit one ton of SO_2. A power plant can then sell its allowances to another power plant—or anyone else, including a speculator—provided that it surrenders to the EPA sufficient allowances to cover its emissions. Power plants facing high incremental abatement costs can avoid incurring those costs by purchasing additional allowances. Power plants are also allowed to bank unused allowances.

Phase 1 of the program required that 263 of the largest SO_2 sources, located primarily in the eastern and midwestern United States, participate. Other sources could participate on a voluntary basis. The total SO_2 cap in 1995, the first year of the program, was 8.7 million tons. This cap was slowly reduced until by 1999, at the end of Phase 1, the cap was 7.0 million tons. Phase 2 extends the program to all but the smallest existing power plants and to all new power plants. By 2010, the aggregate cap is to be reduced to 8.95 million tons of SO_2, approximately half the 1980 emissions.

The program has been successful. By 2001, there had been more than 4,000 trades (EPA 2002a). The flexibility provided by the program enabled power plants to pursue a variety of compliance options. Sources met their SO_2 reduction obligations by installing scrubbers, switching fuels, changing practices or procedures to improve energy efficiency, and/or buying allowances (EPA 2002a). The program's flexibility also significantly reduced the cost of achieving these emission reductions when compared to the cost of a technological mandate or fixed emission rate. Carlson, et al. (2000) estimated that SO_2 trading reduced total abatement costs by $700 million to $800 million per year when compared to command-and-control, all at an overall advantage to the environment.

[1] See, for example, Burtraw 1996; Burtraw, et al. 1998; Ellerman, et al. 2000; Ellerman and Montero 1998; Fullerton, et al. 1997; Kruger and Dean 1997; Rose 1997; and Swift 2000.

public good by private interests. However, this argument is somewhat misguided because it assumes that the pollution would not occur in the absence of emissions trading. The issue is not whether or not to pollute, but rather how to meet existing air quality standards at the lowest cost. The flexibility of emissions trading allows standards to be met at a lower cost. Moreover, great care has been taken in the design of emissions trading programs to ensure that they result in a net decrease in emissions, and that trading actually results in better air quality than would be the case in the absence of it. Considerable care has been directed, for example, at ensuring that no localized high-emission areas, so called "hot spots," are created through emissions trading. This means, at a minimum, that the offset must come from a source located in the same airshed as the acquirer.

Emissions trading is particularly well-suited for policy coordination on the border. Approximately 70% of the border population is located in 14 twin cities (Peach and Williams 2000). The spatial proximity of much of the population means that many of the twin cities form common airsheds, where sources on one side of the border affect air quality on the other side. Moreover, because of the unique nature of the border, the decentralized nature of decision-making under emissions trading is particularly important. The complexities of coordinating policies under command-and-control between state and federal officials in both Mexico and the United States seems unlikely to result in optimal outcomes. Often Washington and Mexico City are indifferent to the logic of local conditions as they (rightly) focus on the overall relations between the countries. Emissions trading allows local citizens to solve local problems. Once mechanisms have been put into place, border residents can negotiate economically rational emission reduction programs without having to obtain special permission from their respective national and state governments. As will be argued in Chapter V, a properly designed emissions trading program will place responsibility for the administration of them with the authorities of the acquiring firms' home countries.

An Example

A good way to understand how emissions trading can reduce the cost of achieving emission standards is with a hypothetical example that captures many of the elements of how a real trading system would work.[3] Suppose an electric company wants to open a new power plant in an SO_2 nonattainment area. Further suppose that the new power plant will emit an additional 2,000 tons of SO_2 per year. Because the power plant is located in a nonattainment area, it cannot operate without offsetting that additional pollution. Offsets can be obtained in any number of ways. The electric company can use internally generated emission reductions by, for example, installing scrubbers at existing facilities. Assuming regulators have established an emissions trading program, the electric company can also obtain offsets by purchasing emission credits directly from another company. Such purchases may contain existing credits generated by the seller on a speculative basis, or the offsets might be generated in response to a specific request from the acquiring electric company. In some markets, a formal exchange, such as that administered by the Chicago Board of Trade for SO_2 allowances (EPA 2003b), may operate, in which case the power company could purchase emission credits via the exchange.

The existence of emissions trading converts emissions into a variable cost subject to a standard "make or buy" analysis. That is, in deciding how to meet emission standards, the electric company will compare the cost of generating offsets internally to the cost of purchasing offsets. To continue the example, suppose that the electric company is required to obtain offsets equivalent to 125% of new emissions. In this example, for the electric company to emit an additional 2,000 tons of SO_2 per year, it must find offsets equivalent to 2,500 tons per year. Suppose the electric company has another facility located in the airshed at which it would cost $400,000 to reduce emissions by the required 2,500 tons per year. Further suppose that another business, a manufacturer perhaps, can reduce SO_2 emissions by 2,500 tons per year at an abatement cost of $100,000. If the electric company were to pay the manufacturer to reduce its emissions, the total gain in efficiency from the trade would be $300,000, which is the difference between the cost of generating emissions internally versus the cost to the manufacturer of reducing emissions. How these gains from trade are split between the electric company and the manufacturer depends on the relative negotiating skills of the two firms. For example, the power company could pay the manufacturer $250,000, in which case the gain would be split evenly.[4] Table 1 summarizes the example.

Consider an alternative scenario in which an SO_2 exchange is operating. In this case, rather than the electric company and the manufacturer trading directly, the transaction takes place through the exchange. The total gain from trade in political terms is unaffected by the existence of an exchange. The net increase in efficiency from using offsets generated from abatement activity by the manufacturer is still $300,000. However, the gains from trade are allocated, not through negotiation between buyer and seller, but based on the market price. For instance, suppose that the price per ton of SO_2 per quarter is $100, so that the value of 2,500 tons is $350,000, which will go to the manufacturer. The electric company will gain $50,000 from the trade (Table 1). Another example is El Paso Electric Company's use of emissions trading to achieve NO_x targets (see box, page 16)

Table 1. An Example of Gains from Emissions Trading

	Electrical Company	Manufacturer
Required abatement§	2,000 tons of SO_2 per year	2,500 tons of SO_2 per year
Annual abatement cost	$400,000	$100,000
Division of the gains from trade#		
Price = $40	$300,000	$0
Price = $80	$200,000	$100,000
Price = $160	$0	$300,000

Notes:
§ The electric company wants to open a new power generation plant but cannot do so unless it obtains SO_2 offsets. The electric company is assumed to have to purchase 2,500 tons to offset exceedences of 2,000 tons.

Total benefit to the two firms from the trade is $300,000. Division of the benefit depends on the relative ability of the two firms to negotiate a price. If the trade takes place via an exchange, then the price will be determined in the market.

Source: Authors

Transborder Emission Reduction Credit Trading: The Case of Brick Kilns[1]

El Paso Electric Company (EPE) uses transborder emissions trading to meet nitrogen oxide (NO_x) emissions targets. EPE is a public utility engaged in the generation, transmission, and distribution of electricity in west Texas and southern New Mexico. The company serves wholesale customers in Texas, New Mexico, California, and Mexico. EPE owns, in full or in part, six power plants, including Newman Station, located in El Paso County. Newman Station includes three grandfathered electric generating facilities (EGFs) that are natural gas-fired boilers. As of May 1, 2003, EPE was required to reduce NO_x emissions from these egfs to below new stricter state standards, or in the alternative, obtain additional allowances as provided under Texas regulations on emissions trading. Currently, 1,058 tons per year of NO_x allowances have been allocated to Newman Station. EPE estimated that controlling emissions at this level would require an initial capital allocation of $3 million. This cost was based on the use of water or steam injection, flue gas recirculation, and boiler tuning.

Due to the significant cost of reducing NO_x emissions at Newman Station, and taking into consideration that the three grandfathered units are scheduled for retirement within the next 15 years, EPE determined that it was more cost-effective to obtain additional allowances rather than install on-site abatement technology. A Texas law (30 TAC § 101.337) allows EGFs in El Paso to meet emissions allowances by using credits generated in Ciudad Juárez.[2]

Located in Ciudad Juárez are approximately 350 primitive kilns used to manufacture bricks (Figure 2). These kilns are open-top structures in which so-called green bricks are stacked. A fire is maintained at the base of the kiln by burning wood, sawdust, tires, refuse, or other fuel. The kilns emit large clouds of soot, carbon monoxide (CO), NO_x, and volatile organic compounds (VOCs) (Figure 3).

Figure 2. A Brick Kiln

Source: El Paso Electric Company

Figure 3. Emissions from a Brick Kiln

Source: El Paso Electric Company

The Marquez kiln is an alternative technology, developed by Roberto Marquez of New Mexico State University with funding from the Southwest Consortium for Environmental Research and Policy (SCERP), which substantially reduces emissions. The Marquez kiln consists of two identical kilns built adjacent to each other and connected by an underground tunnel. One kiln is fired and its effluent is vented through the connecting tunnel into the second kiln, which has been filled with green bricks. The clays in the green bricks serve as a filter, substantially reducing emissions. Moreover, the waste heat helps cure the second kiln's bricks. The Marquez kiln is cleaner, more efficient, less costly to operate, and construction involves materials and techniques already used in the construction of primitive kilns.

EPE generated emission credits for use at Newman Station by replacing 20 traditional brick kilns with Marquez kilns. Each kiln converted resulted in 3.3 tons of NO_x allowances per year. EPE's kiln conversion program represents the first time emission credits generated in Mexico have been used to meet U.S. emissions standards. As such, it illustrates the potential of transborder emissions trading as a policy tool.

[1] This section is based on El Paso Electric 2003.

[2] EPE advocated aggressively for statutory and regulatory changes, which culminated in the passage of 30 TAC § 101.337. This lobbying strategy was an integral part of EPE's strategy for emissions targets.

Air quality standards can be achieved more efficiently when emissions trading is possible, as these examples show. The efficiency gain from trading, illustrated by the first example, represents a gain to society. Presumably some of the additional profits resulting from emissions trading will be retained to finance business expansion, thereby creating jobs. Some of the profits will be passed on to the owners, who will use the proceeds to support their families, and some of the profits will be taxed and can be used to support socially desirable government programs.[5]

Complexities of the Real World

The aforementioned example illustrates the basic benefits from emissions trading, but glosses over many real-world considerations, some of which are unique to a binational setting. The following are among the issues that need to be addressed:

- While U.S. and Mexican air quality standards are similar, they are not identical. Where standards are in conflict, which standard should be used?
- Who will administer the program? Which country will take responsibility for auditing and enforcing standards?

- Should emission banking be allowed? Doing so provides incentives for early abatement efforts but may also result in temporal hot spots.
- Is emissions trading to be organized as a cap-and-trade system or should a baseline-and-trade system be implemented? Indeed, in the absence of strict enforcement of air quality standards in Mexico, is a cap-and-trade program even possible?
- How are permits to be distributed initially? Are emissions grandfathered or should permits be auctioned by the government?
- How exactly is the exchange of emission permits to take place? Will there be an organized exchange? Will the government or the private sector serve as a central clearinghouse?
- How are emission reductions certified and who does the certification? Should government authorities certify them or should private environmental auditors be used?
- Can permits be purchased by third parties and retired from use? Allowing this will result in better air quality, but it will also increase the cost of offsets, thereby reducing economic activity. The result could be greater unemployment.

All of these questions are controversial and different commentators have come to different conclusions, but in nearly every case the controversy is made more complicated by the existence of an international border. For example, take the issue of enforcement of air quality standards. In the United States, air quality standards are set by the national government, specifically EPA, but how those standards are to be met is determined by state governments, each of which submits a State Implementation Plan (SIP) and also occasionally augments air quality standards. Many of these SIPs already use emissions trading as a tool for achieving environmental goals. In Mexico, both air quality standards and the methods by which these standards are to be met are set by the national government.

In some cases, these issues can be resolved by unilateral action by one government or the other; in other cases, international cooperation is required. Much of the remainder of this volume will discuss how to resolve the issues outlined above to promote the establishment of active emissions trading along the U.S.-Mexican border.

Overview

This volume is organized as follows. Chapter II provides a snapshot of the border, which is a complex social milieu. It is an area characterized by both poverty and rapid economic development and population growth. Complicating this is the relative position of the two sides of the border within their respective countries. The border is among the most impoverished areas in the United States and is eligible for help from state and federal governments. The border is also among the wealthiest regions of Mexico, which causes the Mexican government's reluctance to provide resources for environmental problems there because other regions of Mexico have greater needs.

Chapter III summarizes air quality issues facing the border. The air quality standards in Mexico and the United States are compared in detail. Developing an emissions trading program on the border will require cooperation among U.S. and Mexican officials. This cooperation will be facilitated if, as is currently the case, the air quality standards in the two countries are similar. Differences in enforcement efforts between the two countries are discussed. Chapter III also discusses border institutions dealing with the environment, including the North American Development Bank, the Border Environment Cooperation Commission, and the Commission on Environmental Cooperation. Chapter III addresses the attainment status of various airsheds along the border. PM_{10} is identified as a major problem. The chapter ends with a brief history of cooperation on the border on environmental issues.

Chapter IV presents the results of a survey of maquiladoras with regard to their understanding of environmental regulation and emissions trading. The main conclusion from this chapter is that large firms identify PM_{10} as a significant problem; it follows that a trading program dealing with PM_{10} may be possible, although PM_{10} tends to be highly localized in its effects.

Chapter V presents the major results of the monograph. The chapter opens with a discussion of main issues in the design of emissions reduction trading programs. Specific recommendations are made for how a transborder emission reduction credit trading program should be designed. Among these recommendations is a proposal for the establishment of a baseline-and-trade program, with responsibility for certification and enforcement assigned to the home country of the emission purchaser.

Endnotes

[1] This is not to imply that there has been no progress toward developing binational institutions. Especially since the passage of the North American Free Trade Agreement (NAFTA), new institutions have been established to promote the exchange of information and for the coordination of environmental policy. One important recent effort in this regard has been the Border 2012 Program. This is a joint program of the U.S. Environmental Protection Agency (EPA) and Mexico's Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) and involves the cooperation of U.S. and Mexican governments, the 10 Mexican and U.S. border states, as well as U.S. tribal governments. Several working groups have been established under Border 2012, including a working group on air quality issues. The issue of transborder institutions will be addressed in more detail in Chapter III.

[2] A version of this argument has also been applied to corrective taxes.

[3] The example implicitly assumes that the only market failure is excessive air pollution.

[4] The example ignores transaction costs, but these can easily be incorporated. Suppose that the cost of searching for a trading partner, negotiating the transaction, and enforcing the contract after the transaction amounts to $20,000, then the net gain from the trade will be $300,000 – $20,000 = $280,000.

II

A Snapshot of the Border

The Meaning of the Border

The twin city of Puerto Palomas, Chihuahua (pop. 9,000), and Columbus, New Mexico (pop. 900), typify the sleepy border town. The community is most famous as the location of Pancho Villa's crossborder raid into the United States in 1916. Around the twin cities are mountains, cacti, ranches, and the occasional tracks of antelope seeking water (*Economist* 1998). The emptiness may explain why border residents have been such model neighbors. A single road forms the main street of both towns—it is divided in the middle by the border. It is common for tourists to walk across the border, make purchases on the opposite side, then return to their home country after a few minutes. Families have intermarried for generations, and it is common for family members to live on both sides of the border. The two towns form a single community. They shared a fire department for several years, and they still share an ambulance service. For more than 40 years, the elementary-age children of Palomas were educated in Columbus while middle school and high school children traveled to the nearby town of Deming, N.M. For many residents of the area, it was as if the border did not exist. In effect, the border was simply a stop sign with guards (Bennett and Bennett 1997).

All this changed in 1997 when the U.S. Congress passed a law limiting the ability of aliens to register in public schools in the United States. The new law was aimed at reducing the cost of public education to U.S. taxpayers. Indeed, the cost of transborder cooperation has been borne by U.S. residents who, embedded in a far wealthier society, had access to state and federal grants and subsidies that paid for local services. The intention of Congress was to stop using U.S. taxpayer money for services provided to aliens, but the effect has been to disrupt the cultural and political institutions that had grown up to serve the residents of the border. Palomas students could no longer attend public schools in the United States, and a tradition that had lasted two generations ended.

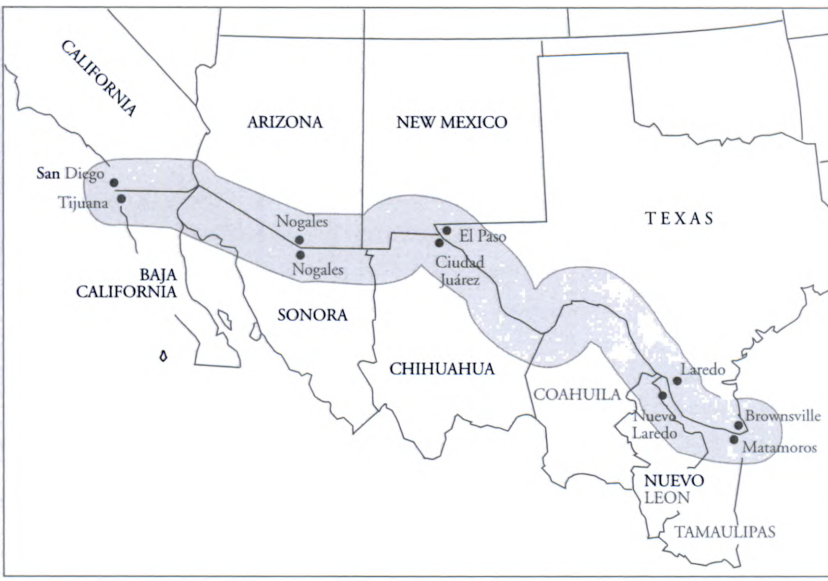
As the example of Palomas-Columbus illustrates, the U.S.-Mexican border has become more of a blur—a zone of transition—than clear line of demarcation. It is a political construct imposed by national interests onto the local landscape. The border divides people and accentuates differences between the United States and Mexico, but the degree to which this is true varies depending upon the sphere of human activity considered (Forster and Hamlyn 2002). While the border is relatively impermeable to political institutions such as systems of law and regulation, the border is less impermeable to the movement of people, finances, and goods and services. The border, however, is almost completely permeable to communication, environmental pollution, and natural systems.

This chapter describes the border and the border economy. It is meant to provide a context in which decision-makers can develop a better appreciation for the issues faced on the border.

GEOGRAPHY

The U.S.-Mexican border is 1,952 miles long, stretching from San Diego-Tijuana on the Pacific coast to the Gulf of Mexico near Brownsville-Matamoros. It is the longest border between a developed and a developing country in the world. It is also the most frequently crossed border in the world. The La Paz Agreement[1] defines the border region as extending 100 kilometers (km) north and south of the political divide (Figure 1). It is this 200-km band that has served as the working definition of the border for several binational institutions (including the North American Development Bank [NADBank]). The region contains parts of four U.S. states—California, Arizona, New Mexico, and Texas—and six Mexican states—Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas. While the climate is varied, most of the border region is characterized by arid conditions, which makes water a major issue. Agriculture is the largest economic activity.

Figure 1. The U.S.-Mexican Border Region



Source: U.S.-Mexico Chamber of Commerce

Formal ports-of-entry are located all along the border. These serve as conduits for both commercial and migration flows, thereby creating economic opportunities (Forster and Hamlyn 2002). Communities have developed around these ports-of-entry on both sides of the border, and it is in these twin cities that most of the border region population is located (Peach and Williams 2000). The largest of these twin cities are San Diego-Tijuana, Calexico-Mexicali (Imperial Valley), Nogales-Nogales (Ambos Nogales), El Paso-Ciudad Juárez (Paso del Norte), Laredo-Nuevo Laredo (Dos Laredos), Eagle Pass-Piedras Negras, McAllen-Reynosa, and Brownsville-Matamoros (Table 1). These urban agglomerations are often referred to as twin cities, although this phrase, while convenient, is misleading. The cities are twins in the sense that they are adjacent, grew up together, and arise from the same mother—the border. But at best they must be considered fraternal twins because certainly they cannot be thought of as identical—they differ in population, density, income, and environmental infrastructure. Despite the limitations of the term "twin city," the phrase is well-established in the lexicon of the border (see, for example, EPA 2002f) and will be used in this monograph to refer to transborder urban areas that have grown up along the boundary.

The Role of Poverty

The U.S.-Mexican border region faces a unique set of circumstances that arise from the juxtaposition of two economies at very different levels of development. Adjusting for purchasing power parity, U.S. per capita income is about four times higher than Mexican per capita income ($36,100 versus $9,100).[2] Moreover, the difference in per capita income is apparent in differences in the quality of life, as is obvious to even the most casual observer. Crossing the border from the United States to Mexico, one leaves a relatively prosperous developed country and enters a less-developed country. Conditions are more crowded, the infrastructure is not as well maintained, and sanitation is poorer in Mexico.

The situation is further complicated by the relative positions of the border communities within their respective countries (Erickson and Eaton 2002). The northern frontier of Mexico is characterized by the low income typical of developing countries, yet it is that nation's wealthiest region. Mexico's northern border region is more industrial and more urban than other regions of Mexico. In contrast, the U.S. borderlands are among the poorest in the United States (Peach and Williams 2000). Per capita income is less than 80% of the national average—approximately 60% of the national average if San Diego is excluded (Table 1). Unemployment is 50% greater than the national average. The poverty rate on the border is 25%, compared to 13% for the United States as a whole.

Table 1. U.S. Personal Income per Capita

City	1990	2000	% Change 1990-2000	% of Mean U.S. Personal Income
Brownsville	$9,946	$14,906	50%	51%
McAllen	$9,325	$13,344	43%	45%
Laredo	$9,443	$15,114	60%	51%
Eagle Pass	$7,052	$12,092	71%	41%
El Paso	$12,404	$18,535	49%	63%
Nogales	$12,143	$17,373	43%	59%
Calexico	$16,069	$18,469	15%	63%
San Diego	$21,145	$32,515	54%	110%
United States	$19,572	$29,469	51%	100%

Source: Bureau of Economic Development

The poverty of the borderlands and commensurate tax coffers limit the resources available to improve air quality there. The Mexican federal government has, reasonably, placed a higher priority on providing potable water and sewage than on improving air quality. Moreover, recognizing the northern border as relatively wealthy, the Mexican federal government often allocates central government funds to regions with more limited resources. Even for the United States, where air quality is a higher priority, other environmental concerns often take precedence over border communities faced with limited resources. For example, unincorporated subdivisions called *colonias*, which are common on the U.S. side of the border, often have inadequate water and sewage treatment and disposal capabilities. Water quality, endangered species, habitat preservation as well as other environmental and non-environmental projects all compete with air quality for local funds.

Economic Development and Environmental Quality

The relationship among air and water quality and economic development is complicated. Several studies have explored this issue, and an empirical regularity—referred to as the Environmental Kuznets Curve (EKC)—has been detected.[1] As economic development and industrialization proceed, it might be expected that air and water quality would decline. After all, industrialization involves expanding output and shifting from relatively non-polluting traditional agriculture toward pollution-intensive industrial production techniques. But this is not what has been observed by economists. Rather, there appears to be an inverted-U relationship between economic development and environmental quality. That is, in the first phase of economic development, environmental quality declines, while in the later phase of economic development, environmental quality improves.

The EKC results from the interaction of industrialization with increased demand for environmental quality (Wheeler 2001; Deacon 1999). Countries regulate pollution more strictly as they gain wealth. Pollution becomes a higher priority as more basic educational and public health needs are satisfied. At the same time, higher incomes lead to stronger regulatory institutions as better trained technical personnel become more available and budgets more generous. Higher income and better education empower citizens to demand stricter enforcement of environmental regulations. The interaction between industrialization and greater demand for environmental regulation results in the inverted-U EKC. In the first stage of industrialization, air and water quality decline because communities are too poor to pay for abatement and people are more concerned about jobs and income. In later stages of development, the balance shifts and there is greater concern for the quality of the environment and, therefore, development and stricter enforcement of environmental laws.

Interestingly, the peak of the EKC is estimated to be between a per capita income of $5,000 and $8,000, which means Mexican per capita income is such that economic development is associated with improvements in air and water quality. Moreover, as Mexico moves further along the EKC, Mexican and U.S. preferences for improved air quality should converge.

