
A Tale of Two Cities: The Regulation of Particulate Air Pollution in Mexico City
and Los Angeles

By

Daniel J. Krebs

B.S. Environmental Engineering
Massachusetts Institute of Technology, 1998

Submitted to the Department of Urban Studies and Planning in Partial Fulfillment of the
Requirements for the Degree of

Master in City Planning

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

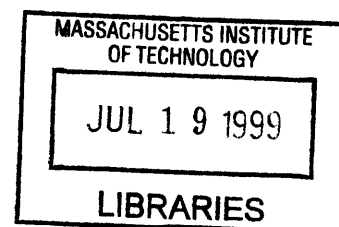
June 1999

© 1999 Massachusetts Institute of Technology
All rights reserved

Signature of Author _____
Department of Urban Studies and Planning
May 20, 1999

Certified by _____
Lawrence S. Bacow
Department of Urban Studies and Planning
Thesis Supervisor

Accepted by _____
Associate Professor Paul Smoke
Chair, MCP Committee
Department of Urban Studies and Planning



ROTCH

A Tale of Two Cities: The Regulation of Particulate Air Pollution in Mexico City and Los Angeles

By

Daniel J. Krebs

Submitted to the Department of Urban Studies and Planning
on May 20, 1999 in Partial Fulfillment of the Requirements for the
Degree of Master in City Planning

ABSTRACT

Mexico City and Los Angeles have employed very similar air pollution abatement programs yet their results have been disparate. Particulate and ozone pollution levels have been significantly reduced in Los Angeles but not in Mexico City. The reasons for this difference in effectiveness are specific to each context. The implementing agencies in Mexico City lack the requisite institutional capacity, political resources and financial resources to adequately address the particulate and ozone air pollution problem. Subsequently, any policies aimed at reducing the particulate levels in Mexico City need to be tailored towards overcoming these institutional barriers. Policies that can accommodate these constraints include creating an independent, autonomous regulatory agency, increasing environmental education and activism at a grass roots level and coupling health and environmental concerns so that air pollution abatement programs provide net fiscal benefits.

Thesis Supervisor: Lawrence S. Bacow
Title: Lee and Geraldine Martin Professor of Environmental Studies

Table of Contents

<i>Table of Contents</i>	5
<i>Acknowledgements</i>	7
<i>List of Figures</i>	9
<i>Map of Mexico City</i>	11
<i>Introduction</i>	13
Why focus on Urban Air Pollution?	15
Why Mexico City and Los Angeles?	15
Thesis Structure	17
<i>Contrasting Mexico City and Los Angeles</i>	19
Policy Analysis Framework	20
Physical Characteristics	21
Topography	22
Thermal Inversions.....	22
Altitude.....	23
Economic Characteristics	24
Position in the National Economy.....	24
Industrial Development.....	25
Industrial Profile.....	27
Patterns of Development	28
Role of Planning.....	30
Demographic Composition	33
Demographics of the Population	34
Vehicles and Housing	35
Government and Politics	36
Government Structure	36
Political Characteristics.....	37
Derivation of Finances	39
Political Institutions.....	40
Political Activism / Views of the People.....	41
Conclusions	44
<i>How Los Angeles has Addressed the Problem</i>	45
Regulation before the 1970 Clean Air Act	45
Clean Air Act of 1970	48
Implementation of the State Implementation Plan (SIP)	49
Air-Pollution Politics	53
Results and Consequences of the Efforts in Southern California	57
Conclusions	61
<i>How Mexico City has Addressed the Problem</i>	63

Influence of Los Angeles on Mexican Environmental Policy	63
Mexican Efforts to Combat Air Pollution.....	65
1971 Federal Law.....	65
1982 Federal Law.....	67
1988 Ley General.....	71
1990 PICCA.....	73
1995 ProAire.....	76
Enforcement.....	77
Implementation	79
Outcomes of the Regulatory Initiatives to Reduce Particulate Levels	82
Conclusions	82
<i>Analysis of the Mega-City Policy Making Process</i>	<i>85</i>
Financial Capacity.....	86
Governmental Financial Capacity.....	86
Industrial Financial Capacity	89
How Financial Capacity affects Policy Making.....	90
Institutional Capacity	91
Individual Institutional Capacity.....	91
Relationship between institutions.....	93
Institutional Capacity Issues within the Metropolitan Commission.....	94
Lack of Political Pressure for Environmental Programs	95
Role of Institutional Barriers to Public Involvement.....	97
Role of Individual Beliefs	97
Role of Auto Industry Politics.....	98
Other Industrial Political Pressure.....	100
Lack of Political Will to promote Environmental Programs	101
Conclusion.....	103
<i>Conclusion</i>	<i>105</i>
Factors that Complicate Implementation	105
Ideas for Possible Solutions	108
Implications for other Cities.....	110
<i>Bibliography</i>	<i>112</i>
<i>Appendix 1: Background on Mexico City</i>	<i>115</i>
<i>Appendix 2: Environmental Programs.....</i>	<i>137</i>
<i>Appendix 3: Social Pressures Analysis</i>	<i>157</i>
<i>Appendix 4: Health and Science Issues</i>	<i>167</i>

Acknowledgements

The research for this thesis was done during the 1998-1999 academic year at M.I.T. under the Mexico City Project in the Center for Environmental Initiatives. Subsequently, I would first like to thank the CEI and all of those that participated in the Mexico City project for their help and insight into formulating these ideas. Specifically, I would like to thank my advisor, Professor Larry Bacow, for his guidance and ideas in writing the thesis and keeping me on task. Writing the document would have undoubtedly become unbearable without his influence, and I appreciate the time he made for me while still attending to the duties of Chancellor. I would also like to extend my heartfelt thanks to my readers: Professor Mario Molina, Dr. Louisa Molina and Professor Greg McRae. Their input and guidance while on the Mexico City project was invaluable. I also had a number of unofficial readers and advisors off whom I was able to bounce ideas and who helped fill in the cracks to paint the "big picture." Thanks go out to Renee Robins, Jim Foster, Jason West, Gustavo Sosa, Ken Oye, Steve Connors, Jack Spengler, Arnold Howitt and David Laws. Finally I would like to thank my parents and friends, not only for supporting me throughout the process, but also for their help reading, editing and revising the document, which became lengthy and time-consuming.

List of Figures

Chapter 1

Figure 1-1 Policy Making Process.....	21
Figure 1-2 GDP of Mexico City as Percentage of National GDP	24
Figure 1-3 Annual Growth Rate, Mexico City and Los Angeles.....	29
Figure 1-4 Mexico City Land Use	32
Figure 1-5 Population of Mexico Entities as Percentage of National Population.....	33

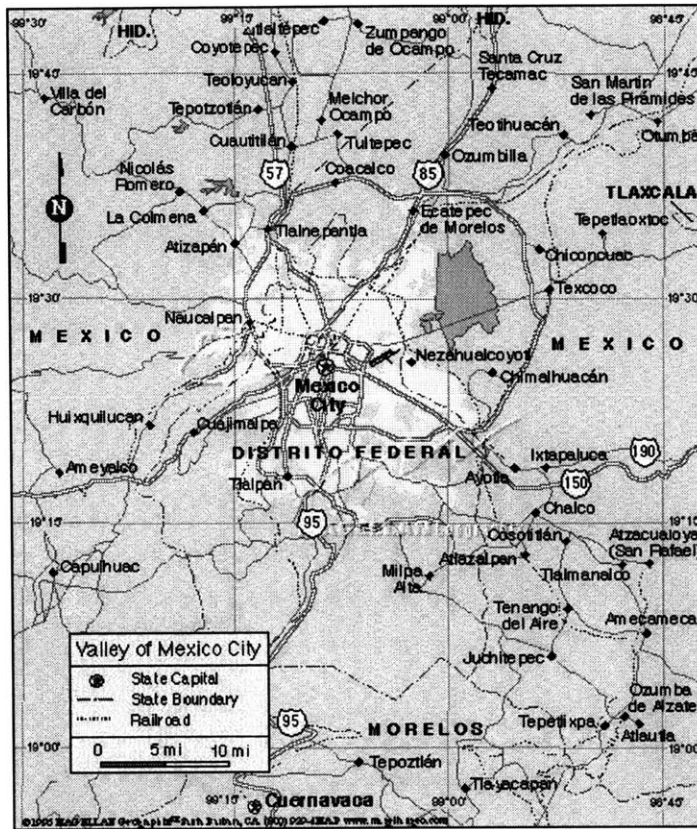
Chapter 2

Figure 2-1 PM10 Levels in Los Angeles, Relative to US Standards	58
Figure 2-2 Annual Exceedences of PM10 24hr Standards – Los Angeles.....	59

Chapter 3

Figure 3-1 TSP 24hr Measurements for Mexico City	80
Figure 3-2 TSP Annual Average for Mexico City	80
Figure 3-3 PM10 24hr Measurements for Mexico City	81
Figure 3-4 PM10 Annual Average in Mexico City	81

Map of Mexico City



Introduction

*It was the best of times, it was the worst of times.*¹

For Los Angeles (LA), it is the best of times. The air quality in LA has been improving since the early 1940s. Despite fifty years of economic progress and growth in both number of cars and population, peak air pollution levels have declined since the 1970s. The two agencies that regulate air pollution, the California Air Resources Board (CARB) and the South Coast Air Quality Management District (SCAQMD or the District), are viewed as successful, competent agencies and are known for their progressive air pollution mitigation plans.² The public in Southern California cares about environmental issues and non-governmental environmental organizations enjoy widespread support. Los Angeles appears to be succeeding in its efforts to control air pollution. Improvements in air quality still need to be made, but the air in LA is cleaner today than it has been at anytime since the late 1940's.

For the Mexico City Metropolitan Area (MCMA), it is the worst of times. On most winter days, it is impossible to see the surrounding mountains due to atmospheric haze. While early efforts to reduce ambient lead, carbon monoxide and sulfur dioxide succeeded, the recent national financial difficulties crippled environmental cleanup efforts aimed at particulates and ozone, leaving the regulatory agencies responsible for dealing with these problems in shambles. Despite the earlier victories, the citizens of Mexico City have a fatalistic attitude toward air pollution and the government's attempts to deal with the problem. They believe that efforts to control air pollution are destined to fail because the problem is just too large to be dealt with effectively. Instead, they suffer while sitting in traffic, their eyes burn, they cough up dust, and

¹ Charles Dickens, *Hard Times*

² Grant, 1996 and Lents, 1993.

they worry about other things. The MCMA's problems with ozone and particulates³ persist despite air pollution laws that are very similar to those in Los Angeles. This thesis suggests explanations for why the regulatory strategy that has been so successful in LA has had little impact on ozone and particulates in Mexico City.

The air pollution problems that plague Los Angeles and Mexico City are not unique. Many large cities around the world, like Bangkok, Sao Paulo, Buenos Aires and Beijing have difficulty keeping their air clean. As these cities swell with people, automobiles, and new industry, air quality often deteriorates rapidly. Some of these mega-cities have become the most polluted places in the world. The immense emphasis placed on industrial and economic growth in the last half of the twentieth century has exacerbated air pollution. Sources of emissions have grown in number and intensity. This growth has made air pollution one of the most pervasive and persistent environmental problems facing urban policy makers around the globe. Given a choice between improving short-term economic welfare or protecting environmental quality, policy-makers almost always opt for the former.

Air quality is so difficult to deal with because it is an enormously complex problem with technical, political, and social dimensions, multiple feedback loops and heavily vested interests. These characteristics force the problem into the realm of governmental action. Once in the governmental sphere of responsibility, environmental protection competes with other issues for attention and requires political, as well as technical, solutions. And unless there is a political constituency that supports clean air and a regulatory mechanism capable of delivering it, well-intentioned legislation is likely to be ineffective. This is the story of the MCMA.

³ Mexican Authorities have succeeded in removing lead and SO₂ from Mexico City's air, one of the successes of air pollution efforts in Mexico.

Why focus on Urban Air Pollution?

Urban air pollution occurs in a number of different forms. Not only is air pollution a nuisance, impeding visibility and damaging property, but carbon monoxide, oxides of sulfur and nitrogen, airborne toxic chemicals, tropospheric ozone and particulates affect human health through multiple pathways and linkages. Not all of these pathways are well understood. Because urban air contains high levels of these contaminants, millions of people are exposed to health hazards every day. The effects of air pollution on human health include respiratory problems, cancer, irritation and toxic exposures.⁴ Thus, an improvement in urban air quality may drastically improve public health. But due to its multi-dimensional nature, urban air pollution problems (and their solutions) vary from city to city.

Why Mexico City and Los Angeles?

A comparative study between Los Angeles and Mexico City is especially attractive for several reasons. First, there is the issue of scale. These cities are two of the largest, most populated and most polluted cities in the world. The sheer size of their populations and areas makes them comparable only to each other. Second, they share a striking similarity in the specifics of their air pollution problem. They are subject to similar geographic and meteorological phenomena that amplify their air pollution problems. They suffer from the same pollutants, and their atmospheric chemistries are similar. Third, the political, economic and social ties between the U.S. and Mexico predispose these two cities to many of the same implementation problems, and their similarly structured governments imply similar stakeholders in air pollution policy formulation.

⁴ See Appendix 4

The officials of the Government of Mexico have not overlooked these similarities. For the most part, they adopted air pollution regulations that are very similar to those implemented in Los Angeles. When the Mexicans designed their regulatory strategies, officials from the U.S. were invited to sit in and help the Mexican government craft air pollution control plans.⁵ The ambient air quality standards of Mexico are similar to those of the United States, and the two cities have employed many of the same pollutant-targeted policies. However, the results differ. Both cities lack comprehensive analysis of their policies, but by most measures, the air quality in Los Angeles has been getting better while the air quality in Mexico City has been getting worse.

The history of pollution control effort in Mexico creates a unique case study. Under very similar physical conditions, similar air pollution abatement plans had disparate outcomes. The underlying differences between the two cities must account for much of the discrepancy in effectiveness. Thus, a study of the two cities creates an opportunity to analyze the effects of political, economic, and social factors on the efficacy of environmental policies. The dynamics behind environmental protection in Los Angeles have been well documented and using Los Angeles as a foil allows for a much clearer analysis of the situation in Mexico City.

This thesis aims to uncover the differences between Mexico City and Los Angeles that make air pollution regulation in Mexico City much less effective than the efforts in LA. These differences then can be used to examine the constraints and influencing factors of the environmental policy process. Politics, economics, and social characteristics played a large role in determining the effectiveness of policies in Mexico City, and an analysis of their effects may shed some light on the regulatory dynamics in a developing nation such as Mexico. To provide a structure for thinking about these dynamic factors and the manner in which they affect

⁵ Williams, 1996, L.A.N.L., 1994 and Miller, 1991

environmental laws and regulations, a model of the policy-making process will be introduced in the beginning of chapter one. Using this model to represent the experience in LA and the MCMA, the constraints on the Mexican programs will be identified, and I will provide some insights into how these constraints can be accommodated by appropriate policy alternatives.

Thesis Structure

After the policy-making process has been simplified, it is useful to examine the context within which environmental regulations work in the two cities. Chapter 1 investigates these differences and similarities to better understand the dynamic systems at work in the cities. The demographic, political, social, governmental and economic differences between the two cities can affect the outcomes of policies to a great degree. Many of these differences were overlooked during the crafting of the Mexican Policies to date which led to erroneous assumptions regarding the likely outcomes.

The manner in which these differences played out in each city is the subject of the second and third chapters. In the second chapter, the air pollution control efforts of Los Angeles are examined and their implementation against the backdrop of the first chapter is noted. In the third chapter, the same analysis is performed for Mexico City. Each of the policies was crafted with the goal of air quality in mind: why were the policies of Mexico City ineffective in drastically reducing ozone and particulate levels?

In the fourth chapter, these observations are summarized into four distinct factors that affected the policy outcome in Mexico. While each of the four factors also occur in Los Angeles, it is the degree to which they exist in Mexico City that determined the fate of the Mexican policies. Financial capacity, institutional capacity, political power and political will all influence the outcome of air pollution regulation to a much greater degree in Mexico City, and

these obstacles need to be addressed by subsequent policies to prevent the same mistakes from being repeated.

To this end, the conclusion offers some suggestions for minimizing barriers to implementation. As noted above, all of these factors also influence Los Angeles when it introduces a new regulatory program. The experience in LA provides insight on how to avoid these problems and identifies issues to be cognizant of when creating new policies. By understanding these factors and by building regulatory regimes that use them as strengths and not weaknesses, future regulatory efforts in Mexico and other similar cities will have a much greater chance of success.

Contrasting Mexico City and Los Angeles

The Mexico City Metropolitan Area (MCMA) and greater Los Angeles (LA) are similar in many ways, but the differences between them provide the most useful insights for an investigation into policy design and implementation. At first glance, the cities' air pollution problems appear almost identical. Ozone and particulates are the pollutants of primary concern and much of the pollution is due to large motor vehicle fleets that emit small particulates and the precursors to "smog." The topography and meteorology of the regions complicate dispersion and exacerbate the pollution problem, trapping pollutants near the surface where their effects on people and property are most pronounced.

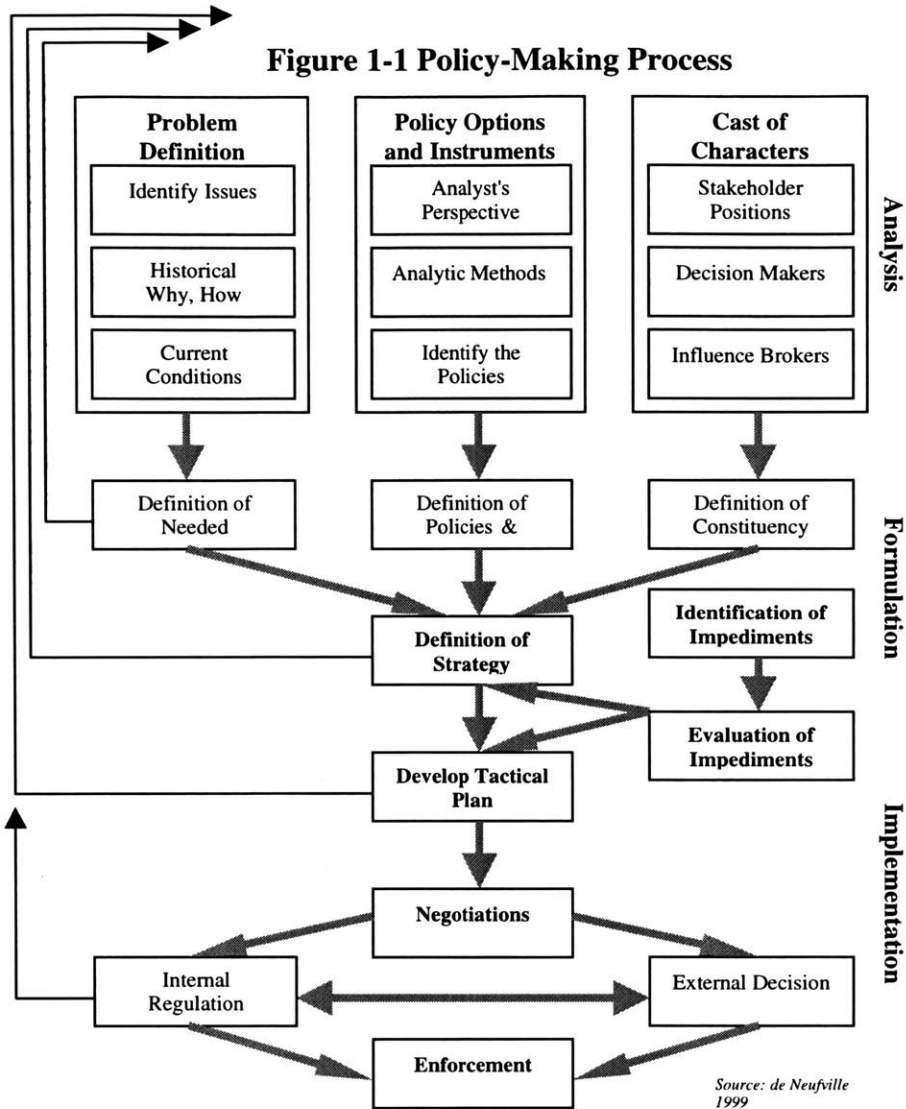
But the United States and Mexico are very different countries. The politics, economies and cultures of LA and Mexico City differ greatly. As the government analyzes the problem and formulates policy options to address it, the economic and political importance of the cities must be taken into consideration. Within the complex set of circumstances that large cities face, successful pollution abatement efforts require coordination at political, social, economic and developmental levels. An effective policy in one context may be woefully inadequate in another due to subtle differences in the dynamics of these four areas. This is the case in comparing Mexico City and Los Angeles. The policies employed to curtail air pollution in the two cities are very similar and were developed with a very technical approach.⁶ This approach was quite successful in dealing with Lead, SO₂ and CO. Unfortunately for the citizens of Mexico City, an analysis of the circumstances surrounding their particulate pollution problem indicates that the

⁶ The government of Mexico realized that the physical conditions for ozone and particulate formation in Mexico City are almost identical to those in Los Angeles. A highly scientific approach would indicate that if the problems are similar, the methods to rectify the problem in one situation could be directly implemented in another for comparable results. This was brought to bear when developing the policies, as Mexican authorities consulted directly with American experts. (Los Alamos National Laboratory, 1994 and Williams, 1996) See Appendix 2 for a discussion of the technical focus of Mexican air pollution regulation.

regulatory approach employed in LA is not appropriate for Mexico City. Significant differences in demographics, economic development and political dynamics demand a set of policies unique to Mexico City to address this pollutant.