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[1] See, for example, Grossman and Krueger 1995; Wheeler 2001; Cole, et al. 1997; and Hettige, et al. 2000. For evidence contradicting the EKC hypothesis see Stern, et al. 2001.

Population and Employment

Perhaps the most significant stressor on the environment is human population, so understanding border population trends is useful in determining the environmental pressures faced by the border. Table 2 reports population statistics for 1990 and 2000 for the largest border cities and for the overall border. Also included for comparison are figures for Mexico and the United States as a whole. According to the 2000 census, the largest U.S. city on the border was San Diego (about 2.8 million), followed by El Paso (about 680,000). The largest Mexican cities are Ciudad Juárez (1.3 million) and Tijuana (1.2 million). Looking at combined populations, the largest twin cities are San Diego-Tijuana (slightly more than 4 million) and El Paso-Ciudad Juárez (slightly less than 2 million). These large cities have stressed the border environment in general and air quality in particular.

Population growth along the U.S.-Mexican border has varied (Table 3). On the U.S. side, the border population grew by 21% between the 1990 census and 2000 census, compared to 13% for the United States as a whole. McAllen was the fastest growing city (48%), followed by Laredo (45%). The only two U.S. border cities to lag behind the U.S. average population growth were San Diego (13%) and El Paso (15%). Population growth in Mexico is even more dramatic. Total Mexican border population grew by 43% between 1990 and 2000 while the overall population of Mexico increased by 20%. The Mexican cities with the most rapid growth

Table 2. Urban Border Population by Twin City

Twin City	United States		Mexico		Total Urban Area	
	1990 Census	2000 Census	1990 Census	2000 Census	1990 Census	2000 Census
San Diego-Tijuana	2,498,016	2,813,833	747,381	1,210,820	3,245,397	4,024,653
Calexico-Mexicali	109,303	142,361	601,938	764,602	711,241	906,963
Nogales-Nogales	29,676	38,381	107,936	164,070	137,612	202,451
El Paso-Ciudad Juárez	591,610	679,622	798,499	1,276,573	1,390,109	1,956,195
Eagle Pass-Piedras Negras	36,378	47,297	98,185	137,764	134,563	185,061
Laredo-Nuevo Laredo	133,239	193,117	219,468	344,501	352,707	537,618
McAllen-Reynosa	383,545	569,463	282,667	402,039	666,212	971,502
Brownsville-Matamoros	260,120	335,227	303,293	434,692	563,413	769,919
Total Border	5,213,774	6,316,212	3,891,578	5,548,039	9,105,352	11,864,251
Total National	248,709,873	281,421,906	81,249,645	97,483,412	329,959,518	378,905,318

Sources: U.S. Census; INEGI

Table 3. Percentage Change in Border Population by Twin City

Twin City	1990-1995			1995-2000			1990-2000		
	United States	Mexico	Urban Area	United States	Mexico	Urban Area	United States	Mexico	Urban Area
San Diego-Tijuana	6%	40%	13%	7%	22%	11%	13%	62%	24%
Calexico-Mexicali	26%	17%	19%	4%	10%	9%	30%	27%	28%
Nogales-Nogales	19%	32%	36%	10%	20%	11%	29%	52%	47%
El Paso-Ciudad Juárez	11%	40%	27%	4%	20%	14%	15%	60%	41%
Eagle Pass-Piedras Negras	22%	30%	28%	8%	10%	10%	30%	40%	38%
Laredo-Nuevo Laredo	30%	44%	38%	15%	13%	14%	45%	57%	52%
McAllen-Reynosa	31%	17%	26%	17%	25%	20%	48%	42%	46%
Brownsville-Matamoros	19%	28%	24%	10%	15%	13%	29%	43%	37%
Total Border	12%	26%	18%	9%	17%	12%	21%	43%	30%

Source: Authors

were Tijuana (62%), Ciudad Juárez (60%), and Nuevo Laredo (57%). In terms of impact on the environment, the most relevant population figures are not those for one side of the border or the other, but rather the population figures for the combined population of each twin city. Four twin cities had growth rates exceeding 40%. These were Laredo-Nuevo Laredo (52%), Nogales-Nogales (47%), McAllen-Reynosa (46%), and El Paso-Ciudad Juárez (41%). Combined population growth of the United States and Mexico was 30% between 1990 and 2000.

While the population growth rate has been rapid, it slowed down somewhat in the second half of the 1990s. The most dramatic decline in growth was in Nogales-Nogales and Laredo-Nuevo Laredo. Both these twin cities experienced rapid, perhaps unsustainable, growth during the early 1990s and both saw a dramatic slowdown in the late 1990s. Population growth on the border as a whole slowed by 5%, from less than 18% during the early 1990s to more than 12% during the late 1990s.

What is the outlook for urban growth on the border? Peach and Williams (2002), working with data from the U.S. and Mexican 2000 censuses, developed population projections for U.S. border counties and Mexican border *municipios*. Their medium growth scenario has the border population increasing to 14 million by 2010, 17 million by 2020, and 19 million by 2030. Peach and Williams project that the list of border cities with a population of more than 1 million—which now includes San Diego-Tijuana, Nogales-Nogales, and El Paso-Ciudad Juárez—will be joined by McAllen-Reynosa by 2005 and Calexico-Mexicali by 2010. Their projections suggest that border region population will grow by 20% between 2000 and 2010, which equals only about two-thirds the rate of the 1990s. Thus, it appears that the slower but still-substantial growth that characterized the late 1990s will continue into the current decade, which means population growth on the border is expected to continue and the already-apparent pressure from human populations on the environment will intensify. Meeting the needs of current and expected future populations yet maintaining adequate environmental standards is a premiere challenge for the border region (Hetch 2000).

Another source of environmental stress is economic activity, which generates air pollutants as byproducts. Industry is a major source of most common pollutants. Power plants are a major source of SO_2; industrial solvents and paints are a source of volatile organic compounds (VOCs); and on the border, agriculture and industry remain significant sources of anthropogenic particulate matter (PM). In addition to the direct effect on air quality from economic development and industrialization, there is also the indirect effect of industrialization increasing the demand for transportation both by workers who commute to and from work sites and by operations such as trucking and warehousing firms that service manufacturers.

Of course, population and economic activity are closely linked, and the growth apparent in the population data is reflected in employment growth. Table 4 displays data for employment in large twin cities as well as for the national economies. Looking first at the United States, between 1990 and 2000 employment grew by 20% at the national level. Employment growth on the border was more rapid, with the most rapid growth occurring in Laredo (59%), followed by Eagle Pass (52%). Employment in San Diego and El Paso grew only slightly faster than the overall U.S. employment—21% in these two cities. Looking at Mexico, between 1990 and 2000 national employment grew by 44%. All border cities except Mexicali and Piedras Negras had employment growth exceeding the Mexican national average. The most rapidly growing city was Reynosa (85%), followed by Tijuana (71%) and Ciudad Juárez (69%). The two slowest-growing cities were Mexicali (42%) and Piedras Negras (43%).

The Maquiladora Industry

Twin cities have traditionally specialized in industries that serve the border, such as customs collection, transportation, and warehousing. These traditional border industries have become less important in recent years. During the last three decades, businesses have increasingly chosen to locate along the border to take advantage of the differences between the two countries in terms of wages and working standards. Indeed, the primary source of economic growth along the border has been the maquiladora industry. Maquiladoras, also commonly referred to as maquilas, are manufacturing assembly

Table 4. Border Employment

Twin City	United States			Mexico			Binational		
	1990	2000	Change	1990	2000	Change	1990	2000	Change
San Diego-Tijuana	1,438,146	1,733,921	21%	261,526	446,339	71%	1,699,672	2,180,260	28%
Calexico-Mexicali	52,717	61,809	17%	200,104	284,884	42%	252,821	346,693	37%
Nogales-Nogales	5,876	7,542	28%	38,936	64,503	66%	44,812	72,045	61%
El Paso-Ciudad Juárez	269,821	327,289	21%	283,182	479,771	69%	553,003	807,060	46%
Eagle Pass-Piedras Negras	10,235	15,531	52%	32,095	46,010	43%	42,330	61,541	45%
Laredo-Nuevo Laredo	54,342	86,234	59%	69,803	115,669	66%	124,145	201,903	63%
McAllen-Reynosa	135,909	210,928	55%	90,573	167,138	85%	226,482	378,066	67%
Brownsville-Matamoros	99,420	141,146	42%	105,127	163,280	55%	204,547	304,426	49%
National Total	139,426,900	167,465,300	20%	23,403,413	33,730,210	44%	162,830,313	201,195,510	24%

Sources: Bureau of Economic Analysis; INEGI plants that take advantage of their location and provisions in Mexican and U.S. law that allow the duty-free import of parts for assembly into Mexico. The assembled product is then exported to its primary market, the United States. Only the increase in value due to assembly in Mexico is taxed upon re-entry into the United States. Foreign corporations, many of them U.S. firms, own approximately three-quarters of the maquilas in Mexico (Dwyer 1994).

The maquila program was formally initiated by Mexico in 1965 as a means of attracting foreign investment, increasing exports, increasing employment, and fostering development, particularly along the U.S.-Mexican border. Before the signing of the North American Free Trade Agreement (NAFTA), all production generated in Mexican plants had to be returned to the originating country or exported to a third country. NAFTA initiated a two-phase change in the maquila program. During the first phase, from January 1994 through December 2000, maquilas continued to benefit from a waiver on Mexican import duties on raw materials and components, but also benefited from preferential duties on products satisfying NAFTA rules of origin (Coronado de Anda and Matulewicz 2003). Starting in 1994, the restrictions on the sale of maquila products domestically in Mexico were phased out. In 1994, maquilas were allowed to sell up to 55% of the value of the previous year's imports within Mexico. Thereafter the limit was increased by 5% each year until 2000, at which time all maquilas' restrictions on domestic sales ended (Watkins 1994).

The maquila industry is controversial. The program is often criticized for its limited contribution to Mexican economic development. In particular, maquilas import materials for assembly from the United States and export the finished product back to the United States. In the past, most managerial and technical staffs have been supplied from the United States. In essence, maquilas are extensions of U.S. corporate supply chains. There was initially little opportunity for backward and forward links from the maquila sector to the rest of the Mexican economy (Sklair 1989). As a consequence, technology transfer has only recently had an impact and economic development has been stalled. The problem is exacerbated by a deliberate policy of the Mexican government to maintain low wages in the maquila industry.[3] According to INEGI, wage rates in 2003 for laborers, who are often young women from the interior of Mexico, are less than $1.42 per hour. Moreover, working conditions are inferior to what is typically found in the United States and living conditions are poor. Not protected by U.S. labor laws, maquila workers are subject to long work weeks and dangerous working conditions, and some are under age (Dwyer 1994). Defenders of the maquila industry, while acknowledging that wages and working conditions in Mexican factories are low by U.S. standards, argue that wages are high compared to those paid in the interior of Mexico and higher yet when compared to many developing countries. Indeed, Mexico is not considered a low-wage country by international standards. Wages in Malaysia and Indonesia, to mention two countries often cited as competitors of Mexico's, are lower.

Another concern with the maquila industry is its impact on the environment. Certainly one of the major industrial sources of air pollution in twin cities is the maquila industry. Many observers have pointed to environmental regulation as an important consideration in locating on the border. They argue that pollution-intensive industries once investigated escaping strict U.S. enforcement of environmental laws by relocating across the border to Mexico, where, it is argued, monitoring and enforcement of environmental regulations is less strict. How important environmental concerns are in determining the country in which to locate is open to discussion. Transnational corporations look at all costs, not just regulatory costs, in deciding where to locate production. Several studies have found that compliance costs are not a major determinant of relocation (Wheeler and Mody 1992; Albrecht 1998; Eskeland and Harrison 1997; Wheeler 2001). Labor, transportation, material, and administrative costs are all considerations in addition to environmental regulations. Indeed, labor costs are traditionally cited as the primary reason for locating production in Mexico. Moreover, while it is probably true that environmental law enforcement is less strict in Mexico than in the United States, Mexico enforces environmental laws more strictly than many other developing jurisdictions. These issues will be addressed in greater detail in subsequent chapters. For now it is sufficient to say that there is some evidence at the margin of regulatory-induced industrial migration to the border, but that the effect is likely small compared to other factors.

Air Quality and Power Generation on the Border

The failure to coordinate environmental policy on the border can result in a regulatory situation that is costly to business and confounds efforts to improve air quality. Two electric generating facilities (EGFs) located in Mexicali—Sempra Energy Resources' Termoeléctrica de Mexicali (TDM) Plant and InterGen's La Rosita Facilities—provide an interesting illustration of this point.

The Sempra plant is a $350 million, 600-megawatt (MW) facility located in the Mexicali Valley 18 kilometers (km) west of the city and adjacent to the Mexicali-Tijuana highway (Sempra 2003a). InterGen's plant is a $484 million, 1,065-MW EGF also located outside Mexicali within eyesight of the Sempra plant. The two plants are approximately 10 km south of the border. Both plants are natural gas-fired, combined-cycle facilities (InterGen 2003a) and both draw water for cooling. Fuel for the two plants is transported through a new 126-mile, crossborder natural gas pipeline running from Ehrenberg, Ariz., to the plant sites near Mexicali. The facilities connect to the western U.S. electrical grid system via transmission lines that cross the border near El Centro, Calif. The plan is to market to U.S. customers a significant portion of energy produced at these facilities.[1] Both plants have supplied power to the United States since test runs, which began in January 2003.

Electric power generation is a source of air pollutants, especially sulfur dioxide (SO_2), carbon monoxide (CO), and nitrogen oxides (NO_x). A single poorly designed power plant can have a significant adverse effect on regional air quality, so extra care is taken in granting a permit to build one. In the United States the process takes about two years; in Mexico it takes about six months (Dow Jones Wire Service 2003). Sempra and InterGen hoped to take advantage of the more streamlined regulatory process, as well as cheaper land and labor, in Mexico by building in Mexicali.

Environmentalists have expressed considerable skepticism about the motivation of Sempra and InterGen in building in Mexico, contending that the reason to build in Mexico is to avoid U.S. clean air laws. These skeptics claim that the two power plants could never have obtained U.S. permits to operate in the Imperial Valley if they had been located in the United States. Opponents believe the two EGFs will significantly boost emissions in the common air basin of Mexicali and Imperial County, which is already plagued by air quality problems and labeled nonattainment for several criteria pollutants. Earth Justice (2003), for example, states in its lawsuit and on its web page that the operation of these power plants would "significantly degrade air and water quality and would likely degrade public health in the border region."

Both InterGen and Sempra are sensitive to their critics. Both facilities far exceed Mexican minimum emission design requirements. Moreover, Sempra maintains that the TDM facility is in full compliance with California laws and is as clean as any facility operating in California (Sempra 2003b). However, although it may be in compliance with areas in California that already have clean air, they are not in compliance in Imperial-Mexicali because of the area's ambient air nonattainment status. While the La Rosita EGF is not in compliance with California law as originally designed, InterGen agreed in January 2003 after public pressure to retrofit the plant to reduce NO_x emissions to meet California standards (InterGen 2003b).

Environmentalists had little success in attempts to influence the Mexican permit process for the plants, so they focused efforts on blocking the U.S. permits for the transmission lines from the two Mexican facilities into the United States. On May 2, 2003, environmentalists scored a significant victory when a federal judge ruled that the U.S. Department of Energy acted inappoprpriately in determining that two Mexicali EGFs would not significantly affect the crossborder region's air and water quality. The ruling dealt a blow to energy companies, which are planning to build more power plants in Mexico to sell electricity in the United States (Lundquist 2003).

[1] InterGen plans to sell only about one-third of its power to U.S. customers. The remaining two-thirds will be sold to Comisión Federal de Electricidad for distribution to Mexican customers. Sempra plans to sell all power to U.S. customers.

The maquila industry imports, as measured by a number of employees and number of maquilas, peaked in 2000 and has plateaued below that peak (Millman 2003). INEGI reported a peak employment of 1,310,171 in January 2001 at 3,713 maquilas and current employment of 1,097,447 at 2,820 maquilas as of April 2004 (*Twin Plant News* 2004). Table 5 shows maquila employment for eight Mexican border towns. The city with the greatest maquila employment is Ciudad Juárez (more than 250,000 at its peak, but approxiamtely 205,000 now), followed by Tijuana (more than 187,000 at its peak but approximately 150,000 now) (*Twin Plant News* 2001; 2004). Between 1990 and 2000, maquila employment growth ranged from 213% in Tijuana to 41% in Nuevo Laredo, but has since fallen between 10% and 25%. Among border cities, only Tijuana and Mexicali had more rapid maquila growth than the national average. Historical restrictions placed on the location of maquilas within Mexico—they had been restricted to within 100 km of the U.S.-Mexican border—causes this phenomenon. In recent years, though, the 100-km restriction has been phased out. With the relaxation of the restriction on location, more and more maquilas have located in the interior, thereby reducing the growth of maquilas on the border. Nevertheless, 86% of maquila production remained in Mexican border states as of 2000 (Erickson Forthcoming).

Table 5. Mexican Maquiladora Employment by Municipio

City	1990	2000	Change	2004	Change
Tijuana	59,870	187,339	213%	150,815	-19%
Mexicali	20,729	60,063	190%	50,487	-16%
Nogales	19,714	38,633	96%	28,783	-25%
Ciudad Juárez	122,231	249,509	104%	204,922	-18%
Piedras Negras	7,986	14,546	82%	13,051	-10%
Nuevo Laredo	16,036	22,603	41%	19,765	-13%
Reynosa	23,541	66,091	181%	77,828	16%
Matamoros	38,360	66,023	72%	52,507	-20%
Nation	446,436	1,285,007	188%	1,092,447	-15%

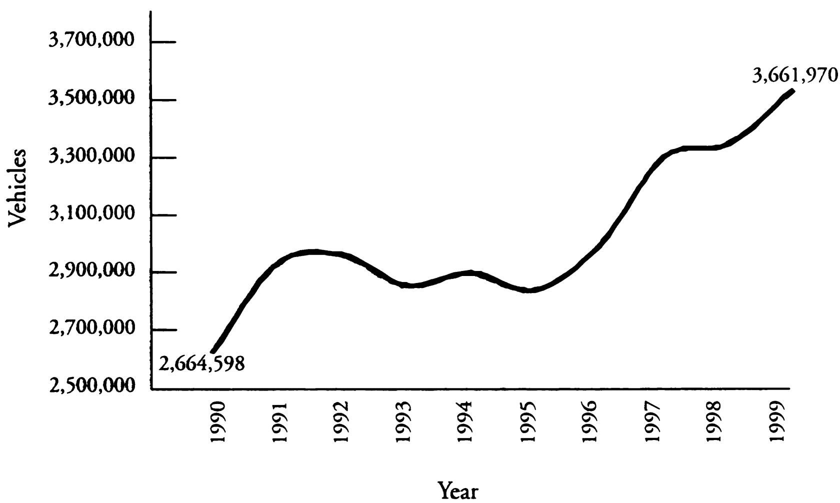
Source: INEGI; *Twin Plant News* 2004

Motor Vehicles and the Border

A major source of air pollution, as indicated above, is motor vehicles—or so-called mobile source pollution. Vehicles contribute to the deterioration of the environment in several ways. They are a major source of carbon monoxide (CO), sulfur dioxide (SO_2), ozone (O_3), and PM and they emit these pollutants directly into the air. When they drive on unpaved roads, they add to the problem by sending dust into the air. There are also indirect costs to the environment from vehicles. Disposal and recycling of old tires, junk cars, and trucks is expensive and difficult. Refining fuel used by automobiles also generates air pollution. Generally speaking, greater economic activity means more vehicles and lower air quality. Thus, it is expected that the number of vehicles registered on the border has increased since 1990. And in fact, the number of motor vehicles registered in Mexican border states increased by 1 million, from 2.7

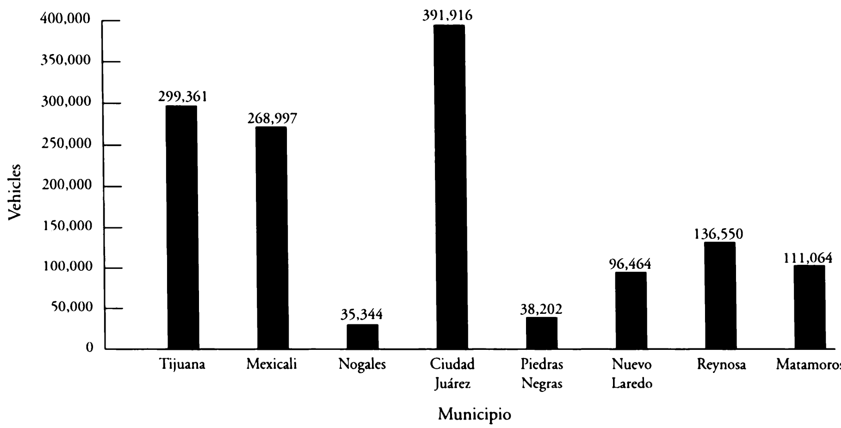
million in 1990 to 3.7 million in 2000, during the decade of rapid economic and population growth (Figure 2). In 2000, just more than 1.3 million vehicles were registered in Mexican border cities (Figure 3). A significant source of mobile air pollution is emissions from vehicles delayed at the border for inspection and for general entry into the country. Truck crossings at Texas border towns have increased since 1990, particularly at Laredo (Figure 4).

Figure 2. Vehicles in Mexican Border States



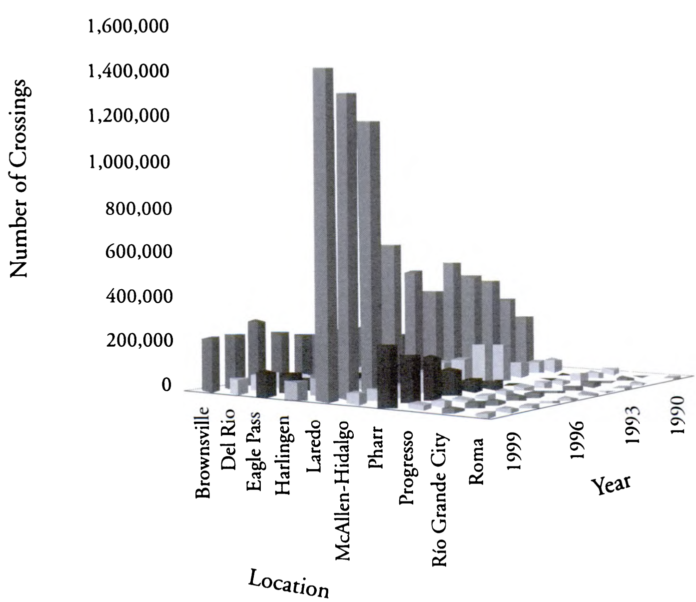
Source: Sistema Municipal de Baso de Data

Figure 3. Vehicles in Mexican Border Towns



Source: Sistema Municipal de Baso de Data

Figure 4. Number by Location of Truck Crossings into Mexico from Texas



Source: Sistema Municipal de Baso de Data

The Environment, Human Activity, and the Border

The complex interplay of human activity and the environment is ubiquitous, but special issues are at work on the border. These include rapid population growth, complex cultural interactions, and the juxtaposition of two countries at very different levels of development. Poverty characterizes both sides of the border. This poverty limits the resources available for pursuing environmental goals, including improved air quality. The poverty of the border makes the logic of emission reduction credit trading more obvious. If the government does not have the resources for air quality improvement, then a policy like emission reduction credit trading, which uses private funds to finance air quality improvements at a lower overall cost to society, is even more valuable. An added benefit is that in most cases, it will be firms in the relatively wealthy United States that will pay for emission reductions by Mexican firms.[4]

Endnotes

1 U.S. President Ronald Reagan and Mexican President Miguel de la Madrid signed the La Paz Agreement on August 14, 1983. It deals with cooperation on the border and serves as the legal basis for much of the subsequent cooperation on environmental issues.

2 These are estimates for 2000 (CIA 2002).

3 Generally speaking, wages in Mexico are not determined in the market. Instead, wages are set by negotiation between semi-official labor unions and the federal government. Thus, the central government has considerable influence over wages.

4 Of course, the U.S. firms are not doing this out of altruism but because they can achieve their emission reduction goals at a lower cost by buying emission reduction credits from Mexican firms. Thus, as argued in Chapter I, emission reduction credit trading is a win-win situation.

III

Environmental Regulation and the Border

Transborder Cooperation in the Sonoran Desert

Ambos Nogales consists of the twin cities of Nogales, Ariz., and Nogales, Sonora. Located in the heart of the Sonoran Desert, the cities are surrounded by stark desert terrain with mountain ranges floating like islands in the distance. The border is omnipresent in Nogales, Ariz., and plays an important part in the economy. Nogales is a high-volume port-of-entry—it is the most important entry point for Mexican produce into the United States. Indeed, one cannot help but be impressed when driving into Mexico by the sometimes several miles-long lines of 18-wheelers traveling the opposite direction, waiting to pass through U.S. Customs.

Residents of the region share many cultural and business links, but they also share air pollution. Nogales, Ariz., has been deemed a nonattainment area for coarse particulate matter less than 10 microns in diameter (PM_{10}) by the U.S. Environmental Protection Agency (EPA). While Mexico does not have the equivalent of U.S.-enforced nonattainment areas, examination of records show that ambient air quality in Nogales, Sonora, does not meet Mexican total PM standards.[1] The existence of a common airshed means that neither U.S. nor Mexican officials can easily solve air quality problems unilaterally. A reduction in transborder pollution in Ambos Nogales can be achieved if regulators coordinate their efforts. To this end, the Ambos Nogales Binational Air Quality Study was undertaken. The project represented an unprecedented level of cooperation between local, state, and federal officials (ADEQ 1999) and involved the comprehensive gathering of information on air quality in an 8-mile by 12-mile rectangle divided approximately in half between the United States and Mexico. Data were gathered on air quality, metrological monitoring was undertaken, and an environmental inventory was compiled.

The Ambos Nogales study found that air quality is essentially identical on both sides of the border, so the health risk faced by both U.S. and Mexican border residents is similar. Using data generated from the project as inputs, simulations were conducted showing that an average person would face a PM_{10} exposure of 30 micrograms per cubic meter ($\mu g/m^3$) in Nogales, Ariz., and 31 $\mu g/m^3$ in Nogales, Sonora. The excess exposure to PM will, on average and on both sides of the border, cause 2% more hospitalizations, 8% more asthma episodes, 8% more lower-respiratory illnesses, 3% more coughs, and 47 more premature deaths from cardiovascular or respiratory diseases. The project identified unpaved roads as the major source of PM in the region. Auto and truck emissions associated with the border crossing area and industrial sources were also deemed significant. The data support the conclusion that Ambos Nogales is a single airshed and that improving air quality for residents requires binational action.

These particular twin cities provide an example of how cooperation can significantly improve air quality. Attempts to improve air quality on one side of the border without emission controls on the other side are likely to fail by nature of the interconnectedness of the environment. Cooperation can take many forms and a variety of approaches could be used—just three possibilities include road paving projects, improved management of traffic at the port-of-entry (Figure 1), and direct subsidies of enforcement efforts. Could emissions reduction trading be used to coordinate a PM control program? The answer is yes, at least when dealing with industrial sources. Indeed, a functioning PM market operates in Santiago, Chile. In the case of Nogales, PM sources could be allowed to purchase offsets without regard to the side of the border on which the offsets are generated.

Figure 1. A Small Sample of Traffic Headed Northward from Tijuana Toward the United States

Source: SCERP

As Ambos Nogales illustrates, cooperation is often a key ingredient in the formula for improving border air quality. Congruent U.S. and Mexican institutions and shared goals are important prerequisites for cooperation, so understanding these institutions and goals is important in promoting cooperation. This chapter compares the legal and regulatory environmental institutions of the United States and Mexico. The chapter demonstrates that the air quality standards of the two countries, while not identical, are similar. This is important because cooperation is easier when goals are shared. This chapter also discusses the U.S. and Mexican border institutions within which cooperation will likely take place. Finally, the chapter addresses the environmental status of the border and details the most significant problems faced by policymakers. The basic conclusion, not surprising to anyone familiar with the issues of border air quality, is that the border is characterized by poor air quality, thus the scope for transborder cooperation is considerable.

U.S. Air Quality Regulation

U.S. institutions involved in regulating air quality are well developed. This facilitates the maintenance of air quality within the continental United States. The main law governing air quality in the United States is the Clean Air Act and Amendments (CAAA), originally passed in 1970 and amended in 1977 and 1990. CAAA is among the most complex and ambitious laws ever passed by the federal government (Michaels 2002). The purpose here is not to describe CAAA in detail[2] but rather to focus on those aspects of the law most relevant to permit trading.

The primary goal of CAAA is to protect the public from the negative health effects from all pollution, including air pollution.[3] To this end, EPA established National Ambient Air Quality Standards (NAAQS), which set the maximum atmospheric concentrations for a pollutant consistent with human health. Six criteria air pollutants are subject to NAAQS: ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). In addition to the six criteria pollutants, EPA tracks the two precursors for ozone, volatile organic compounds (VOC) and nitrogen oxides (NO_x). EPA also has established standards for dozens of other less-widely spread pollutants. These minor pollutants are collectively referred to as hazardous air pollutants (HAPs).

NAAQSs typically take the form of maximum atmospheric concentration averaged over a period of time. The standards for the six criteria pollutants are displayed in Table 1. For example, the standard for SO_2 is 0.145 parts per million (ppm). This is averaged over eight hours. If the eight-hour average exceeds 0.145 ppm, then the location is in violation of EPA standards. The second exceedence for the SO_2 standard in a year results in an area being deemed in noncompliance with NAAQS. Each of the criteria pollutants has a similar standard, as do VOCs, NO_x, and HAPs. Counties or parts of counties that consistently fail to meet NAAQS for specific criteria pollutants can be designated a nonattainment area for those pollutants. Nonattainment areas are subject to increased monitoring and enforcement, and a state must specify a strategy for achieving attainment for any nonattainment area within its borders.

Table 1. Comparison of U.S. Federal and U.S. Border States' Air Quality Standards

Pollutant	Symbol	Units	Averaging Time	U.S. Federal Standards		Standards in U.S. Border States Where Different from Federal Standards	
						California	New Mexico[2]
				Primary Standards**	Secondary Standards**	General Standards	General Standards
Carbon Monoxide	(CO)	ppm*	1 hr (a)	35.5	35.5	20	13.1
			8 hr (a)	9.5	9.5	9	8.7
Nitrogen Dioxide	(NO_2)	ppm*	1 hr (a)	0.25			
			24 hr (b)				0.1
			Annual Mean	0.054	0.054		0.05
Particulate Matter	($PM_{2.5}$)	$\mu g/m^3$	24 hr (c)	66	66		
			3 yr Annual Average	15.1	15.1		
Particulate Matter	(PM_{10})	$\mu g/m^3$	24 hr (c)	150	150	50	
			Annual Mean (d)	50	50	30	
Ozone	(O_3)	ppm*	1 hr (a)	0.125	0.125	0.09	
			8 hr (e)	0.085	0.085		
Sulfur Dioxide	(SO_2)	ppm*	3 hr (a)		0.55		
			24 hr (a)	0.145		0.04	0.01
			Annual Mean	0.035			0.02
Lead	(Pb)	$\mu g/m^3$	Calendar Quarter (b)	1.55	1.55		
			30 Days Average (b)			1.5	
Total Suspended Particles	(TSP)	$\mu g/m^3$	24 hr (a)				150

a) Not to be at or above the standard more than once per calendar year
b) Not to be at or above the standard
c) The three-year average of the annual 99th percentile for each monitor within an area
d) The three-year average of the annual arithmetic mean concentrations at each monitor within an area
e) The average of the annual four highest daily eight-hour maximums over a three-year period is not to be at or above the standard
* ppm = parts per million
** Primary standards are adopted to protect public health; secondary standards are to protect public welfare
1. Arizona and Texas have adopted standards identical to U.S. federal standards
2. California also includes air quality standards for visibility-reducing particles, sulfates, and hydrogen sulfide, which have no corresponding U.S. or Mexican federal standards
Sources: EPA; New Mexico State Air Quality Bureau; California Air Resources Board; Arizona Department of Environmental Quality; Texas Commission on Environmental Quality

An important aspect of CAAA is that air pollution regulation is highly decentralized and administration of NAAQS is the responsibility of the states. In particular, states are individually responsible for the development of a State Implementation Plan (SIP). SIPs are a collection of regulations that ensure NAAQS (or stricter state standards, where applicable) are met and maintained. SIPs are adopted after public comment and are subject to approval by EPA. While CAAA calls for EPA to set standards for criteria pollutants, each state is allowed to set stricter local standards, if desired. Two border states—California and New Mexico—have done so. Two other border states—Texas and Arizona—have chosen not to do so.

Table 1 displays NAAQS for each of the criteria pollutants as well as the standards set by U.S. border states when they differ from national standards. California (one-hour average) and New Mexico (one-hour and eight-hour averages) have stricter standards than NAAQS for CO. New Mexico sets stricter standards for CO, NO_x, and SO_2. New Mexico also includes a standard for total suspended particulates. California sets stricter standards for CO, PM, O_3, and SO_2.

The 1990 amendment to CAAA empowered EPA to implement a permitting system. Emission sources are now required to obtain, in effect, a license to emit a pollutant prior to the start of operations. Permits include information on which pollutants are being released, how much may be released, and steps to be taken by the facilities' operators to reduce emissions. Permits also include a plan on how emissions are to be monitored. Monitoring is critical because if an environmental regulation is to have teeth, regulators need to know if and when the environmental standards are violated. The issuing of permits is a tool that can be used by regulators to improve air quality in nonattainment areas. New permits for sources emitting the nonattainment pollutant can be restricted. Often, new emitters must obtain an offset—which takes the form of a reduction from another source of the pollutant in question—before a permit is issued. Usually the offset must be more than 100%. While required by federal law and overseen by EPA, the actual administration of the permitting system is the responsibility of the states; state authorities issue permits.

The EPA permit requirement opens the door to the establishment of an emissions reduction trading program. Federal law allows the transfer of permits between operators. Emissions reduction trading as a practical matter, then, is the transfer of a permit to emit a quantity of a pollutant for a fee. (In the U.S. Acid Rain Program, for example, each allowance is a permit to emit one ton of SO_2; see box, page 12).

Not only does federal law allow the transfer of permits, thereby establishing a mechanism for emissions trading, but the law goes further, actually promoting emissions trading. In particular, CAAA includes provisions to promote the use of markets and market incentives, of which permit trading is a prominent example. The stated reason behind the inclusion of these provisions is to allow emission sources flexibility in choosing how to meet a standard, thereby reducing the cost of achieving any given standard. For example, if a major source operating in a nonattainment area wants to expand production or otherwise increase the amount of a criteria pollutant it is emitting, an offset must be obtained. Under CAAA, the offset must be greater than the planned increase in emissions so that the net release into the environment is reduced. The offset, which in all cases must come from within the nonattainment area, can be obtained from another stack within the same plant, from another plant owned by the firm, or it can be obtained from another company. In the latter case, money often changes hands.

Mexican Environmental Regulations

The main environmental law in Mexico is the Ley General de Equilibrio Ecológico y la Protección al Ambiente (LGEEPA), passed in 1988 and amended in 1997 and 2001. Environmental regulation is the responsibility of the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). Within SEMARNAT, power is distributed among three institutions. Instituto Nacional de Ecología (INE) is responsible for setting and enforcing most environmental standards, including those for air quality. Comisión Nacional del Agua (CNA) is responsible for setting and enforcing standards for water quality.

The Procuraduría Federal de Protección al Medio Ambiente (PROFEPA) is charged with factory inspections and enforcement of all pollution regulation.

The relationship between federal and state authorities is in flux in Mexico, with power slowly devolving more and more to the states. This general trend in Mexican law is evident in environmental regulation. Until recently, enforcement of environmental regulation has been highly centralized and individual states had almost no responsibility. Moreover, enforcement was limited primarily to large cities. The trend has been toward greater responsibility for enforcement devolving to state and local officials, but that process has been slow as well. For example, although all Mexican states have established state-level environmental agencies, until recently they have had little enforcement power because of the limited local budgets and a lack of local technical expertise (Lybecker and Mumme 2002).

The 1997 and 2001 amendments to LGEEPA more carefully delineated the responsibilities of the federal, state, and local governments. For example, Mexican states will take the lead in developing emissions inventories (see box, page 53). The process of decentralization involves states negotiating judicial frameworks with the federal government, under which states will have more power to determine and enforce environmental regulations. Each state is negotiating a separate agreement with the central authorities, with different states potentially undertaking different tasks depending on the resources of the state. In many cases, the responsibility for local enforcement will continue to rest with the SEMARNAT state delegation. In other cases, local responsibility will rest with state and local officials. While the balance of power still favors the Mexican federal government, the authority of local governments in matters having to do with the environment is increasing.

Mexican law authorizes the establishment of atmospheric concentration standards, referred to in Spanish as *norms*. These have been developed for the same six criteria pollutants covered by NAAQS, ozone precursors (VOCs and NO_x), and for various HAPs. The guiding principle in setting these standards, as with NAAQS in the United States, is the protection of human health. Often Mexican officials refer to U.S. studies in determining what concentration of a pollutant is consistent with protecting health, so it is not surpris-

U.S. and Mexican Cooperation: Air Monitoring and Emissions Inventory on the Border

The monitoring of ambient air quality had been hit-and-miss in Mexico until recently. Even now it remains true that coverage is limited—concentrated on the border and in a few large cities. One objective of the Border 2012 Program is to solve this problem. Current efforts involve the establishment of an integrated national monitoring system for ambient air quality in conjunction with the U.S. Environmental Protection Agency's (EPA) Aerometric Information Retrieval System (AIRS), which allows public access to data via the Internet. In the initial phase of this effort, a monitoring system has been installed on the border.

The data are being maintained by the Information Center on Air Pollution for the U.S.-Mexico Border, known by its Spanish acronym CICA. According to its web site, "CICA provides bilingual (English/Spanish) technical support and assistance in evaluating air pollution problems along the U.S.-México border and to other areas and countries according to the resources available" (EPA 2002e). As of 2002, data are available for Ciudad Juárez, Nogales, Mexicali, and Tijuana.

A second effort underway in Mexico is the development of an emissions inventory, spearheaded by the Western Governors Association in cooperation with EPA, the Mexican Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT), and local officials. Air pollution results from a complex mix of literally thousands of sources ranging from industrial smoke stacks and motor vehicles to the individual use of grooming products, household cleaners, and paints (Radian Corporation 1996). A full understanding of the emissions sources allows the development of detailed regional and local plans for control of air pollution. Emissions inventories have routinely been undertaken in the United States, but no complete systematic inventory exists for Mexico, although such inventories for industrial sources are required by Mexican law.[1] An inventory will be developed first for the six Mexican border states and then for Mexico as a whole.

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[1] Article 17 of the Mexican environmental law states that point sources must provide information to authorities about their emissions. Article 112f requires states and *municipios* to create and continuously update the emissions inventory (Radian Corporation 1996).

ing that U.S. and Mexican standards are similar (Table 2). Moreover, where the standards do differ, it is not necessarily true that U.S. standards are stricter than Mexican standards. For example, the United States imposes a one-hour standard on carbon monoxide; Mexico does not, but it does impose a stricter eight-hour standard (9 ppm v. 11 ppm). For NO_x, the Mexican standard is stricter (0.21 ppm v. 0.25 ppm), but Mexico has no standard for the annual arithmetic average, while the United States does impose an annual standard. The United States and Mexico have the same standard for PM_{10}. Mexico has a stricter one-hour ozone standard (0.125 ppm v. 0.11 ppm) but has no eight-hour standard. For SO_2, Mexico has a stricter 24-hour standard (.014 ppm v. 0.13 ppm) but has the same annual standard as the United States. The United States and Mexico have the same standard for lead (1.5 $\mu g/m^3$). Mexico has no standard for $PM_{2.5}$, while the United States has no standard for total suspended particulates.

The similarity of air quality standards between the United States and Mexico greatly facilitates coordination of environmental policy on the border. If there were great disparities between the two regimes, officials of the country with the more liberal policy might resist projects aimed at achieving the tighter standard. As noted above, while the standards of the United States and Mexico are similar, they are not identical, and where they differ there is potential for conflict. The difference between the two countries in regulating PM is troubling since PM is of special concern in the arid desert border region and several regions are in noncompliance. These differences may complicate transborder cooperation. For example, Mexico has no standard for $PM_{2.5}$. Programs to reduce $PM_{2.5}$

Table 2. Comparison of U.S. and Mexican Federal Standards

Pollutant	Symbol	Units	Averaging Time	U.S. Federal Standards		Mexican Federal Standards
				Primary Standards**	Secondary Standards**	General Standards
Carbon Monoxide	(CO)	ppm*	1 hr (a)	35.5	35.5	
			8 hr (a)	9.5	9.5	11
Nitrogen Dioxide	(NO_2)	ppm*	1 hr (a)	0.25		0.21
			Annual Mean	0.054	0.054	
Particulate Matter	($PM_{2.5}$)	µg/m³	24 hr (c)	66	66	
			3 yr Annual Average	15.1	15.1	
Particulate Matter	(PM_{10})	µg/m³	24 hr (c)	150	150	150
			Annual Mean (d)	50	50	50
Ozone	(O_3)	ppm*	1 hr (a)	0.125	0.125	0.11
			8 hr (e)	0.085	0.085	
Sulfur Dioxide	(SO_2)	ppm*	3 hr (a)		0.55	
			24 hr (a)	0.145		0.13
			Annual Mean	0.035		0.03
Lead	(Pb)	µg/m³	Calendar Quarter (b)	1.55	1.55	1.5
Total Suspended Particles	(TSP)	µg/m³	24 hr (a)			260

a) Not to be at or above the standard more than once per calendar year
b) Not to be at or above the standard
c) The three-year average of the annual 99th percentile for each monitor within an area
d) The three-year average of the annual arithmetic mean concentrations at each monitor within an area
e) The average of the annual four highest daily eight-hour maximums over a three-year period is not to be at or above the standard
* ppm = parts per million
** Primary standards are adopted to protect public health and secondary standards to protect public welfare
Sources: EPA; SEMARNAT

sources, for example, in Ciudad Juárez to aid El Paso in meeting U.S. $PM_{2.5}$ standards might be politically unpalatable to Mexican officials. Nevertheless, the broad consistency between U.S. and Mexican standards presents many opportunities for cooperation.

Despite the similarity in air quality standards, enforcement efforts on the two sides of the border differ substantially. The United States has among the most strictly enforced environmental laws in the world. Under the 1990 amendments to CAAA, EPA need not even go to court when enforcing air quality standards because the law gives the agency the power to fine violators directly, much like a police officer giving traffic tickets. Penalties for violation were also increased under the 1990 amendments (EPA 2002c). The record on enforcement in Mexico is not stellar. For example, action against Mexico for failure to enforce LGEEPA in issuing a permit to Molymex, S.A., for expansion of its site in Cumpas, Sonora, continues before the Commission for Environmental Cooperation (CEC) (CEC 2003a). Molymex processes residual generated from copper smelting, an activity that potentially could have severe adverse effects on the local environment.

Of course, Mexico's failure to strictly enforce environmental laws is not surprising. As argued in the previous chapter (see box, page 28), low-income countries have limited resources. Often, pressing social needs such as education, potable water, and sewage will exhaust these resources, leaving little budget for enforcement of air quality standards. The consequence is that enforcement actions such as plant inspections often go undone. Unfortunately, this scenario appears to apply to Mexico.

NAFTA and the Border Environment

In the late 1980s, Canada, Mexico, and the United States began negotiations to form a free trade area that ultimately resulted in ratification of the North American Free Trade Agreement (NAFTA) in 1994. The negotiation brought environmental issues to the fore. Environmentalists opposed to free trade argued that the economic development arising from free trade would result in environmental degradation on the border. They argued that free trade would attract population to the border that could not be sustained by the sensitive desert ecosystem. They also expressed concerns about the border becoming a pollution haven in that pollution-intensive operations would relocate to the border to avoid strict U.S. environmental laws (Wheeler 2001). This, coupled with increased industrial output, would cause an environmental disaster.

Transborder Pollution

The 1990 amendment to the Clean Air Act includes a provision, Section 179B, which provides an exception from National Ambient Air Quality Standards (NAAQS) when the U.S. Environmental Protection Agency (EPA) determines that pollution is from an international source. Under the law, if the EPA administrator is satisfied that the area is in attainment except for emissions emanating from outside the United States, then the area is considered in attainment.

To date, two areas have been considered exempt from provisions of the act under Section 179B—El Paso and Imperial Valley. In both cases, the pollutant in question is PM_{10}.[1] For El Paso, the state of Texas found that El Paso would be in compliance except for sources emanating from Ciudad Juárez (TNRCC 2000). As of July 2002, EPA had not taken action on El Paso's 179B status. In the case of the Imperial Valley, the finding was that the area was in nonattainment from domestic sources, a status the area has had since 1994, but that the area was not in serious noncompliance (EPA 2001). Had a 179B exemption not been granted, reclassification to serious status was likely, which would trigger more stringent environmental actions (Earth Justice 2000). The Imperial Valley's 179B status, coupled with the Sempra and InterGen power plant controversies (see box, page 37), have roiled environmentalists.

Those critical of the 179B provision complain that regardless of the source of a pollutant, areas that do not meet NAAQS expose residents to unacceptable health risks. Thus, the source of a pollutant is irrelevant.

Clearly, when the source of a pollutant is transborder, coordination of environmental policy becomes paramount if a healthy environment is to be achieved. To this end, emission reduction credit trading can be a solution.

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[1] Another nonattainment area where studies have documented the transborder nature of PM_{10} is Nogales-Nogales (ADEQ 1999), which is in noncompliance for PM_{10}. The area has not received an exemption under Section179B.

Free trade advocates argued that these environmentalists' concerns were overblown. Proponents of free trade argued that the maquiladora program, which applied only to the border, artificially diverted development to the border. The passage of a free trade agreement, which abolished the special status of the border under the maquiladora program, would eliminate the border's advantage in attracting foreign capital, thereby slowing border economic growth. Moreover, much employment on the border, especially on the U.S. side, arises from border-related activities such as drayage and warehousing. To the extent that NAFTA eliminated these activities, for example, by allowing continent-wide trucking, development on the border would be slowed. Finally, the proponents of free trade argued that indigenous Mexican environmentalists would most likely take action to mitigate damage to the border ecosystem, thereby eliminating the potential of the border as a pollution haven. Some proponents of free trade went further, arguing that economic development might actually promote environmental sustainability. According to this argument, attempts to cure the border's environmental woes were doomed as long as Mexico remained an underdeveloped country. By promoting economic growth, more resources would be available for environmental programs. The kick to economic growth would, in effect, move Mexico forward on the Environmental Kuznets Curve to the benefit of environmental causes (Erickson 1992).

Regardless of the relative merits of the two sides' arguments, the environmentalists' opposition to free trade began to gain traction with the public and in the U.S. Congress, thus threatening to derail NAFTA. The administrations of U.S. presidents George H. W. Bush and Bill Clinton sought to garner votes by blunting environmentalists' concerns though negotiated environmental side agreements. The first of these side agreements—the North American Agreement on Environmental Cooperation (NAAEC)—involved all three NAFTA partners and established the CEC, which is primarily responsible for the enforcement of the provisions of NAAEC. CEC was established with the goal of fostering environmental protection, promoting sustainable development, increasing cooperation among the three countries, supporting the environmental goals of NAFTA, enhancing enforcement of environmental laws, promoting transparency and public participation in environmental policymaking, and promoting pollution prevention policies and practices (CEC 2003b). It also has a quasi-judicial role in reviewing submissions from the public on enforcement matters. CEC serves as an arbitration panel to resolve disputes among the NAFTA parties on specific trade-related issues associated with the failure to enforce environmental laws and regulations effectively. In particular, Articles IV and V of NAAEC require each party to enforce its environmental laws. An action can be instigated by either a signature government or private parties. Failure to enforce environmental laws can result in an adverse finding by CEC, but there is no explicit mechanism for imposing sanctions. This lack of an enforcement mechanism greatly weakens CEC as an institution that can help achieve environmental goals.