Policy Analysis Framework

To develop this unique approach, a government needs to carefully assess the dynamics of the situation and devise a program to accomplish its goals within the constraints that bind its actions. As seen in Figure 1-1, the policy-making process can be represented as occurring in three different stages: situational analysis, policy formulation and program implementation. The situational analysis process consists of a detailed examination of the government's objectives, the policy instruments available to attain those objectives, and the political, social, economic and institutional impediments that oppose the program. Then, using this information as a foundation, a policy is formulated that will work within the limits imposed by societal factors (political, social, economic and developmental) to realize the policy goals. When applied to the Mexico City example, regulating air pollution is more difficult than just adopting the California standards and programs. The government in southern California does not have the same set of constraints upon its actions as does the Mexican government, nor does it have the same goals. It is these differences in the situations of the two countries that shaped the outcome of the Mexican regulatory effort.



Physical Characteristics

The government of Mexico adopted LA’s air pollution regulations partially because of the similar physical characteristics of Mexico City and Los Angeles. In a regulatory agency dominated by technocrats⁷, it is little surprise that Los Angeles would seem the perfect donor for air pollution reduction strategies to be employed in Mexico.

⁷ *Técnicos*, or bureaucrats that have a technical education and background, as opposed to career-politicians.

Topography

The first physical characteristic that Mexico City and Los Angeles share is topography. Most of the MCMA is contained in a valley surrounded by high mountain ridges and dormant volcanoes. Similarly, the San Gabriel, San Bernardino and Santa Ana Mountains hem Los Angeles in on three sides. These mountains, while providing a majestic backdrop for the city, complicate the region's meteorology as prevailing air currents rarely dip into the city and are prone to move at mountain peak level instead. As a consequence, the only appreciable winds that enter the cities come from the one open side. In Los Angeles, cool winds come off of the Pacific Ocean and push up against the mountains. In the MCMA, winds funnel in through channels in the northeast and northwest and the air settles in over the city as the mountains trap it inside the basin.

Thermal Inversions

The similar topography also makes both cities susceptible to a meteorological phenomenon called a thermal inversion. In a thermal inversion, a layer of warm air traps cooler, more dense air at the surface.⁸ The quality of the trapped air deteriorates rapidly under these conditions since the contaminants mix with the air at the very surface, but do not disperse vertically to the higher atmosphere. In LA, inversions are caused when cool air blows in from the Pacific Ocean (or sometimes from the north) and settles at the surface, pushing up the warmer, less dense air that was at the surface. In Mexico City, the cool, less dense air comes down the slope of the mountains and settles around the city, drawn by the displacement of warm, buoyant city air that rises into the higher altitudes because of density variations.⁹ In both cities, the

⁸ Normally, the temperature profile of the atmosphere is decreasing with height, the warmest air near the ground. In an inversion, a cold pocket of air is held in place vertically by a warmer layer of air above it. This is a stable condition until the air at the surface is buoyant (warm) enough that it displaces the air mass above it.

⁹ The inversion is partially caused by the "urban heat island" effect. As the night descends upon the city, the surrounding lands cool much faster than the pavement and buildings in the urbanized area. These "heat islands"

inversion persists until the temperature of the air at the surface rises enough to become unstable once again. During the winter in both cities, inversions can last for days, and these sustained inversions constitute the worst pollution episodes, as many days worth of contaminants are trapped at the surface.¹⁰

While the surface heating that solar radiation provides is beneficial to release the air trapped by inversions, sunlight also catalyses complex chemical reactions in the atmosphere that contribute to air pollution. The photo-oxidation of airborne pollutants creates tropospheric (ground level) ozone¹¹ and as contributes to atmospheric particle formation.¹² Sunlight combined with groundwater depletion also has a secondary effect on particulate pollution. By removing what little moisture remains at the surface after groundwater has been withdrawn, the microclimate of the area changes, which may lead to increased particulate suspension.

Altitude

The important physical characteristic in which distinguishes the cities is altitude. While Los Angeles is at sea level, Mexico City is at an average altitude of 2,240 meters. The higher altitude of Mexico City affects the air pollution problem in two ways. First, the air contains 20 percent less oxygen in Mexico City than at sea level. As a consequence, combustion sources need to be carefully tuned to the proper oxygen/fuel stoichiometry. Improper adjustment leads to inefficient combustion and increased emissions.¹³ Second, the higher altitude has a biological

cause the air to rise slightly, to be replaced with the cool air rushing in off of the mountainsides. This reinforces the thermal inversion condition. See Seinfeld, 1998 for more information.

¹⁰ Exacerbating the pollution problems in the winter season is the fact that neither city receives much rainfall. Rain rinses pollutants out of the air as they become suspended in the water droplets instead of air.

¹¹ While ozone in the upper atmosphere (stratosphere) is beneficial, blocking ultraviolet radiation from reaching the surface, ozone at the surface (troposphere) aggravates health problems and damages vegetation. For information about Health Effects of ozone, see Appendix 4

¹² For more information see Seinfeld, 1998.

¹³ Most automobiles come from the manufacturer equipped to run optimally at or near sea-level. Adjustment is needed to maintain emissions profile at higher altitudes. However there is a performance penalty associated with the proper stoichiometry and for consumers highly concerned about performance, this provides an incentive to run an automobile at the improper tuning. Much of the Mexican "car culture" is based on high performance engines (Adrián Fernández, personal communication) so tampering to achieve maximum performance in the automobile is a

effect with direct consequences on respiratory health. Because more air needs to be inhaled for an equivalent amount of oxygen at altitude, more pollutants are inhaled for a given amount of oxygen inhaled.¹⁴ Therefore, for any given concentration of pollutants in the atmosphere, people at higher altitudes are likely to inhale more and become affected by respiratory ailments to a greater degree.¹⁵

Economic Characteristics

The important role that these cities play in their nations' economies requires that financial effects are an essential component of any policy analysis. Pollution reduction programs that ignore the economic health of the area are unlikely to be successful because they will be unable to garner the political and institutional support necessary for implementation.

Position in the National Economy

Because of their prominent role in the economy of their nations, the economic dynamics of Los Angeles and Mexico City are a national concern. Mexico City has been a focal point for economic development in Mexico for many years.¹⁶ Following the development model that much of Latin America has used, industry and job growth focused on the MCMA to take advantage of the infrastructure, educated population, and larger workforce that Mexico City provided. By 1980, Mexico City's proportion of the national gross domestic product had reached 38 percent, and half of the manufacturing operations in Mexico had located there.¹⁷ (See

common activity. Lack of financial resources devoted to maintenance is also part of the difficulty in Mexico City, as automobiles need periodic re-tuning to maintain their emissions profile. See Beaton, 1992

¹⁴ See Garza, 1996

¹⁵ Due to the diminished efficiency of the respiratory system.

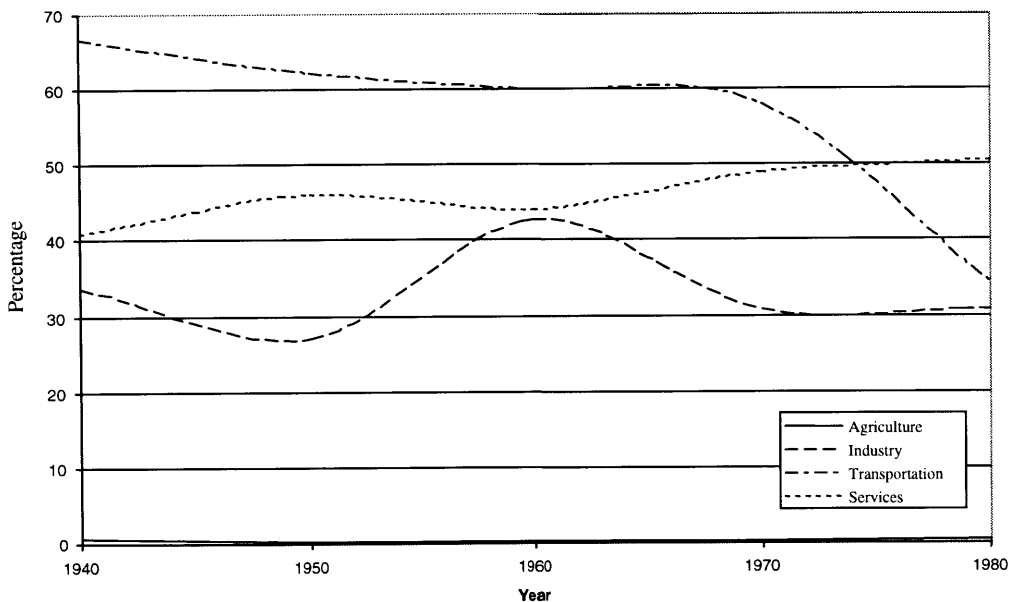
¹⁶ This has changed a bit in recent years due to the North American Free Trade Agreement (NAFTA), see Appendix 1 for more information regarding Mexico City's relationship to the national economy

¹⁷ Ward, 1998 p.27-28

Figure 1-2) To support this industrial growth, the population had ballooned to 15 million people in 1990, 18 percent of the total population of the country.¹⁸ (See demographics section)

Los Angeles, while not the most important city in the United States, enjoys a similarly prominent position in the economy of the western US. During the twentieth century, development flourished because of its west-coast location, nearby access to valuable resources and attractive quality of life (weather, recreational opportunities, etc). As a consequence, it is the largest commercial center west of the Mississippi River and has enormous importance for the western half of the country.

Figure 1-2: Gross Domestic Product of Mexico City as Percentage of National GDP (Source: Pick, 1997)



Industrial Development

Despite the important role that these cities play in their respective national economies, the roles they have played in the industrial development of the nation are distinct. The industrial

¹⁸ Pick, 1997, Chapter 1

profiles of these cities differ because of the different roles the cities have played in the development of their respective countries. Most of the heavy manufacturing¹⁹ in the United States occurs in the mid west and eastern United States, due to their close proximity to the large population centers in the east and the traditional sources of raw materials. Consequently, most of the industrial activity that occurs in LA today tends to be of the “light” manufacturing variety.²⁰ For example, the aerospace industry has played a very large role in LA’s economy, but its effects upon air pollution are not as pronounced when compared with those of heavy industrial processes.²¹

In contrast, Mexico City was the first area to develop out of Mexico’s industrialization push of the 1970s and 1980s.²² (See Table 1-1) In keeping with the pattern and goals of import-substitution industrialization, heavy industries (in particular petroleum refineries) were some of the first industries to locate in Mexico City. With the money from petroleum sales came other types of industrial investment in Mexico City. Development was, at this time, focused on heavy industries that could provide the raw materials to fuel further industrial growth. The thinking at the time was that, as the economy grew and Mexico was able to provide its own manufactured goods, it could afford to focus later development on more environmentally friendly industries.

¹⁹ By heavy manufacturing, I am referring to industries such as steelmaking and durable goods manufacturing that populate the “rust belt” of the United States

²⁰ None of the top ten particulate emitters in Los Angeles are of the heavy manufacturing genre. Eight of the top ten are petroleum refineries. SCAQMD, 1998

This reflects the de-industrialization trend in the United States as the economy moves away from manufacturing and into an information-based economy. See Powell, 1997b.

It is also worth noting that much of the development of Los Angeles that occurred during the Second World War was of the heavy industry genre. One of the first targets for pollution control was a rubber- making plant and in the early efforts combat pollution targeted heavy industries such as refineries and chemical operations. Over time many of these facilities either moved to other parts of Southern California or out of the state. After the emissions from those industries that stayed had been controlled and it was obvious that the problem was not going to be solved by just industrial controls. Then smaller and mobile sources became the key targets for pollution abatement efforts.

²¹ Primarily because these industries do not rely upon combustion as a key part of their process like much of the heavy manufacturing activity.

²² See Appendix 1

Table 1-1 Industry in Mexico City, 1930 – 1970

(Source: Pick, 1997)

Year	Population	Industrial Sector Indicators			
		Number of Establishments	Number of Workers	Total Production (M. New Pesos)	Value Added (M. New Pesos)
1930	1,029,068	3,180	54,105	844	475
1940	1,802,679	4,290	89,358	2,182	1,049
1950	3,137,599	12,704	156,697	7,323	3,905
1960	5,251,755	24,624	406,905	13,535	6,513
1970	8,799,937	33,185	658,275	32,437	18,287
Growth (%) from '30 to '70	855	1,044	1,217	3,843	3,850

Industrial Profile

As a consequence of the different development paradigms, another economic characteristic, the industrial profile of the two cities, varies significantly. Most of the refining and manufacturing operations in Southern California occur in Long Beach, an area in a different airshed than Los Angeles. Industrial activities that produce significant amounts of pollution were targeted by pollution reduction measures as far back as the 1940s. Accordingly, the Los Angeles Basin is not perceived as an easy location to site new industrial facilities and heavily polluting industries chose to locate elsewhere.²³

Even though developing industrial capacity is much more important for the country of Mexico, Mexico City has seen a decline in new industrial development as the government created incentives for development in the northern (such as Monterey) and border regions.²⁴ While in times of economic health this policy does not harm the development prospects of Mexico City, during times of hardship and crisis the Mexican Government can not afford the luxury of being able to choose which industries to develop in the capital.²⁵ Due to the recent economic crises that have plagued the country, Mexico City has needed to accept a large number

²³ This topic will be dealt with in the approaches to the air pollution problem since these types of actions can be interpreted as informal air pollution regulation. Studies have documented this trend and account environmental regulations as the main cause of 107,000 lost jobs to other states between 1997 and 1992. But, it is difficult to separate the effects of the aerospace industry downsizing and recession. See Grant, 1997 p. 63.

²⁴ Undoubtedly benefiting from the North American Free Trade Agreement

of heavy-polluting industries. The 94 most polluting facilities produce 74 percent of the total industrial emissions for the city.²⁶ Mexico City has a limited number of options to deal with these facilities. They can require emissions control equipment, shut the site down and force it to relocate or let it continue to pollute at current levels.

Patterns of Development

Aside from the physical characteristics of the cities, the development pattern is their most striking similarity. During their development, both cities became populous and land-intensive.²⁷ As the cities began to enlarge, real estate prices in the center of each city rose. To accommodate future growth, the city governments had the option to either encourage increased density and development within the city core, or increase land use on the periphery of the city. Developments in both Los Angeles and Mexico City have followed this second pattern.²⁸

²⁵ As discussed in Chapter 2, Los Angeles has deterred some industries from siting facilities within the basin through strict emissions controls. Also see previous footnote

²⁶ Metropolitan Commission, 1997

Another interesting issue regarding location theory involves the strength of enforcement of industrial emission standards. As this will be explored in further depth later, it is sufficient to note that while the cities may have similar emissions standards for new factories, differences in enforcement and permitting may greatly influence the development patterns.

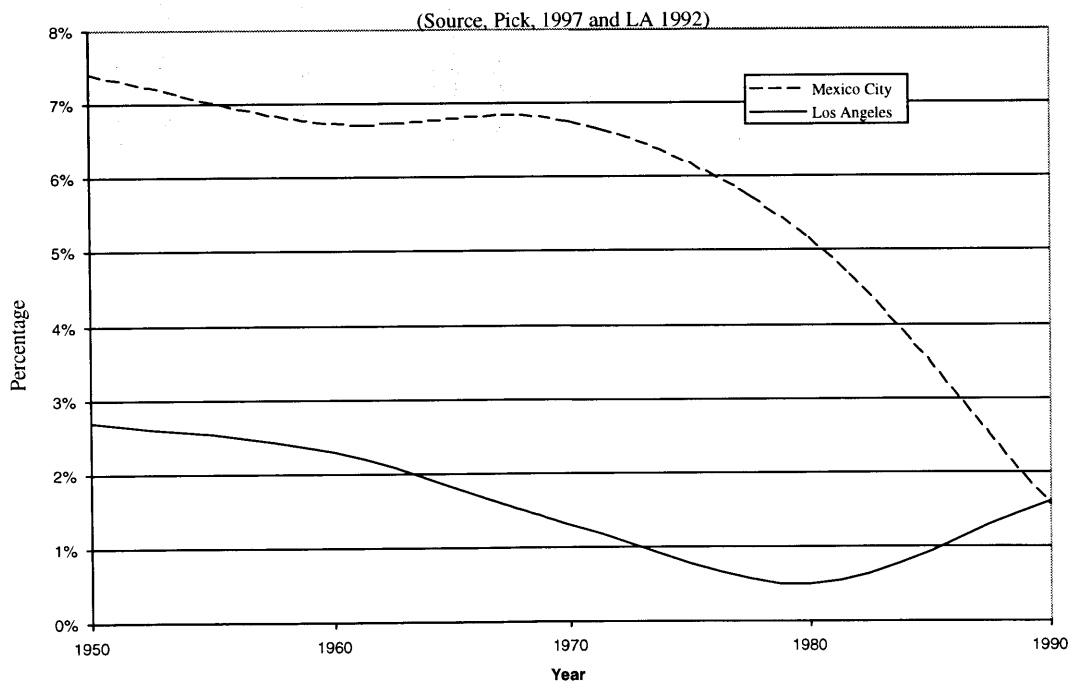
²⁷ Mexico occupies over 1,500 square kilometers and the South Coast Air Basin occupies 1,200 square miles. Not only are the cities quite large in population (16 million people in Mexico City, 14 million people in LA) but the population density, even in the core of the cities, is much less than that of other large world cities.

²⁸ Although not for the same reasons. Greedy land developers and corrupt civic leaders influenced much of the development process in Los Angeles. See Reisner, 1993. On the other hand, the local government in Mexico City was largely powerless to stop the development of the outlying areas due to institutional and political reasons. See Chapters 3 and 4.

Growth Patterns

The first pattern of development to examine is the urban area growth pattern. During Los Angeles' growth spurt in the early and mid 1900's, land speculation and zoning that limited building density led to increased development of surrounding areas.²⁹ To accommodate the increased growth, infrastructure was extended to the new developments. The construction of more roads led to a transportation infrastructure and culture based around the use and promotion of the automobile for transportation.²⁹ Instead of locating within the city core, businesses were attracted to the suburbs because of cheap land and nearby housing. As people moved further away from each other and the city, the urbanized area of LA grew rapidly. To satisfy the demand for transportation, more roads were built. These roads then acted as a positive feedback

Figure 1-3 Annual Growth Rate, Mexico City and Los Angeles



to this development pattern and the cycle continues to this day.

²⁹ Grant 1995

³⁰ I will deal with the idea of an automobile culture in the second chapter.

In Mexico City, the development patterns are similar, but the factors driving growth were different. As the economic expansion of Mexico City attracted increasing numbers of citizens from the surrounding countryside in search of employment, a housing shortage developed. This housing shortage increased housing prices and further disadvantaged the migrants who come to the city to fill relatively low-paying jobs. In response to the housing need, temporary settlements sprung up on the periphery of the city to accommodate the influx of workers. These encampments gradually achieved semi-permanent status as they were structurally improved over time and eventually supplied with basic services.³¹ With a majority of the new workers living on the periphery, a complex system of public, semi-public and private transportation emerged.³² All three modes of transport are (with the exception of a limited mass transit system) based around the automobile.³³ This dependence on the automobile requires that road construction be a major infrastructure investment, at the expense of other transportation investments. In a manner similar to that of Los Angeles, this growth pattern reinforces the position of the automobile as the only viable method of transportation for much of the population.

Role of Planning

In LA and Mexico, the role of planning to influence development in these two cities was limited and thus forms a second point for an analysis of growth patterns. Much of the development occurred in an ad hoc, free-market manner that gave little thought to coordination of development patterns and land use within the city. Transportation planning has been almost exclusively concerned with the automobile: decreasing congestion, increasing speeds and

³¹ See Chapter 4 or Appendix 1 for a more complete description of the irregular settlements and the politics behind their establishment.

³² In Mexico City, most of the industrial development has been in the North or Center of the city (as opposed to LA's diffuse employment), but the housing settlements were built all over the city.

³³ Public transportation's limited effectiveness is no surprise given the large area and dynamic development patterns of Mexico City. A mass transit system is most appropriate for large concentrations of people in a relatively small area. See Appendix 1 for a description of the transit system that developed.

providing access by road to the new areas of the city. The reasons for this myopic vision are partially political, partially practical, but the lack of foresight serves to reinforce the dominance of the automobile as *the* mode of transport. For example, the construction of new highways over other forms of transportation infrastructure has contributed to automobile use. Yet with congestion in many parts of the city bringing commerce to a standstill, it is necessary to free up traffic. Politicians provide an additional input into the process by bringing their constituents' desire for new roads to bear on the local planning departments. Land use planning has fared as poorly because political and economic interests as well as citizens' preference towards large plots of land has encouraged urban sprawl. The rapid development of the metropolitan areas forced overwhelmed planning department staffs to abandon carefully orchestrated development plans³⁴ focused on mobility, efficiency and city dynamics. (Due to lack of consensus among the groups affected by handling incompatible land-use development issues).³⁵ This rapid economic expansion, population growth and political pressure for the continued primacy of the automobile allowed urban sprawl to continue unabated and preclude many proactive transportation and/or land-use policies.³⁶

³⁴ Combined land use master plans and transportation master plans.

³⁵ Much of the lack of power of the development process in Los Angeles can be attributed to the political strength of homeowners associations. These groups voluntarily impose building density restrictions and create significant political pressure against planning if they perceive it as a threat to their property values. See Grant, 1995

³⁶ Volumes could be written about the informal political pressure towards the automobile in these cities. The "auto culture" of the United States (acquisition of a car as a rite of passage, the correlation between an automobile and freedom, etc) greatly restricts the political viability of any policy that would restrict the unrestrained use of the automobile. See Grant, 1995 or Howitt, 1999.

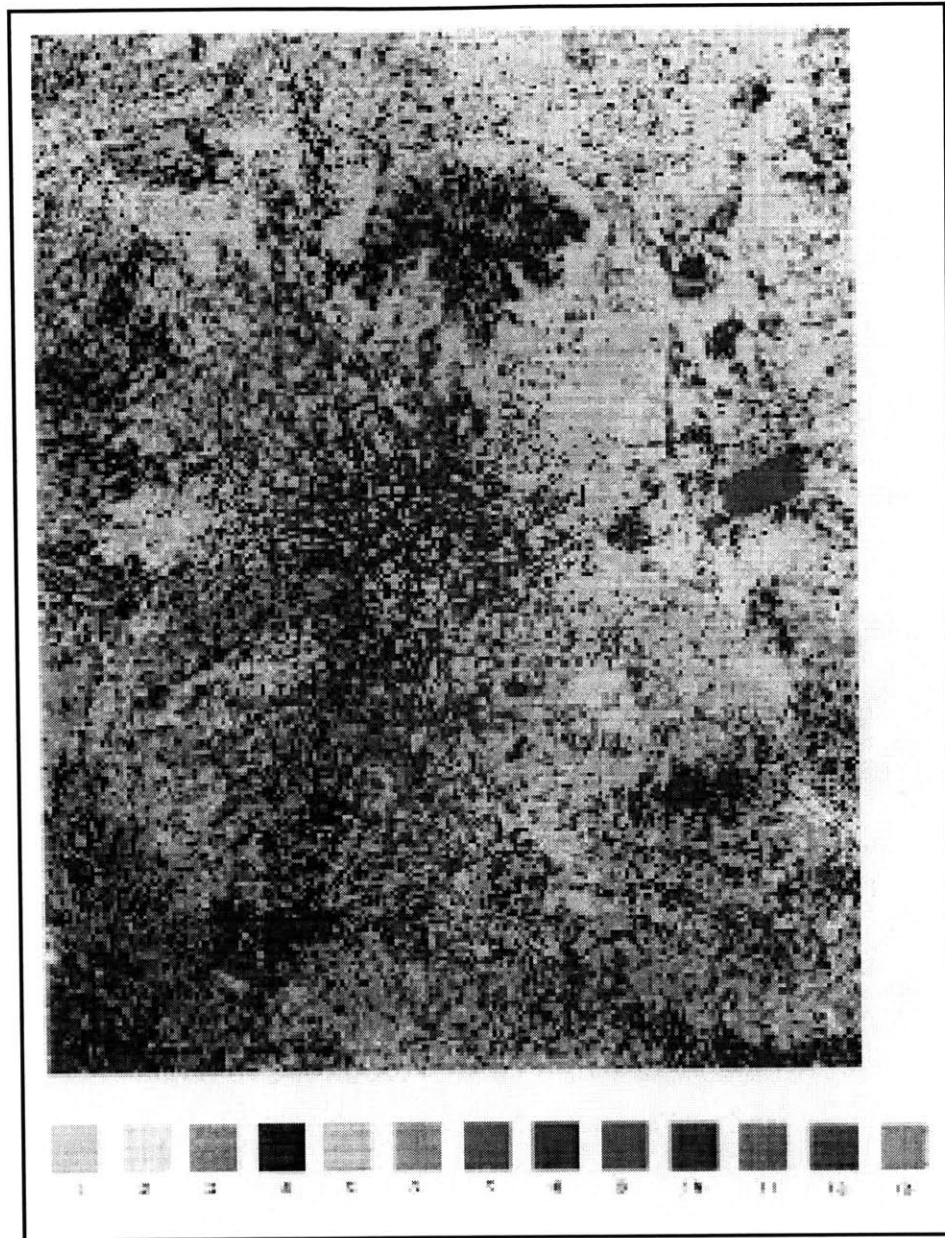


Figure 1-4 Mexico City Land Use (Source: LANL, 1994)

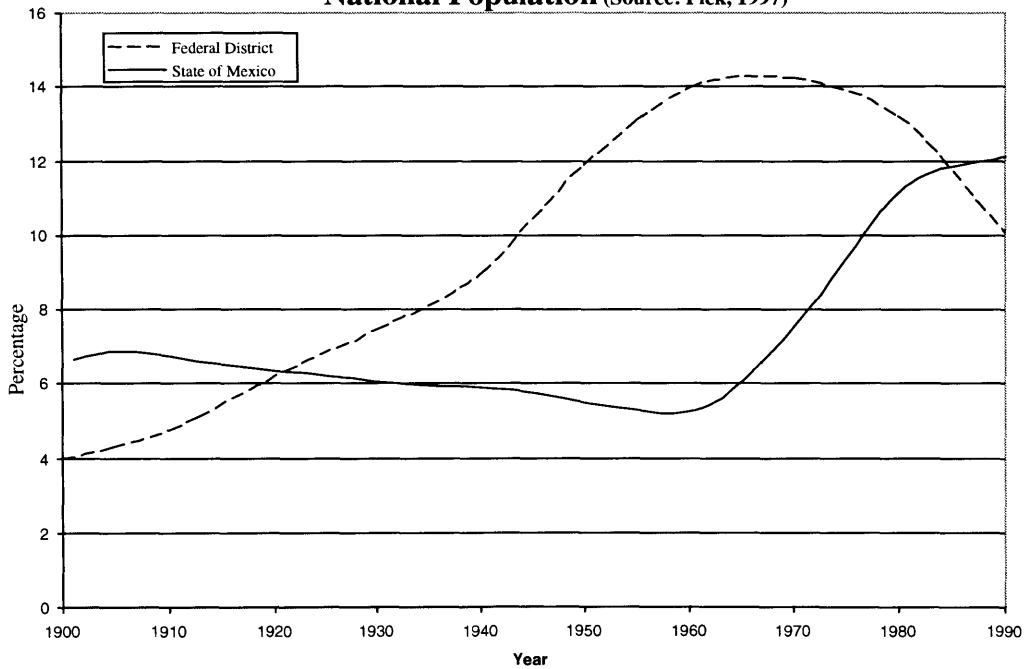
Legend

- 1 Vegetation
- 2 Mostly Bare Soil
- 3 Dark Soil
- 4 Shadow/Volcanic/Urban
- 5 Urban/Lower Income
- 6 Vegetation/Foothills & City
- 7 Water
- 8 Dark Urban Material
- 9 Urban Material Mix
- 10 Urban/Mostly Downtown
- 11 Vegetation Mix
- 12 Mountain Vegetation
- 13 Vegetation & Rock Mixture Mountain

Demographic Composition

Even though the development patterns of the two cities are somewhat similar, the demographics for the two regions are quite different. If we think about effect on the environment as being a function of the population, its consumption, and the environmental consequences of that consumption, then demographic differences become vitally important for understanding environmental impacts. These demographic differences affect the population, their consumption level, and the amount of resources they are willing to designate for environmental protection. By using automobile usage as a proxy for consumption, these relationships and their implications for regulatory programs can be explored.

Figure 1-5 Population of Mexico City Entities as Percentage of National Population (Source: Pick, 1997)



Demographics of the Population

Total population for Los Angeles and Mexico City (The MCMA has 14 million people, while LA has 16 million) is one of the few demographic characteristics that the two cities share. The residents of Mexico City are less educated, have a lower income and lower standard of living than the residents of Los Angeles do.³⁷ The effects of the difference in income are too numerous to list, but the housing and automobile population (as discussed later) are two indicators of the environmental consequences of the differences in wealth. The age profile of the population is also different for the two cities. While Los Angeles has a bell-shaped population profile skewed towards the upper end (indicating a somewhat older population), Mexico City's population is heavily skewed towards teenagers. Currently, the largest age group in the MCMA is that of the 15- to 19-year-olds.³⁸ This indicates that the additional economic pressures facing Mexico City as these residents begin to enter the workforce will necessitate significant economic growth if they are to be employed and if the standard of living is to rise. While the population of Mexico City may not be growing as fast as it was in previous decades, the additional pressure on the economy caused by workers entering the labor force for the first time necessitates additional economic development (and the pressures on the environment that normally accompany it).³⁹

Table 1-2: Percent of the Population of Mexico City Metropolitan Area

	(Source: Pick, 1997)	
	1970	1990
Age 0-17	50.1	39.9
Age 18-64	46.7	54.6
Age 65+	3.2	5.5

³⁷ For a more complete discussion of the demographic data for Mexico City see Appendix 1 or Pick, 1997

³⁸ Pick, 1997

³⁹ Specific information regarding the age profile can be found in Appendix 1 or Ward, 1998

Vehicles and Housing

Mexico City has three million vehicles for 16 million people (a vehicle for every five people) whereas Los Angeles has 10.6 million vehicles for 14 Million People (a vehicle for every 1.3 people)⁴⁰. This figure is very indicative of the demographic differences between the two cities. The vehicle age is also indicative of these differences: the average age of vehicles in Mexico City is nine years, compared to five years in the United States.⁴¹ This difference in average age is indicative of the differences in wealth between the two cities, but the difference in resources not only means fewer automobiles that were designed to minimize emissions, but also manifests itself in inadequate maintenance of the vehicle fleet causing the emissions profile to closely resemble the automobiles in Los Angeles 15 years ago.⁴²

Also of consequence for pollution abatement efforts is the housing situation and its effects on the environment. Much of the housing stock in Mexico City is in substandard condition and increases burdens on the environment due to resource-intensive development. Many settlements lack proper water and sewer services and without sewer facilities, domestic waste and excrement are dumped in open pits where they are then suspended by the wind, adding to the particulate problem. Lack of plumbed water causes residents to use wells or surface water, which lowers the water table.⁴³ Since many of the new developments on the periphery of the city are “irregular,”⁴⁴ additional environmental pressures are exerted on the ecological preserves that ring the city as squatters look for materials with which to build their houses. Los Angeles, on the other hand, has been able to meet the housing needs of the population by continuing urban sprawl.

⁴⁰ Howitt, 1999 and SCAQMD 1997b

⁴¹ Metropolitan Commission, 1997

⁴² Beaton, 1992

⁴³ A more comprehensive discussion of housing stock and health effects can be found in Appendices 1 and 4.

⁴⁴ Illegal squatters settlements. See Chapter 4 or Appendix 1

Government and Politics

The final contrast between Los Angeles and Mexico City comes in the form of the politics of the region. To understand the dynamics of the political system, it is necessary to examine each of the levels of government that has jurisdiction over the city (federal, state, local and the courts⁴⁵) as well as the political responsiveness of the local population. The efficiency and legitimacy of the institutions responsible for regulation and the population's response to them have a direct and noticeable influence on the success of regulatory efforts, normally through their effects on policy design and implementation. These considerations need to be accounted for in the policy analysis to ensure the selection of a policy that is appropriate to the political dynamics of the area.

Government Structure

On paper the Mexican and American systems of government look very similar. Each is a federalist system with three branches of national government and various state and local agencies. A president, the head of the executive branch, is responsible for implementing laws made by the legislative branch. The courts act as a check to balance the power of the other two against the constitution. The constitution that gives the legislative branch of the national government certain powers delegates all other responsibilities to the states. Most states have a similar institutional structure, with an executive and legislative branch that are given certain responsibilities, and leave smaller matters to the local governments (whether they are city or county level).

In some situations, there is an additional level of government (a recent construct) to deal with issues that cross the traditional boundaries of political action. These regional agencies

⁴⁵ I will treat the courts as a separate entity because they have external effects on the primary Federal, State and Local governments.

attempt to coordinate efforts among a number of distinct, independent political entities. Air pollution is one of the issues that lends itself to this approach, and so regional air pollution agencies have been created in both Mexico City and Los Angeles. They traditionally work to coordinate efforts among a number of local delegations whose actions directly affect each other. In order to be effective, the institution must have the capacity to resolve disputes, enforce agreements and be seen as a legitimate entity by the parties with whom it works.

Political Characteristics

While in theory they are very similar, the actual political structures of the United States and Mexico are very different. In Mexico, one political party and the president it nominates rules the system. It is a complicated structure, built around a history of co-opting opposition and a hierarchy based more on loyalty to the president than any political ideology. The president handpicks his successor, who becomes the next head of the political party. The president and the upper party leadership also make the candidate decisions for the rest of the nation, distributing positions based on loyalty and patronage down to the most local level. Since the congress is picked in a similar fashion (with the party picking the candidate), the legislative branch acts merely to rubber stamp the policies of the president, which are then returned to his agencies for regulation and implementation. This highly structured system focuses the political power at the top level positions which are renewed every six years when a new president takes office (the president is limited to one, six-year term).⁴⁶ While this system is slowly being replaced, one party and the upper-level leadership still retain a disproportionate share of power in Mexico.

⁴⁶ It is important to note that the current changes in the Mexican Government suggest that this system has become outdated. It is slowly being replaced by a system of multiple parties and distributed power. While this does not have any direct bearing on historical analysis except for the events of the past 2 or 3 years, the changes are important to suggestions on how to improve the system. Therefore I have included a more detailed analysis of the system and the recent changes in Appendix 1.

When contrasted with the political system in the United States, in which political struggles between the two main parties and two main branches of federal government are common, the policies that result from the Mexican system will be more single-minded and focused. The laws that emerge from the federal legislative process in the United States are carefully crafted to represent complicated compromises between multiple parties and interests. The Clean Air Act and its Amendments, for example, are hundreds of pages long and represent countless hours of negotiation and study.⁴⁷ Once the U.S. Federal Government decides to act on an issue, it must review its constitutional jurisdiction to act and craft legislation appropriate to realize its goals within the boundaries of jurisdictional and implementation concerns.⁴⁸ An example of this method of legislation is the Clean Air Act, in which significant portions of the law are implemented by state agencies due to federalism. See Cohen, 1995.

If the subject area of the legislation is one that the federal government does not have a constitutional mandate to regulate, the laws are crafted for implementation at a state level, with guidance (and money) from the federal government. In Mexico, the state will defer its regulation of the problem to the federal government when possible and there are no constitutional grounds upon which to restrict the federal government's actions.⁴⁹ Since the Mexican federal government controls an overwhelming portion of the budget, it decides which programs are important and allocates money accordingly. In some instances, issues have been given to the states to regulate,

⁴⁷ Cohen, 1995

⁴⁸ Because issues that are not expressly given to the Federal Government are reserved for State Regulation, the Federal Government indirectly implements many laws. This process usually involves withholding federal funds from the state unless it fulfills certain requirements. The Clean Air Act was one example of this strategy. See discussion of funding sources for environmental regulation.

⁴⁹ Political and funding considerations almost guarantee this federal supremacy that does not exist in the United States.

but in these cases the policies are implemented according to the wishes of the federal government.⁵⁰

Derivation of Finances

Another economic difference between the two cities lies in the source of funding for public programs: a crucial aspect to the success of regulatory initiatives. The level and source of financing plays a large role in determining what policy options are possible and who the important stakeholders are. Without a careful examination of this issue, a policy analysis is incomplete and will likely recommend a set of initiatives that are not suited for the economic and political climate and are likely to be ineffective.

In the United States, funding for regulatory activity comes from a number of sources. The federal government dispenses the funds collected through the federal taxation process to the states, either for general expenditures or designated for specific uses (transportation infrastructure, etc). The states (and in some cases local governments) also levy taxes of different types to address their budgetary needs. These alternatives to federal funding provide diversification of sources and important supplemental income. In Los Angeles, environmental initiatives and agencies are funded through a combination of federal, state and local monies (Money raised by taxes, federal grants and permit fees). The multiple funding options reduce an agency's dependence on any one appropriation channel and prevent one source from becoming too important politically.

Government funding in Mexico reflects the centralized power structure of the country. The federal government is the primary taxing authority in Mexico, disbursing the funds collected

⁵⁰ One reason for this could be the budgetary issues raised above. Another could possibly be the lack of trained, competent, professional staff at any level other than federal. As will be discussed later, this is of primary concern in Mexico where staff turnover is high and salaries are low. Also, a patronage system is prevalent at the lower levels of government so it is unlikely that purely professional staff would make much headway in many of these situations.

to the states for their (and the local government's) needs.⁵¹ While the state and local governments do have the ability to levy taxes, this power is used only on a small scale and the funds generated in this manner are insignificant.⁵² Federal agencies derive their funding directly from the President's federal budget, which is distributed through the Ministry of the Budget. Due to this funding system, environmental agencies at all levels are dependent on the President and his ministries for resources and are often subject to their influence when making policy decisions.

Political Institutions

The willingness of states to have the federal government act on their behalf in Mexico illustrates the institutional weakness of the local levels of government. Without the implementation duties corresponding to political responsibilities, the local levels of government have little institutional capacity to accomplish anything other than basic political party functions and have little effect on the governing process.⁵³ In the United States, local governments are most interested (and effective) when dealing with issues of infrastructure and land use. Insomuch as these actions affect the state or region as a whole, these responsibilities are often co-opted by the state to either be regulated by the state government or to be overseen by a regional governing body.

The final governmental branch to be discussed, the courts, is the most subtle of the three federal branches. The role of the courts in Mexico has been minimal because it is not the powerful, independent branch of government that it is in the United States. Judges serve, for the most part, at the pleasure of the party leadership and are thus intimately tied to the political

⁵¹ This distribution is based on a complex formula involving contribution to the national income, population, number of industries, land area, etc. See Appendix 1 or Ward, 1998.

⁵² The local governments are severely restrained in money-generating activities because of the sensitive nature of the economy. If a state were to impose a significant tax on business (it is not politically viable to tax citizens at high levels, the only levels at which significant revenues could be generated due to the low average annual income in Mexico) the national government would likely become involved for economic development reasons.

⁵³ The obvious exception to this is the government of the Federal District of Mexico (Mexico City) but it is little more than an agency of the federal government.

parties. As a consequence, their role in affecting change in the environmental arena does not deviate much from supporting the platform of the president. In the United States, the courts have had a tremendously important role in forcing action, clarifying the intent of legislation and settling disputes regarding pollution legislation. Many environmental statutes include citizen suit provisions that grant average citizens standing to sue for enforcement of laws and regulations. This provision has opened the door to citizen participation in the environmental regulation process and provided a mechanism to force action by reluctant agencies and/or administrations.

Political Activism / Views of the People

In general, the participation and views of the public towards governance issues are directly correlated to their role in affecting the process and the United States and Mexico are no exception. The US system is highly participatory⁵⁴ and there are many levels in which individuals can get involved in the policy-making process to influence a particular outcome or to gain more information about government activities. As a consequence, the United States has a large politically active population that influences regulatory outcomes.⁵⁵ Consisting of businesses, special interest groups and broad based popular organizations, lobbying groups often find themselves as allies of the government in one instance and opponents in the next. But, in each case, the special interest organization feels that it has the right to influence the outcome of the regulatory process and provide input as informed citizens.

In the United States, this tradition of participatory government has been reflected in attempts to ameliorate the air pollution problem in major urban areas. Under intense public

⁵⁴ Not only do citizens have the opportunity to elect their representatives in a meaningful way (in contrast to the Mexican System) but there are also many opportunities to comment on rule-making, testify before boards of authority, write your representative, or challenge actions in court.

⁵⁵ Some may dispute this claim, contending that it is instead a relatively small number of people that participate in any meaningful way in governmental activity. My point here is to merely contend that there are numerous points in which a citizen can interject his or her opinion into the system. In addition, certain events have mobilized large

pressure, the federal and state governments have been addressing the issue of air pollution for the past thirty years. Numerous public advocacy and non-governmental groups have been formed around air quality and health issues.⁵⁶ This rise in public pressure regarding air pollution issues can be directly tied to the environmental movement in the United States in the late 1960s and early 1970s. Court challenges by the environmental groups became one of the most powerful tools to force government action and allowed advocacy organizations to compete with much more powerful forces in the political process.⁵⁷ In addition, the political consciousness that grew along with the environmental movement helped mobilize citizens to work toward goals they felt strongly about, such as improvement of the air quality.

The attitude of the average citizen of Mexico City, on the other hand, is one of resignation. Elections for representatives have traditionally meant very little since there has been only one political party and one candidate for any given position (primary elections are not used). The practice of co-opting opposition has left the PRI with an amorphous platform, without any controversial positions on issues since it has been the party of all people. Mexico does not have the public disclosure requirements of the US and consequently, little information about the government affairs is released to the public. Without such information, being involved and informed about issues central to the public interest is very difficult. As a result, the Mexican populace does not have a tradition of activism in the government and has adopted a fatalistic attitude to many public issues. Their view is that the government does not care about the public's opinion, does not want its input, and does not work on anything except the few issues that government leaders care about. Since the avenues for participation are so limited, the

numbers of citizens around an issue at a basic level (the Toxic Waste at Love Canal for example) and have affected political change.

⁵⁶ EDF, Clean Air Foundation, NRDC, etc

⁵⁷ Switzer, 1998

general public does not believe it can influence change. Instead, it expects that either the government will act on the problem, or nothing will get done.⁵⁸

In Mexico, the lack of participation has prevented public pressure from becoming a major force in the national political scene. Resignation about the political system as a whole makes it very unlikely that an environmental movement similar to that of the United States will develop unless fundamental changes in the political process are made. The non-governmental organizations and advocacy groups that were so instrumental in achieving progress in the United States are still in their infancy in Mexico and are seen as a disgruntled group of people on the fringe of the system.⁵⁹

In addition, because Mexico faces a myriad of other social problems clean air is seen as a luxury good. This trend is observed in other countries as well as the United States and Mexico. Demand for a cleaner environment is a monotonically increasing function with respect to income. Hence, the more prosperous a country and its citizens, the greater demand for pollution abatement.⁶⁰ Since Mexico is still developing its economy and the income of its citizens is less than that of the United States, they demand less pollution abatement. Instead, the citizens are more concerned with basic services and needs, such as food and shelter. As these needs are met, interest in pollution issues is expected to increase and pressures on the government to act will increase in proportion.