The second NAFTA environmental side-agreement involved the United States and Mexico and established two border environmental institutions—the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADBank). BECC's primary objective is to provide technical assistance to border communities. This assistance is designed to ensure sound and feasible projects, master plans, project design, environmental assessment, and local institutional capacity building. A second major function of BECC is to certify infrastructure projects. Certified projects are eligible for financing consideration by NADBank and other sources (BECC-NADBank 1999). Certified proposals must meet criteria for technical and financial feasibility. The projects must be environmentally sound, self-sustaining, and supported by the public (GAO 2000). BECC also assists states and localities in the preparation, development, implementation, and oversight of environmental infrastructure projects in the border region. BECC has mainly restricted its concerns to water, wastewater, and municipal solid waste disposal, but BECC could play a role in improving air quality by certifying projects as contributing to improved air quality and perhaps by serving as a third-party auditor. Recently, BECC has certified road-paving projects aimed at improving air quality.

NADBank's primary purpose is to facilitate financing for the development, execution, and operation of environmental infrastructure projects on the border. Only projects certified by BECC qualify for construction financial assistance from NADBank. The bank provides direct financing in the form of loans or guarantees for BECC-certified environmental projects. NADBank is funded by equal contributions from the United States and Mexico. The agreement governing NADBank calls for a total lending capacity of $3 billion, with $450 million as paid-in capital and an additional $2.55 billion as callable capital. Callable capital is composed of funds that the governments are to provide to the bank, if required, to meet outstanding debt obligations or guaranties issued by the bank (GAO 2000). The bank's paid-in capital is available to support borrowing for its international programs. From a practical viewpoint, the total lending capacity of NADBank is limited to the total of its paid-in and callable capital.

The bank's lending program has faced difficulties. Under its charter, the bank is required to make loans at a rate sufficient to compensate for the cost of funds. These rate restrictions often result in NADBank being priced out of the market. Larger communities on the U.S. side generally have access to lower-cost loans. Smaller communities, many of which are located in Mexico, can't afford NADBank's interest rate. Recognizing these problems, EPA has established a program called the Border Environmental Infrastructure Fund (BEIF). BEIF grants are administered by NADBank and can be used to reduce the total cost of funds to low income communities (Erickson and Eaton 2002).

NADBank is not currently making loans to finance air quality projects, but may decide to become active in the future. One possible role for NADBank would be to finance projects that result in emission reductions, and then sell these emission reductions credits to defray lending costs, thus allowing NADBank to lend at more favorable terms. Such a program would be particularly attractive in dealing with small and medium businesses. NADBank would be able to package several small emission reductions into larger, more marketable securities.

Border Environmental Plans

The history of cooperation between the United States and Mexico on border environmental issues is mixed. The La Paz Agreement,[4] signed in 1983, serves as the legal basis for cooperation. It gives responsibility for coordinating border environmental policy to the Mexican and U.S. environment agencies, SEMARNAT and EPA. Each country is required to designate a specific official as the contact person for border issues—currently those are the administrator of EPA for the United States and the secretary of SEMARNAT for Mexico. The La Paz Agreement allows SEMARNAT and EPA to negotiate directly on border issues, develop comprehensive plans, and form working groups.

A number of official programs have been adopted under the authority of the La Paz Agreement, with mixed results. The Integrated Border Environmental Plan (IBEP, also commonly referred to as the Border Plan) was the first of these. IBEP established six workgroups, each dedicated to an aspect of the border environment, including those for water and air. The working groups sought to develop border-wide responses, but many criticized this approach, pointing out that the border is a diverse area that requires local responses to local problems. The lack of local focus was not the only criticism of IBEP—it was also criticized for lack of public involvement because it was initiated with few public hearings and had limited mechanisms for public input. Many observers cite the lack of public involvement as the most important limitation of IBEP (CDC 2000).

Improving Transboundary Air Quality with Binational Emission Reduction Credit Trading

In response to the criticism of IBEP, a new program for border cooperation called Border XXI was announced in 1996. Border XXI emphasized three strategies for achieving sustainable development on the border:

- Ensuring public involvement in development and implementation of the Border XXI Program
- Building capacity and decentralized environmental management to encourage state and local institutions in the implementation of Border XXI goals
- Ensuring interagency cooperation to maximize resources and minimize duplication of efforts (EPA 1996)

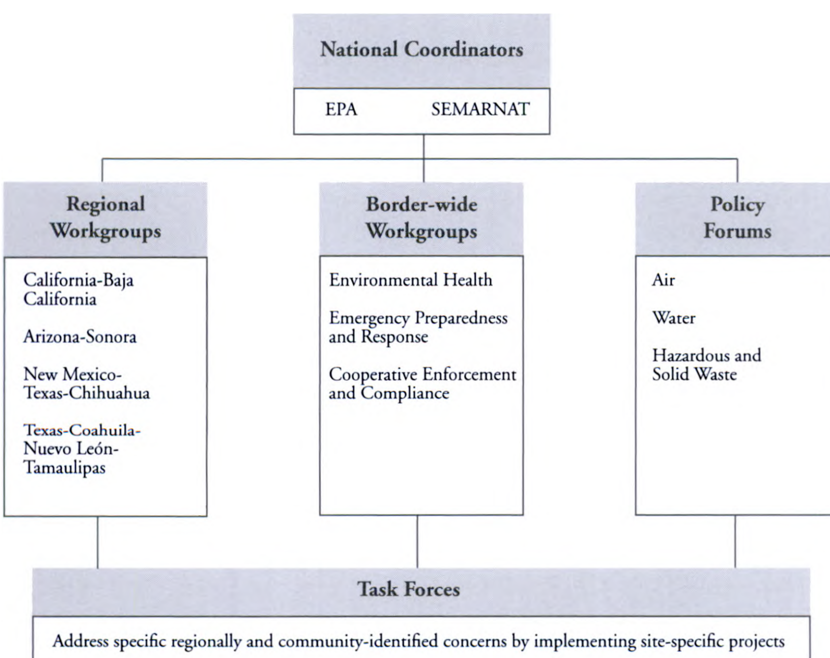
The Border XXI air workgroup identified five major goals for the five-year period of the program:

- Develop air quality assessment and improvement programs such as monitoring, inventorying, and modeling
- Build institutional infrastructure and technical expertise in the border area
- Encourage ongoing public involvement
- Promote air pollution abatement
- Study potential economic incentive programs for reducing air pollution (EPA 1996)

While Border XXI paid considerable lip service to public involvement, especially after the criticisms leveled against IBEP, in practice Border XXI had many of the same flaws of its predecessor. The decision to continue to rely on border-wide working groups tended to minimize state, tribal, and local input, thereby minimizing public involvement. State, tribal, and local officials complained bitterly of not being adequately consulted. In 1999, for example, New Mexico refused to participate in the Border XXI process as a protest against what was viewed by local officials as heavy-handed federal regulation (Faulker 1999). In public hearings during the final year of the Border XXI program, a continuing theme was the need for additional opportunities for public input (see, for example, NEJAC 2003). Like IBEP that preceded it, Border XXI was of limited success in large part due to the lack of opportunity for public participation.

Stung by the criticism of their previous efforts, EPA and SEMARNAT sought to increase public participation in the development of their next border plan, Border 2012 (Figure 2). Indeed, Border 2012 includes 10 goals, six of which deal with promoting local participation either directly or indirectly (see Appendix).[5] Overall coordination of Border 2012, consistent with the La Paz Agreement, rests with EPA and SEMARNAT. The program is organized into 10 sub-organizations. Three of these are policy forums—air, water, and hazardous solid waste; three are border-wide working groups—environmental health, emergency preparedness, and cooperative enforcement and compliance; the final four, in an innovation aimed at increasing local participation, are regional working groups—California-Baja California, Arizona-Sonora, New Mexico-Texas-Chihuahua, and Texas-Coahuila-Nuevo León-Tamaulipas. Any of these 10 sub-organizations can form task forces to address specific issues that may arise.

Figure 2. Organization of the Border 2012 Program



Source: EPA 2002f

Border 2012 deals with several issues relevant to air quality. Goal #2 aims to reduce air emissions "as much as possible toward attainment of respective national ambient air quality standards, and reduce exposure in the border region." This is a rather vaguely worded goal. A major problem with such a vague goal is that quantifying success in achieving this goal will be difficult.[6] Recognizing this, Border 2012 contains two interim objectives dealing with air quality: the development of baseline and alternative scenarios for emission reductions by 2003 and the defining of specific emission reduction strategies and air quality and exposure objectives to be obtained by 2012. Achievement of these objectives will require, through a currently ongoing process, the installation of monitoring stations along the border and the integration of data into the Aerometric Information Retrieval System (AIRS), which allows public access to data via the Internet. Border 2012 sets a rather modest health objective for air: The evaluation of various studies concerning respiratory health in children to determine the policies most likely to improve health on the border.

The program also deals with compliance and enforcement issues relevant in achieving air quality goals. Goal #6 is the improvement of environmental performance through increased compliance, enforcement, pollution prevention, and the promotion of environmental stewardship. The plan sets three enforcement objectives: an increase in voluntary compliance and self-audits of 50% compared to the baseline by 2006, the determination of high-risk pollution sources in the border area and the setting of priorities in dealing with these sources, and increased enforcement in accordance with the priorities set in the second objective.

The Border 2012 Program is an improvement over its predecessors, especially in the promotion of public participation. With regard to emissions trading, monitoring of ambient air quality, development of an emissions inventory, and on-site monitoring are prerequisites for a cap-and-trade system. All are included in Border 2012. However, the plan sets only modest goals, envisioning, for example, only a 50% increase in point-source monitoring. It appears, then, that the prerequisite for a cap-and-trade system on the border is years away. This is unfortunate because cap-and-trade has been effective in achieving air quality goals set by the U.S. Acid

Rain Program. The practical alternative, though, is baseline-and-trade. A baseline-and-trade approach has already been successfully executed in the case of the El Paso Electric Brick Kiln Project. The conditions under which baseline-and-trade can contribute to meeting air quality goals will be addressed in Chapter V.

Attainment Status on the Border

Air quality is poor in many locales, as is reflected in the nonattainment status of U.S. border communities (Table 3). EPA has designated 154 areas as noncompliant (EPA 2002b) and 10 of these nonattainment areas are on the border. Of the 154 areas designated as noncompliant, 27 are nonattainment for two criteria, and two of these are on the border. Of the 154 noncompliant areas, eight are noncompliant for three criteria. One of these, El Paso, is on the border. Of the 25 U.S. counties that border Mexico, all or part of eight are in noncompliance.[7] Some 895,000 of the 6.3 million U.S. residents of the border, or 14%, are living in nonattainment areas.[8] Environmental data for the Mexican side of the border are more fragmentary. While EPA and SEMARNAT are developing a more systematic monitoring method, current monitoring stations are fewer and the variety of data gathered is less. For example, as of June 30, 2002, EPA has maintained no data on SO_2 on the Mexican side of the border even though a 1997 study found that Ciudad Juárez and Agua Prieta were in noncompliance for this pollutant. Table 4 reports the air quality status of Mexican *municipios*. Current data are available for Ciudad Juárez, Nogales, Mexicali, and Tijuana. Presently, Ciudad Juárez, Mexicali, and Tijuana are nonattainment for ozone, carbon monoxide, and particulate matter; Nogales is nonattainment for particulate matter (EPA 2002e).

Table 3. Nonattainment Status on the Border: United States as of June 30, 2002

Criteria Pollutant	Nonattainment Area	
	Area	County, State
Ozone	El Paso (Serious)	El Paso, TX
	Sunland Park (Marginal)	Dona Aña, NM
Carbon Monoxide	El Paso (Moderate)	El Paso, TX
Nitrogen Dioxide	None	None
Sulfur Dioxide	Ajo (Primary)	Pima, AZ
	Douglas (Primary)	Cochise, AZ
Particulate Matter	El Paso (Moderate)	El Paso, TX
	Anthony (Moderate)	Dona Aña, NM
	Ajo (Moderate)	Pima, AZ
	Rillito (Moderate)	Pima, AZ
	Paul Spur (Moderate)	Cochise, AZ
	Nogales (Moderate)	Santa Cruz, AZ
	Yuma (Moderate)	Yuma, AZ
	Imperial Valley (Moderate)	Imperial, CA
Lead	None	None

Source: EPA 2004

Table 4. Nonattainment Status on the Border: Mexico as of June 30, 2002

Criteria Pollutant	Nonattainment Area	
	Municipio	State
Ozone	Ciudad Juárez	Chihuahua
	Mexicali	Baja California
	Tijuana	Baja California
Carbon Monoxide	Ciudad Juárez	Chihuahua
	Mexicali	Baja California
	Tijuana	Baja California
Particulate Matter[a]	Ciudad Juárez	Chihuahua
	Nogales	Sonora
	Mexicali	Baja California
	Tijuana	Baja California

a) Ozone and carbon monoxide are not monitored in Nogales
Source: Authors' calculations using data obtained from the U.S.-Mexico Border Information Center on Air Pollution

A common problem in the arid border region is PM_{10}. All Mexican *municipios* monitored are in violation of PM_{10} standards. All or parts of seven U.S. border counties are nonattainment for this pollutant, including Imperial Valley, all Arizona border counties, Dona Aña County, and El Paso County. The reasons for the border's problem with PM_{10} vary from area to area, but it seems certain that one contributing factor is the desert environment. Certainly deserts are characterized by dry conditions, blowing dust, and unpaved roads. All of these contribute to high PM_{10} levels. While data are fragmentary, what is available indicates that Mexican PM sources contribute to PM_{10} problems in U.S. border communities, and vice versa. For example, the aforementioned Ambos Nogales study found high concentrations of PM_{10} on both sides of the border and identified several sources of PM_{10} in Nogales, Sonora, that contributed to PM_{10} levels in Arizona (ADEQ 1999). Similarly, Ciudad Juárez is a major source of PM in El Paso (TNRCC 2000).

El Paso-Ciudad Juárez, a typically unhealthy border area, is nonattainment for three criteria pollutants—ozone, carbon monoxide, and PM_{10}.[9] Transborder pollution is a major cause of the pollution in El Paso. As discussed in Chapter I, Texas has determined that El Paso is in attainment based on domestic sources of pollution, but the continuing status of El Paso as a nonattainment area results from pollution emanating from Ciudad Juárez (TNRCC 2000). This illustrates once again the theme of the impact of economic development on environmental quality. The fact is that Ciudad Juárez is a large, industrialized city located in a relatively poor country. As is typical of such cities, many residents of Ciudad Juárez live in substandard housing where heating is often provided by burning wood or even solid waste. As is also typical, many small and medium enterprises operate outside the formal sector. Not only are these businesses not regulated, they are not even officially recognized as existing businesses. Ciudad Juárez does not have the resources necessary to monitor or enforce all air quality standards. Public funds are allocated to higher priorities, such as providing sanitation services, education, and basic health needs, which are more pressing. The same argument applies to other regions along the border.

ENDNOTES

[1] The status of Nogales, Sonora, was determined by the authors using data obtained at the U.S.-Mexico Border Information Center on Air Pollution (http://www.epa.gov/ttn/catc/cica).

[2] Several detailed summaries of the U.S. CAAA are available (see, for example, EPA 1993).

[3] EPA is also required to consider the effect of air pollution on the public welfare by limiting the effect of air pollution on visibility and by limiting damage to agriculture and private property.

[4] The La Paz Agreement is formally referred to as the Agreement Between the United States of America and the United States of Mexico on Cooperation for the Protection and Improvement of the Environment in the Border Area.

[5] A full discussion of Border 2012 is beyond the scope of this monograph. Excerpts from the Border 2012 Program are included in the appendix to this chapter. Included are the mission statement, guiding principles, and a summary of the goals and objectives. The full Border 2012 document is available at http://www.epa.gov/usmexicoborder/.

[6] The vague wording of the goal is made more obvious when compared to the other objectives of Border 2012. Take, for example, the objectives for water quality, which set specific numeric objectives (see Appendix, Goal #1).

[7] Nonattainment areas are determined by the extent of the pollution being considered and do not correspond to county borders. Thus, a nonattainment area may be an entire state (i.e., Connecticut for ozone and PM_{10}), several counties located in different states (i.e., New York City-North New Jersey-Long Island for ozone, carbon monoxide, and PM_{10}), or several nonattainment areas could be

located in one county. On the border, there are three counties that contain two nonattainment areas each: Pima and Cochise Counties in Arizona and Doña Ana County in New Mexico.

[8] Authors' calculation using affected population estimates taken from EPA 2002b.

[9] The two nonattainment areas in the New Mexico borderlands—Sunland Park and Anthony—are adjacent to El Paso. Sunland Park is also adjacent to Ciudad Juárez, being located at the juncture of Texas, New Mexico, and Chihuahua. A significant portion of the pollution in these two locales originates in El Paso and/or Ciudad Juárez.

Appendix A

Excerpts from the Border 2012 Program

Mission Statement

As a result of the partnership among federal, state, and local governments in the United States and Mexico, and with U.S. border tribes, the mission of the Border 2012 program is to protect the environment and public health in the U.S.-Mexican border region, consistent with the principles of sustainable development. In this program, sustainable development is defined as "conservation-oriented social and economic development that emphasizes the protection and sustainable use of resources, while addressing both current and future needs and present and future impacts of human actions."

Border 2012 Guiding Principles

The following principles are designed to support the mission statement, ensure consistency among all aspects of Border 2012, and continue successful elements of previous border programs:

- Reduce the highest public health risks, and preserve and restore the natural environment
- Adopt a bottom-up approach for setting priorities and making decisions through partnerships with state, local, and U.S. tribal governments
- Address disproportionate environmental impacts in border communities
- Improve stakeholder participation and ensure broad-based representation from the environmental, public health, and other relevant sectors

- Foster transparency, public participation, and open dialogue through the provision of accessible, accurate, and timely information
- Strengthen the capacity of local community residents and other stakeholders to manage environmental and environment-related public health issues
- Achieve concrete, measurable results while maintaining a long-term vision
- Measure program progress through development of environmental and public health-based indicators
- The United States recognizes that U.S. tribes are separate sovereign governments, and that equity issues impacting tribal governments must be addressed in the United States on a government-to-government basis
- Mexico recognizes the historical debt it has with its indigenous peoples; therefore, appropriate measures will be considered to address their specific concerns, as well as to protect and preserve their cultural integrity within the broader environmental purposes of this program

Goals and Objectives

Goal #1: Reduce Water Contamination

- Objective 1 by 2012, promote a 25% increase in the number of homes connected to potable water supply and wastewater collection and treatment systems
- Objective 2 by 2012, assess significant shared and transboundary surface waters and achieve a majority of water quality standards currently being exceeded in those waters
- Objective 3 by 2006, implement a monitoring system for evaluating coastal water quality at the international border beaches; by the end of 2006, establish a 2012 objective toward meeting coastal water quality standards of both countries
- Objective 4 by 2005, promote the assessment of water system conditions in 10% of the existing water systems in the border cities to identify opportunities for improvement in overall water system efficiencies

Goal #2: Reduce Air Pollution

- Objective 1 by 2012 or sooner, reduce air emissions as much as possible toward attainment of respective national ambient air quality standards, and reduce exposure in the border region, as supported by two interim objectives
- Interim Objective 1 by 2003, define baseline and alternative scenarios for emission reductions along the border and their impacts on air quality and human exposure
- Interim Objective 2 by 2004, based on results from Interim Objective 1, define specific emission reduction strategies and air quality and exposure objectives to be achieved by 2012

Goal #3: Reduce Land Contamination

- Objective 1 by 2004, identify needs and develop an action plan to improve institutional and infrastructure capacity for waste management and pollution prevention as they pertain to hazardous and solid waste and toxic substances along the U.S.-Mexican border
- Objective 2 by 2004, evaluate the hazardous waste tracking systems in the United States and Mexico; during the year 2006, develop and consolidate the link between both tracking systems
- Objective 3 by 2010, clean up three of the largest sites that contain abandoned waste tires in the U.S.-Mexican border region, based on policies and programs developed in partnership with local governments
- Objective 4 by 2004, develop a binational policy of clean-up and restoration resulting in the productive use of abandoned sites along the length of the border contaminated with hazardous waste or materials, in accordance with the laws of each country

Goal #4: Improve Environmental Health

- Objective 1 (Air) by 2006, evaluate various measures of respiratory health in children that might be tracked to assess changes that may result from actions to improve air quality in border communities

- Objective 2 (Water) by 2006, evaluate various measures of gastrointestinal illness that might be tracked to assess changes that may result from actions to improve water quality in border communities
- Objective 3 (Pesticides) by 2006, an assessment and pilot program will be completed that explores the feasibility of harmonizing a binational system for reporting acute pesticide poisonings; by 2007, reduce pesticide exposure by training 36,000 farm workers on pesticide risks and safe handling, including ways to minimize exposure for families and children
- Objective 4 (Capacity Building) by 2006, establish a "distance-learning," post-graduate degree program to support advanced training on environmental health in conjunction with Pan American Health Organization regional offices and academic institutions; by 2004, extend current efforts in binational environmental health training for 100 health care providers for pesticides and water

Goal #5: Reduce Exposure to Chemicals as a Result of Accidental Chemical Releases and/or Acts of Terrorism

- Objective 1 by 2004, a chemical emergency advisory/notification mechanism between Mexico and the United States will be clearly established, as well as identification of existing chemical risks on both sides of the border
- Objective 2 by 2008, joint contingency plans for all 14 pairs of sister cities will be in place and operating (including exercises), with the establishment of binational committees for chemical emergency prevention (or similar border forums)
- Objective 3 by 2012, 50% of sister city joint contingency plans will be supplemented with preparedness- and prevention-related efforts, such as risk and consequence analysis, risk reduction, and counter-terrorism

Goal #6: Improve Environmental Performance through Compliance, Enforcement, Pollution Prevention, and Promotion of Environmental Stewardship

- Objective 1 by 2006, increase by 50% the number of industries along the U.S.-Mexican border implementing voluntary compliance and/or self-audits (such as the development of an Environmental Management System or participation in voluntary assessment programs), using 2003 as a baseline year
- Objective 2 by 2006, determine the pollution sources in the border area subject to regulation that present high risks to human health and the environment and set priorities for actions to lower the risk
- Objective 3 by 2012, increase compliance in the priority areas determined in Objective 2 by assessing and responding to citizen complaints, compliance assistance, compliance incentives, compliance monitoring, and enforcement to reduce the risks from non-compliant facilities and encourage voluntary pollution prevention

IV

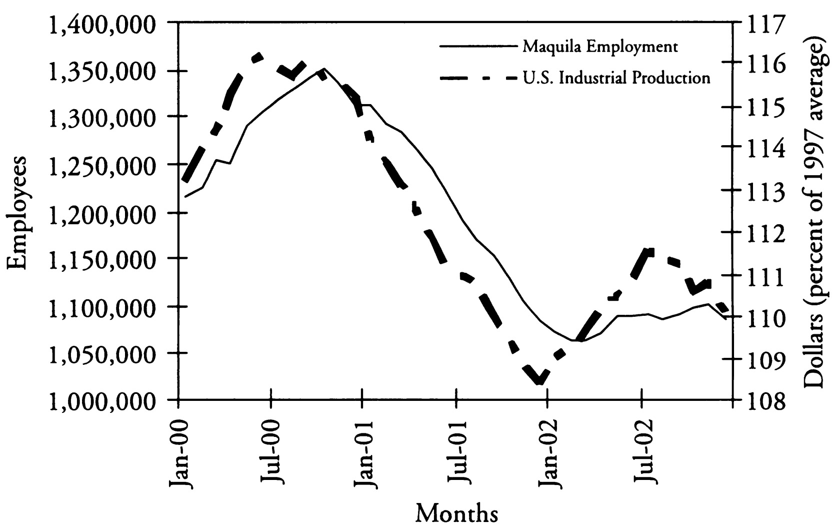
Maquiladora Attitudes

THE MAQUILADORA SITUATION

A few days before Christmas 2001, workers lined up outside the entrance to the Mabamex toy factory in Tijuana, which manufactures toys for Mattel. The workers were there to receive their Christmas bonus, which consisted partly of toys. Many of the workers also received layoff notices (Enriquez 2003). While conditions in maquilas are often dangerous and unpleasant by U.S. standards, the jobs are attractive to Mexican workers who migrate in large numbers from the interior to the border to find work. As the Mabamex story illustrates, these jobs are becoming harder to find as layoffs become more common. Indeed, the maquila industry has been in a sharp recession since October 2000. That month, employment peaked at 1.3 million workers. By December 2002, workers numbered only 1.1 million, a decline of 19.5% (Erickson Forthcoming).