⁵⁸ Once again, the state of flux of the Mexican Political system casts doubt that this will remain the prevailing attitude. Opposition parties, addressing these issues of alienation and lack of input, have been moderately successful in gaining ground in all levels of government. Every indication is that the system is moving towards more public participation, input and disclosure.

⁵⁹ Victor Urquidi, Mexico City Workshop February 16, 1999.

⁶⁰ This is logical since pollution control can be seen as a normal good. The marginal cost for most pollution abatement is increasing, meaning that for each additional unit of pollution control, the per-unit cost gets higher. At low incomes, a country cannot afford very much pollution control. As incomes rise, so does demand, and more pollution abatement is sought

Conclusions

While very similar in physical characteristics and patterns of development, Mexico City and LA are very different in demographics, political environment and economic resources. One would expect that in the policy analysis for Mexico, these differences would preclude some policies employed in Los Angeles and make others more attractive. Yet the policies in Mexico City and Los Angeles have been remarkably similar so far. This indicates that the policies employed by the Mexican Government so far will not be effective because of these fundamental differences between the two cities. To formulate effective policies, the specifics of the MCMA need to be addressed in the initial analysis stages of policy making.

How Los Angeles has Addressed the Problem

Air pollution issues in Los Angeles are not a modern phenomenon. As early as 1542, Spanish explorers noticed that smoke from their fires did not rise more than a few hundred feet before spreading out at the base of the mountains. Public concern about air pollution in Los Angeles dates back to the turn of the century. One day in 1903, the smog⁶¹ was so thick that the residents of LA mistook it for an eclipse of the sun. Beginning in 1912, the city sought to ameliorate its problem by regulating large industrial sources. But until relatively recently, not much was known about the science and composition of air pollution. As a consequence, although abatement efforts were made at an early stage in the century to reduce air pollution, technological knowledge of the problem was not advanced enough to successfully address the sources that contribute the most to air pollution until the early 1950s.⁶² Before then, most efforts had been aimed at large, fixed sources emitting visible plumes. These were the sites that were easiest to rally the public around, as they are obvious problems and directly affect the residents of surrounding areas. After these sources were significantly reduced in the 1940s and 1950s and the problem still remained, efforts focused on other sources.

Regulation before the 1970 Clean Air Act

In the early 1940s, pollution became a crucial issue for the residents of Los Angeles as it began to affect their daily lives. Drying laundry outside became problematic as “dust-fall” coated clean sheets right after they had been put out and eye irritation was a persistent problem. After World War II, many Americans were enjoying the prosperity of the post-war era and

⁶¹ The term “smog” itself is a combination of smoke and fog because in other cities, these were the believed constituents of the pollution. Even though Los Angeles rarely experiences foggy conditions, the term was put into wide use and is now used to describe air pollution in general terms

demanded improvements in air quality as more resources were available to devote to clean air programs. Public sentiment against this air pollution was strong among residents and there was tremendous political pressure for the government to address the issue. In response, scientific experiments were undertaken in the late 1940s to establish basic knowledge about the constituents of air pollution. With this knowledge, regulatory initiatives were designed to reduce the contribution of airborne contaminants due to industry⁶³ and other large sources that could be easily targeted. These efforts, in addition to municipal efforts to reduce dust suspension, cut dust-fall by two-thirds by 1960.

These initiatives are of particular interest when investigating particulate pollution because they represent the easy solutions, the “low hanging fruit.” It was easy to convince the public that something had to be done about noxious facilities and heavily polluting diesel automobiles.⁶⁴ In addition to these efforts, advances in particulate reduction were made by prohibiting trash burning⁶⁵ in dumps and backyard incinerators (at this time there were more than 300,000 backyard incinerators in LA) that emitted large quantities of soot and small particles.⁶⁶ When combined with agricultural smudge pots used to heat orchards when the temperature was low enough to threaten crop damage (they burn oil, tires, and any other flammable material),

⁶² Most air pollution was thought of as “smoke,” a notion consistent with the primacy of combustion in all types of industrial activity during this period. Indeed, smoke from coal and oil combustion in the Northeast was the most well-known air pollutant type

⁶³ This included a permitting program of dubious effectiveness. Industry had tremendous power over these fledgling districts and could receive permits easily. But, there was significant pressure placed on the highly visible polluters to reduce emissions by these permitting programs. The \$1.5 M installation on the Aliso Street butadiene plant is one example (in 1943)

⁶⁴ One of the most bizarre command-and-control regulations of the time was uniformed policemen that were authorized to stop and ticket polluting automobiles. These “smog-cops” were high-profile and targeted the largely unpopular diesel trucks. Mexico City has tried a similar approach.

⁶⁵ This reflects a general characteristic of regulatory initiatives. It is easy to rally the public around a common enemy, a noxious facility for instance. It is politically difficult to place controls on the use of a technology that is already in widespread use by a diverse number of individuals. People are generally reluctant to make individual sacrifices that they interpret as having very little effect on the problem. Collective action is difficult to encourage when the benefits will not accrue back to those individuals (a negative externality, tragedy-of-the-commons situation).

⁶⁶ At this time, it was a normal practice to burn refuse. There was no central garbage collection mechanism. The practice could not be outlawed until a refuse disposal alternative could be devised.

backyard incinerators provided a significant source of particulate pollution that could be easily controlled.

Despite all of these efforts, little about the health effects of various pollutants (or even the constituents of the air pollution) was known at this time, so the regulatory focus was on pollutants that had an easily measured economic or nuisance effect. Then, in 1950, a Dutch chemist named Haagen-Smit discovered that ozone is the irritant associated with smog⁶⁷ and is created in the atmosphere through a photochemical process. Since the health effects of particulates were not as apparent, particulates were determined to be a secondary concern. Most of the regulatory goals of the period reflected this understanding and were focused on reducing the precursors to ozone: nitrogen-oxides (NO_x) and volatile organic carbons (VOCs). The first comprehensive effort to regulate sources came in 1953, when a committee appointed by the Governor of California suggested that:

1. Hydrocarbon emissions be reduced by cutting vapor leaks from refineries and fueling operations
2. Automobile exhaust standards be established
3. Heavily polluting industries consider slowing their growth
4. Open burning of trash be banned
5. A rapid transit system be developed

Despite the obvious emphasis placed on ozone precursors in these recommendations, particulate levels were also reduced by these measures.⁶⁸ Additional efforts to reduce particulates at this time included: oiling of dusty areas to reduce re-suspended dust, a paving program to reduce dust emitted from automobile traffic, containment of animal processing operations, and limitations on non-residential combustion. Implementation of the non-mobile measures was done

⁶⁷ Haagen-Smit also demonstrated the linkage between ozone and eye-irritation, respiratory problems and crop damages. Lents and Kelly, 1993

⁶⁸ Particulates are also formed in the atmosphere by ozone precursors.

on a county-by-county basis and there was no enforcement mechanism to ensure compliance.⁶⁹

The city of Los Angeles was the first city to take these recommendations seriously, but the neighboring counties followed suit and by the mid-1960's every county had some pollution control measures in place. Later, they implemented vapor recovery equipment for fueling stations, regulated petroleum-based solvents, and even required permits for rendering plants that process animal waste. But in response to similar problems in the rest of the country, the federal government felt compelled to act on a nationwide basis, which led to the 1970 Clean Air Act.

Clean Air Act of 1970

Only one attempt had been made previous to 1970 to regulate air pollution on a nationwide level, the Air Pollution Control Act of 1963. It required the Secretary of Health to define air quality criteria based on scientific studies of the health effects of pollution. But, the standards were only advisory in nature⁷⁰ and only a single enforcement action was taken by 1970.⁷¹ In the face of mounting environmental activism in the U.S. and the failure of previous federal programs, the Clean Air Act of 1970 was passed and enforcement functions were given to the newly created Environmental Protection Agency (EPA).

The Clean Air Act (CAA) was the first attempt to regulate an entire environmental medium nationwide. It replaced a system of state air quality standards based on the health effects criteria documents prepared under previous legislation with mandatory, national standards based on health standards devised by the Secretary of Health under the 1963 Air

⁶⁹ Mobile (auto) sources began to be regulated by the state in 1959, when the California Motor Vehicle Pollution Control Board was formed. It implemented a number of measures that were impractical for any region to implement (for example, blow-by gas recovery equipment on all new cars)

⁷⁰ The only enforcement action available was a conference procedure that had no real power

⁷¹ Two other laws worth noting are the Motor Vehicle Air Pollution Control Act of 1965 and the Air Quality Act of 1967. Neither of these laws dealt with ambient pollution levels directly. The first developed auto emissions standards for 1970 automobiles. The second defined air quality control regions and urged action be taken to meet ambient air quality standards within these areas

Pollution Control Act.⁷² States retained their responsibility for implementation through the development of a Clean Air Act State Implementation Plan (SIP),⁷³ but EPA was charged with promulgating a plan if the state plan was found to be inadequate. EPA was also directed to set nationally uniform emissions limits for major new stationary sources⁷⁴ and determine a process for the control of vehicle emissions nationwide based on reduction targets. In recognition of the severity of its problem and previous efforts to deal with mobile sources, California was allowed to set more stringent standards for mobile sources.

Implementation of the State Implementation Plan (SIP)

Even as California was forced to look at the air pollution situation for the entire state, it was impossible to ignore the pivotal role of the Los Angeles Basin in any plans to clean up the air. By the early 1970's, Los Angeles had the worst air quality of any area in the US, up to five times worse than any other city. As a consequence, it was necessary to craft the SIP plan to deal directly with Los Angeles. If the fairly draconian SIP was to be implemented, it was necessary to strengthen the regulatory power of the authorities in LA or create an entirely new agency to administer the plan. Because air pollution did not respect political boundaries, successful implementation of the SIP would require coordination between the county-based air quality agencies. Furthermore, because federal funding was directly tied to these SIPs, California realized it must exert significant pressure on the local governments to work towards implementing the SIP. Instead of leaving mobile issues to the local air quality management districts, the state government decided to regulate mobile source technology at the state level, through the newly created California Air Resources Board (CARB). It was CARB's job to

⁷² These are the primary ambient standards. The law also provided for secondary standards that protect the public welfare, but secondary standards have not been implemented in any meaningful way to date.

⁷³ An SIP details the program that the state intends to pursue that will fulfill the requirements of the Clean Air Act.

oversee the implementation of the SIP program, to force local air quality boards to comply with the measures contained in the SIP and to undertake actions that only made sense on a statewide level.⁷⁵

A number of measures in the SIP that became the providence of local governments necessitated a high degree of coordination among different localities. Permitting, vehicle local inspection/maintenance efforts and regulation enforcement (regarding backyard incinerators, etc.) were all tasks that could only be effectively implemented on a local level yet the jurisdictional complexity of the area required a high degree of collaboration. In response to these needs, the regional governments attempted to voluntarily consolidate their pollution control programs in 1973. Without sufficient enforcement authority, this organization soon failed, and in 1975, the California legislature created the South Coast Air Quality Management District (SCAQMD) to fill this role. It was given the responsibility for local air pollution enforcement in Los Angeles, Orange, Riverside and San Bernardino Counties.

By this time, particulates had slipped below the regulatory radar. The Clean Air Act had requirements for both ozone and particulates and the California SIP addressed both types of pollution. It was believed that ozone is the main health problem and the ozone problem was much worse (when compared to the standard), so most regulators ignored particulates. Since evaporative emissions of hydrocarbons from stationary sources had already been addressed in many of the heavily polluting industries and efforts had already been taken to reduce NO_x emissions from stationary sources in LA. The SCAQMD, which believed that industrial sources

⁷⁴ A complex, nationwide system was established for attaining primary standards through source performance standards. These standards differ based on the existing air quality and type of facility. See bibliography for references to learn more about the various emissions performance standards.

⁷⁵ Mobile source technology was something that should obviously be regulated at a statewide level since auto manufacturers were unlikely to make significant changes in their auto equipment for just a few counties. CARB has been successful in forcing manufacturers to install blow-by gas collectors and catalytic converters and, more recently, researching alternatively fueled vehicles.

were as clean as they could reasonably be, ignored the particulates issue. The district instead pressed CARB to clean up mobile sources. While “passing the buck” to CARB for the ozone problem, the particulate regulations in the air-quality management plans of 1979 and 1982 were largely paper exercises and had little bearing on business practices. Because particulates were measured as total suspended particulates (TSP) at this time, the efforts to reduce them were mainly focused on dust, smoke, and other large diameter particle sources that were easily controllable.⁷⁶

Since the auto manufacturers were an easier target for regulatory effort than local (job-creating) industries,⁷⁷ technology based regulation that was targeted towards the automobile was largely accepted by government officials until the mid 1980s. At this time, most of the efforts of SCAQMD had been focused on the ozone problem at the expense of addressing the particulate problem. The SCAQMD and CARB instituted a highly unpopular system for inspection and maintenance⁷⁸ and, with the help of the California legislature, initiated a cleaner fuels program. Vapor recovery equipment was required for the gasoline distribution infrastructure (another unpopular program) and further requirements for large industrial facilities were passed.⁷⁹

Despite these programs, the public attacked the SCAQMD for complacency and lax enforcement. Legal actions were brought against the SCAQMD and the state of California to force implementation of the SIP programs as the many loopholes in the CAA and SIP allowed significant leeway in the regulations and SCAQMD had done little to address these issues. In

⁷⁶ Ozone made an easy regulatory target because it is an irritant and its health effects are easily observed. The health effects of particulates were less obvious and until studies during the 1970s began to focus on the size distribution of particles and indicated that they may have significant health effects, TSP had been regulated for aesthetic reasons.

⁷⁷ The auto-makers are less active in congressional lobbying at both state and local levels than other industries. This lack of effort, combined with a small number of companies (and jobs in California) effected by auto-controls encouraged an auto-technology focus for most of the 1980s. See Grant, 1995 or Cohen, 1995

⁷⁸ I/M programs were required by the Clean Air Act, but a number of parties tried to eliminate the requirement by bringing suit in federal court. The Clean Air Act was upheld and even though the programs were very unpopular in Southern California, the SCAQMD had little choice but to implement an I/M program, even though it was politically unpopular.

response to the growing political pressure from public interest organizations and the governor's office, the SCAQMD underwent a number of structural changes. In 1986, James M. Lents, the former director of clean air efforts for the State of Colorado, took the helm. He initiated an effort to identify specific control measures to attain clean air standards by 2007. In coordination with these efforts, the California legislature restructured the SCAQMD board in 1987 to grant it new responsibilities and powers. It now has the responsibility for achieving local, state and federal standards in LA and possesses enforcement powers to implement its programs.⁸⁰

In addition to these new powers and the role-shift they represented, the revision of the national particulate standards in 1987 prompted additional change in the regulation of particulates. Reflecting new scientific and health-based studies, the regulatory emphasis on particulates shifted away from total suspended particulates (TSP) and towards the respirable particles, those with a diameter less than ten microns (PM10). This shift in emphasis changed the regulated types of particulates from dust and coarse, man-made particles to the finer products of combustion and wear that had previously escaped much attention.⁸¹

In response to these two events, the SCAQMD initiated a number of new programs aimed at reducing pollution from industry. Incentive-based regulation for large emitters of NO_x, SO_x and particulates that only imposed overall emissions limits for facilities gave industry the flexibility to choose the most effective ways of reducing emissions (including trading credits among themselves). Additional controls on stacks became necessary to reduce PM10 and ozone precursors in accordance with the new SIP. Additional efforts were made to not only ensure

⁷⁹ This was easy politically for the SCAQMD because the stationary source provisions of the Clean Air Act leave little room for discretion in applying stationary source standards.

⁸⁰ An additional point worth noting is that by 1987, significant progress had been made cleaning up vehicles and yet the ozone problem persisted. On a cost-effectiveness basis, it began to make sense to target sources other than the automobile because the easy gains in automobile technology had been made.

⁸¹ Another change, one that might also explain the shift in regulatory emphasis, is that before this point, PM10 was difficult, if not impossible to monitor for. This made the regulation very difficult. New monitoring technology had been introduced to allow for monitoring of PM10 and made it a viable regulatory target in the mid 1980s.

compliance with the federal emissions standards, but to surpass those limitations whenever possible.

In addition to non-vehicle focused initiatives, a number of revolutionary and controversial steps were taken to limit pollution from vehicles, at this time. The zero-emissions vehicle mandates were made, as well as ever-tightening emissions standards for internal combustion automobiles. Diesel emissions were targeted for the first time because they are high PM10 emitters. A new technology, particulate traps, was required on all new diesels to reduce the levels of particulates in their exhausts. Vehicle fuel substitution was also an important and popular initiative, moving heavy-duty vehicles and locomotives towards alternative fuels such as natural gas, propane or bio-diesel.

All of these previously mentioned programs focused primarily on ozone-level reductions. This emphasis was to be expected considering the pressure from federal and state authorities to address the ozone problem. Once these programs began to enjoy some measure of success, the information was relayed to the citizens as a sign of some progress, especially since this progress was realized in the face of tremendous population and industry growth. The particulate problem has remained largely hidden in the shadow of ozone because the health effects are less widely understood and the problem was not as severe (with respect to the established guidelines) as the ozone problem.

Air-Pollution Politics

The politics that formed this process evolved during this first wave of regulation in the 1950s. Although everyone would like clean air if it had no costs, the economic repercussions of regulation separated stakeholders into four groups: The legislature (both state and federal), the executive branch (the governor and his executive agencies), the regional air quality management

districts and the special interest groups (including both business, utilities, and the environmental/public health lobby). An important characteristic of the process to note is that it was largely a bipartisan effort.⁸² Everyone wanted clean air; they just differed on the preferred means to accomplish the goal.

The California legislature has always taken a large part in forming air pollution policies. This active role reflects their constituents high level of interest in air pollution issues. The key influence in the California assembly is the Natural Resources Committee (NRC)), the committee where most air quality measures are considered. Personalities in the legislature, both on the NRC and the Transportation Committee, have traditionally played a large role in affecting legislation.⁸³ Since air pollution is such a politically charged issue, most of the debate in California has revolved around how to trade-off air pollution against other political interests. The representatives and senators from California took these interests to the US Congress where national air policy has long represented the experience in California. The same debate occurs at the federal level, where air policy is a “good” but the costs associated with it are hotly debated.⁸⁴

The governor and his executive branch agencies are the key players in the California political system. The governor has wide influence in the legislative process and his control of the state budget assures a powerful position. The California Air Resources Board (CARB) is one of the most powerful executive branch agencies. It was created to address the issues raised by the 1970 Clean Air Act and is charged with protecting the air quality in California.⁸⁵ It is a very effective agency, with an independent source of revenue (collecting air permit fees) and a strong

⁸² This is not representative of the politics of California as a whole so it is interesting that the air pollution issue has played out this way. Other resource issues (such as water) have not been so bipartisan.

⁸³ For a discussion of the personalities, see Grant, 1995. The fights over the Clean Act in the US Congress was similarly affected by individuals, see Cohen 1997 for a discussion.

⁸⁴ See Cohen, 1997

⁸⁵ It was actually formed by merging the Bureau of Air Sanitation and Motor Vehicle Pollution Control Board in 1967, but it became of primary importance in its role to devise the State Implementation Plan for the CAA.

political power.⁸⁶ It has traditionally seen itself as a technology-forcing agency that achieves its goals through a balanced consensus-building approach that resonates with public opinion.⁸⁷

Although it has experienced some political turmoil associated with special interests, CARB still enjoys tremendous popular support and is held in very high regard.

The actual implementation and enforcement of the SIP plan is the responsibility of the local air pollution control districts. The South Coast Air Quality Management District (created in 1975) is the responsible district in Southern California. Although it also raises its own revenues through permitting operations as well as government funding, it does suffer from some political problems. It was criticized in the early 1980s for lax enforcement.⁸⁸ In response, its recent efforts to control pollution since have been draconian and wide reaching. This action may have damaged its political legitimacy.⁸⁹

I think that the District as an institution is problematical because of the sort of smudged accountability that it has in terms of it isn't directly elected, it isn't appointed directly by the governor, it's this sort of second- hand process of county supervisors selecting amongst their own and the cities selecting amongst their own. So when you have an agency with the amount of power and authority and potential public impact, the strains of its political legitimacy arise and I think the District over the last three or four years really has suffered a loss of its political legitimacy, maybe by doing too much, too far, too fast, maybe by doing not enough well, maybe by simply suffering the slings and arrows that accompany its own job.⁹⁰

Due to the bipartisan nature of the air pollution issue, lobbying groups become increasingly important in air pollution politics. The three main factions lobbying on air pollution are business (especially the automotive and oil industries), utility companies and public interest groups (both environmental and public health based). The power of the public interest groups is

⁸⁶ It can force a local air quality management district to enforce certain regulations after a public hearing in which the local district is determined to be delinquent in managing its authority.

⁸⁷ Grant, 1995

⁸⁸ These criticisms came in the form of both political pressure and legal actions to force the SCAQMD to implement the very strict measures contained in the SIP.

⁸⁹ As a response to this threat, the SCAQMD is forced to maintain its own lobbying presence in the Legislature.

⁹⁰ Lobbyist, quoted in Grant, 1995 p. 59

tied directly to public interest in environmental issues at that time⁹¹, but the business presence remains throughout. Businesses lobby based on their concerns about the environmental regulations and the effects of such regulations on their competitiveness.⁹² Much of the utility lobbying has occurred along the same lines, with competitiveness and equity as primary concerns. The public interest lobby has benefited from a surge in public interest in environmental and health-issues and was the driving force behind much of the regulatory efforts to date.

In California, many of the groups that comprise the public interest lobby enjoy “insider” status in the policy-making process. Many of the groups are well financed, publicized and supported by the general public. The public support ensures that the government can not treat them as periphery interests and consequently environmental public interest groups have had tremendous success in shaping the legislative agenda. The recession of the late 1980s and early 1990s had a neutralizing effect on the environmental lobby as their supporters realized that environmental programs have a cost, but popular support for environmental programs remains strong and increases with economic prosperity.⁹³ Groups such as the Sierra Club, the American Lung Association and the Natural Resources Defense Council are examples of powerful lobbying organizations in California.

⁹¹ Public interest in environmental issues has risen and fallen since the 1970s related to economic health of the country and catalyzing environmental events (such as Bhopal, Love-Canal, and the London Smog Episode).

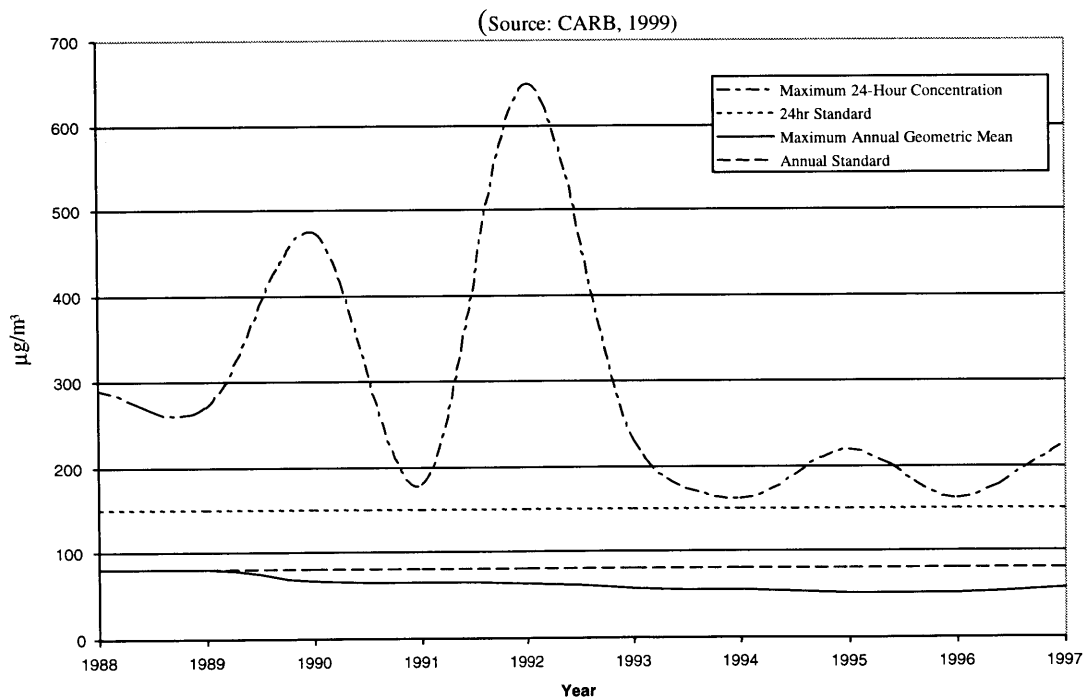
⁹² Much of the business lobbying has been efforts to get other industries to pay the costs associated with reducing air pollution. Manufacturing calls for cleaner fuels and autos, the oil industry calls for increased point-source controls (they have avoided vehicles since AFV technologies would ultimately drive fuel demand away from oil) and the auto industry calls for increased efforts on the part of both fuel-makers and point-sources. For a thorough discussion of these positions see Grant, 1995 or Cohen, 1997

⁹³ The recessions of the 1980's effect the environmental lobby in several different ways. The public was less inclined to support environmental measures that had high economic costs. It also manifested itself in less funding available to the environmental lobby to conduct operations, yet this is closely linked to the first point.

Results and Consequences of the Efforts in Southern California

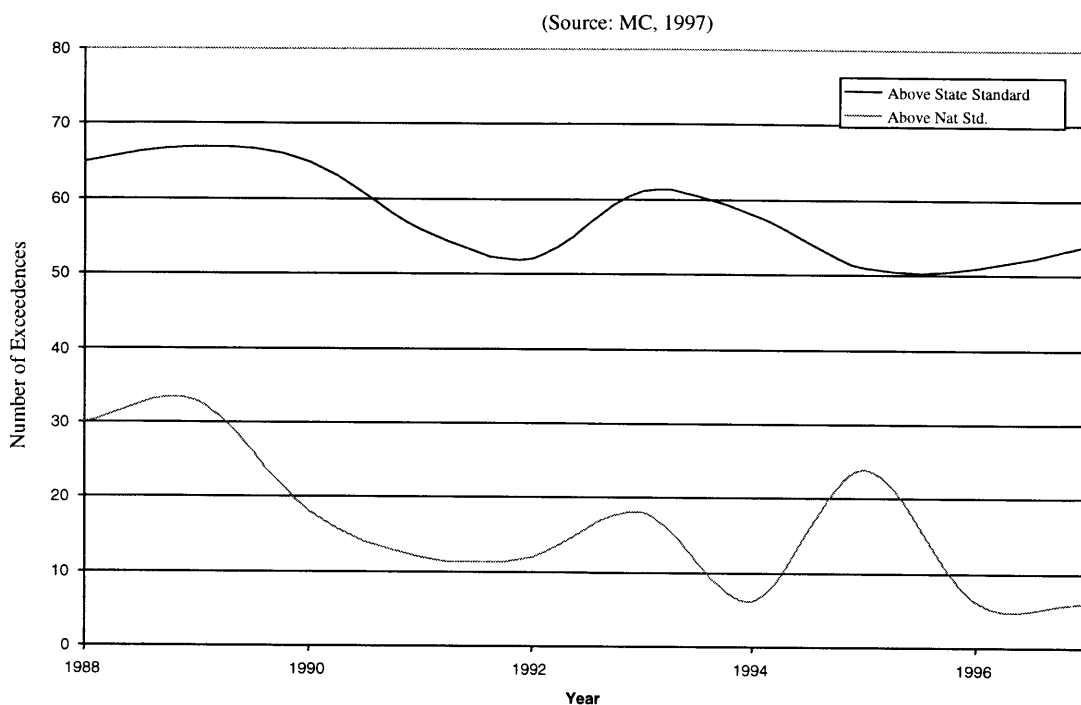
There were a number of positive results from the efforts to regulate pollution in Los Angeles. In general, the air quality has improved significantly in the past four decades. Peak ozone levels are down by 50 percent from the peak levels in the 1960s. Tremendous progress has been made in reducing dust-fall, which was once as high as 100 tons per square mile per month. By most accounts, pollution has been steadily declining since the 1960s in the face of tremendous population growth. Ozone control efforts, though not the focus of this analysis, have been fairly successful. While the ambient levels are still not at or below the health-based standards, the progress so far has been promising.

Figure 2-1 PM10 Levels in Los Angeles relative to US Standards



When examining particulate levels, some success has also been enjoyed. Total suspended particulates have been drastically reduced in Los Angeles. Beginning with efforts to

Figure 2-2 Annual exceedences of PM10 24 hour Standards



reduce “dust-fall,” the suspended particles in the atmosphere have returned to their pre-1940 levels.⁹⁴ This reduction accounts for some of the reason particulates were given little attention between 1970 and 1987. Regulators believed they had largely conquered the particulate problem by controlling dust, reducing ash, soot and other particles from combustion, and controlling coarse particles in industrial emissions.

In 1987, as a response to new health based studies, the Federal Government set an ambient air quality level for smaller particulates (particles with a diameter less than 10 microns, PM10). Once the regulatory focus shifted from TSP to PM10, there was progress to be made and particulates became an issue for regulators once again. Although not as dramatic as the

⁹⁴ In the 1960’s TSP deposition had been as high as 100 tons per square mile per month. Since monitoring statistics for ambient levels are unreliable for previous years, precipitation is a good measure of the total reduction

reductions for TSP, PM10 levels have dropped since monitoring efforts for PM10 began (See figure 1). The particulate trap for diesel automobiles and the targeting of small particles in industrial emissions are two of the programs that have contributed to the success. (Keep in mind that while total emissions have remained relatively unchanged, the LA basin has experienced significant growth and thus, maintaining emissions levels must be viewed as a partial success) Targeting agricultural and other area-wide sources has been less effective. It is important to note that many of these efforts are complementary to efforts to control ozone precursors and progress may have been observed even without efforts aimed specifically at reducing PM10.

Table 2-1 (Source: CARB, 1999)

PM10 Emission Trends (tons/day, annual average)			
Emission Source	1985	1990	1995
All Sources	503	549	496
Stationary Sources	33	36	33
Area-wide Sources	414	459	421
On-road Mobile	42	39	28
Gasoline Vehicles	12	9	10
Diesel Vehicles	30	30	18
Other Mobile Sources	14	15	14

The success of ozone reduction programs in reducing particulates also bolsters a significant observation: air pollution control efforts are largely complementary and as such, often realize two goals at once. For example, the efforts to reduce the ozone precursors contained in smoke from garbage combustion by banning backyard garbage incinerators also decreased particulates released or formed in the atmosphere. (SO₂ scrubbers are one example of this factor, as particles are removed with the SO₂) It is likely that many of the gains in particulate reduction have been made because of this positive effect of ozone reduction efforts. Once air pollution regulation became a significant business issue and industries began to take the problem seriously,

the shift from uncontrolled emissions to pollution control equipment was likely to reduce pollution levels for other pollutants concerned.⁹⁵ When business decisions are made regarding operations, the effect of those decisions on air quality can no longer be ignored and subsequently the businesses that prefer not to deal with the regulatory complexities that accompany air emissions will opt for cleaner alternatives.⁹⁶

But, on a number of fronts, efforts to reduce contaminants in the air of Los Angeles have not been very successful. If the purpose of the Clean Air Act is to protect human health, then its effectiveness may be questionable. New epidemiological evidence indicates that the constituent of air pollution that is most damaging to human health is very small particles, PM2.5 (2.5 microns in diameter). A new PM2.5 standard has been promulgated by the EPA, almost 30 years after the original clean air act. But the previous efforts to control particles may have actually increased PM2.5 pollution.⁹⁷

Another component missing from the regulatory efforts in Los Angeles is program effectiveness evaluation. While the reduction in total pollution has been recorded in monitoring stations, the actual reasons for that decrease have not been investigated thoroughly. Since there has been no evaluation at a program or initiative level to ascertain the effectiveness of the individual measures adopted in Los Angeles, other factors contributing to a reduction in air pollution⁹⁸ have not been eliminated as the source of the reductions. In any case, while there has

⁹⁵ There is anecdotal evidence that indicates that once businesses begin to think about the effects of their processes on air pollution and think about pollution as a basic constraint on doing business, compliance increases. See Greve and Smith, 1992 for more information.

⁹⁶ See Powell, 1997b or Switzer, 1998.

⁹⁷ Depending on the control technology, the larger particles are either removed or broken down into smaller particles. Either way, the reduction in TSP and PM10 has increased the fraction of the particles in the air that are the most harmful to human health

⁹⁸ Such sources could be the increasing de-industrialization of the American economy (as indicated by the Three-Cities study by Powell (1997b)), monitoring error (as indicated by National Academy of Sciences Report on particulate monitoring) or merely changes in the activities of the LA basin not caused by regulation (A natural shift towards more consumer activity as population grows: connected to de-industrialization)

been progress, no analysis has been done to attribute that success to any initiative or group of programs.⁹⁹

Conclusions

Regulatory efforts in Los Angeles to combat air pollution began in earnest in the early 1950s. At that time, the scientific understanding of air pollution was still very basic and regulation was targeted at the gross-emitters. While some attempts to regulate individual behavior have been attempted, the most significant progress to reduce contaminant emissions has come from the automotive sector. Today, automobiles pollute 90 percent less than those in the 1970s¹⁰⁰ and this decrease is largely due to regulation of the auto industry. Progress on the industrial front is not as definite. There have been some reductions in emissions but the role of de-industrialization in this reduction is uncertain. Whatever the source of the progress, Los Angeles has successfully dealt with the TSP, is making significant progress at addressing the ozone problem and is making headway against PM10.

⁹⁹ This raises an interesting question of how to measure effectiveness of programs.

¹⁰⁰ For Ozone pre-cursors, see Howitt, 1999

How Mexico City has Addressed the Problem

Similar to the experience in Los Angeles, the susceptibility of the physical environment to pollution was realized early in the development process of Mexico City. Inhabitants as early as 100 AD had their lifestyles affected by their impacts on the environment. The Teotihuacanos, inhabiting the area in the second century AD, deforested the area to the extent that it significantly reduced the water available from precipitation. This eventually led to the downfall of their society as floods and subsequent droughts devastated their agrarian society.¹⁰¹

Influence of Los Angeles on Mexican Environmental Policy

For modern Mexico, the interest in environmental protection has largely mirrored the developments in the United States. As environmental issues became publicly visible in the United States and scientific discoveries pointed to imminent disaster due to environmental degradation, Mexico felt it needed to respond. Additionally, the Mexican government could see the progression of the air pollution problem in Los Angeles and recognized that due to its similarity with Los Angeles, Mexico City was likely to experience similar difficulties. Since Mexico City was developing in a manner very similar to Los Angeles, but lagging behind on the development curve, the regulatory thinking of the time indicated that adopting measures similar to those used in LA to deal with air pollution might be a good way to address the problem.¹⁰²

Indeed, as Mexican officials began their analysis of the environmental threats to Mexico City in the late 1960s, the similarities to Los Angeles were not lost on them. Since the United States and Los Angeles were investing significant time and resources in ameliorating air pollution in LA and other major cities across the US, the possibility for borrowing this analysis

¹⁰¹ Simon, 1997

¹⁰² Much of the early formulation of policy was done by consulting US regulators. Williams, 1996.

led the Mexican government to adopt an approach that almost exactly mirrored the one the United States employed. The command-and-control approach to regulation advocated in the US in the 1960s and 1970s (when these issues first became regulated) was ideal for the strong, centralized, national government of Mexico.¹⁰³ The reasons for action were the same in both countries. Industrialization combined with growing population exposed a large proportion of the residents to unknown health threats caused by air pollution. When combined with the loss of visibility and accelerated degradation of property due to suspended particulates, these threats forced the government to take action. Actions were initially taken against the visible polluters, because the noxious facilities have a high profile and actions against them are politically popular.

This mindset is clearly manifested in the regulations that Mexico has adopted. Most of the Mexican programs of the 1960s and early 1970s, since they were based heavily on the understanding of the air pollution problem and methods of solving it in the United States at that time,¹⁰⁴ were targeted towards the visible pollution sources. The facilities that bore the brunt of the efforts were those that emitted large quantities of soot and smoke. By the late 1970s and early 1980s, the pollution reduction programs became focused on ozone and particulates as the emphasis in the US shifted to these pollutants and lead (the pollutant previously targeted) had been eliminated from gasoline. The emissions sources targeted by these regulations were hydrocarbon rich sources, NO_x emitters and automobiles. Now, as the emphasis changes towards fine particulates, these sources are more important and are increasingly targeted for emissions control.

¹⁰³ In the United States, the command-and-control approach has most often manifested itself in the setting of standards. This regulatory mechanism is well suited to a strong regulating agency with broad authority for enforcement. This is the case in Mexico.

¹⁰⁴ This is hardly surprising. Recent PRI administrations have become dominated by *Técnicos*, politicians and bureaucrats who had been educated at Ivy League institutions in the United States (mostly advanced degrees, their undergraduate degrees from the National University of Mexico, UNAM) and had returned to teach or take posts in government. These leaders brought American ideas about government and regulation back to Mexico.

Mexican Efforts to Combat Air Pollution

Efforts to deal with the air pollution problem in Mexico City began in earnest in 1971 and have continued to this day. Similar to the approach taken in Chapter 2, the focus of this chapter is not the specifics of the initiatives but rather their effects on particulate air pollution and the political environment in which they took place. Efforts to remove lead and SO_x from the atmosphere were based upon the American programs and were successful, reflecting the small number of regulated sources and availability of alternatives/emissions abatement equipment.¹⁰⁵ The specific measures promulgated by each program for all pollutants can be found in Appendix 3. The purpose of each initiative was clear: to improve the air quality in the MCMA. The approach has also been very consistent: a command and control approach similar to that employed by CARB and SCAQMD in Los Angeles. An official effectiveness analysis has not been done for any of these programs,¹⁰⁶ and many of the measures of each were never implemented.

1971 Federal Law

The first regulatory efforts in Mexico coincided with the environmental push in the United States. The Federal Law for the Prevention and Control of Environmental Pollution (1971 Federal Law) was first passed in 1971, just one year after the Clean Air Act of the United States. President Echeverría's (1970-1976) administration pursued the law to restore Mexico's environmental quality by eliminating the leading causes of pollution.¹⁰⁷ The 1971 Federal Law reflected an understanding of air pollution similar to that of the United States in the 1960s, with

¹⁰⁵ Lead reduction efforts targeted leaded gasoline. With the removal of leaded gasoline from the market, ambient lead levels promptly plummeted. SO_x comes from relatively few sources in the MCMA, and thus regulatory efforts were easy to target.

¹⁰⁶ An analysis of the ProAire program is currently being completed. Personal Communication with Adrián Fernández, April 1999.

combustion sources and dry soil as a threat to health. Subsequently, the Ministry of Health was the agency given the responsibility for implementing the regulations.¹⁰⁸ Although the 1971 Federal Law represented a step forward towards regulating air pollution, the regulations passed to implement the legislation¹⁰⁹ defined air pollution rather narrowly as “smoke and dust.” While this definition made it easier to enforce the regulations in a manner compatible with economic growth and liberalization, many of the gaseous contaminants that prove vital to efforts to combat air pollution were effectively excluded from regulation. The 1971 Federal Law was not driven by public sentiment, like the laws in the US. Rather, it was the result of a progressive administration becoming increasingly concerned with developments in the United States and the research that indicated that air pollution was a serious problem.

Observing what the United States was doing about the pollution problem, President Portillo (1976-1982) changed the institutional context for the 1971 Federal Law. He created the Interministerial Commission of Environmental Sanitation in 1978 to oversee the implementation of the 1971 regulations (taking a page from President Nixon and the creation of the Environmental Protection Agency). The Interministerial Commission was intended to coordinate the environmental efforts between the ministries that had jurisdiction over industry, agriculture and marine production. Initially, the commission was well funded and politically visible due to Portillo’s support and by 1979 it had devised a plan to combat the air pollution in the MCMA. This plan was based around vehicular and industrial emissions and sought to reduce

¹⁰⁷ The Echeverría administration was very progressive, in partial response to the conservative administration of Díaz Ordaz (1964-1970), so it is not surprising that this type of progressive move by the government happened in 1971 and not before

¹⁰⁸ The Air Pollution Control Act of 1963 (See chapter 2) dealt with the problem similarly and is likely where most of the ideas for the 1971 law came from.

¹⁰⁹ Similar to the system in the United States, it is the regulations and not the actual laws that bear the burden of implementation. In Mexico, there is very little pressure either by the courts or the public to issue regulations to enforce legislation. As a consequence, many laws are never effective at all because of a lack of implementing regulations. The passing of legislation without accompanying regulations has been a political ploy by multiple presidencies to provide the appearance of efforts to address a problem without any real intent.

them through inspection/maintenance programs, technological upgrades of auto exhaust systems, improved automotive fuel and relocation of industries with emissions that could not be easily controlled with existing abatement technology. All of these programs were very similar to their counterparts in Los Angeles (as discussed in Chapter 2) and employed the command-and-control regulation style that was in vogue in the United States during the 1970s. Since command-and-control programs need a significant amount of funding to be successful, Portillo allocated \$190 million (US) to implement the program.¹¹⁰ The necessary ingredient for these programs that Portillo did not address was the perpetuation of the Interministerial Commission as a strong, capable (both in institutional and political capacity) agency to implement the program. Originally, his patronage was all that was needed for the Interministerial Commission to operate effectively. Yet with little public pressure for environmental efforts and few allies in other parts of the government, the Commission could not implement a program that diverted resources away from economic development without Portillo's constant support. Since Portillo had limited amounts of time and political favors to devote to environmental protection, the Interministerial Commission's plan would only be successful if it was the focal point of his administration. Due to the absence of public demand for environmental protection versus economic development and quality of life improvement, the program made little headway during Portillo's administration as he was unwilling to make it the major platform of his presidency.

1982 Federal Law

In an effort to address the shortcomings of the Interministerial Commission, President de la Madrid (1982-1988) passed the 1982 Federal Law of Environmental Protection (1982 Federal Law). As a response to the growing concern about the environment that he had witnessed on the

¹¹⁰ Because Mexico was experiencing an oil boom at this time, it was easy to acquire external funding. The World Bank provided a \$60 Million (US) loan to be disbursed beginning in 1982 to be used for this project. The Treasury

campaign trail, de la Madrid created the Ministry of Urban Development and Ecology (SEDUE) to administer the programs previously devised to combat the air pollution problem. By making SEDUE a cabinet level ministry, de la Madrid hoped to provide the implementing agency with enough institutional capacity and political power to fully implement the previous programs. The cabinet status and the corresponding patronage of the President obligated the state and municipal governments to take heed of SEDUE's implementation of the existing program and allocated the budget that Portillo had allocated in place for the implementation of the Interministerial Commission's plan.