Both cyclical and structural factors have contributed to the decline in maquila employment and production since 2000; the U.S. economy has also played a role. Maquilas sell most of their production to the United States and the U.S. corporations own a large majority of the plants, so the close link between U.S. industrial production and maquila employment is not surprising (Figure 1). Mexican maquilas are also facing increasing global competition, especially from China, Central America, and the Caribbean (GAO 2003). The real depreciation of the peso relative to the dollar is also a problem. Representatives of the maquila industry complain of uncertainty about taxes. At the same time, the special status of the maquila industry has been phased out as part of the North American Free Trade Agreement (NAFTA). The decline of the maquila industry has been felt on the U.S. side as well. Border tariffs were down 10% in 2001 (GAO 2003).

Figure 1. U.S. Industrial Production v. Maquila Employment



Sources: Federal Reserve Board of Governors; INEGI

The maquila industry is likely to be a major player in any emissions trading program developed on the border, so conditions in the maquila industry will be important in determining the success of emissions trading. The current adverse conditions, one might think, would limit interest in establishing an emissions trading program. To test this, a survey of maquilas was conducted in Ciudad Juárez, Matamoros, and Reynosa. Two basic findings were made: There is considerable confusion about emissions trading, and despite the downturn in the maquila industry, there is interest in finding out more about it. This chapter summarizes the survey results.

METHODOLOGY USED IN THE SURVEY

The survey was conducted in the summer of 2002 and consisted of 27 questions—21 objective questions and six subjective, open-ended questions. The questions were designed to elicit information about respondents' knowledge of emissions trading, willingness to participate in emissions trading programs, as well as information about the institutional framework in which emissions trading will take place, such as the prevalence of environmental committees. It is unusual to include so many open-ended questions in a questionnaire of this type; however, it was thought that open-ended questions were necessary to elicit the information desired. A total of 200 maquilas were surveyed. Ciudad Juárez, having the most maquilas among the three Mexican border cities surveyed, was allocated a sample size of 80 maquilas. Reynosa and Matamoros were each allocated a sample of 60 maquilas. Local contacts from each city were used to administer the survey, including Lic. Patricia Vázquez Zarate of the Instituto Tecnológico de Matamoros, Ing. Esperanza Rosales Gutiérrez of the Instituto Tecnológico de Reynosa, and Ing. Cesar Nuñez of the Departamento de Ecologia del Estado (Chihuahua) in Ciudad Juárez. Each of these individuals consulted with at least one of the authors and supervised the students who conducted the survey.

In Reynosa and Matamoros, surveys were sent to all maquiladoras. After a few weeks, students followed up by making calls to individual plants. This process was continued until all 60 surveys were collected. In Ciudad Juárez, all maquiladoras registered with the state's environmental agency were contacted. The same procedure of follow-up calls was performed until the 80 surveys were collected. The individual students were handed a random list of maquiladoras to contact, thus attempting to eliminate any bias in terms of which were contacted by phone. The instrument itself was written in Spanish. A copy of the instrument is included as an appendix to this chapter.

Responses to Individual Questions on the Survey

This section presents several tables that review various aspects of the survey according to the distribution of the responses. Basic characteristics of the respondents and the firms are presented in Table 1. Ciudad Juárez accounted for 40% of the responses and Reynosa and Matamoros for 30% each. Environmental manager was the most common position of the individuals who responded to the survey. Human resources was the second most common occupation indicated, followed by engineer and manager. The majority of these individuals have been with the firm 10 years or less. The sample included firms of all sizes ranging from less than 250 employees to more than 1,500. These firms are relatively lean with few managers; most firms report that 85% of workers are directly involved in production. Most of the maquilas in the survey sell their output primarily to U.S. customers.

Table 1. Basic Information on Respondents and Firms

Question	Missing Observations	Results (%)	
Cities where survey was conducted	None	Ciudad Juárez	40.00
		Reynosa	30.00
		Matamoros	30.00
Respondent	27	Manager	8.09
		Environmental Manager	39.88
		Engineer	13.87
		Other[1]	38.15
		Human Resources	23.07
Tenure with the firm	None	Less than 5 years	31.50
		6 to 10 years	28.00
		11 to 15 years	23.50
		16 years or more	17.00

Table 1. continued

Question	Missing Observations	Results (%)	
Number of employees	None	250 or less	17.50
		251 to 500	26.00
		501 to 750	14.50
		751 to 1,000	20.00
		1,001 to 1,500	12.00
		1,501 or more	10.00
Percentage of employees that are production workers	None	Less than 71%	13.00
		71% to 80%	13.00
		81% to 85%	11.50
		86% to 90%	32.50
		91% to 95%	24.50
		96% or more	5.50
Percentage of output sold in the U.S.	None	Less than 50%	13.00
		51% to 99%	46.00
		All	41.00
Percentage of output sold in Mexico	None	Less than 50%	90.50
		51% to 99%	6.00
		All	3.50
Percentage of firms selling more than 10% of output to other parts of the world[2]	None	Europe	13.50
		Asia	6.00
		Other	1.50

[1] The largest category within "Other" was Human Resources, which accounted for 23.07%; other categories mentioned were security, maintenance, purchases, sales, etc.
[2] Note that this category does not need to add up to 100%
Source: Authors

In Table 2, the results for the perceptions of environmental laws are presented. These results will be highlighted later when cross-tabulated with the position of the respondent in the firm. Nearly 60% of respondents think Mexican environmental laws and U.S. laws are very similar. Also worth noting is the fact that most think Mexican laws are more restrictive than U.S. laws (16.58% versus 13.07%).

Nearly 90% think Mexican environmental laws are adequate. It is also clear that most respondents think Mexican state and local environmental laws are similar or less restrictive than the federal laws.

Table 2. Environmental Laws

Question	Missing Observations	Results (%)	
In general, how would you compare Mexican environmental laws to U.S. laws?	1	Similar	58.29
		Less restrictive	13.07
		More restrictive	16.58
		Not comparable	2.01
		Don't know	10.05
		Easy to interpret	22.11
With regard to the environment, Mexican laws are...	1	Somewhat easy to interpret	48.24
		Somewhat confusing	27.64
		Very confusing	2.01
		Very appropriate	14.00
What is your opinion of the Mexican environmental laws and their enforcement?	None	Somewhat appropriate	30.00
		Appropriate	44.00
		Somewhat inadequate	4.00
		Very inadequate	0.00
		No opinion	8.00
		Similar	64.32
How do you compare the environmental requirements of state and local governments to that of the federal government?	1	Less restrictive	15.58
		More restrictive	9.55
		Not comparable	3.52
		Don't know	6.03
		There are no state regulations	1.01

Source: Authors

Table 3 deals with how the firm manages environmental issues. More than half the firms stated they do not have an environmental manager, yet this alone does not mean the firm does not have an individual who is responsible for environmental issues. Proof of this is that only 16.5% of the firms state they do not have such a position. Furthermore, nearly 80% of the firms have between one and five individuals connected to environmental issues. There is no question that they view governmental issues as a major obstacle to operating in an environmentally responsible way (72.3%). Interestingly, nearly 8% blame environmental problems on the private sector, pointing to their operating in an environmentally irresponsible manner. Slightly more than a quarter of the firms (25.76%) comply with ISO 14000 standards. Perhaps more telling is the fact that less than 3% of the respondents indicate not knowing what ISO 14000 is.

Table 3. The Firm and the Environment

Question	Missing Observations	Results (%)	
Does the firm have an Environmental Manager/Engineer?	3	Yes	45.69
		No	54.31
How long has this position existed?	none	5 years or less	68.50
		6 to 10 years	26.50
		11 years or more	5.00
How many employees are in the environmental office?	none	None	16.50
		2 or less	38.50
		3 to 5	40.00
		6 or more	5.00
What do you view as the largest obstacle to your firm operating in the most environmentally sensitive manner?[1]	16	Bureaucracy/Lack of coordination of the government	25.54
		Government inefficiency	26.63
		Lack of interest of private industry	7.61
		Other	17.39
		Don't know	2.72

Table 3. continued

Question	Missing Observations	Results (%)	
Is your firm under the administration of ISO 14000?	2	Yes	25.76
		No	67.68
		Don't know, but I know what it means	4.04
		Don't know, but I don't know what it means	2.53
Is ISO 14001 applied in your company?	12	Yes	26.60
		No	62.77
		Don't know	6.38
		Other	4.79
Based on the environmental laws established by the Mexican government in 1993, which pollutants are relevant for your company?[2]	7	PM_{10}	45.00
		Ozone	15.00
		Carbon Monoxide	55.50
		VOCs	40.00
		NO_x	18.00
		Sulfur Dioxide	13.00
		Carbon Dioxide	57.50
		None	9.50
Are the terms "environment" or "industrial security" included in firm literature?	2	Yes	72.73
		No	27.27
Has your firm been involved in community activities that have an environmental impact?	6	Yes	17.53
		No	82.47

[1] An open-ended question
[2] Note that the responses do not need to add up to 100%
Source: Authors

Table 4 presents information about respondents' understanding of emissions trading. An interesting result is that less than one in five have ever heard of emissions trading (15.23%). Because this was anticipated, a brief description of the practice was presented before proceeding with the subsequent questions. Clearly, a steering committee of some sort would be welcome to establish the guidelines needed to begin transboundary trading. Respondents were asked about whom they felt should be included on the steering committee. A larger number (13.64%) thought the committee should be drawn exclusively from government officials, in contrast to the smaller number (5.11%) that wanted the government excluded from the committee. In addition, nearly a quarter would expect all interested parties to attend, including nongovernmental organizations (NGOs). The majority (44.32%) wanted the committee to be drawn only from government and private industry. Finally, the majority of respondents were undecided about whether their firm would participate in emissions trading. While not presented in the table, nearly all expressed cost considerations in determining participation. Only slightly more than 7% would be willing to participate without qualification.

Cross-Tab Analysis

These results presented in the previous section are themselves interesting, but it is also interesting to see if the position of the respondent, the geographical region, or some other factor influenced the survey responses.

Table 5 presents the impact respondents' positions in the firm had on the answers to questions related to environmental laws. The results seem to indicate that environmental officers are more likely to think there are no differences in U.S. and Mexican environmental laws. This is an interesting finding since these respondents are charged with coordinating environmental policy.

Table 4. The Firm and Emissions Trading

Question	Missing Observations	Results (%)	
Have you heard of emissions trading?	3	Yes	15.23
		No	84.77
Do you think, from your experience, that a technical commission is needed to set up the emissions trading market?[1]	14	Yes	91.4
		No	6.45
		Undecided (or unclear answer)	2.15
From where should the members of this committee come?[1]	24	Only the government	13.64
		Government and private industry	44.32
		All parties (including NGOs)	24.43
		Exclude the government	5.11
		Miscellaneous	10.8
		Don't know	1.7
Under what circumstances would your firm be willing to partcipate?[1]	15	Will	7.03
		Will not	4.32
		Maybe	67.57
		Management must decide	9.19
		Miscellaneous	3.78
		Don't know	8.11

[1] An open-ended question

Source: Authors

Table 5. Response to Questions Depending on Respondent's Position in the Firm (Percent)

How do Mexican environmental laws compare to the U.S. laws?					
Position	Similar	Less Restrictive	More Restrictive	Not Compatible	Don't Know
Manager	50.00	0.00	7.14	0.00	42.66
Environmental Officer	76.61	5.80	13.04	1.45	2.90
Engineer	50.00	29.17	20.63	0.00	0.00
Other	47.69	12.31	16.92	4.62	18.48

Mexican environmentlal laws are:				
Position	Easy to Interpret	Somewhat Easy	Somewhat Confusing	Confusing
Manager	7.14	35.71	57.41	0.00
Environmental Officer	36.23	55.07	5.80	2.90
Engineer	2083.00	56.33	20.83	0.00
Other	4.62	43.08	49.23	3.08

Mexican environmental laws are:						
Position	Very Appropriate	Somewhat Appropriate	Appropriate	Somewhat Inadequate	Inadequate	Don't Know
Manager	0.00	35.71	21.43	0.00	0.00	42.86
Environmental Officer	18.84	17.39	59.42	1.45	0.00	2.90
Engineer	8.33	25.00	58.33	8.33	0.00	0.00
Other	7.58	36.36	39.39	6.06	0.00	10.61

Source: Authors

Those that usually deal directly with environmental laws—environmental officers and engineers—are most likely to view the laws as easily understood. Environmental officers and engineers are not as quick to praise the Mexican environmental laws as managers are, since at least a small number of them indicate that the laws are somewhat inadequate.

As is clear in Table 6, neither occupation nor city of residence seemed to affect who is viewed as an obstacle. Regardless, government is blamed while the private sector is viewed as relatively innocent. There is one difference: Managers are less likely to blame government inefficiency but more likely to profess ignorance of the exact cause. The respondents who had the largest concerns about the willingness of the private sector to cooperate in reducing pollution were in Ciudad Juárez. This is interesting. Of the cities surveyed, Ciudad Juárez has the most developed environmental movement. This movement may have generated awareness among the private sector, thereby drawing attention to the need for greater cooperation.

Table 6. Response to Questions Depending on Respondent's Position in the Firm and Geographical Region (Percent)

How do you compare the environmental requirements of state and local governments to that of the federal government?						
Position/City	Similar	Less Restrictive	More Reestrictive	Not Compatible	Don't Know	There are No State Laws
Manager	50.00	14.29	0.00	7.14	28.57	0.00
Environmental Officer	72.48	15.94	7.25	1.45	2.90	0.00
Engineer	66.67	16.67	12.50	4.17	0.00	0.00
Other	60.00	16.92	13.85	0.00	9.23	0.00
Ciudad Juárez	66.25	15.00	10.00	1.25	7.50	0.00
Reynosa	55.93	20.34	8.47	8.47	3.39	3.39
Matamoros	70.00	11.67	10.00	1.67	6.67	0.00

Table 6. continued

What do you view as the largest obstacle to your firm operating in the most environmental sensitive manner?						
Position/City	Bureaucracy	Lack of Government Coordination	Government Inefficiency	Lack of Interest by the Private Sector	Other	Don't Know
Manager	25.00	25.00	8.33	8.33	16.67	16.67
Environmental Officer	23.08	21.54	33.85	6.15	12.31	3.08
Engineer	37.50	16.67	33.33	4.17	8.33	0.00
Other	18.03	22.95	21.31	13.11	22.95	1.64
Ciudad Juárez	26.39	18.06	16.67	15.28	16.67	6.94
Reynosa	30.77	17.31	23.08	1.92	26.92	0.00
Matamoros	20.00	25.00	41.67	3.93	10.00	0.00

Source: Authors

In Table 7, answers to questions pertaining to emissions trading are reviewed, and several items are worth noting. First, managers are generally not willing to allow other interested parties (beyond the government and private firms) to participate in the steering committee. Second, environmental officers in particular want government representation on the committee. Another interesting finding is that no managers are willing to state unequivocally that they will participate in emissions trading.

Finally, an evaluation of the pollutants by number of employees was analyzed and presented in Table 8. Respondents were asked to identify the most important environmental issue facing their firm. Interestingly, the response varied depending on the number of employees (Table 8). Most small firms identified carbon monoxide (CO) or carbon dioxide (CO_2) as their major environmental concern, while most large firms identified particulate matter 10 microns or less in diameter (PM_{10}). This finding is significant for the design of a border emissions trading program. First, as explained in Chapter III, the most common nonattainment pollutant on the border is PM_{10}. Therefore, the gains from an emissions trading program aimed at PM_{10} may be significant. Second, all else being equal, organization of an emissions trading program among a few large firms would be easier than among many small firms. Thus, the results support the conclusion that there is a potential gain from the organization of a PM_{10} emissions reduction trading program.

Table 7. More Response to Questions Depending on Respondent's Position in the Firm and Geographical Region (Percent)

From where should the members of this committe come?						
Position/City	Government	Government and Private Sector	All Parties	Exclude Government	Miscellaneous	Don't Know
Manager	38.46	53.85	0.00	7.69	0.00	0.00
Environmental Officer	13.24	47.06	33.82	0.00	4.41	1.47
Engineer	9.52	19.05	33.33	4.78	33.34	0.00
Other	9.43	62.26	13.21	7.59	5.66	1.89
Ciudad Juárez	17.50	55.00	23.75	0.00	2.50	1.25
Reynosa	12.82	7.69	28.21	20.51	28.21	2.56
Matamoros	8.77	54.39	22.81	1.75	10.52	1.75

Under what circumstances would your firm be willing to participate?						
Position/City	Will	Will not	Maybe	Management Must Decide	Miscellaneous	Don't Know
Manager	0.00	7.14	71.43	7.14	7.14	7.41
Environmental Officer	5.88	0.00	79.41	10.29	2.94	1.47
Engineer	19.05	0.00	71.43	9.52	0.00	0.00
Ciudad Juárez	0.00	0.00	72.50	13.75	8.75	5.00
Reynosa	17.02	17.02	34.04	6.51	0.00	23.40
Matamoros	8.62	0.00	87.93	3.45	0.00	0.00

Source: Authors

Table 8. Number of Firms Stating Particular Pollutant is an Issue, According to the Number of Employees (Percent of Firms of that Size that State Pollutant as a Concern)

Pollutant	Number of Employees					
	250 or less	251-500	501-750	751-1,000	1,001-1,500	1,501 or more
PM_{10}	42.88	26.92	34.48	52.50	58.33	80.00
Ozone	8.57	17.31	10.34	25.00	16.67	5.00
Carbon Monoxide	42.86	57.69	58.62	72.50	54.17	35.00
VOCs	40.00	36.54	27.59	47.50	45.83	45.00
NO_x	20.00	13.46	24.14	20.00	20.83	10.00
Sulur Dioxide	20.00	7.69	17.24	10.00	20.83	5.00
Carbon Dioxide	48.57	61.54	65.52	72.50	45.83	35.00
None	11.43	17.31	6.90	2.50	4.17	10.00

Source: Authors

Appendix B

Survey Instrument

Encuesta sobre la Viabilidad Fronteriza del Comercio de los Permisos de Emisiones

Participante: Gerente de la Planta, Gerente Ambiental, Ingeniero Otro (Especifique)

1) ¿Cuántos años tiene trabajando esta planta?

2) ¿Cuántos empleados trabajan en esta planta?

3) ¿Cuántos empleados de la planta son trabajadores del área de producción?

4) Aproximadamente, ¿qué porcentaje del producto de la planta se distribuye en los siguientes mercados?
Estados Unidos
México
Europa
Asia
Otro

5) ¿La planta tiene un Gerente Ambiental/Ingeniero? Sí No
(pasa la pregunta 6 si el participante es Gerente Ambiental/ Ingeniero)

6) ¿Qué tiempo tiene desde que se estableció este puesto en la planta?

7) ¿Cuántos empleados tiene la oficina ambiental?

8) En general, ¿cómo podrías describir las Leyes Ambientales Mexicanas en relación con las Leyes de los Estados Unidos?
Similares a
Menos estrictas que
Más estrictas que
No son comparables
No sé

9) Las Leyes Mexicanas relacionadas con el Ambiente son:
Muy fáciles de interpretar
Más o menos fáciles para interpretar
Un poco confusas
Extremadamente confusas

10) ¿Cuál de las siguientes respuestas reflejan de mejor manera, tu opinión sobre las Leyes Mexicanas del Medio Ambiente, así como su aplicación?
Muy apropiadas
Más o menos apropiadas
Apropiadas
Algo inadecuadas
Muy inadecuadas
No tengo opinión

11) ¿Cómo comparas los requerimientos ambientales del municipio del Estado con los requerimientos de la federación?
Similares
Menos estricto
Más estricto
No tienen comparación alguna
No sé
Aquí no existen requerimientos ambientales del Estado.

12) ¿Cuál es el obstáculo principal que encuentras desde el punto de vista legal en cada nivel institucional para el mejor funcionamiento de tu empresa en términos ambientales?

13) ¿Tu compañía está bajo la dirección del sistema de administración ambiental ISO 14000? (si la respuesta es No [b-d] pasa a la pregunta 15).
Sí
No
No sé, pero sí lo que es el ISO 14000
No sé, y no sé lo que es el ISO 14000

14) ¿El ISO 14001 (Medio Ambiente) es aplicado en tu compañía?
Sí
No
No sé

15) En 1993 el Gobierno Mexicano estableció las Leyes que regulan la Contaminación del Aire (Normas Oficiales Mexicanas-NOMs). En general, ¿cuál de estos contaminantes son relevantes para tu compañía?
Partículas Suspendibles (PM_{10})
Ozono (O_3)
Monóxido de Carbono (CO)
Componentes Orgánicos Volátiles (VOCs)
Óxidos de Nitrógeno (NO_x)
Bióxido de Azufre (SO_2)
Bióxido de Carbono (CO_2)
Ninguno
(Si la respuesta es h, pasa a la pregunta 17)

16) Indica el orden de importancia de los contaminantes para tu compañía (1-el más importante, 7-el menos importante, N/A si no es aplicable a).
Partículas Suspendibles (PM_{10})
Ozono (O_3)
Monóxido de Carbono (CO)
Componentes Orgánicos Volátiles (VOCs)
Óxidos de Nitrógeno (NO_x)
Bióxido de Azufre (SO_2)
Bióxido de Carbono (CO_2)

17) ¿Los términos "ambiental" o "seguridad pública" son mencionados en cualquier parte o forma, en los medios de comunicación y folletos comerciales de la empresa?
Sí
No

18) ¿Tu compañía ha estado envuelta en alguna actividad comunitaria que tuviera problemas relacionados con el medio ambiente? Si la respuesta es "Sí", explica por favor:
Sí
No

19) ¿Cuando es comparada con las plantas similares en los Estados Unidos, pudieras decir que la tecnología usada es:
Antigua
Parecida
No comparable
No sé
Si la respuesta es b o c, pasa a la pregunta 21.

20) ¿Cuál es la principal explicación de tu respuesta a la pregunta número 19?
Edad de la planta
La tecnología fue desarrollada en esta planta
Es difícil adoptar la tecnología en los Estados Unidos, por el exceso de regulaciones.
El costo para implementar la tecnología en los Estados Unidos es muy alto (excluyendo los costos de regulación)
Los costos de implementación de esta tecnología en México son muy altos (excluyendo los costos de regulación)

21) ¿Consideras que el TLCAN (NAFTA) ha tenido un impacto sobre los costos ambientales de la producción?
Sí. Explica por favor:
No

22)¿Habías oído hablar de la comercialización de las emisiones?
Sí. Explica por favor:
No

Nota: La comercialización de las emisiones, es una política ambiental de los Estados Unidos orientada al control de la contaminación ambiental a través del ejercicio de las fuerzas del libre mercado. Actualmente, en los Estados Unidos se ha desarrollado ya la comercialización de permisos para el Bióxido de Azufre (SO_2) en el Intercambio Mercantil de Chicago. La comercialización de permisos es normalmente usada para controlar las emisiones de Bióxido de Azufre de las plantas generadoras de electricidad de carbón de los Estados Unidos. A través de un programa piloto de Comercialización de la Reducción de las Emisiones (PERT) se está llevando a cabo entre compañías de Canadá y los Estados Unidos. Bajo el mecanismo de la comercialización de los permisos, los esfuerzos han sido encaminados para incluir los Óxidos de Nitrógeno (NO_x) y las Partículas Suspendibles (PM). Además, hay la intención de establecer un programa similar en la frontera entre México y los Estados Unidos. Dentro de los esfuerzos en México por la administración de la calidad del aire, el Gobierno Mexicano ha establecido bajo la supervisión general del INE (Instituto Nacional de Ecología) un plan de acción e implementación colectiva para el mejoramiento de la calidad del aire. En este nuevo escenario, el INE y la Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) están interesados en examinar las posibilidades de un mecanismo de comercialización de los permisos de emisiones, en el que participan las plantas y compañías a lo largo de la frontera entre los Estados Unidos y México. Las compañías Americanas o Mexicanas obtendrán créditos de reducción de emisiones (ERC) los cuales pueden ser usados como moneda de intercambio para emisiones actuales. Los ERCs son creados cuando una fuente reduce sus emisiones a un nivel por debajo del de las emisiones actuales o del nivel requerido por las leyes estatales y federales. Los ERCs pueden ser usados también por las compañías Mexicanas o Americanas como moneda de intercambio para permisos de emisiones para sus respectivas agencias de protección ambiental. Los beneficios por usar los ERCs pueden potencialmente ser una ventaja positiva para los costos actuales de la reducción de la contaminación.