This increasing power of the environmental agency corresponded to increasing public awareness of the pollution problem and demands to address it. While the Mexican environmental movement was nowhere near as powerful as the movement in the United States, environmental issues were becoming important to the citizens of Mexico City and the deterioration of local air quality caused alarm. On the spectrum of political issues, environmental quality was increasing in its importance to the citizens of Mexico City as they enjoyed the prosperity brought by the oil boom of the late 1970s and early 1980s. Because the economy of Mexico was so robust in 1982, citizens felt comfortable pursuing quality of life issues such as environmental protection. It seemed that, in this era of prosperity, a quality of life similar to that enjoyed in industrialized countries was just around the corner.

Unfortunately, the 1982 financial and political crisis doomed what appeared to be a promising environmental remediation program and silenced budding environmentalists. The 1982 crisis was primarily financial. The de la Madrid administration inherited an enormous balance of payment deficit (\$16.1 billion¹¹¹) from the Portillo administration and a series of price

had committed \$130 Million of its own money to ensure adequate funding. This type of reckless external borrowing on oil profits was characteristic of Portillo's administration and contributed to the 1982 economic crisis.

¹¹¹ Williams, 1996. page 324

shocks caused a lack of investor confidence in the Mexican economy that resulted in a capital flight that averaged \$100 million a day. This debt and instability made servicing the government's \$81 billion¹¹² in external debt difficult and led de la Madrid to drastic spending reductions (as mandated by an International Monetary Fund austerity plan). The de la Madrid administration's ineffectiveness in responding to the crisis further compounded the lack of faith in the government and created a political crisis as the PRI struggled to regain control of the country.

Caught in the middle, SEDUE was faced with a daunting regulatory task and little money to realize its goals. Without the necessary funding, the command-and-control program devised by the 1982 law was impractical. The 1984 amendments to the 1982 law aimed to assist SEDUE in its task. The amendments addressed some deficiencies in the original law: lack of an air quality monitoring system, ambiguity surrounding air quality goals and definitive standards for criteria air pollutants. Unfortunately, while providing the guidance necessary to implement the 1982 law, it did not provide any more funding. The budget of SEDUE was slashed to half of its original amount. Financial cutbacks hurt employee productivity and morale, leading to a large turnover in professional, technical staff as they fled to private industry. By 1988, the ministry had lost half of its personnel (2,500 employees) and had only 10 inspectors to enforce the existing regulations for the entire Mexico City Metropolitan Area.¹¹³ Without the necessary staff, SEDUE could not promulgate new regulations to implement the 1982 law, so the regulations accompanying the 1971 law remained in force. The 1971 law was not suited to the modern understanding of air pollution and did not equip SEDUE to address the appropriate pollution sources. In addition to funding issues, SEDUE suffered from a serious lack of a political

¹¹² *ibid*

¹¹³ *ibid* p 325

constituency for environmental protection. Its creator and primary benefactor, de la Madrid, was mired in a crisis that taxed his personal and political relationships. Therefore he was unable and unwilling to make SEDUE's mission a primary governmental initiative in the face of economic crisis. The primary issue on the public agenda was economic recovery and he spent the remains of his political capital in attempts to rescue the Mexican economy.

As a result, the 1980s had a devastating effect on the political and institutional capacity of SEDUE (and to some degree any of the agencies that have followed). Without the necessary financial and political resources, SEDUE was not able to effectively realize its mission. The severe lack of funds hobbled the agency because it was not able to develop new regulations and was forced to enforce those already on the books. The lack of funds also precluded enforcement efforts and subsequently industry became unconcerned about compliance because the enforcement efforts were so weak and SEDUE's legitimacy was called even further into question. As its institutional capacity waned and pollution increased, SEDUE staff and leadership became increasingly disillusioned and went into denial regarding the magnitude of the environmental problems, insisting that the pollution problem was getting better and SEDUE was responding to its mandate.¹¹⁴ This posturing in the face of obvious regulatory failure tarnished the image of the agency and eroded any political power it had wielded. The citizens had heard claims that pollution would soon be eradicated and because the pollution problem was actually getting worse, SEDUE was opened to public ridicule.¹¹⁵ As the public became increasingly skeptical about any efforts on behalf of pollution abatement, new policies and programs aimed at addressing previous deficiencies were met with resistance on all sides. Without a political advocate in the President, other agencies were reluctant to listen to SEDUE, especially if the

¹¹⁴ The public statements from the SEDUE office during this time indicated that they believed that they had the problem under control. See Ward, 1998, Williams, 1996 or Miller, 1991.

¹¹⁵ Analysis of SEDUE's political fortunes from Williams, 1996

program would act as a drain on the economy (which the Interministerial Commission program would do). At this point, the best SEDUE could manage was a series of stopgap measures as substitutes for a coordinated program.¹¹⁶

1988 Ley General

By 1988, Mexico had begun to emerge from the economic crisis and again turned towards addressing the environmental crisis facing Mexico City. By this time, pollution levels had skyrocketed and ozone levels in the city were the worst in the world. A new law and agency were needed to restore the public's faith in government efforts and reflect the understanding of the pollution problem in the United States in the late 1980s. Drawing again from the American model, de la Madrid passed the 1988 General Law of Ecological Equilibrium and Environmental Protection (Ley General or LGEE). President de la Madrid was still concerned with the air pollution problem,¹¹⁷ yet he realized that SEDUE was unlikely to have the strength to implement a strong command-and-control program due to its tarnished public image and political power. Ending the federal government's sole authority over environmental protection and reflecting the decentralization model of the United States, the Ley General stripped SEDUE of its lead agency status and transferred much of the power over environmental affairs to local and state governments. In Mexico City, the LGEE divided regulatory responsibilities between the State of Mexico (EM), the government of the Federal District (DDF) and SEDUE.

¹¹⁶ These included elimination of lead from gasoline and development of emergency response measures for extreme pollution episodes (contingencies). These fall under the headings of "21 Measures to control air Pollution in the MCMA" and "100 Actions to fight against environmental degradation". See Appendix 2 for more information.

¹¹⁷ Although the population was concerned about economic development, it still desired progress on the air pollution issue. But SEDUE's efforts had been so ineffectual that it became a political liability to have pollution control functions at the national level. So, while public demand for a pollution control program was still high, the populace began to believe that the problem was intractable and the government, at least in its current form, could never make significant headway.

According to the Ley General, the DDF would be the lead agency.¹¹⁸ The government of the Federal District was responsible for emissions from commercial enterprises, private autos and public transportation services in Mexico City. The EM was given similar jurisdiction over the same sources in the State of Mexico. SEDUE retained its responsibility over industry¹¹⁹ and was to assist in coordinating efforts within the fuel and energy sectors as well (although this was unlikely due to interagency contempt for the Environmental Ministry). In addition, the LGEE encouraged the development of policy instruments based on alternative regulatory schemes such as the polluter-pays-principle,¹²⁰ other market mechanisms (taxes, etc) and inclusion of cost-benefit analysis into policy making. All of these efforts held the promise of less-expensive programs that would be just as effective as the command-and-control regulations.¹²¹ In an early effort to flex its regulatory muscle, the DDF implemented the *Hoy No Circula* (HNC) program in 1989. Originally intended as an emergency measure for combating extremely high pollution levels, it limited the number of automobiles in circulation by restricting one-fifth of the automobiles from the road at any given time.¹²²

¹¹⁸ This distribution of power to the local level led to a number of defections from SEDUE to the DDF. In fact, Salinas appointed Camacho Solís the mayor of Mexico City concurrent at the same time. Solís had been director of SEDUE and had been one of the most successful executives in that agency. Accordingly, he brought much of his staff over to the DDF to oversee its new responsibilities. With the staff came many of the old ideas about environmental regulation, so the new efforts undertaken by the DDF were consistent with measures SEDUE would have taken if it had continued to be the primary regulatory authority. Thus, the DDF inherited the same attitudes and institutional biases as SEDUE.

¹¹⁹ Given the importance of industrial development in the recovery from the 1982 crisis, it is little surprise that regulation of industry was still overseen at the federal level, as then it would be even closer to the President.

¹²⁰ A market-based mechanism whereby polluters are given an incentive to reduce pollution by charging them based on the pollutants they produce. Attempts to force polluters to incorporate the societal costs of their pollution into their cost structure so that their decisionmaking incorporates the negative externality effects of the pollution.

¹²¹ In addition to the fact that these types of policies were being widely discussed in the United States and other industrialized nations. In fact, some of the World Bank financing for these early programs included incentives for these types of policies.

¹²² Based on license plate numbers, cars are excluded from the roads one day a week. Because it was seen as a firm measure to combat pollution, it was initially very popular among the public and was incorporated into subsequent programs. Analysis of the program has indicated that it was unsuccessful, actually increasing the number of cars on the road due to increased car sales and increased trips on days when driving was allowed. See Eskelund, 1992 and Landa, 1995.

1990 PICCA

Due to public popularity,¹²³ the *Hoy no Circula* initiative was incorporated into the first full program implemented under the Ley General, The Comprehensive Program Against Air Pollution in the Valley of Mexico (Comprehensive program or PICCA). A coordinated effort between the DDF, EM, SEDUE, the state oil monopoly Petróleos Mexicanos (PEMEX), the Federal Electricity Commission (FEC) and the Ministry of Commerce, PICCA was a \$4.6 Billion command-and-control program very similar to efforts in Los Angeles prior to 1989.¹²⁴

The main regulatory thrusts of PICCA were:

6. Improve fuel quality by producing oxygenated - low sulfur fuel
7. Decrease vehicular emissions through catalytic converters and enhanced maintenance programs
8. Increase the use of natural gas and LPG by industry and thermoelectric plants
9. Promote ecological restoration of the valley through reforestation and better land-use management techniques.

All of these measures were identified by previous SEDUE studies (based on efforts in Los Angeles) as necessary to reduce the air pollution in the MCMA.¹²⁵ While it may have been expedient to evaluate previous efforts and study the dynamics of Mexico City before embarking on yet another program, Mexico was again enjoying economic prosperity and the public demand for environmental protection that accompanies it. President Salinas felt the political pressure to undertake a new program and build on the momentum of the HNC program. So, he urged the federal district to create and implement a new air pollution program.¹²⁶

¹²³ The idea behind HNC was very popular because it was perceived as a “getting-tough” program on air pollution. When it began to inconvenience the populace, it lost some of its luster and people began looking for ways around the restriction.

¹²⁴ See Appendix 2 for detailed analysis of PICCA program

¹²⁵ Actually, the program was only intended as a stopgap measure to reduce pollution for eight years. After that, growth would again increase pollution levels.

¹²⁶ The United States was applying additional pressure. The North American Free Trade Agreement was a centerpiece of the Bush administration and some of the most vocal opposition came from the environmentalists protesting Mexico’s environmental record. As a consequence, the US applied pressure on Mexico to introduce new environmental remediation programs and begin enforcing the existing ones.

Since PICCA was based around Los Angeles' program to reduce air pollution, it shared the weaknesses of that effort as well as inherited other difficulties caused by translating policies from a different city.¹²⁷ By this point, Los Angeles had strong, capable agency in the SCAQMD¹²⁸ to implement emissions reduction programs based on years of political and scientific analysis of the problem. Mexico City did not have such an institution. While much of the analysis could be borrowed, more research was needed regarding the particulars of applying such a program so an appropriate policy could be formulated and implemented in Mexico City. The weaknesses imported from Los Angeles with the PICCA included a lack of timetable for full implementation, lack of serious consideration of alternative regulatory regimes (market based, etc.) and deficiencies in the structure for evaluating the program after it had been implemented.

While scientific studies of Mexico City had addressed many of the technical issues, implementation became a bigger issue for PICCA. Two changes in the agency structure altered the implementation of PICCA in 1992 as it became clear that the DDF was going to need help in implementing PICCA: SEDUE became SEDESOL (The ministry of Social Development) due to national politics¹²⁹ and the Metropolitan Commission for the Prevention and Control of Environmental Pollution in the Mexico City Metropolitan Area (Metropolitan Commission) was created by a presidential decree. The implementation of PICCA was difficult because of the jurisdictional issues that accompany a distribution of authority like the one contained in the Ley

¹²⁷ One of the interesting attributes of the PICCA program is that it was explicitly based on the experience in other countries. Experts from the United States, Japan, Germany, England, France and Canada were brought to Mexico to assist in developing the PICCA.

¹²⁸ The SCAQMD, a multi-jurisdictional agency with broad enforcement powers and powerful political backing, is a key attribute of the regulatory environment in Southern California that Mexico lacks.

¹²⁹ SEDUE was converted into the Ministry of Social Development (SEDESOL) and given responsibility to administer the National Solidarity Program. But, since SEDESOL was seen as a continuation of SEDUE, the new ministry was subject to severe criticism regarding ineffectiveness and incompetence. In an effort to combat this view and offer the new agency some legitimacy, its budget was increased twelve-fold and became politically powerful due to its "super-agency" status. Within SEDESOL, two sub-agencies were created to administer the environmental tasks: the Attorney General for Environmental Protection (PROFEPA) was given enforcement and monitoring functions, and the National Institute of Ecology (INE) was given the role of formulating and

General. There was no legal mechanism for inter-bureaucratic coordination (similar to Los Angeles before the creation of the SCAQMD), hence efforts to achieve technical objectives that required interministerial cooperation (gas reformulation for instance) were never implemented. In addition, the decentralized enforcement across jurisdictional lines resulted in confusion and inefficiency. Without strong enforcement, PICCA was doomed to failure. The Metropolitan Commission was an effort to address these concerns and, since so much of the PICCA program had been borrowed from Los Angeles, it only made sense to create a regional agency in the mold of the SCAQMD.

The Metropolitan Commission's permanent members include the governor of the EM, the director general of PEMEX, the Ministers of Finance, Energy, Transportation, Social Development, Health, and the mayor of Mexico City. The mayor of Mexico City, the governor of the EM and the Minister of Social Development fill the Commission's presidential position. The rotating president position was an attempt to create an authority that could coordinate efforts among the different actors through a hierarchical relationship. While the creation of the Metropolitan Commission did install leadership to attack the air pollution problem in a coordinated manner, there was no mechanism in the Metropolitan Commission requiring the members to follow directives given by the president. A Commission president with real power would have been politically disastrous for Salinas since it would have given an individual the power to dictate policy to other ministries. In addition, no mechanism to resolve conflicts was established so that President Salinas retained his role as final arbiter in the case of disagreement.

implementing policy. As INE consisted of the SEDUE command-and-control advocates, the focus at a national level remained towards technological, command-and-control approaches to regulating the pollution problem.

1995 ProAire

The Metropolitan Commission's first coordinated effort was the Program to Improve the Quality of the Air in the Valley of Mexico: 1995 – 2000 (ProAire). This program, developed by the DDF, EM, SEMARNAP (SEDESOL became the Ministry of the Environment, Natural Resources and Fisheries, SEMARNAP, in 1994 under President Zedillo), and Ministry of Health built on the scientific knowledge accumulated from the studies since PICCA and once again incorporated the experience of Los Angeles. The scientific analysis of the problem has been improved significantly by studies from the Mexican Petroleum Institute, Los Alamos National Laboratory and others.¹³⁰ Studies regarding hydrocarbon speciation, improved emissions inventories and new pollution models have offered scientific insight into the problems facing Mexico City. But, the policy formulation was still heavily based on efforts in Los Angeles and represented recent efforts by the SCAQMD.

ProAire set new emissions standards for mobile and fixed sources (by industrial category) based on different pollutants (criteria and toxic) in a structure identical to that used in the United States. The policies to attain these standards are based on four categories: Cleaner Industry, Cleaner Vehicles, Behavior Modification and Ecological Restoration. The twenty measures to improve industry, similar to those required by the Clean Air Act, are based mainly on technological controls of emissions and a few non command-and-control measures (education, new gasoline pricing structures). The vehicular control measures are similar to those of Los Angeles as well and rely heavily on emissions reduction technology, fuel reformulation and enhanced inspection/maintenance. The behavior modification measures are also very similar to those tried in Los Angeles by the SCAQMD: better transportation planning, better land-use

¹³⁰ See Los Alamos National Laboratory, 1994 and bibliography for sources of this analysis

planning, education and trip reduction. The ecological restoration measures include re-forestation and topsoil conservation programs as well as ecological preservation.

The political environment behind ProAire is completely different than any other to date. President Salinas left the government in chaos when he left office in 1994 and once again the economy of Mexico was in shambles.¹³¹ In order to address the situation, President Zedillo was forced into a drastic austerity plan that restricted his flexibility and tarnished his reputation. In addition, Zedillo inherited unprecedented political instability attributable to public discontent with the PRI's term under Salinas.¹³² The ProAire program should be viewed in the context of a party struggling to regain control over its destiny. The ProAire program is ambitious and expensive. Considering the financial crisis it was conceived in, it was unlikely to be fully implemented, even in 1995, the year of its creation.¹³³ It is likely then that the ProAire program was intended to pacify public discontent regarding the progress made thus far to address the air pollution in the capital. The PRI has found itself in the midst of widespread public discontent over many aspects of its administration, and ProAire was but one effort to address it.

Enforcement

There were a few common themes seen in the implementation and enforcement of each of these policies. Because regulation can often entail difficult decisions regarding the value of environmental protection versus economic development, enforcement has often taken a back seat

¹³¹ The first four years of the Salinas administration were built upon privatization, removal of trade barriers and free trade. The PRONASOL solidarity program was in direct opposition to these reforms as it necessitated big-government and large-scale borrowing on the international markets. The economic growth that ensued was largely a house of cards, dependent upon foreign investment and increasing growth. At the end of his term, Salinas did not devalue the currency, as other presidents have, and left Zedillo with the need to devalue the peso. To shore up the economy, Zedillo's administration devalued the peso 15 days into his tenure without securing the support of Washington and Wall St. This sent financial markets into a tailspin and caused large-scale capital flight.

¹³² The political uprising in Chiapas, embezzlement charges against Salinas' brother, a political assassination and accusations of widespread corruption tarnished the last year of the Salinas administration and the reputation of the PRI has suffered accordingly.

to promoting industry.¹³⁴ When the government's decision is made as to whether to allow a new factory to be built, even if it will contribute to the air pollution problem, these values are weighed and a decision is made (normally in favor of the factory). Throughout the history of Mexican environmental regulation, the decision has often been made to not enforce or implement a law so that the city can develop economically. This trend continues as Mexico struggles to industrialize and remain competitive in global markets. Politically, this decision is understandable given the importance of economic development to the public. Air quality is relatively high on the public agenda, but economic growth and increasing quality of life is even higher. Thus, when in conflict, the politically expedient action is that which is best for the economy.¹³⁵

Corruption also becomes a factor in the enforcement of any environmental regulations. In the United States, early inspection and maintenance programs were often undermined by corrupt or lax enforcement. In LA, this corruption was overcome by centralizing and professionalizing the I/M program, to reduce the incentives and opportunities for corruption. The testing is now done in a highly automated manner, in central facilities by well-paid staff. Similarly, Mexico has had a problem with corruption in the enforcement of environmental laws. It is often less expensive and easier to pay a bribe than fix an older vehicle so that it will pass emissions testing.

¹³³ Recent evaluations leading to the new program in 2000 have shown that much of ProAire was never implemented. Interview with Adrián Fernández, April 1999.

¹³⁴ The decision-making has been done by the PRI and subsequently all of the decisions and trade-offs are made by the PRI leadership. This is often done by depriving the enforcement agency necessary funding or allowing a facility to be out of compliance with the regulation.

¹³⁵ See Preston, 1999, Simon, 1997 or Appendix 3 for more information about the Public's attitude towards environmental protection

Implementation

Implementation of environmental regulations is significantly different in the United States due to the role of the courts and public input. Implementation of legislation is influenced in two ways in the United States. Citizens (or sometimes an adversarial legislature)¹³⁶ can bring a case into the federal court to force the executive branch to issue regulations to enforce a law. If a group of citizens feel that the regulations do not comply with the law, the enforcing agency can be brought to court, providing a check on the executive's power. Second, citizens can put political pressure on their representatives, or even the president, to try to force some action. Neither of these routes exists in Mexico and as a result, implementation of laws is often slow or non-existent. The 1982 Federal Law and ProAire are examples of the non-existent implementation of Mexican environmental legislation. Because no new regulations to implement the laws were ever developed, these programs were not ever brought into the implementation stage.

¹³⁶ This phenomenon of an adversarial legislature is very important. Many times in the United States, the legislative body is quite explicit in the lawmaking so that the executive will be forced to implement a law in a certain way. The Clean Air Act of 1990 is a very good example as the law promulgates very specific details. Then, if the implementing regulations are in conflict with these details, the courts will rule on the issue and force action (if it was within the legislature's providence to detail that action). In the Mexican system, the laws are largely of the President's design and hence congress does not provide this function. This is likely to change as opposition parties gain more power in the legislature and seek to promote an agenda different than that of the President.