23) ¿Qué aspectos sobre el TLCAN (NAFTA), consideras que pudieran ser útiles como apoyo al proyecto de la comercialización de las emisiones?

24) De acuerdo a tu experiencia técnica, profesional y administrativa, ¿consideras que debe existir un Comité, Consejo u Organismo Binacional que supervise, sancione o certifique, las transacciones del proyecto de la comercialización de las emisiones?

25) En este Organismo, Consejo o Comité Certificador, ¿quiénes lo deberían de integrar para su mejor funcionamiento?

26) ¿Bajo qué circunstancias pudiera tu planta estar dispuesta a participar en este proyecto de la Comercialización de las Emisiones?

27) De acuerdo a lo antes expuesto sobre las emisiones, ¿cuáles serían tus dudas sobre el proyecto?

V

Designing a Transborder Trading Scheme

The Kyoto Accord: Lessons for Transborder Trading?

Concerns about anthropogenic global warming from greenhouse gases led to the international agreement known as the Kyoto Accord. The accord, which is not fully ratified, sets targets and timetables for 39 industrialized countries to reduce emissions of six greenhouse gases implicated in global warming. The United States, for example, would cut greenhouse emissions 7% below 1990 levels on average during the years from 2008 to 2012 (Fisher, et al. 1999). Similar cuts are required in Western Europe and Japan. Russia and Ukraine must freeze emissions at 1990 levels (Victor 1998).

Greenhouse gases mix on a global scale. Once the gases are emitted, air currents carry them worldwide (although there is some evidence that mixing does not occur between the northern and southern hemispheres). Mixing pollutants, such as greenhouse gases, are ideal candidates for emissions reduction trading since mixing prevents the formation of local hot spots. Indeed, Kyoto relies heavily on emissions trading as a mechanism for achieving national goals.[1] The logic for emissions trading is compelling. Reducing emissions in Western countries, where strict environmental regulations have been in effect for decades, is difficult and costly. But in developing nations, the fruits hang low and are thus easy to pick. Projects to refurbish inefficient power plants in Poland have cut greenhouse gas emissions at one-tenth the cost incurred in the West, for example (Victor 1998). Trading lets investors earn valuable emission permits while the Poles get new technology. It is expected that emissions trading will reduce the cost of implementing the Kyoto Accord by as much as half (Victor 1998).

The development of an emissions trading scheme for greenhouse gases has proved to be a complex and difficult process. A number of issues need resolving (Boemare and Quirion 2002; Rosenzweig, et al. 2002), including those concerning trading mechanisms, permit allocation, monitoring, and enforcement. During a series of international meetings over several years, including important meetings in Marrakech and Berlin, these issues have been decided for the most part. By July 2003, 118 countries had ratified the Kyoto Accord, including 32 industrial countries. Nevertheless, the accord is on the verge of collapse (Global Environment Committee 2003). The United States withdrew from the agreement in 2001 and Russia announced its intention to withdraw in late 2003, both citing fears it would reduce economic growth. Undoubtedly, skepticism about the importance of greenhouse gases in global warming also contributed to the countries' decisions.

The experience of the Kyoto Accord illustrates the many problems faced by policymakers attempting to design an emissions trading program on the U.S.-Mexican border. Many technical issues concerning the mechanism of trading must be solved. Perhaps more important is whether the political will exists to coordinate environmental policy across the U.S.-Mexican border. This chapter addresses the issues involved in designing such a transborder trading regime.

Elements of Trading Schemes

As has been argued throughout this monograph, emission reduction permit trading is superior in many situations to traditional command-and-control because it makes achieving air quality standards possible at a lower cost. The idea is straightforward—firms that can reduce emissions below a specified target generate permits that can be sold to other firms. By generating cash flow, emissions trading provides an incentive for firms facing low abatement costs to reduce emissions. At the same time, firms facing high abatement costs can avoid those costs by purchasing permits as offsets. By contrast, traditional command-and-control forces facilities to meet similar emission standards regardless of abatement costs. While simple in principle, the actual implementation of a trading permit system requires dealing with a number of specific issues related to permit allocation and enforcement. The resolutions of these issues have important implications for the trading system and will determine whether or not policy goals can be achieved at reasonable costs.

Development of an emissions trading program will involve compromise. Economists argue that the guiding principle in the design of an abatement policy should be efficiency. That allows features of an emissions permit trading scheme to be chosen for their ability to minimize the social and transactional costs of achieving a given policy goal. After all, this is the *raison d'etre* for emissions trading. Of course in practice, politics often trump efficiency considerations. A political entity proposing a trading scheme will be subject to diverse pressures from different special interests on virtually every aspect of the proposal (Boemare and Quirion 2002). Ignoring lobbyists' demands altogether is a recipe for political failure. It follows that understanding the efficiency and political implications of a trading program can inform the decision-making process.[2]

Table 1 lists major features that must be dealt with in developing a transborder emissions trading program. In the first column, 10 attributes of emissions trading programs are listed. The second column briefly describes each attribute. The third column lists alternative policy choices. The first feature listed is the trading regime. This refers to the decision between adopting a cap-and-trade program and a baseline-and-trade program.[3] A cap-and-trade program involves the establishment of an overall emission rate sufficiently low enough to achieve the desired ambient air quality standards. A baseline-and-trade regime does not seek to establish an overall emission level, but rather sets a standard for a given facility. The second feature listed is the initial allocation of permits. Interestingly, this is more a political question than an economic one, as any initial allocation can, in principle, achieve desired emission levels. Distributional and equity issues, therefore, determine how permits are to be initially allocated. The third and fourth features listed involve the extent of coverage. Should coverage be broad, involving multiple airsheds and industries, or should it be limited? This decision involves technical issues specific to particular pollutants, which are beyond the scope of this monograph. Nevertheless, economics does provide some insight into these issues. The next feature listed is the degree of intertemporal flexibility. Economists generally argue for greater temporal flexibility, but borrowing against future emission reductions is controversial, as there is concern among environmental activists that the promised emission reductions will not materialize. Monitoring, enforcement, and liability are closely linked. Any enforcement action is predicated on the monitoring of emissions to detect violations. The assignment of liability to either the seller or the buyer of permits has important efficiency implications, depending on the characteristics of the enforcement regime. Perhaps the most politically charged issue in the design of a transborder emissions trading program is the harmonization of air quality standards across jurisdictions. It will be argued here that this is a non-issue when it comes to transborder permit trading. The following is a discussion of each of the features listed in Table 1 in detail.

Regulatory Regime: The Choice Between Cap-and-Trade and Baseline-and-Trade

In a cap-and-trade system, regulators determine the desired ambient air quality for a particular pollutant, then issue permits sufficient to achieve the standard. The allowed maximum level of emissions is the cap. Permits are standardized, usually expressed in units of emissions per year, and transferable, which facilitates trade. Establishing a cap-and-trade program requires well-developed environmental infrastructure. Regulatory coverage should be broad, with most or all sources covered. Unfortunately, Mexico lacks the resources to establish a tough environmental regime. Mexican environmental regulations are not strictly enforced, and Mexico does not have a comprehensive permit program. As yet, there is no up-to-date comprehensive environmental inventory (although one is being developed in conjunction with the Western Governors Conference, see box, page 53). Indeed, a significant portion of the Mexican economy

Table 1. Features of Emission Trading Programs

Attribute	Description	Alternative Solutions
Regulatory Regime	Mechanism for determining total permits available for trade	Cap-and-trade; baseline-and-trade
Permit Allocation	Initial allocation of permits among potential traders	Auction; exogenous; output-based
Determination of Baseline	Determination of the baseline in a baseline-and-trade regime	Exogenous; output-based
Spatial and Sectoral Coverage	Region and industries to be covered	Limited coverage; broad coverage
Trading Organization	Whether to require trading via a centralized exchange	Private exchange; public registry; no exchange or registry
Intertemporal Flexibility	Whether to allow borrowing and banking of permits	Banking current unused permits for future use; borrowing future permits for use today; no banking or borrowing
Monitoring	Monitoring emissions by a third party to ensure environmental standards are met	Monitoring by the seller's jurisdiction; monitoring by the buyer's jurisdiction; private monitoring; public monitoring
Enforcement	Mechanism for enforcement of environmental standards	Enforcement by the seller's jurisdiction; enforcement by the buyer's jurisdiction; enforcement via private court action
Liability	Allocation of liability for failure to meet stated environmental standards	Seller liability; buyer liability
Harmonization	Whether to require uniform environmental standards across jurisdictions	Harmonize; don't harmonize

Source: Adapted from Boemare and Quirion 2002; Rosenzweig, et al. 2002 remains in the informal sector with little or no oversight by regulators. (For example, the Ciudad Juárez brick kiln industry, a major source of pollution in the Paso del Norte, is not currently subject to strict environmental enforcement.) The border region is years away from developing the regulatory institutions necessary for a cap-and-trade program.

Under a baseline-and-trade program, a baseline is established for each covered emitter. If an action is taken that reduces emissions, the difference between the baseline and the new level of emissions is the amount of emissions available for trading. Such a reduction is said to have generated an emission reduction credit (ERC).[4] ERCs can be bought and sold, and purchasers of ERCs would be allowed to emit above their baseline.

While the overall air quality standard is guaranteed under a cap-and-trade regime, no such assurance exists with baseline-and-trade. In fact, it could come to pass that an ERC could be used as an offset that allowed an increase in emissions at a site located in a nonattainment area. Indeed, it is even conceivable that an ERC could be generated at the same time that overall environmental quality in a region declined. To avoid these sorts of perverse outcomes, care should be taken to ensure that abatement projects used to generate ERCs meet three criteria: emission reductions should be quantifiable, permanent, and real if baseline-and-trade is to be effective.[5] An ERC is quantifiable if the emission reduction can be measured with confidence using a replicable methodology. An ERC is permanent if the reduction in emissions will continue for a substantial period of time, usually the life of the facility generating the emission credit. To be real, an ERC must represent a net improvement to the environment.

Quantifiability and permanence are essentially technical monitoring issues within the purview of environmental engineers and monitoring technicians; they will not be discussed in detail here. Reality is an economic issue as well as a technical one. Whether a given abatement project represents a net reduction in emissions depends on the project's effect on equilibrium emissions. Emissions arise as a byproduct from the production of desired products and depend on the technology used in production and on the equilibrium level of output. If abatement is achieved through the adoption of a new technology with lower emissions per unit of output, the reduction in emissions will represent a net gain for the environment. But, if abatement arises from a reduction in output, the outcome may not be a net emission reduction because market forces will cause output to return to the equilibrium level. More specifically, when a firm reduces output to create an ERC, the reduction in output will cause the market price of the goods being produced to rise compared to what it would have been. The higher price provides an incentive for other firms to expand output. Ultimately, expanding production will return prices and production to their initial equilibrium levels. If the firms that expand output use the same technology as the firms that create the ERC, emissions will also return to their initial level. Thus, there will be no net environmental gain and the original abatement project would not produce a real reduction in emissions. Of course, in many cases, the firms expanding output will be using newer production facilities characterized by lower emission rates, so that expanding production will not cause emissions to return to their initial levels. In this case, the abatement project does result in real emission reductions, but the net result is less than implied by the original project.[6]

An example further illustrates the point. Suppose a brick kiln operator agrees to cease production to generate an ERC, which he sells to a manufacturer. The manufacturer then uses the ERC as an offset for a new production facility. Now consider two cases. Given that demand is unchanged, the exit of the brick kiln operator will result in a higher price for bricks locally. This provides an incentive for another operator to expand production to satisfy the demand left unsatisfied due to the ERC. Indeed, if the original brick kiln operator is unscrupulous, he could open a new facility, earning income from the ERC while still producing bricks.[7] In any case, there is no reduction in brick production and no reduction in emissions. Thus, the abatement from the reduction in brick production underlying the ERC is not real. Allowing the manufacturer to use the ERC as an offset would mean deterioration in the local environment.

Suppose now that the demand for bricks has declined, perhaps due to a slump in construction activity. Further assume that the decline in demand was sufficient enough that the brick kiln operator would shut down whether he sells the ERC or not. Again, the emission reduction underlying the ERC is not real because the ERC does not represent a reduction in emissions net of other actions that the brick kiln operator would have undertaken anyway. Using the ERC as an offset would result in a net increase in emissions, so it should not be allowed.

Of course, determining whether an emission reduction is real or not can be difficult in practice because it involves evaluating a counterfactual. That is, it requires evaluating what would have happened had the ERC not been issued.

Cap-and-trade and baseline-and-trade each have their advantages and disadvantages. With a cap-and-trade program, the overall permit level can be set to incorporate health and other environmental externalities in an optimal fashion (Dewees 2001). On the other hand, a cap-and-trade program is more complex to administer and must be implemented on a region-by-region basis. Baseline-and-trade programs can be implemented on a project-by-project basis—a significant advantage on the border. Moreover, a baseline-and-trade program can be established in the absence of a full environmental inventory and with incomplete regulation. For the present, a baseline-and-trade program implemented on a project-by-project basis is the only practical alternative on the U.S.-Mexican border. Baseline-and-trade was adopted by both the El Paso Electric Brick Kiln Project and CleanAir Canada (see boxes, pages 107 and 109).

Initial Allocation of Permits

There are three economically distinct methodologies for determining the initial allocation of permits: auction to the highest bidder, allocation exogenous to the firm, and an output-based allocation (Boemare and Quirion 2002; Rosenzweig 2002). Economists generally recommend the use of auctions for allocating permits for three reasons (Boemare and Quirion 2002; Goulder 1995; Jensen and Rasmussen 2000). First, auctions allocate permit efficiency. Firms with higher abatement costs will purchase more permits while firms with lower abatement costs will choose to forego the purchase of permits in favor of reducing emissions.[8] Second, revenue generated from auctions can be used to reduce distortionary taxes, such as

Structuring Border Trades: El Paso Electric and Brick Kilns[1]

As discussed in Chapter I, El Paso Electric Company (EPE) is using transborder emission trading to meet nitrogen oxides (NO_x) emission targets at its Newman Station plant. Newman Station includes three grandfathered electric generating facilities that are natural gas-fired boilers. EPE must reduce NO_x emissions below stricter new levels or obtain additional allowances. Rather than install on-site abatement technology, EPE determined it would be more cost-effective to obtain additional allowances by using credits generated in Ciudad Juárez.[2] These credits are generated by replacing existing primitive brick kilns with new, low-emission Marquez kilns, thereby reducing PM_{10}. Texas law allows inter-pollutant trading under some circumstances. The brick kiln project involves the exchange of reductions in PM_{10} emissions for NO_x. In designing the emission trade, EPE and the Texas Commission on Environmental Quality (TCEQ) had to deal with a number of the issues inherent in the design of emissions trading programs.

Baseline

Determining the emission reduction from conversion to Marquez kilns involved two steps. First, field tests were conducted by New Mexico State University. These determined that PM_{10} emissions and emissions of some volatile organic compounds (VOCs) were significantly reduced when using Marquez kilns compared to standard kilns. In the second step, EPE constructed a test kiln in Sunland Park, N.M., near the Texas border. Emissions from these kilns were measured using the methodology established by the U.S. Environmental Protection Agency (EPA) for sampling and analysis of emissions from unmodified and modified kilns. Testing determined that the reduction in emissions available for credit creation was 3.3 tons of PM_{10} per kiln per year. By using well-established, replicable methodology, EPE established quantifiability for the brick project. The emission reductions are also permanent in that they can be expected to last for the life of EPE's Newman Station facility.

The emission reductions are also real; the credit is generated by substituting a low-emission technology rather than by reducing brick production.

Coverage

EPE indicated that it would give preference to kilns located near the U.S.-Mexican border. However, any kiln in the *municipo* of Ciudad Juárez is eligible.

Monitoring and Enforcement

Issues associated with monitoring and enforcement are greatly reduced because the proposed kiln modification involves a one-time process change. Each affected kiln owner enters into an agreement with EPE under which EPE funds construction of a Marquez kiln. In exchange, the kiln owner agrees to the destruction of his existing kiln and operates the new kiln in a manner that will create credits for EPE. Texas requires EPE to provide an annual report documenting the ongoing use of the new kiln.

Liability

Any enforcement action will involve EPE only. No enforcement action is expected by Mexican officials.

Harmonization

Enforcement resides with TCEQ and is governed by the Texas State Implementation Plan. EPE must comply with Texas law.

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[1] This section is based on El Paso Electric 2003.

[2] EPE advocated aggressively for statutory and regulatory changes, which culminated in the passage of 30 TAC § 101.337. This lobbying strategy was an integral part of EPE's strategy for emission targets.

Transborder Trades: The Experience of CleanAir Canada[1]

Smog and acid rain are important environmental issues in eastern Canada. CleanAir Canada sponsors an emissions trading program designed to reduce smog and acid rain in eastern Canada by limiting emissions of nitrogen oxides (NO_x) and sulfur dioxide (SO_2). From its inception, CleanAir Canada recognized that prevailing weather patterns made the midwestern United States a major source of acid rain precursors in Canada and that an effective program would require transborder trades. With this in mind, procedures were developed that facilitated international emissions trading between Canada and the United States.

Before a project is certified, applicants must provide a protocol that includes a general description of the emission project and details the qualification methodology. The protocol involves assessing five core criteria: real, additional, verifiable, quantifiable, and unique. Certification of an emission reduction credit (ERC) requires a creation report describing the quantity of emission reduction. Each creation report must be accompanied by a verification report prepared by an independent third party. For projects originating in the United States, the U.S. Environmental Protection Agency is an acceptable third party for verification purposes.

Prior to certification, each project is subject to a review process designed to ensure that only qualified projects are certified. This process includes review by outside experts and requires confirmation by a multi-stakeholder panel. Once approved, a project is re-certified each year during the life of the ERC.

In developing projects for registry with CleanAir Canada, great care is taken to seek out and develop public support. Projects without such public support are usually rejected. For example, local opposition to a project originating in the United States would usually result in rejection of that project.

[1] This section is based on CleanAir Canada 2002; 2004.

sales taxes, thereby improving overall economic efficiency. The third argument for auctions has more to do with equity than efficiency. It is often asserted that giving permits free of charge to industry would be a give-away of public assets and that this cannot be justified for reasons of justice. Of course, this argument can be stood on its head: Industry has already been allocated emission permits and to force it to now pay for those permits represents an unfair tax on the industry, precisely when industry is being asked to incur new abatement costs. There is no economic criteria by which this equity issue can be settled; the solution becomes a political question.[9]

The most common exogenous criterion for allocating permits is grandfathering, under which historical emissions are used to allocate permits.[10] Grandfathering is generally not recommended as it may introduce a bias against new firms that must purchase permits while existing firms receive them for free.[11] Moreover, grandfathering rewards bad behavior by giving the most permits to precisely the facilities generating the most emissions. In the extreme, the prospect of earning a more generous allocation might even induce bad behavior in the run-up to establishment of an emissions trading program. A final criticism against grandfathering is that it reduces the incentive to develop innovative abatement technology because innovation reduces the value of permits.

With an output-based allocation, firms receive an allocation of permits based on production—more production results in more permits. Such an allocation is dynamic in that it changes with current industry conditions. Output-based allocations have generally been superior to grandfathering. First, new entrants into an industry are automatically given an allocation of permits so incumbent firms cannot use permit allocations as a barrier to entry (Malik 2002). Output-based allocations are not based on an individual firm's past emissions, so they do not reward past bad behavior. Thus, output-based emissions, unlike grandfathering, do not provide an incentive to pollute in anticipation of a higher allocation. Finally, output-based allocations reduce the incentive to relocate production to a pollution haven because output at a new location would count against a firm's allocation (assuming that the new location is covered by an emissions trading program). A problem with output-based permit allocation is that it subsidizes production. Assuming that emissions associated with new production meet preset standards, a firm does not have to purchase new permits to increase output. But this means a firm can increase emissions, which imposes costs on society, without themselves incurring costs. Thus, individually and collectively, firms have an incentive to both produce and emit more than is socially optimal.

The existence of market power influences the optimal allocation of permits. When emission markets are competitive, the initial allocation of permits is irrelevant to efficiency because trading will continue until permits are optimally allocated (Montgomery 1972). However, when one firm gains a significant share of the market so that it can influence prices, markets will no longer allocate permits correctly because the monopolist will withhold some permits from the market to drive up the price. This adverse outcome can be mitigated by allocating permits equal to the optimal permit distribution that would arise under competition (Hahn 1984). Of course, if regulators know the optimal allocation, permit markets are hardly necessary. Still, to the extent that regulators can approximate the optimal allocation, then matching the initial allocation to this will improve market performance.

Closely related to the initial allocation of permits for a cap-and-trade regime is determining the baseline for a baseline-and-trade regime (Brown and Walker 2003). Baselines can be based on exogenous factors or on output. Because baseline-and-trade schemes are not universal in their coverage, auctions are not relevant. After all, an emitter could avoid incurring the cost of purchasing permits in an auction simply by refusing to participate. The pros and cons of grandfathering and output-based allocations outlined in the context of cap-and-trade are relevant to the determination of baseline. Despite its drawbacks, the most commonly used methodology for determining a baseline is grandfathering. Alternatively, one could establish a single baseline for an entire industry. This has the advantage that, once established, the baseline could be applied to all firms in the industry. The problem is that it may result in a standard that is too strict, making it difficult for firms not using cutting-edge abatement technology to make improvements that actually generate emission credits. This, therefore, makes an emissions trading program non-operational. A third approach would be to establish a baseline, not by industry, but by technology. This would allow firms not using cutting-edge technology to still generate emission credits. This is the approach used by the El Paso Electric Brick Kiln Project (see box, page 107).

Sectoral and Spatial Coverage

A major concern with emissions trading is that it could result in pollution hotspots. Restricting coverage may be necessary to avoid hotspots, but doing so has the unfortunate effect of limiting the number of emitters included in a trading program. There are several reasons why this is so. First, decreasing coverage lowers the probability that the pool of traders will include firms with both high and low abatement costs, thus limiting the benefit-from-trade (Boemare and Quirion 2002). There are three general categories of gains-from-trade specific to emissions trading. First is the revenue that accrues to the seller, second is the reduced abatement cost accruing to the user, and third is improved environmental quality that accrues to society generally. For these gains-from-trade to be realized, differences in abatement costs among participants must exist. This argues against limiting coverage and for inclusion of the maximum number of participants from diverse sectors using different technologies and production processes.

The second reason for maximizing coverage to the extent possible is to increase market efficiency. Specifically, a major advantage of using markets to allocate permits is that prices can be used as a signal to market participants of the relative value of permits. Firms can use this information to determine their optimal level of abatement activity and permit use. If the price of a permit is high, firms will choose to increase abatement activity; if prices are low, firms will acquire permits via purchases. Generally speaking, market prices more accurately reflect true opportunity costs when transaction volume is greater (Andersson 1997; Liski 2001). In thin markets with few transactions, prices will reflect conditions as of the last trade, which may or may not reflect current conditions. In such a situation, prices are said to be stale. These stale prices may provide firms with incorrect signals, distorting the incentives they face in deciding what abatement activity to undertake. Since including more emitters will increase trade volume, increasing coverage should also increase market efficiency. Unfortunately, expanding coverage sufficiently to make a significant impact on market efficiency is unlikely in the context of the border, where participation is likely to be limited, at least at first. This means posted prices will be an unreliable guide for future transactions and transaction costs will be high. Steps to mitigate these problems, such as streamlining regulation, should be considered.

Increasing the number of emitters covered reduces the market power of any one trader, which is the third benefit of expanded coverage. Market power adversely affects emissions markets by reducing the volume of transactions. A seller with market power will restrict sales to raise prices, while a buyer with market power will restrict purchases to hold prices down (Boemare and Quirion 2002). In either case, lower trading volume prevents full realization of the gains-from-trade from permit trading. Market power in emissions markets can have implications for other markets as well. A firm that gains a monopoly position in the permit market could restrict access by product market competitors, thereby gaining a monopoly position in its product market (Misiolek and Elder 1989). By increasing coverage, the probability that any one firm can gain market power is lowered.

Markets perform better with greater numbers of participants, which argues for maximizing sectoral and spatial coverage to include the most emitters possible. This conclusion, however, is conditional on the assumption that location does not affect the damage from emissions. The concept of mixing uniformity is useful in this context (Hanley, et al. 1997). Mixing uniformity refers to the degree to which a pollutant emitted at one location contributes to the pollution potential at another location. Mixing uniformity varies by pollutant type. At one extreme are greenhouse gases, which are mixing uniformly across the globe. The impact of particulate matter, specifically PM_{10}, on the other hand, is much more localized and measured in tens of miles. The mixing uniformity of a pollutant can depend in a complicated way on climate and geography. The bowl formed by the Juárez and Franklin Mountains in the Paso del Norte, for example, forms a region that tends to trap ozone and in which relatively uniform mixing of ozone occurs. At the same time, the prevailing westerly winds cause the ozone plume from Paso del Norte to extend in an easterly direction (see Figure 1 in Chapter I).

Limiting spatial coverage of an emissions trading program may be necessary when pollutants do not mix uniformly. Otherwise, permit trading might cause unacceptable high concentrations near emitters that have obtained offsets in lieu of further controls, thus creating hotspots. In this context, both Texas (TNRCC 2002) and California (RECLAIM 2004) restrict trading to only those emitters within the same bubble. A bubble is a limited area, usually corresponding to a single urban area, in which a pollutant is assumed to be mixing uniformly. An alternative to using bubbles is to define "exchange rates" between regions with the rate of interregional pollutant transportation determining the coefficient of exchange (Hanley, et al. 1997). Thus, if 20% of a pollutant emitted at A diffuses to B, then a user at B can apply only 20% of an ERC generated at A as an offset. Such a system can be socially optimal; however, administrative costs may be prohibitive, and as of 2002 no program using exchange rates had been established (Boemare and Quirion 2002).

Trading Organization

Minimizing transaction costs is important in the design of an emissions trading program. Financial markets can provide insights in this regard. It is frequently suggested, for example, that an exchange[12] on which standardized emission credits trade, just as shares of IBM stock trade on the New York Stock Exchange, would minimize transaction costs. Exchanges, however, do not always lower transaction costs. They are characterized by high fixed costs and only if the volume of transactions is sufficient are they cost-effective. The fact is that most financial transactions are not made via exchanges but rather involve the direct negotiation between borrower and lender[13] or the use of an intermediary, such as an investment bank. A similar outcome is likely to be true for emissions trading on the border.

In deciding between an exchange and direct negotiation or intermediation, the trade-off is between the higher fixed cost of creating a tradable security and the lower transaction cost per trade. The nature of the market will determine which approach is most cost-effective. If it is expected that there will be an active secondary market with the same security being bought and sold numerous times, then creating a security makes sense. If trades are few or if the characteristics of the emission credit make the cost of developing a security high, then directly negotiating a transaction or using an intermediary is preferred. Markets that include a large number of participants are likely to have a higher volume, hence the organization of an exchange is more cost-effective. Similarly, when the pollutants traded are standardized, volume is likely to be higher and an exchange is more likely to be cost-effective. The greenhouse gas market provides an example that illustrates these points. Coverage is global and greenhouse gases have been standardized in terms of carbon equivalents, making securitization less expensive. Consequently, a nascent global exchange is developing and the volume of emission permits traded is growing. The trading of sulfur dioxide (SO_2) in conjunction with the U.S. Acid Rain Program provides another example. Here again coverage is extensive and the pollutant, SO_2, has been standardized. SO_2 futures are traded on the Chicago Board of Trade.

The conditions that make exchanges cost-effective are not present on the border. Coverage is likely to be limited to one urban area and standardization of emissions has yet to be completed. Creation of an emissions trading exchange specific to the U.S.-Mexican border is likely years in the future, if it should ever become practical. This does not mean emissions trading cannot be a valuable tool in achieving air quality standards, but it is likely that emissions trading will take place via direct negotiation between buyer and seller or via an intermediary acting on behalf of buyers and sellers. For example, the North American Development Bank (NADBank) may be able to play an important role as an agency that intermediates between buyers and sellers of ERCs on the border.

Intertemporal Flexibility

Intertemporal flexibility refers to the ability of firms to bank unused ERCs for later use or borrow future ERCs to use in the present. The basic conclusion coming from economic theory is that greater flexibility improves efficiency, provided there are no temporal hotspots (Rubin 1996; King and Rubin 1997; Yates and Cronshaw 2001; Innes 2003). Emission banking and borrowing allows firms to time abatement activity to maximize the benefit to the firm. Moreover, emission banking provides firms with an incentive to make investments earlier because emissions savings can be used in the future. Indeed, the heavy use of banking has been credited with the early reduction and substantially lower overall cost of compliance in the U.S. Acid Rain Program, which achieved its goals earlier than regulations required (Boemare and Quirion 2002). A further benefit of banking is that it provides flexibility in the face of uncertainty. Should emissions spike, say, due to a sudden rise in demand for the firm's product, the firm avoids compliance costs by either using banked emissions or by borrowing against future emissions (Schenmach 2000; Van Egteren and Webber 1996).

The major concern with intertemporal trading of emissions is the possibility of temporal hotspots, in which permits saved from a previous period or borrowed from a later period allow a firm to emit large quantities of a pollutant in a short period of time. The potential seriousness of such a concern depends on the characteristics of the pollutant. Ozone and PM_{10} are pollutants for which peak levels are important, for example. An obvious fix for this problem is for regulators to impose absolute limits on the level of emissions allowed in any one time period. Such a temporal constraint, when bidding, increases the cost of pollution abatement, but is necessary when temporal hot spots are a concern (Rubin 1997). A major concern specific to emission borrowing involves more politics than economics. If an industry borrows heavily against future emissions, in future time periods when the borrowed emissions come due, the industry will face heavy abatement costs to make up the accumulated deficit. The question is, Will regulators have the political will to enforce air quality standards when faced with intense industry lobbying? If not, then an industry that recognizes this will "game the system" by borrowing heavily today on the assumption that emissions will never need to be repaid, thereby creating a self-fulfilling prophesy (Boemare and Quirion 2002).[14] Two complementary solutions to this situation present themselves. First, borrowing should be limited to sustainable levels by imposing a quota on the cumulative amount that can be borrowed. Second, legislation should be put into place that limits the ability of regulators to waive emissions standards. The second fix is of interest on the border, where the ability of the Mexican Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) to enforce existing regulations is suspect.

An interesting issue that arises with intertemporal trading is the interaction of banking and borrowing with market power. Hagem and Westskog (1998) show that creating multi-period ERCs can reduce the negative effect of market power in emission markets. When ERCs last only one period, a seller with market power has an incentive to restrict sales to raise prices. But the price increase is less in a market with multi-period ERCs. This is because a firm with market power has an incentive to reduce prices in later periods to induce buying by holdouts. Realizing this, buyers will delay purchases (in effect becoming holdouts) to take advantage of lower prices in later periods, which puts downward pressure on price in earlier periods. That is, expectations of lower prices in future periods reduce prices in the current period. The problem with multi-period ERCs is that they interfere with banking and borrowing. Thus, regulators face a trade-off between mitigating market power and less efficient intertemporal allocation. Indeed, multi-period ERCs improve social welfare, but the gain may be negligible when market power is weak (Hagem and Westskog 1998).

Monitoring, Enforcement, and Liability

Unregulated emitters adjust production to minimize private costs. The implementation of environmental regulation forces firms to alter their production techniques, thus raising private costs (although, social costs are reduced because undesirable pollution is eliminated). The desire to avoid these additional private costs provides regulated firms with an incentive to cheat. Thus, efficiency of an emissions trading system depends on both the technical ability to detect violations and the legal ability to deal with cheating to create an incentive for deterrence (Boemare and Quirion 2002). This raises interesting issues for a transborder emissions trading regime. The United States enjoys unparalleled technical and legal expertise with regard to the environment. Strict monitoring and enforcement is the norm. Mexico, typical of a developing country, has less-strict monitoring and weak enforcement. Consequently, emission monitoring and enforcement of emission reductions in Mexico may not be to the standard required by U.S. officials. One solution would be to allow U.S. officials to monitor emission reductions used as offsets in the United States, but this is likely to be politically unpalatable for both governments. While Mexicans will view such an outcome as compromising national sovereignty, U.S. citizens will be reluctant to foot the bill for enforcement of Mexican environmental laws, even when the benefits to U.S. taxpayers are substantial. A common practice in existing programs is to hire a private third party to monitor and verify emission reductions used in trades (Rosenzweig, et al. 2002). Third-party verification makes sense on the border; this avoids problems of national sovereignty because government officials are not directly involved. Moreover, when parties to the transaction pay for monitoring, verification costs are internalized within the transaction, thus improving the efficiency of markets in correctly pricing trades. Adequate penalties are critical for successful enforcement. Indeed, penalties must increase as the level of noncompliance increases for efficient regulation. Otherwise, emitters may actually choose to pollute more as monitoring becomes more strict (Heyes 2001). This perverse effect arises because some polluters find that stricter monitoring makes compliance too costly, so they choose to increase emissions. This result is prevented if penalties are sufficiently severe.

Closely related to the issue of monitoring are the liability rules that apply when a violation is detected. With seller-liability, the seller is subject to a penalty for excess emissions. Since the ERC remains valid, the buyer remains compliant. With buyer-liability, violations invalidate the ERC so that the buyer using the ERC as an offset becomes non-compliant. Liability can also be divided between both buyer and seller, with penalties accruing to both. Generally speaking, seller liability is easier to administer since monitoring and enforcement can be conducted by a single agency; however, when monitoring or enforcement is weak, pure seller liability should be avoided because sellers will be tempted to over-sell ERCs in the face of little chance of sanction. Allocating some of the liability to the buyer provides an incentive for buyers to monitor compliance. Weak monitoring and enforcement by Mexico argues for allocating liability to U.S. buyers. Under this scheme, violation by Mexican sellers would instigate enforcement action by the U.S. Environmental Protection Agency (EPA) and/or state officials. Thus, U.S. buyers would face a similar incentive for compliance as with a strictly domestic transaction.

HARMONIZATION

Harmonization refers to the establishment of identical standards in two jurisdictions. Many observers point to differences in environmental standards between Mexico and the United States as a reason why transborder emissions trading will not work. Will Mexican officials, for example, allow enforcement of standards in excess of those required under Mexican laws?

The question is, Which ambient air standard should be enforced, U.S. or Mexican? As indicated in Chapter III, Mexican and U.S. ambient air quality standards are similar. Both U.S. and Mexican law authorize the establishment of atmospheric concentration standards. These have been developed for the six criteria pollutants, ozone precursors (volatile organic compounds [VOC] and nitrogen oxides [NO_x]), and various hazardous air pollutants (HAPs). The guiding principle in setting standards in both countries is the protection of human health. When the standards do differ, it is not necessarily true that U.S. standards are stricter than Mexican standards. The United States imposes a one-hour standard on carbon monoxide (CO); Mexico does not, but Mexico does impose a stricter eight-hour standard. For NO_x, the Mexican standard is stricter, but Mexico has no standard for the annual arithmetic average, while the United States does impose an annual standard. The United States and Mexico have the same standard for PM_{10}. Mexico has a stricter one-hour ozone standard but has no eight-hour standard. Mexico has a stricter 24-hour standard for SO_2 but has the same annual standard as the United States. Mexico has no standard for $PM_{2.5}$, while the United States has no standard for total suspended particulates.

A solution to conflicts in standards is to treat the emissions trading program as if it were a domestic transaction in the purchaser's home country, in essence where the credit is being applied, with the exception of using a third-party monitor to certify compliance in the other country. That is, if an ERC generated in Mexico is purchased by a U.S. firm, the purchaser would be allowed to use the ERC as an offset only if the transaction met the requirements for a strictly domestic U.S. trade. Mexican officials would have no active involvement in the transaction. This requires the least amount of international negotiation, yet allows use of emissions trading to achieve environmental goals at a low cost. An important point in this regard is that the selling country always benefits from emissions trading while the purchasing country only benefits if the emission reduction actually occurs. To see this, consider the situation after a trade. Emissions are lower and the selling firm has generated revenues that otherwise would not have been generated. The selling country enjoys both a stronger environment and financial gain. The buying country benefits from the improved environment, but partially offsetting this is the financial loss arising from the payment to the seller. Thus, the seller should favor any trade that the buyer is willing to authorize.

A complicating issue of harmonization is the effect of trading on employment. A wide variety of issues are considered in setting ambient air quality and point-source emission standards, as well as in determining the level of enforcement. Not the least of these issues is the impact of environmental standards on employment. Tighter standards may have a negative impact on employment and jobs. Such job loss has a different impact in a developing country like Mexico than it does in a developed country like the United States. Mexico, like other developing countries, has a limited social safety net so job loss has more serious consequences for a Mexican citizen than for a U.S. citizen. Under these circumstances, it is understandable that Mexico would place a greater value on preserving jobs when evaluating environmental regulation than the United States would. Job loss is not necessarily a byproduct of emission reduction, but certainly job loss can happen. When job loss occurs as an outcome of a U.S. firm's purchase of an ERC from a Mexican emitter, Mexican officials may not want such transactions to be consummated, even though U.S. officials favor the transaction. (While job loss may be an issue in some cases, it was not an issue with the El Paso Electric Brick Kiln Project; see box, page 107).

Emissions Trading on the U.S.-Mexican Border

Emissions trading is particularly well-suited for policy coordination on the border. The border is highly urbanized and most of the population and industry are concentrated in 14 twin cities (Peach and Williams 2000). Many of the twin cities form a single airshed where sources on one side of the border affect air quality on the other side. In three cases, twin cities are labeled nonattainment for the same pollutants on both sides of the border: El Paso and Ciudad Juárez are nonattainment for ozone, carbon monoxide, and suspended particulates; and Ambos Nogales and Mexicali-Calexico are nonattainment for suspended particulates. For all of these twin cities, studies have found that at least some pollution sources on the Mexican side of the border contribute to nonattainment on the U.S. side. These areas at least are candidates for emissions trading programs.

As part of an outreach effort, the authors conducted a series of workshops along the U.S.-Mexican border in Mexicali, Nuevo Laredo, Reynosa, Matamoros, and Ciudad Juárez. Participants from both sides of the border were invited and representatives from state and federal governments, non-governmental organizations (NGOs), academia, and the business community were included. The purpose of these workshops was to bring together interested stakeholders in an open discussion forum for examining the feasibility of emissions trading along the border. More than 200 people participated. Workshops consisted of presentations, small group discussions, and numerous other types of interactions. An important goal was to discern conditions under which emissions trading would receive public support. In this regard, six principles for designing emissions trading programs were identified:

- Emissions trading must respect the sovereignty of both the United States and Mexico

- Only mutually beneficial trades should be allowed; that is, emissions trading programs must result in improved environmental quality for both trading partners
- Emissions trading programs must not adversely affect employment opportunities in either country
- Direct negotiation between U.S. and Mexican government officials should be kept to a minimum
- Where direct coordination between governments is necessary, the negotiations should be handled by local officials when possible
- Emissions trading programs should be phased in over time; as an intermediate step, pilot programs like the El Paso Electric Brick Kiln Project should be implemented

With these basic principles in mind, the authors developed the following recommendations on the design of a transborder emissions trading program.

1. A transborder emissions trading program should be a baseline-and-trade program. Mexico does not currently have the comprehensive emissions inventory required for cap-and-trade, and environmental enforcement is weak. Both of these facts make a cap-and-trade trading scheme impractical. Further, baseline-and-trade allows for project-based trades, which are easier for U.S. officials to monitor if the seller is in Mexico and for Mexican officials to monitor if the seller is in the United States.
2. Baseline should be determined by the officials of the purchaser's jurisdiction. The asymmetry in benefits from emissions trading provide perverse incentives to regulators of the seller's jurisdiction because citizens of the seller's country benefit from both an improved environment and from the cash flow arising from the sale of the ERC. Citizens of the buyer's jurisdiction only benefit to the extent that the value of the environmental improvement exceeds the cost of purchasing the ERC. Thus, officials of the seller's country have an incentive to approve a baseline that generates only marginal, or even no, environmental benefit in the hopes of generating cash flow. The only

incentive to officials in the buyer's jurisdiction is to approve baselines that generate ERCs providing net environmental benefits in excess of abatement costs. Thus, incentives for these officials are more closely aligned with society's and should be given responsibility for determining baselines.

3. Coverage should be as extensive as possible within the twin city airsheds to achieve the maximum gain from emissions trading.
4. An Internet registry should be established for each twin city listing ERCs. A formal exchange is unlikely to be practical in the short run, but Internet registration is a low-cost way to improve market efficiency.
5. Borrowing and banking should be allowed, provided care is taken to avoid intertemporal hotspots. As argued previously, intertemporal flexibility improves efficiency.
6. Projects certified for transborder trading should adopt low-emission technology. This proposal provides two advantages. First, ERCs generated from adoption of low-emission technologies are more likely to be real than ERCs generated from reductions in production. Second, adoption of low-emission technologies is less likely to affect employment adversely.
7. Projects should be chosen for their minimum negative impact on employment. This recommendation is to comply with the concern expressed by workshop participants that emissions trading will adversely affect employment opportunities, which is a special concern among Mexican nationals. It is best not to require that projects generating ERCs have no adverse effect on employment because there may be cases in which emissions trading, while adversely affecting employment, has a lesser adverse effect than other abatement projects.
8. Care must be taken that emissions trading not create temporal or spatial hotspots. While this is more a general consideration than a concern specific to a transborder trading program, concerns about potential hotspots were frequently expressed at workshops and so should be explicitly addressed to maximize public acceptance.
9. Offsets should be more than one-reduction-for-one-pollutant with the ERC to ensure that the trade has an overall benefit to the environment and the health of the residents.

10. Monitoring should be handled by private third parties and paid for by the parties to the trade. The use of third-party monitoring is common among existing emissions trading programs (Rosenzweig, et al. 2002). They are cost-effective, and because they require parties to the trade to pay, they also internalize the cost of monitoring, which helps ensure that only socially beneficial trades take place. An important additional factor for transborder emissions trading is that the use of a private third party reduces infringements on sovereignty.
11. Primary responsibility for certifying ERC trades should rest with the officials of the buyer's home country. The asymmetry benefits that accrue from emissions trading to the seller are again at play. The seller's jurisdiction benefits from reduced emissions, improved air quality, and from the financial gains of selling ERCs; therefore, the seller's jurisdiction always has an incentive to certify a trade, even when environmental gains do not justify doing so. On the other hand, for a trade to benefit the citizens of the purchaser's jurisdiction, transportation of the pollutant must be sufficient such that emissions are reduced in the neighborhood of the purchaser. When this condition is not met, officials of the buyer's jurisdiction should not approve the use of the ERC as an offset. Thus, the officials of the seller's and buyer's jurisdictions face different incentives—the seller's to always approve and the buyer's to approve only if the ERC generates environmental benefits near the buyer. Because only mutually beneficial trades should be approved, only the buyer's jurisdiction has the correct incentive.
12. Enforcement should be the primary responsibility of the purchaser's jurisdiction. Even if no true emission reduction occurs, the seller's jurisdiction benefits from the revenue generated from the sale of the ERC. Thus, the incentive to enforce emission reduction is attenuated for officials of the seller's jurisdiction. The buyer's jurisdiction only benefits if emission reduction actually occurs. This provides an incentive to officials of the buyer's jurisdiction to enforce emission reductions strictly.

13. Liability should be allocated to the ERC's purchaser. Again, officials of the purchaser's jurisdiction have the incentive to enforce emission reductions while the officials of the seller's jurisdiction have a lesser incentive. Allocating liability to the purchaser ensures that the officials with the correct incentive are responsible for enforcement.
14. Air quality standards of the purchaser's jurisdiction should be enforced. This is the only arrangement consistent with national sovereignty. The buyer's jurisdiction must approve the trade, since its emissions are located at a site within its country being allowed exceedence; doing so requires the approval of local officials. The seller, in contrast, is emitting at a rate lower than required by its jurisdiction, so special permission from local officials is not needed by the seller because the seller's action is not in conflict with the laws of the seller's home country.

Endnotes

[1] The Kyoto Accord includes two "flexible" mechanisms for achieving greenhouse gas targets—joint implementation (JI) and clean development mechanism (CDM). JI allows for Annex-I countries to work together to achieve emission goals jointly. CDMs are similar but involve cooperation between the industrialized Annex-I countries and developing non-Annex-I countries. Exactly how JIs and CDMs would work was not specified by Kyoto, but as things have evolved through various rounds of negotiation by the Conference of Parties (COP), particularly the Marrakech COP, it has become clear that the main policy tool for implementing JIs and CDMs will be ERC trading, if Kyoto goes into effect (REC 2003).

[2] Systematic analyses of ERC trading programs are scarce. Schwarze and Zapfel (2000) compare two U.S. programs—RECLAIM and the U.S. Acid Rain Program. Harrison and Radov (2002) explore 10 programs, but only with regard to initial allocations of permits. Sonneborn (1999) evaluates the status of programs as of the late 1990s. Two articles that do systematically discuss elements of trad-

ing programs are Rosenzweig, et al. (2002), and Boemare and Quirion (2002). Much of the discussion in this chapter is informed by these latter two articles.

[3] Boemare and Quirion (2002) criticize the use of this terminology as ambiguous.

[4] The distinction here is between a permit, which is permission to emit a particular quantity of emissions, and an ERC, which is a reduction below a particular baseline level of emissions.

[5] A concept closely related to permanence and additivity is surplus. An emission reduction is surplus if it is over and above the emission reduction required by environmental regulations. That is problematic in the context of the U.S.-Mexican border because environmental laws, especially in the informal sector, are weakly enforced.

[6] The substitution of new technology does not have to be direct. For example, Ontario Electric purchased older, high-emission cars that were then destroyed by crushing. Studies showed that the older cars were replaced by newer vintage, lower-emission cars. The net result was a reduction in overall emissions by the total urban auto fleet.

[7] Of course, a vigilant regulator could prevent this type of unscrupulous behavior by refusing to issue the necessary permits.

[8] While beyond the scope of this monograph, the design of the auction is critical if an efficient allocation is to be achieved (Fisher, et al. 1999). A bidding system with desirable efficiency characteristics is a uniform price open auction (McGuigan 2001). With uniform price open auctions, public bids are submitted. Participants, who are able to review the bids submitted by others, are allowed to revise bids until the close of the auction. The auctioneer determines the price that clears the market and all bidders submitting a price higher than the market clearing price receive an allocation, but pay only the market-clearing price. Those who have participated in multi-unit auctions on eBay will be familiar with this type of auction.

[9] Indeed, the famous Coase Theorem states that the initial allocation of property rights is irrelevant from an efficiency aspect (Hanley, et al. 1997).

[10] Grandfathering is exogenous in the sense that past action, which cannot be altered by current behavior, is what determines the current allocation.

[11] This concern applies only if financial markets are imperfect or incumbent firms enjoy market power.

[12] The financial literature distinguishes between formal exchanges, such as the New York Stock Exchange, and over-the-counter markets, such as the NASDAQ. Almost certainly any emission credit exchange that might be established would be over-the-counter.

[13] Direct negotiations are often facilitated by a broker.

[14] This is an example of a well-known phenomenon in game theory know as time inconsistency.