Figure 3-1 TSP 24hr Measurements for Mexico City

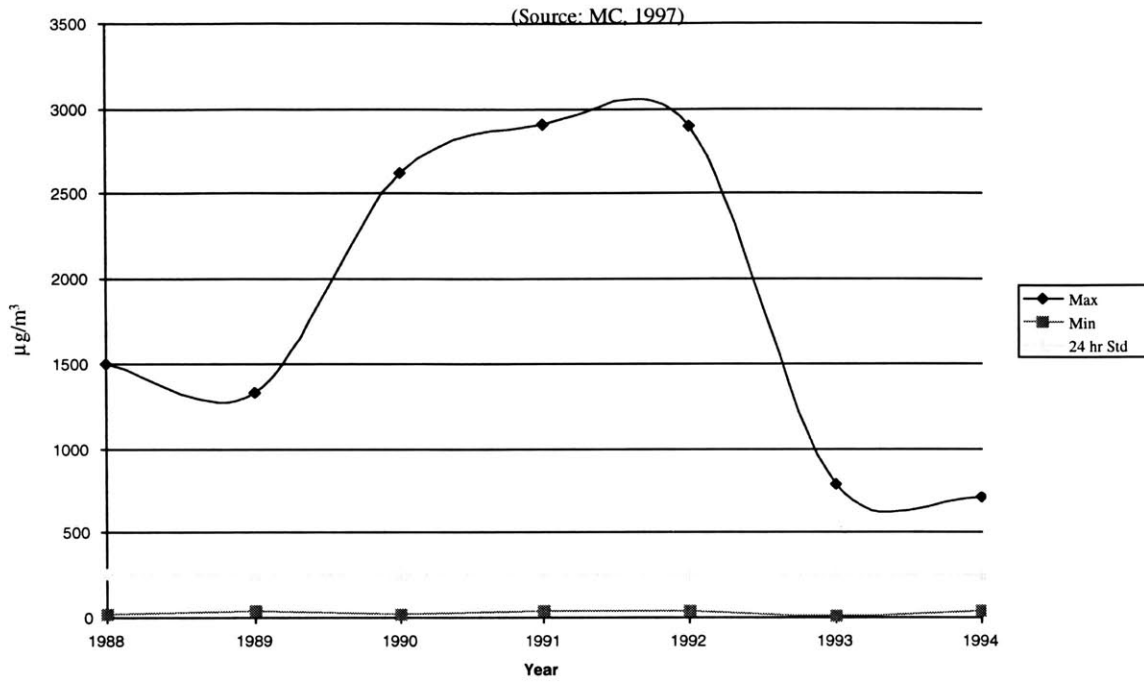


Figure 3-2 TSP Annual Average for Mexico City

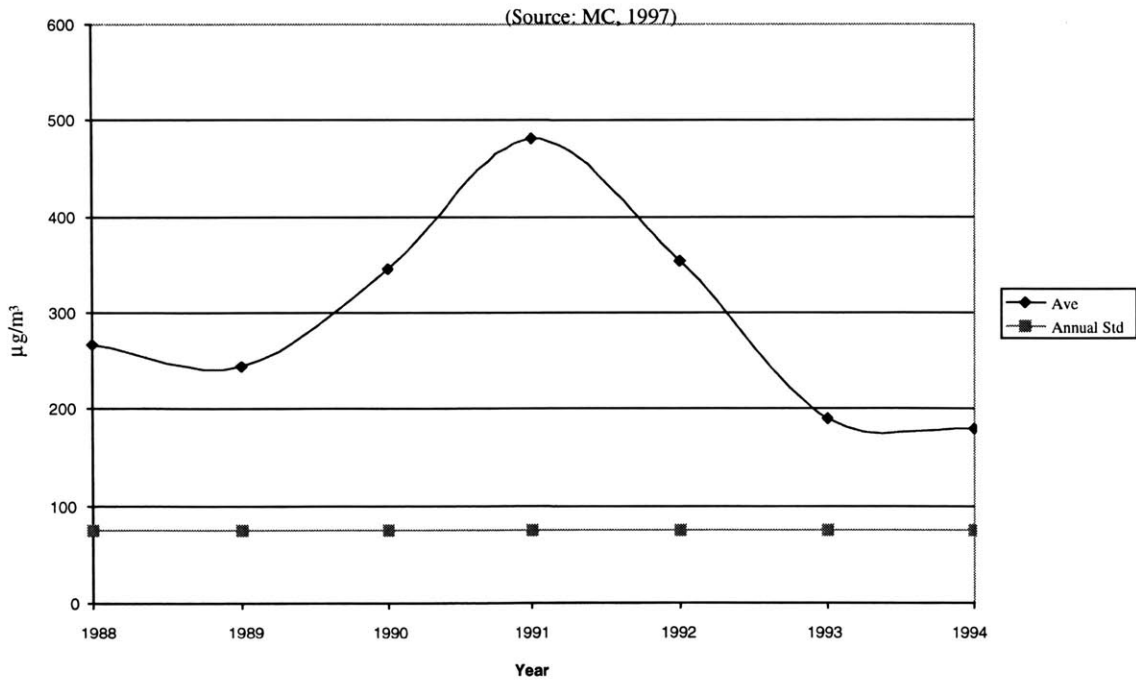


Figure 3-3 PM10 24hr Measurements for Mexico City

(Source: MC, 1997)

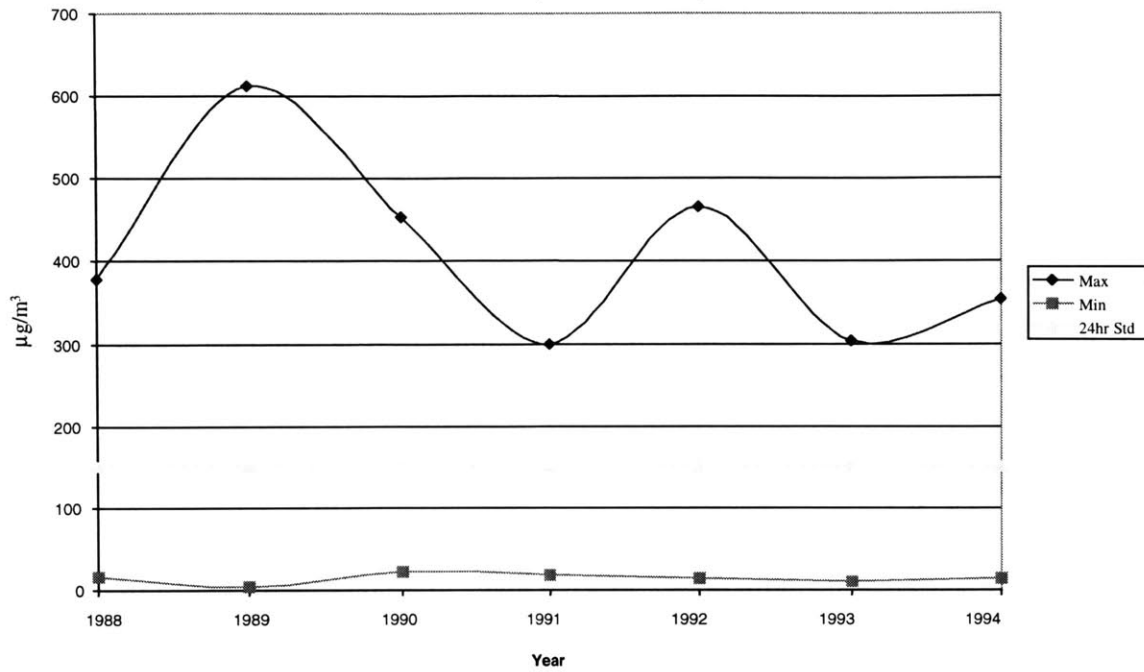
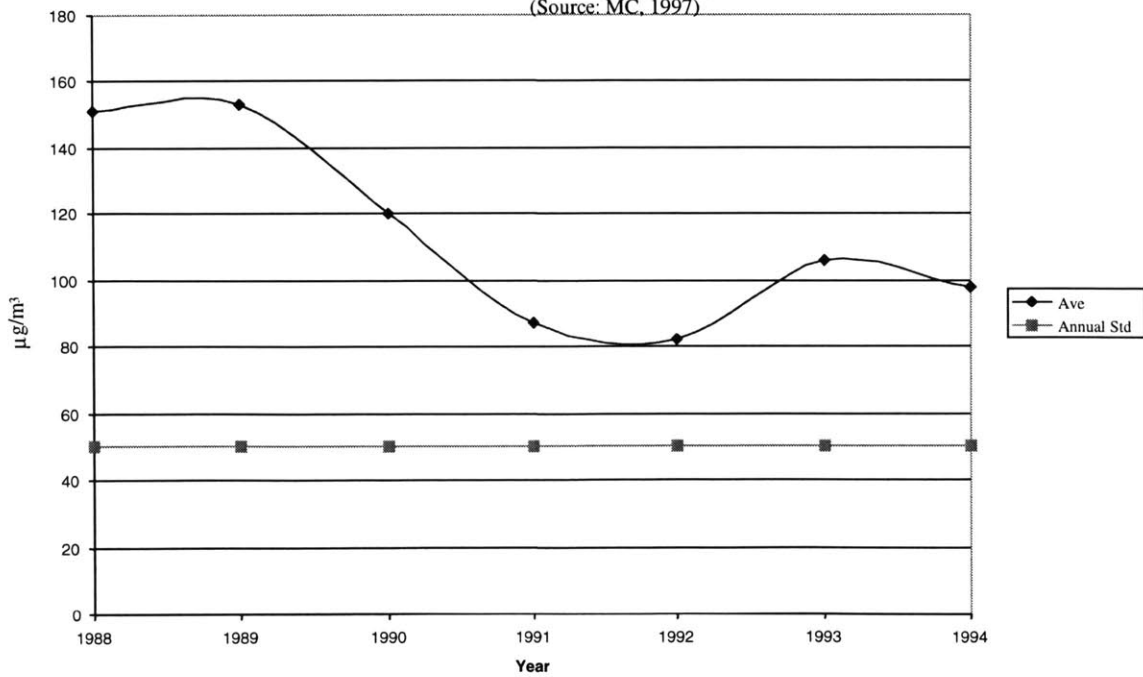


Figure 3-4 PM10 Annual Average in Mexico City

(Source: MC, 1997)



Outcomes of the Regulatory Initiatives to Reduce Particulate Levels

As most of the efforts in Los Angeles have been aimed at reducing ozone levels and not particulates, very little progress has been made to reduce particulate air pollution in Mexico City. (See Figures 3-1 through 3-4) Even when programs have been introduced to address particulates, the predominance of ozone in policy-making activities and limited budget for environmental enforcement has robbed particulate reduction efforts of funding. As a result, there has been very little reduction in particulate levels particularly in reduction of the PM10 particulates, which is the most important for health.¹³⁷

The outlook for the near future doesn't appear much more promising. Most of the policies aimed at particulate pollution in the ProAire program have not been implemented to date.¹³⁸ Ozone efforts, while they have succeeded in reducing the magnitude of ozone peaks, have been expensive and the accomplishments have been undermined by many other factors. Growth in population and industry, the accompanying increases in congestion and vehicle miles traveled, and efforts to reduce total suspended particulates¹³⁹ have increased the presence of respirable (PM10) particulates in the air in Mexico City.

Conclusions

The steps taken to reduce air pollution in Mexico City have been very similar to those employed in Los Angeles. Most of these programs have been based on the various methods

¹³⁷ The Mexicans are just now beginning to monitor for PM2.5 but have no regulations specifically addressing it.

¹³⁸ According to Adrián Fernández, the reforestation program was never implemented, diesel emissions testing has not been fully initiated and substitution of alternative fuel vehicles for public transportation has been put on hold. Most of the available funding was used for programs that have definite ozone benefits and hence any improvement in particulate levels is likely due to secondary effects. (As discussed in Chapter 2).

employed in LA during the preceding two to five years. Mexico adopted the programs of LA because of the physical similarities of the two cities and did not take other differences into account when the pollution reduction plans were formulated or implemented. In addition to this lack of analysis, the financial instability and the institutional deficiencies of the federal government in Mexico have largely undermined these programs. Now, pollution reduction programs are largely used as political platforms and have little chance of being fully implemented.

¹³⁹ As the larger particulates have been targeted, many of the methods to reduce TSP have merely broken them down into smaller particles. Hence, the effect has been to skew the particle size distribution towards the smaller, more damaging, particles.

Analysis of the Mega-City Policy Making Process

As discussed in Chapter One, the policy-making process can be modeled as occurring within three distinct steps, and a deficiency at any of the three steps can account for policy failure. Analysis is the first step of the process and distinguished from the others as the information-gathering step. It is in this step that the problem is recognized and broken into its three components: Technical problem definition (the specific science behind the air pollution problem), the policy options (tools that policy-makers can employ to affect the necessary changes to ameliorate the problem) and a stakeholder analysis (the actors who need to be taken into account when formulating policy). From this stage, the policy action is formulated by taking into account the change needed, the options for achieving that change, and the constituency that will be affected. Once the policy is formulated, implementation of the policy requires that the plan be legislated,¹⁴⁰ implemented through regulations and enforced, with ongoing sensitivity to the need to resolve conflicts between the stakeholders.

As has been seen, one of the differences between the air pollution problems in Mexico City and Los Angeles is the sheer scale of the problem. Los Angeles is open on one whole side to the ocean, while the MCMA has two narrow channels to bring in fresh air. The altitude and population growth rates of Mexico City also ensure its pollution problem will be more pronounced. Yet these differences cannot alone account for the difference in effectiveness of the two cities' air pollution abatement efforts. Thus within the policy-making process framework, four fundamental differences between Los Angeles and Mexico become evident. These

¹⁴⁰ Sometimes the formulation and legislation steps are combined into one. This is a function of the diverse interests and approaches to policy-making. In the United States, the legislation process often entails many revisions and compromises so that a policy action rarely survives the entire legislation process in its original form. Nonetheless, it is useful to use the model presented in Chapter 1 to understand the general process.

distinctions broadly account for the remaining discrepancy of effectiveness of the air pollution control policies employed in the two cities.

The financial capacity, institutional capacity, political pressure and political will in the Mexican context differ enough from the situation in Los Angeles that the same policies could not be employed effectively in Mexico City notwithstanding the other, scientific factors that further complicated pollution reduction efforts. No environmental protection agency has the money, manpower and political resources to embark on every project it wishes. It is the variations in each of these qualities, not the existence or absence, which explains why the agencies in Los Angeles were effective in deploying these policies to their full potential and Mexico City was not.

Financial Capacity

The financial capacity to embark on an air pollution abatement program is determined by two distinct criteria, the financial capacity of government and the financial capacity of industry. The financial capacity of government refers to the ability of the administration to raise funds sufficient to implement their programs. Although it is closely linked to that of the government, the financial capacity of industry is unique in that it refers to the capability of an industry to respond to the demands placed upon it by the government to reduce air pollution.

Governmental Financial Capacity

Two obvious differences between the United States and Mexico are income and financial development. During the past 50 years, the United States enjoyed high levels of economic prosperity and industrial development. As a consequence, funding for public programs has been relatively easy to obtain (when compared to Mexico). The position of the United States as an industrial power allows it to borrow at very low interest rates and yet it still remains very

attractive to investors. Thus, although the funds for the government are limited, the main consideration at many levels is the opportunity cost of spending the money on environmental protection versus another social program.

The experience in Mexico has been much different. As a developing nation without a large domestic investment infrastructure, Mexico is largely dependent upon international funding¹⁴¹ to finance industrial development and, to some degree, domestic infrastructure.¹⁴² To finance its development, Mexico has exploited its oil reserves for both of these purposes, borrowing heavily from international lenders based on oil. As this borrowing is not interest free, servicing the interest on the loans is very important to keep the international line of credit open.¹⁴³ The loan payments restrict the flexibility of a government to spend as they wish, so a large portion of income derived from growth is already earmarked for paying back the debt. Many of these loans also come with fiscal austerity programs attached to ensure the country remains solvent. These programs serve to further restrict the financial flexibility afforded to the borrowing country.

International loans have shaped the Mexican development experience and the environmental programs by association. The crises of 1982 and 1994 were both caused by large scale borrowing on the international markets and the inability (perceived or actual) of the

¹⁴¹ The United States can levy tariffs and tax its citizens and corporations without fear that they will relocate, although issues of competitiveness and job creation still factor into decisions about environmental protection. Similarly, developing nations can not tax either their citizens or corporations too heavily for fear of stunting the very growth they are trying to promote. If the tax rates are too high, domestic markets will not develop, foreigners will not invest, and the economy won't develop. This is the same problem as the in the U.S. but to a much greater degree. There are many other developing nations that a company can locate in, whereas the United States is unique in many ways.

¹⁴² This is the paradox that developing nations face. It is difficult to attract industry until the necessary infrastructure and markets are in place. These pre-requisites are difficult to develop until the domestic productivity of a country is increased; hence a cyclical condition has developed. One way to jumpstart domestic development is through loans from the international community.

¹⁴³ These interest payments must be a fiscal priority for the governments because if they do not meet their payments, faith in their economy is shaken and additional funding is difficult (if not impossible) to obtain.

government to service its international debt.¹⁴⁴ The United States government does not suffer from these constraints and chooses its domestic policies based on a different set of limits. When policies are borrowed from the US, the role of public spending as a main determinant for success should be carefully considered as programs in the United States often enjoy success because they are so well financed. In regions that have limited access to funds, environmental programs need to be carefully crafted to work within the budgets that can be reasonably expected over their lifetime. Environmental programs of the de la Madrid and Zedillo administrations were built upon budgets that are only realistic in the best of times. In times of financial hardship, the programs were largely ineffective because of lack of funding.

Exacerbating the difficulty in accessing capital is a developing nation's enormous need for investment, hence more competition for each available dollar. Whereas much of the public spending in the United States is to maintain infrastructure, developing nations such as Mexico are starting from scratch. Thus, their capital needs are huge. Roads need to be built, basic services such as electricity and water need to be provided, and a large proportion of the population depends on the government for some sort of financial support. Consequently, one of the primary goals of the government in a developing nation is to develop the economic base of their country so that it can better support the citizens. For Mexico, these challenges are very costly. It must develop infrastructure to attract new development, provide welfare support to a large proportion of its population, and strive to increase the standard of living of the average citizen. It is easy to see why spending on the environment is often neglected in the face of these pressing needs.

¹⁴⁴ The effect of the inability to service the national debt is compounded by capital flight. This occurs when private investors liquidate their investments in the country to invest in other countries, fearing financial instability. The conversion of large amounts of domestic investments into hard foreign currencies devalues the currency of the country in question, depletes its foreign currency reserves, and increases inflation, all of which further excite investors.

The consequences of the diminished financial capacity of Mexico are obvious. When compared to the environmental agencies in the United States, less money is available for government programs and the funds that are available are more difficult to procure because of competition between agencies. Even if the Mexican government devotes the same fraction of public money to protection of the environment, it can afford less environmental protection than the United States. Yet, by adopting the exact same standards and policies as Los Angeles, Mexico indicates it has an equivalent level of resources available for environmental protection. Thus, regardless of other complicating factors, pollution control efforts in Mexico City would be less effective if only for lack of funds.

Industrial Financial Capacity

Along with the financial capacity of the government, policy analysis must also consider the financial capacity of industry to comply with the environmental regulations. As mentioned before, the government must be sensitive to the burdens placed on industry by environmental protection. Even in a country like the United States with a well-developed industrial base, the financial burden that emissions reduction equipment represents can be prohibitive. This is especially true for the immature industries of a developing nation such as Mexico. Easy access to abundant natural resources and relatively few governmental burdens are two factors that assist local businesses in their formative stages. By requiring the same level of performance for multi-national companies and local start-ups alike, a nation would be putting their local industries at a relative disadvantage.¹⁴⁵

At the same time, multi-national companies locating in a country such as Mexico should be expected to observe a higher level of environmental performance. A large firm should not

locate in a developing nation just to avoid their responsibility to be socially conscious and minimize their impacts on the environment. It is not unreasonable to expect a US firm to comply with US emissions regulations, even when building a plant in Mexico. Therefore, the financial capacity of industries also plays heavily on the environmental protection of Mexico. While some firms can be expected to have better performance, these standards are difficult to implement without stifling international investment and thus a country such as Mexico is faced with a difficult balancing act.

How Financial Capacity affects Policy Making

The analysis phase of policy-making is where lack of funds first enters the policy process. When evaluating the characteristics of various policy options, it should be apparent that some options open to Los Angeles are too expensive for Mexico City, for both the government and industry.¹⁴⁶ If the financial component is not carefully considered, it may result in a policy being identified as a good candidate and passed to the formulation step when it is not a practical option. The complications caused by under-funding will manifest themselves in the implementation phase. This is what happened to the Mexican programs. Whether it was in the analysis or formulation stages, the costs of various programs were not matched to the funds available and many programs were planned that could not be funded.¹⁴⁷ For example, major

¹⁴⁵ The startups are at a relative disadvantage because the larger, more established firms will already have access to lines of credit, preferred relationships with suppliers, and other factors that would make compliance easier for larger companies

¹⁴⁶ Note that the financial capacity is intimately linked with the two points regarding political aims of the program that follow in this chapter. A policy that is impractical now because of lack of funding could become viable at a later date because environmental protection becomes a greater priority politically and more of the national budget is allocated towards pursuing it.

¹⁴⁷ The reasons for this could be twofold. It could be that the government was so optimistic (or uninformed) about future revenues that it believed it could finance a project as large as ProAire. Or, it could be that, for political reasons, it was better to overstate the actual program steps and then not implement those programs it could not afford. Due to the recent political upheaval in Mexico, it is likely that there is some truth to the second point and for short-term political gain the program was overstated to give the appearance of action. If this is the case, then the public's disillusionment with the effectiveness of the government could be directly attributed to the overselling of the government's capabilities.

portions of the ProAire program, such as the reforestation component, were abandoned due to lack of funding.