References

Albrecht, J. 1998. "Environmental Policy and Inward Investment Position of U.S. Dirty Industries." *Intereconomics* 33(4): 186–194.

Andersson, Fredrik. 1997. "Small Pollution Markets: Tradable Permits vs. Revelation Mechanisms." *Journal of Environmental Economics and Management* 32: 38–50.

Arizona Department of Environmental Quality. 1999. *Ambos Nogales Air Quality Study: Hazardous Air Pollutant and Particulate Matter Risks to Human Health.* Cited 29 July 2002. http://www.adeq.state.az.us/envirn/region/sro/download/citzensreport.pdf.

Barry, Tom. 1994. *The Challenge of Cross-Border Environmentalism: The U.S.-Mexico Case.* Albuquerque, N.M.: Resource Center Press.

Bennett, Melissa, and David Bennett. 1997. "Border Tradition on the Line Community Rallies Behind Mexican Students." *Rethinking Schools* 11(3). Cited 21 May 2002. http://www.rethinkingschools.org/archive/11_03/bennett.shtml.

Birdsall, Nancy, and David Wheeler. 1993. "Trade Policy and Industrial Pollution in Latin America: Where are the Pollution Havens?" *Journal of Environment and Development* 2(1): 137–149.

Boemare, Catherine, and Philippe Quirion. 2002. "Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Literature and International Experience." *Ecological Economics* 43: 213–230.

Border Environment Cooperation Commission/North American Development Bank. 1999. *Joint Status Report.* San Antonio: NADBank.

Brown, Michael, and Nicola Walker. 2003. "The CDM, Carbon Credits, and Decentralized Energy." *Cogeneration and On-Site Power Production Magazine* 4(4).

Burtraw, Dallas. 1996. "The SO_2 Emissions Trading Program: Cost Savings without Allowance Trades." *Contemporary Economic Policy* 14(April): 79–94.

Burtraw, Dallas, Alan J. Krupnick, Erin Mansur, David Austin, and Deirdre Farrell. 1998. "Costs and Benefits of Reducing Air Pollutants Related to Acid Rain." *Contemporary Economic Policy* 16(October): 379–400.

Carlson, Curtis. 1998. "Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?" Resources For the Future Discussion Paper 98/44R.

Carlson, Curtis, Dallas Burtraw, Maureen Cropper, and Karen L. Palmer. 2000. "Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?" *Journal of Political Economy* 108(6): 1292–1326.

Centers for Disease Control. 2000. "U.S.-Mexico Border Environmental Health Issues." Cited 24 July 2002. http://www.cdc.gov/nceh/hsb/border.htm.

Central Intelligence Agency. 2002. "World Fact Book." Cited 25 June 2002. http://www.cia.gov/cia/publications/factbook/index.html.

CleanAir Canada. 2002. "Background." Cited 13 June 2002. http://www.cleanaircanada.org/bgmission.htm.

CleanAir Canada. 2004. "Review Process." Cited 1 February 2004. http://www.cleanaircanada.org/ercoverview.asp.

Cole, M. A., A. J. Rayner, and J. M. Bateman. 1997. "The Environmental Kuznets Curve." *Environment and Development Economics* 2(4): 401–416.

Commission for Environmental Cooperation. 2003a. "Citizen Summary of Enforcement Matters." Cited 2 July 2003. http://www.cec.org/citizen/submissions/details/index.cfm?varlan=english&ID=56.

Commission for Environmental Cooperation. 2003b. "Milestones." Cited 2 July 2003. http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1189.

Coronado de Anda, Hector, and Anthony Matulewicz. 2003. "Short History of the Maquila Industry." Cited 26 March 2003. http://66.90.130.23/mdandt/memo/a_short_history_of_the_maqula_i.htm.

Daly, Herman E. 1996. *Beyond Growth: The Economics of Sustainable Development.* Boston: Beacon Press.

Deacon, Robert F. 1999. "The Political Economy of Environmental Development Relationships: A Preliminary Framework." University of California Santa Barbara Preliminary Framework Working Paper.

Dewees, Donald N. 2001. "Emission Trading: ERC or Allowances?" *Land Economics* 77(4): 513–526.

Dhanda, Kanwalroop Kathy. 1999. "A Market-Based Solution to Acid Rain: The Case of Sulfur Dioxide (SO_2) Trading Program." *Journal of Public Policy & Marketing* 18(2): 258–264.

Dow Jones Wire Service. 2003. "Mexican Pwr Plants Begin Operations Amid US Legal Battle." *The Wall Street Journal* (14 June). Cited 28 June 2003. http://online.wsj.com/article/0,,BT_CO_20030614_000311-search,00.html?collection=autowire%2F30day&vql_string=mexicali%3Cin%3E%28article%2Dbody%29.

Dwyer, A. 1994. *On the Line: Life on the U.S.-Mexican Border.* Hampshire Research Institute. Cited 18 May 2002. http://www.hampshire.org.

Earth Justice. 2000. "Court Settlement Requires Clean Air Actions in Six Communities Across Nation." Cited 28 June 2003. http://www.earthjustice.org/news/display.html?ID=73.

Earth Justice. 2003. "Urgent Cases: Run for the Border." Cited 28 June 2003. http://www.earthjustice.org/urgent/display.html?ID=106.

Economist. 1998. "Good Fences and Good Neighbors: Columbus, NM and Palomas, Mexico." (28 February): 28.

El Paso Electric. 2003. "Proposal for Using Emission Reduction Credits from Brick Kiln Conversions in Ciudad Juárez, Mexico to Meet NO_x Allocation Requirements Under TNRCC's Senate Bill 7." Cited 20 June 2003. http://air.utep.edu/bca/jac/special_projects/brick_kilns/epec/.

Ellerman, A. Denny, and Juan Pablo Montero. 1998. "The Declining Trend in Sulfur Dioxide Emissions: Implications for Allowance Prices." *Journal of Environmental Economics and Management* 36: 26–45.

Ellerman, A., R. Schmalensee, P. Joskow, J. Montero, and E. Bailey. 2000. "Emissions Trading Under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance." In *From Obstacles to Opportunity: How Acid Rain Emissions Trading is Delivering Cleaner Air.* Washington, D.C.: Environmental Defense.

Enriquez, Ana. 2003. "Sounding Barbie's Alarm: A Toy Factory Worker's Story." Cited 26 July 2003. http://www.maquila solidarity.org/campaigns/toy/barbie_factorx.htm.

Erickson, Christopher A. 1992. "The Border Economy and NAFTA." *Business Forecaster* 4(1): 2.

Erickson, Christopher A. Forthcoming. "China, Maquila Employment and the WTO: An Investigation." In *Proceedings of the Pan Pacific Business Association.*

Erickson, Christopher A., and David W. Eaton. 2002. "Border Finance: Paying for Environmental Infrastructure." In *The U.S.–Mexican Border Environment: Economy and Environment for a Sustainable Border Region: Now and in 2020* SCERP Monograph No. 3, Paul Ganster, ed. San Diego: SDSU Press.

Eskeland, G., and A. Harrison. 1997. "Moving to Greener Pastures? Multinationals and the Pollution Haven Hypothesis." World Bank Working Paper 1744.

Faulkner, Tina. 1999. "Border XXI Meeting Highlights Accomplishments, Failings." *Borderlines Updater.* Cited 30 July 2002. http://www.us-mex.org/borderlines/updater/1999/june4b21.html.

Fisher, Carolyn, Suzi Kerr, and Michael Toman. 1999. "Using Emission Trading to Regulate U.S. Green House Gases: An Overview of Policy Design and Implementation Issues." *National Tax Journal* 51(3): 453–464.

Forster, Craig, and Edwin Hamlyn. 2002. *Border+20: A System Dynamic Approach to Understanding and Analyzing Communities along the U.S.-Mexico Border.* Manuscript.

Fullerton, Don, Shaun P. McDermott, and Jonathan P. Caulkins. 1997. "Sulfur Dioxide Compliance of a Regulated Utility." *Journal of Environmental Economics and Management* 34: 32–53.

General Accounting Office. 2000. *U.S.-Mexico Border: Despite Some Progress, Environmental Infrastructure Challenges Remain.* Report GAO-03-891. Cited 25 July 2003. http://www.gao.gov/new.items/ns00026.pdf.

General Accounting Office. 2003. *International Trade: Mexico's Maquiladora Decline Affects U.S.- Mexico Border Communities and Trade; Recovery Depends in Part on Mexico's Actions.* Report GAO-03-891. Cited 25 July 2003. http://www.gao.gov/new.items/d03891.pdf.

Ghosh, Soumen, and David J. Molina. 2002. "Public Decisions for Private Management: The Case of the U.S.-Mexico Border Region." *The Journal of Developing Areas* 36(1): 93–107.

Global Environment Committee. 2003. *Climate Regime Beyond 2012: Basic Considerations.* Tokyo: Japan Ministry of Environment. Cited 2 January 2004. http://www.env.go.jp/en/topic/cc/031126.pdf.

Goulder, L. 1995. "Environmental Taxation and the Double Dividend: A Readers Guide." *International Tax and Public Finance* 2(2): 157–183.

Grossman, Gene, and Alan Krueger. 1995. "Economic Growth and the Environment." *Quarterly Journal of Economics* 110(2): 353–377.

Gutierrez, Nancy. 2002. *Presentation to the Matamoros Workshop.* Cited 31 August 2002. http://www.cbae.nmsu.edu/~sghosh/BAET/.

Hagem, Catherine, and Hege Westskog. 1998. "The Design of a Dynamic Tradable Quota System under Market Imperfections." *Journal of Environmental Economics and Management* 36: 89–107.

Hahn, R. W. 1984. "Market Power and Transferable Property Rights." *Quarterly Journal of Economics* 99: 753–765.

Halvey, Richard. 2002. "Presentation to the Juárez Workshop." Cited 31 August 2002. http://www.cbae.nmsu.edu/~sghosh/BAET/.

Hanley, Nick, Jason F. Shogren, and Ben White. 1997. *Environmental Economics in Theory and Practice.* New York: Oxford University Press.

Harrison, D., and D. B. Radov. 2003. "Evaluation of Alternative Initial Allocation Mechanism in a European Union Trading Scheme." National Economic Research Association for the European Commission Report. http://www.nera.com/publication.asp?p_ID=1072.

Hetch, Alan. 2000. "Toward a Virtual Border: Meeting the Needs of U.S.-Mexican Border Communities in the Twenty-First Century." In *The U.S.–Mexican Border Environment: A Road Map to a Sustainable 2020* SCERP Monograph No. 1, Paul Ganster, ed. San Diego: SDSU Press.

Hettige, H., M. Mani, and D. Wheeler. 2000. "Industrial Pollution in Economic Development: Environmental Kuznets Revisited." *Journal of Development Economics* 62(2): 445–476.

Heyes, Anthony. 2001. "A Theory of Filtered Enforcement." *Journal of Environmental Economics and Management* 44: 24–46.

Innes, Robert. 2003. "Stochastic Pollution, Costly Sanctions, and the Optimality of Emission Permit Banking." *Journal of Environmental Economics and Management* 45: 546–568.

InterGen. 2003a. "La Rosita." Cited 28 June 2003. http://www.intergen.com/rosarito.html.

InterGen. 2003b. "InterGen Announces Plan to Install State-of-the-Art Emissions Control Technology on Border Power Facility in Mexico." Cited 28 June 2003. http://www.intergen.com/pr/012803pr.html.

Jensen, Jesper, and Tobias N. Rasmussen. 2000. "Allocation of CO Emissions Permits: A General Equilibrium Analysis of Policy Instruments." *Journal of Environmental Economics and Management* 40: 111–136.

King, C., and J. Rubin. 1997. "Bankable Permits for the Control of Environmental Pollution." *Journal of Public Economics* 64: 101–115.

Kruger, Joseph, and Melanie Dean. 1997. "Looking Back on SO_2 Trading: What's Good for the Environment Is Good for the Market." *Public Utilities Fortnightly* 135: 30–37.

Liski, Mattii. 2001. "Thin Versus Thick CO_2 Market." *Journal of Environmental Economics and Management* 41: 295–311.

Lundquist, Diane. 2003. "Ruling Deals Blow to Power Plants in Mexico." *San Diego Union-Tribune* (6 May). Cited 28 June 2003. http://www.signonsandiego.com/news/business/20030506-9999_1b6power.html.

Lybecker, Donna, and Stephen Mumme. 2002. "Decentralization and Environmental Protection on Mexico's Northern and Southern Boundaries." *Journal of Development and Environment* 11(4): 402–429.

Malik, Arun S. 2002. "Further Results on Permit Trading with Market Power and Cheating." *Journal of Environmental Economics and Management* 44: 371–390.

McGuigan, James R., R. Charles Moyer, and Fredrick Harris. 2001. *Managerial Economics: Applications, Strategy, and Tactics 7th ed.* Cincinnati: South-Western.

Michaels, Patricia. 2002. "Air Pollution: A Brief History of Legislative Activities in the United States." Cited 22 July 2002. http://environmental.about.com/library/weekly/aa062500.htm.

Millman, Joel. 2003. "Mexico's Maquiladoras May Be Putting Together a Comeback." *Wall Street Journal* 25 July.

Misiolek, W. S., and H. W. Elder. 1989. "Exclusatory Manipulation of Markets for Pollution Rights." *Journal of Environmental Economics and Management* 16: 156–166.

Montero, Juan-Pablo, Jose Miguel Sanchez, and Ricardo Katz. 2002. "A Market-Based Environmental Policy Experiment in Chile." *The Journal of Law and Economics* 45: 267–287.

Montgomery, D. W. 1972. "Markets in Licenses and Efficient Pollution Control Programs." *Journal of Economic Theory* 5: 395–418.

National Environmental Justice Advisory Committee. 2003. "Unheard Voices from the Border: A Report on Environmental Justice in the U.S.-Mexico Border Region From the Past to the Future." Cited 7 July 2003. http://www.epa.gov/compliance/resources/publications/ej/nejac-ej-border-report.pdf.

Peach, James, and James Williams. 2000. "Population and Economics Dynamics on the U.S.-Mexican Border: Past, Present and Future." In *The U.S.–Mexican Border Environment: A Road Map to a Sustainable 2020* SCERP Monograph No. 1, Paul Ganster, ed. San Diego: SDSU Press.

Peach, James, and James Williams. 2002. "Border Population Projections to 2025." Manuscript.

Radian Corporation. 1996. "Implementation Plan Mexico Emissions Inventory Methodology Version 2.0." Cited 1 July 2003. http://www.epa.gov/ttn/catc/dir1/impplan.pdf.

Regional Clean Air Incentive Market. 2004. "Regional Clean Air Incentive Market." Cited 30 August 2004. http://www.aqmd.gov/reclaim/reclaim.html.

Regional Environmental Center for Central and Eastern Europe. 2003. "Kyoto Flexibility Mechanism." Cited 30 December 2003. http://www.rec.org/REC/Programs/SofiaInitiatives/EcoInstruments/GreenBudget/GreenBudget6/kyoto.html.

Rose, Kenneth. 1997. "Implementing an Emissions Trading Program in an Economically Regulated Industry: Lessons from the SO_2 Trading Program." In *Market-Based Approaches to Environmental Policy: Regulatory Innovations to the Fore,* Richard F. Kosobud and Jennifer M. Zimmerman, eds. New York: Van Nostrand Reinhold.

Rosenzweig, Richard, Matthew Varilek, Ben Feldman, Radha Kuppalli, and Josef Janssen. 2002. *The Emerging International Greenhouse Gas Market.* Arlington, Va.: Pew Center on Global Climate Change.

Rubin, Jonathan D. 1996. "A Model of Intertemporal Emission Trading, Banking, and Borrowing." *Journal of Environmental Economics and Management* 31: 269–286.

Schenmach, Susanne M. 2000. "The Economics of Pollution Permit Banking in the Context of Title IV of the 1990 Clean Air Act Amendments." *Journal of Environmental Economics and Management* 40: 189–210.

Schwarze, R., and P. Zapfel. 2000. "Sulfur Allowance Trading and the Regional Clean Air Incentive Market: A Comparative Design Analysis of Two Major Cap-and-Trade Permit Programs." *Environment and Resource Economics* 17: 279–298.

Sempra Energy Resources. 2003a. "Termoeléctrica de Mexicali (TDM)." Cited 28 June 2003. http://www.sempraenergyresources.com/Pages/Projects/TDM.aspx.

Sempra Energy Resources. 2003b. "Why Sempra Energy is Building Energy Infrastructure in Mexico." Cited 28 June 2003. http://www.sempra.com/perspective_030107_felsinger_mexico.htm.

Sklair, Leslie. 1989. *Assembling for Development.* Boston: Unwin Hyman.

Sonneborn, C. 1999. "An Overview of Greenhouse Gas Emissions Trading Pilot Schemes and Activities." *Ecological Economics* 31: 1–10.

Soto, Gloria. 2000. "Mexico City's 10 Year Plan for Improving Air Quality." Cited 13 June 2003. http://www.pewclimate.org/media/soto_presentation.pdf.

Stern, David L., Tony Auld, Michael S. Commons, and Kali K. Sanyal. 2001. "Is There an Environmental Kuznets Curve for Sulfur?" *Journal of Environmental Economics and Management* 41(2): 162–178.

Swift, Byron. 2000. "Allowance Trading and Potential Hot Spots—Good News from the Acid Rain Program." *Environment Reporter* 31: 954–959.

Texas Natural Resource Conservation Commission. 2000. "Air Quality: The Skies Over El Paso." Cited 10 May 2002. http://www.tnrcc.state.tx.us/admin/topdoc/pd/020/00-12/elpaso.html.

Texas Natural Resource Conservation Commission. 2002. "Chapter 101: General Air Quality Rules." Cited 7 July 2004. http://www.tnrcc.state.tx.us/oprd/rules/pdflib/101_ind.pdf.

Twin Plant News. 2004. "Maquila Scoreboard." *Twin Plant News* May.

Twin Plant News. 2001. "Maquila Scoreboard." *Twin Plant News* July.

U.S. Environmental Protection Agency. 1993. "Air Quality Index." Cited 29 May 2002. http://www.epa.gov/airnow/aqibroch/.

U.S. Environmental Protection Agency. 1996. "Border XXI Framework." Cited 23 July 2002. http://yosemite1.epa.gov/oia/MexUSA.nsf/Border+XXI+-+Framework?OpenView.

U.S. Environmental Protection Agency. 2001a. "EPA Finalizes Imperial County Air Quality Rating for Dust as Moderate Nonattainment." Cited 23 July 2003. http://yosemite.epa.gov/r9/r9press.nsf/268400f6f4b727f288256b6100659fe6/d93b93f13aa12dbb88256ae100695109?OpenDocument.

U.S. Environmental Protection Agency. 2001b. "U.S.-Mexico Border XXI Program: Progress Report 1996-2000." Cited 27 July 2004. http://www.epa.gov/usmexicoborder/progress/eng/index.htm.

U.S. Environmental Protection Agency. 2002a. "Acid Rain Program." Cited 14 July 2002. http://www.epa.gov/airmarkt/arp/index.html.

U.S. Environmental Protection Agency. 2002b. "Green Book: Nonattainment Areas for Criteria Pollutants." Cited 26 July 2002. http://www.epa.gov/oar/oaqps/greenbk/.

U.S. Environmental Protection Agency. 2002c. "Plain English Guide to the Clean Air Act." Cited 12 May 2002. http://www.epa.gov/oar/oaqps/peg_caa/pegcaain.html.

U.S. Environmental Protection Agency. 2002d. "United States Environmental Protection Agency Directory of Air Quality Economic Incentive Programs." Cited 15 May 2002. http://yosemite.epa.gov/aa/programs.nsf.

U.S. Environmental Protection Agency. 2002e. "U.S.-Mexico Border Information Center on Air Pollution." Cited 28 July 2002. http://www.epa.gov/ttn/catc/cica.

U.S. Environmental Protection Agency. 2002f. "New U.S.-Mexico Border Environmental Program (2002)." Cited 30 July 2002. http://www.epa.gov/usmexicoborder/2002/index.htm.

U.S. Environmental Protection Agency. 2003a. "Acid Rain Program: 2001 Progress Report." Cited 20 July 2003. http://www.epa.gov/airmarkets/cmprpt/arp01/2001report.pdf.

U.S. Environmental Protection Agency. 2003b. "Clean Air Markets." Cited 20 July 2003. http://www.epa.gov/airmarkets/.

U.S. Environmental Protection Agency. 2004. "Green Book: Nonattainment Areas for Criteria Pollutants." Cited 11 August 2004. http://www.epa.gov/air/oaqps/greenbk/index.html.

Van Egteren, Henry, and Marian Weber. 1996. "Marketable Permits, Market Power, and Cheating." *Journal of Environmental Economics and Management* 30: 161–173.
Victor, David G. 1998. "Kyoto Shell Game." *The Washington Post* (20 November): A29. Cited 30 December 2003. http://greatrestoration.rockefeller.edu/KyotoShellGame/.
Watkins, Ralph. 1994. "NAFTA and Mexico's Maquiladora Industry." *Industry Trade and Technology Review* February.
Wheeler, David. 2001. "Racing to the Bottom? Foreign Direct Investment and Air Pollution in Developing Countries." *Journal of Environment and Development* 10(3): 235–245.
Wheeler, David, and Ashoka Mody. 1992. "International Investment Location Decisions: The Case of U.S. Firms." *Journal of International Economics* 33: 57–76.
Yates, Andrew J., and Mark B. Cronshaw. 2001. "Pollution Permit Markets with Intertemporal Trading and Asymmetric Information." *Journal of International Economics* 42: 104–118.

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THE SCERP MISSION

The Southwest Consortium for Environmental Research and Policy (SCERP) was established by the U.S. Congress in October 1990 to "initiate a comprehensive analysis of possible solutions to the acute air, water quality, and hazardous waste problems that plague the United States-Mexico border region." SCERP is a consortium of five U.S. universities (Arizona State University, New Mexico State University, San Diego State University, University of Texas at El Paso, and University of Utah) and five Mexican universities (Colegio de la Frontera Norte, Instituto Tecnológico de Ciudad Juárez, Instituto Tecnológico y de Estudios Superiores de Monterrey, Universidad Autónoma de Baja California, and Universidad Autónoma de Ciudad Juárez). SCERP carries out its mission through a cooperative agreement with the U.S. Environmental Protection Agency. A permanent administration office is maintained by the consortium in San Diego.

ENVIRONMENTAL PROBLEMS OF THE U.S.-MEXICAN BORDER REGION

The border region lies 100 kilometers, or 60 miles, on each side of the U.S.-Mexican political boundary and encompasses parts of four states in the United States—Texas, New Mexico, Arizona, and California—and six Mexican states—Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas. Approximately 13 million people live in the U.S. counties and Mexican *municipios* on the border. The high density of people and increased industrialization since the passage of the North American Free Trade Agreement (NAFTA) have placed an even greater burden on the inadequate infrastructure and environmental resources of the region. Exacerbating the problem is the fact that many U.S. counties along the border are categorized as "economically distressed," and few communities possess the resources needed to address their environmental concerns. Some of the critical border environmental issues include:

- Rapid urbanization and lack of adequate infrastructure
- Air pollution from open burning, vehicle emissions, and industrial operations
- Contamination of surface water and groundwater from open sewers and industrial waste
- Overuse of aquifers and surface streams
- Transportation and illegal dumping of hazardous wastes
- Destruction of natural resources

THE SCERP SOLUTION

SCERP uses a broad, integrated, multidisciplinary approach to address the issues of the border. SCERP researchers collaborate with the U.S. Environmental Protection Agency (EPA) and Mexico's Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT), as well as local and state governments, tribal nations, business and industry, non-governmental organizations, and communities of the border region. SCERP organizes research, outreach, and training programs devoted to improving environmental conditions and building capacity in the border region for resolving critical environmental problems. SCERP is pioneering a model of binational cooperation that brings U.S. and Mexican researchers together and introduces new skills and perspectives in binational environmental problem solving.

CONSORCIO DE INVESTIGACION Y POLITICA AMBIENTAL DEL SUROESTE

SOUTHWEST CONSORTIUM FOR ENVIRONMENTAL RESEARCH & POLICY