Institutional Capacity

Closely linked with the idea of financial capacity, is institutional capacity. Institutional capacity is the ability of the various agencies of the government to fulfill their mandate and effect the change desired from their agency. For example, the local public works authority is charged with providing residents and businesses with electricity, water and sewer services. The ability of the agency to provide these services to the residents quickly, affordably and competently depends on its institutional capacity. The most capable institutions are those with professional staff, an adequate budget, political clout and institutional power to pursue their agenda in the face of opposition.

Individual Institutional Capacity

Most of the institutions in Mexico suffer from deficiencies in institutional capacity. Professional staff is difficult to attract in Mexico. The frequent financial crises have driven a large number of the best public sector employees into the private sector as morale in the various agencies waned.¹⁴⁸ To fill this gap in employees and to create jobs, governmental agencies are often used as entitlement programs to provide jobs that help alleviate unemployment. This staff is often insufficiently prepared for the daunting challenges that face civil servants in Mexico. The United States also suffers from similar problems as some of the most talented workers are lured into private practice because it is more lucrative, but in the US the problem is not as severe.¹⁴⁹

¹⁴⁸ As previously examined in Chapter 3

¹⁴⁹ CARB is a very professional agency as indicated in Grant, 1995. For more information about the American situation see Grant, 1995 or Ward, 1998.

Compounding this problem is the lack of funding to properly implement the programs the agencies are given. As discussed in the financial capacity section, funding is scarce in Mexico and is not sufficient to meet all of the demands of the government agencies. Consequently, agencies often find themselves with budgets inadequate to address even a small fraction of their statutory mandate. Environmental agencies in Mexico are forced to choose between programs and prioritize line items within a program for funding to a degree that agencies in the US do not have to. With insufficient resources, it is difficult for an agency to be successful. And success is often crucial in developing power to influence other governmental entities.

This power is crucial to the pursuit of an agency's goals. Often as an institution implements its programs, it finds that its programs conflict with those of other agencies. The agency with less political and institutional power is the one that normally loses the conflict and must accept defeat. In Mexico, agencies not directly associated with the budget or economic development are politically weak and give way when such conflicts arise. This weakness is directly attributable to the public agenda as communicated through the PRI and President, an important topic that will be discussed later. But, because economic development is the primary priority in Mexico, when programs conflict, the one that is more directly linked to economic development carries more clout. Since the institutions associated with environmental protection and development are not directly tied to economic development and their policies often conflict with the interests of business, their interests are often subordinated to the interests of the economic development program. While this does happen in the US, in California the SCAQMD and CARB have tremendous political power and compete equally with other interests.

Relationship between institutions

Because the problems in Mexico City are multi-dimensional, social problems tend to affect multiple agencies, compounding institutional capacity problems. A good example of this is the interplay between transportation planning, land use, and environmental protection efforts.

Rapid population growth has forced immigrants into “irregular settlements” on the fringes of the city.¹⁵⁰ Residents build dirt roads to the settlements, and private transportation systems arise to accommodate their transportation needs. Water is trucked in, as is fuel for cooking and heating. Since these developments lack basic services such as sewer and garbage disposal, refuse is dumped in open areas and defecation occurs outdoors in communal latrines. The population pressures degrade the environmental health of the area, urban sprawl continues unabated and particulates are suspended through deforestation, increased erosion and combustion.

The Mexico City municipal planning department, the institution responsible for regulating this type of activity, is largely powerless to stop these settlements for a number of reasons. Politically, the land use planning agency is at the low end of the power spectrum and is not strong enough to withstand the political demands of the populace for more areas to develop.¹⁵¹ Financially, it is unable to fund any programs that would protect the areas or fund housing construction on alternate sites that may be more suitable for development. Its only option is to provide the settlements with paved roads, sewer, water and electricity to raise the standard of living for the residents and attempt to minimize their environmental impact. But providing services has the effect of legitimizing the encroachments and encouraging further development on marginal lands, perpetuating the development cycle.

¹⁵⁰ For a more complete discussion of the irregular settlement phenomenon, see Appendix 1

The capacity deficiency of the planning department also affects the environmental agencies. Not only does the Metropolitan Commission need to worry about implementing programs that are traditionally thought of as the province of environmental agencies (emissions controls, fuel reformulation, etc.), but it also needs to be concerned with basic development issues and the capacity of the planning agency to fulfill its mandate, since they both directly affect the air pollution problem.¹⁵² These capacity issues have increased the burden on the environmental agency to the point where any policies it attempts to implement are likely to be undermined by the institutional capacity problems of other agencies. Transportation planning has had a similar influence on the efforts of the Metropolitan Commission. Attempts to reduce vehicle miles traveled and congestion within the city have been largely unsuccessful and the responsibility for reducing pollution from mobile sources falls squarely on the Metropolitan Commission. Thus the efforts under the ProAire program to modify behavior have largely focused on assisting other agencies with their jobs. Collaboration with transportation and land-use planning agencies, even under the guise of the Metropolitan Commission, has been largely unsuccessful because these agencies lack the institutional capacity to address their own basic roles and do not have nearly enough resources to coordinate their efforts with other departments on problems largely peripheral to their basic mission.

Institutional Capacity Issues within the Metropolitan Commission

In addition to dealing with the capacity problems of other agencies, the Metropolitan Commission (MC) and its member agencies must deal with gaps in their own institutional capacity. The funds necessary to administer the Commission's programs have not been available

¹⁵¹ Much of the population views the environment as a luxury good. Basic needs, such as housing, are more important and consequently when decisions need to be made between the two, there is enormous pressure to favor development of the land.

¹⁵² These issues have been faced in Los Angeles as well. Planning efforts there have not addressed the sprawl issues well at all.

to the agencies. ProAire has been largely ineffective because it has lacked the funds for full implementation. In addition, the available funds are distributed inequitably among the Metropolitan Commission Agencies, leading to internal strife. Instead of funding SEMARNAP, the DDF and EM equally, the DDF receives the lion's share of the funding available for environmental programs.¹⁵³ The discrepancy of funding levels shifts the balance of power towards the Federal District and creates tensions over the expected roles for each agency. The president position of the Metropolitan Commission is insufficient to alleviating these conflicts and the political viability of the entire Commission suffers.

In addition to financial deficiencies, the Metropolitan Commission has been given no legal enforcement authority. Without a legal means to force other agencies and institutions to comply with its programs, interagency conflicts must be resolved through political means. Because of the weak political standing given environmental issues, most of the ideas from the MC are received by other institutions as suggestions and nothing more. This lack of political power is a manifestation of the lack of political pressure and will to address the air pollution problem in the face of other needs that are viewed as more pressing.

Lack of Political Pressure for Environmental Programs

In the United States, much of the progress made in cleaning up the air can be attributed to public outrage and pressure to reduce contaminants in the atmosphere. In the early 1970s, public pressure and awareness of pollution sparked the environmental movement and catalyzed the formation of public interest groups formed around environmental issues. Books such as *Silent*

¹⁵³ In Mexico, most of the budgets for government agencies can be directly traced to federal funds. Traditionally, the funds earmarked for environmental protection have been funneled in a disproportionate manner towards SEDUE/SEDESOL/SEMARNAP and the Environmental Agency of the Federal District. Consequently, the department in the State of Mexico is much less capable than the other two. For a more detailed discussion see Appendix 1.

*Spring*¹⁵⁴ became rallying points around which public interest groups formed to force environmental concerns onto the public agenda. In Los Angeles, it was the local government that initially responded to the air pollution problem with efforts aimed at reducing emissions from easily controlled sources. When it became obvious that the problem would not disappear after regulating these sources alone, legislation aimed at reducing air pollution was passed at increasingly high levels of government: first at a local level as the counties of Los Angeles tried to unite to regulate the problem themselves, then at the state level as the State of California passed the California Clean Air Act to address the squabbling and superficial actions of Los Angeles, and finally at the Federal level with the passage of the US Clean Air Act. Interest groups created a national political pressure base for change that reached the highest levels of government. In response to this movement, states had to at least appear to address the air pollution problem or else risk the political backlash that would accompany negative publicity about their efforts. When national pressure came in the form of the Clean Air Act, local governments could no longer respond to the issue in a superficial manner (cleaning up the easily controlled, politically unpopular sources) and had to take definitive (and politically painful) action against air pollution in major cities in a manner which inconvenienced the common person. The threats of lost federal funding forced California and Los Angeles to stand up and take notice of air pollution as a major issue and invest significant resources to address the issue.¹⁵⁵

¹⁵⁴ By Rachael Carson

¹⁵⁵ While many efforts of the pre-1970 air pollution boards seem drastic, such as the creation of the smog police, these were programs targeted against politically unpopular entities anyway. It took the Clean Air Act and the threat of withheld federal transportation funding to force California to take unpopular action, such as vapor collection equipment.

Role of Institutional Barriers to Public Involvement

The important observation about the environmental movement in the United States is the role that ordinary citizens play in pressing the government for action. The citizens of Los Angeles have been very vocal about their desire for clean air.¹⁵⁶ They have formed special interest groups to lobby their representatives for action and have been quite vociferous in their criticisms of ineffective government efforts.¹⁵⁷ The citizens of Mexico City, on the other hand, have a fatalistic attitude towards the pollution problem and are reluctant to pressure the government for action.¹⁵⁸ The causes of this behavior are varied. The Mexican system of government has not traditionally promoted or rewarded public participation on an issue-by-issue basis. It has a history of co-opting opposition into the PRI rather than fighting it out in a public forum, which has the effect of suppressing public discourse.

Also, the closed-door nature of policy-making in Mexico prevents widespread public information regarding programs or air quality that would educate the population about the problem and encourage public participation.¹⁵⁹ In the United States, knowledge about pollution issues is encouraged through US administrative law, such as the sunshine laws that require public disclosure. Without these measures in place, even if a citizen wanted to become more educated about pollution control efforts, the exercise would largely be futile.

Role of Individual Beliefs

The individual attitudes of Mexican citizens towards pollution have an important role in discouraging political pressure. Since the standard of living in Mexico is much lower than in the

¹⁵⁶ While the citizens of LA have been willing to demand strict concessions from industry and automobile manufacturers, they have been less receptive to individual behavior modification such as car-pooling and voluntary trip reductions. See Howitt, 1999

¹⁵⁷ See Cohen, 1995

¹⁵⁸ Preston, 1999

¹⁵⁹ See Chapter 1 or Cornelius, 1991

United States, there is more concern over issues that US citizens take for granted. Housing, food and healthcare are primary concerns for most of the population of Mexico City. In periods of prosperity, public concern regarding environmental quality in Mexico increases because people can afford to divert energy away from the pursuit of basic necessities.

Education is another important determinant of how environmental issues are perceived by the population. Many citizens are unaware of the connections between air pollution, property damage, health effects and their own actions. The lack of understanding of the relationship between individual action, the creation of pollution, and the effects that pollution has on people hinders individual action to reduce pollution. If citizens realized their link to air pollution, the health effects that air pollution has on them and what they could do (politically, individually, etc) about the problem, then they may feel more motivated to mobilize against air pollution. But, most of the citizens of Mexico City view air pollution as an intractable problem so complicated that an individual effort to reduce it would make no difference, and no environmental groups exist to educate them otherwise. Although acute health effects play an important role in their lives, citizens prefer to let the government deal with the problem, not realizing that political pressure might shift the institutional balance of political power towards the environmental agencies and make them more effective.¹⁶⁰

Role of Auto Industry Politics

Another interesting issue regarding political pressure in the clean air movement is the role industry politics played in regulatory efforts in Los Angeles. The automobile manufacturers were logical regulatory targets because of their high visibility and the small number of companies to be regulated. By forcing the “Big 3” domestic automakers to reduce tailpipe

emissions, regulators in the United States were able to have a significant effect with minimal political backlash. The car companies were forced to comply and reduced the pollution emitted by their product by 90% without adding significantly to the price. Hence, the costs of the program were widely distributed among auto-buyers, the pressure was focused on a few companies, and the gains in emissions reductions were relatively easy, politically.

In this regard, Mexico has benefited from the experience in Los Angeles. Since catalytic converter technology has already been developed and tested, Mexico did not need to employ technology-forcing policies. In Mexico, the battles have been fought around the issue of affordable, clean automobiles. Encouraging car manufacturers to sell cars with these cleaner technologies at competitive prices has been difficult. Automobiles must be much less expensive to have broad appeal in Mexico and the cost of a catalytic converter is enough to appreciably raise the price of a car. Consequently, the government required catalytic converters on all new automobiles sold in Mexico. The politically difficult aspect of the war on mobile source pollution was the development of lead-free, low-sulfur fuel that is compatible with the catalytic converter. The elimination of lead and reduction of sulfur in fuel required huge capital investments by PEMEX. Because the unleaded gasoline needs to be priced so as to be competitive with leaded (to prevent intentional misfueling) the costs could not be passed on to the consumers. Consequently, the government had to bear the full cost of upgrading the refinery capacity, at a significant expense.¹⁶¹

¹⁶⁰ That is, if the population decided to stress air pollution reduction over other issues. Until the income issue is addressed, it is likely that citizens would make similar decisions to favor economic development over environmental protection.

¹⁶¹ Even though it seems that it would be in its interest to make cleaner gasoline that it could then export to the United States.

Other Industrial Political Pressure

Easy pollution gains in Los Angeles during the early years of regulation include reducing dust in the air,¹⁶² banning of backyard incinerators¹⁶³ and reducing of visible smokestack emissions from noxious facilities. Most of these programs had little organized political opposition from industry and little negative effect on the economy.¹⁶⁴ The more difficult gains were achieved after this “low-hanging fruit” had been picked and entailed significant political costs. But, by this time, the environmental movement in Los Angeles was politically powerful enough to overcome objections by industry.

Industry objections in Mexico have been tempered by lax enforcement of many of the laws. While industry shutdowns during high-pollution episodes do entail considerable financial consequences and have spawned some political backlash, many companies have not become concerned with pollution control because emissions standards have been so slow to develop and those that have been promulgated have been weakly enforced.¹⁶⁵ The few actions taken against industry to reduce pollution have come at significant political costs. The most significant plant closing for air pollution reasons, that of the *15 de Marzo* oil refinery, proved politically impossible for the environmental agencies even though it was one of the worst polluters in the Mexico City area. It took a presidential decree to close the plant because the political interests opposed to the closing were so powerful that SEMARNAP was unable overcome political and institutional opposition. Presidential actions such as these are the exception not the rule and successes such as these have been infrequent.

¹⁶² Paved roads were demanded independently of their environmental benefits and topsoil suspension created a property-damage/nuisance issue.

¹⁶³ The cost of garbage collection was small and more appealing for aesthetic/public health reasons.

¹⁶⁴ While some industries were forced to install costly abatement equipment, these were mostly noxious facilities that were publicly unpopular anyway.

¹⁶⁵ Another thing worth noting is that much of the pollution in Mexico City comes from smaller businesses that escape regulation due to their size. When compared to those in Los Angeles where smaller businesses have been regulated, in Mexico City they are still largely free of oversight.

Lack of Political Will to promote Environmental Programs

Closely linked with the absence of political pressure from citizens and industrial incentives not to regulate, is the idea of political will. Political will is the initiative of a few members of the regulating community who believe that an issue is important and are willing to push it through the government. The political will of Senators Muskie and Mitchell largely fueled the Clean Air Act and its amendments.¹⁶⁶ They believed in the need for legislation to address the air pollution issue and were persistent in pursuit of comprehensive clean air legislation. At a local level, the air pollution problem of Los Angeles during the late 1980s and early 1990s was one of the top issues on the agenda and politicians elected during this time were willing to make sacrifices to address this concern.

The Mexican political system does not lend itself to policymaking outside the executive branch, and a lack of political will from within the executive has hampered air pollution regulation efforts to date. Due to the structure of the Mexican government, only a few major platforms are pursued each term. These are the issues about which the President feels most strongly and for which he is willing to use his political capital (favors, leverage, personal relationships, etc). Since there is no policy innovation in the legislature or within the lower ranks of the executive branch, these are the only issues that attract serious attention. These major initiatives, and the institutions responsible for pursuing them, are the ones that enjoy the institutional and political power: power that is necessary for implementation in the face of competing interests. The fact that pollution issues have not been one of the primary issues on the President's agenda has contributed to a deficiency in institutional capacity of the agencies

¹⁶⁶ See Cohen, 1995

dealing with the pollution issue. This lack of political will can be traced directly back to the lack of political pressure upon the President to make environmental protection a priority.¹⁶⁷

One of the reasons that the air pollution in Mexico City has not become a primary issue for the President is that it is not an issue of national scale. The programs that the President makes a priority are likely to be of a national scale because it is these initiatives that will garner enough nation-wide support to carry him and his party to the next election. Although the air quality of Mexico City is very important for the residents of the capital, it does not rank as a “national” issue for Mexicans that reside outside the MCMA.¹⁶⁸ Thus, while it is necessary for the President to promote some policies to address the air pollution issue so as to appease the citizens of the MCMA, it cannot be a major program of his administration. The benefits to the party do not outweigh the political costs. Subsequently, pollution abatement programs and their implementing agencies are not likely to become powerful or important enough to sequester a large amount of the President’s political will.

In response to the subordinate status of air pollution as a national issue, the politically sound course of action for the President is to create programs that placate the citizens of the MCMA but do not divert resources from the programs important to the nation as a whole (traditionally economic development programs). A meaningful effort to address the air pollution problem would entail diverting a large portion of the Gross Domestic Product into social spending for Mexico City. But this program would inevitably conflict with a number of other policies (and stakeholders), and relegate other programs that enjoy higher political standing to a subordinate status. Because of these consequences, an environmentally focused presidency is unlikely to be feasible politically. Thus, pollution programs that will continue support for the

¹⁶⁷ President de la Madrid is a possible exception, but financial difficulties precluded his support for a strong environmental remediation program.

President's political party yet cause minimal conflict with other programs, are the preferred course of action. Until the politics of the region are fundamentally restructured,¹⁶⁹ this phenomenon is likely to continue.

Conclusion

There are four fundamental differences between Los Angeles and Mexico City that can account for the policy successes and the failures. Institutions which deal with the pollution problem are deficient in the funding, staff and power necessary to compete with other interests to pursue an effective environmental remediation program. The funding necessary for such a program is further restricted due to Mexico's developing country status. Until Mexico's economy develops further and the standard of living increases, the citizens are unlikely to exert political pressure on the government to address the issue. Even if the political pressure were to develop, it is unclear that the necessary political will would be allocated to the problem unless a fundamental restructuring of the governmental power structure were to take place.

¹⁶⁸ Contempt for Mexico City by residents of other areas ensures that the President can not objectively consider Mexico City based on its importance. The party would lose too much political power in rural areas as a result. Ward, 1998

¹⁶⁹ Which is happening currently as the opposition parties gain a greater foothold in national politics.

Conclusion

In light of the differences between Los Angeles and Mexico City, and the effect of these differences on the efficacy of programs to reduce air pollution, it is possible to draw some conclusions about the Mexican regulatory experience. This experience offers some insights on how future regulatory initiatives can be given an improved chance of success. Emulating the particulate abatement policies of Los Angeles is very attractive and certain aspects of Mexico City's situation favor the command-and-control approach employed in Los Angeles. Lead and SO_x were dealt with very effectively in this manner through Mexico's strong government and broad authority that favors command-and-control type regulation. The technical similarities of the pollution problem (topography, meteorology, development patterns, etc) make the experiences of Los Angeles an intellectually attractive knowledge base for future regulatory actions, yet Mexico City is more extreme in each of these respects. It is also important to note that the authorities in Mexico City have made progress in reducing particulate air pollution with far fewer resources available to them than their counterparts in the United States, albeit a lesser degree of progress.

Factors that Complicate Implementation

But it is also clear that a number of factors that characterize environmental regulation in Mexico make the particulate control policies that Los Angeles has employed ineffective when translated to the Mexican context. The primary difference is one of resources: the United States is the most prosperous nation in the world and, consequently, has tremendous resources (financial, man-power, etc) to apply to the large demand for environmental protection. Mexico, on the other hand, is developing its industrial base and can not afford the large sums of public (and private) money that LA has spent to address the problem. Linked to the issue of funding,

yet also dependent upon the political distribution of power, is the institutional capacity of the agencies implementing the regulations. For political, financial and institutional reasons, the Environmental Protection Agency, California Air Resources Board and South Coast Air Quality Management District are powerful, effective agencies that can enforce regulations that conflict with the interests of other groups. This political power can be traced directly back to strong, popular support for environmental protection that does not exist to the same degree in Mexico City. Without the political pressure and the decentralized decision-making structure of the United States, it has been difficult to generate the necessary political will in the Mexican Government to implement a strong program of environmental protection. (It is easier to build a constituency for environmental protection when there are multiple parties that can wield power.)

To ameliorate these weaknesses and implement more effective policies, a number of changes need to be made. These changes will not be easy considering the problems are inter-related and there is no clear priority with which to address them. One necessary course of action is that the regulating institutions need to be empowered with more political, financial, and human resources to accomplish their tasks. Focusing on one institution will not be sufficient since the interconnected nature of the problem requires concerted action. Instead, the competence of all of the institutions needs to be increased at once. In concert with these improvements, relationships between the institutions need to be built so that they can approach the regulatory task in a more holistic manner, recognizing the relationships between social problems and the need for coordinated action.

To provide the necessary political impetus for these changes, the Mexican citizens need to be educated and engaged in the regulatory process. Through education, residents of the city can discover how air pollution affects their lives. This discovery, if accompanied by increased opportunities for participation in governmental affairs, will serve to mobilize the population

around environmental issues and influence the leaders to affect change. At the same time, the more basic concerns of the citizens must be addressed. Since environmental activism is so directly tied to the satisfaction of other basic needs, a plan for addressing environmental issues must include raising the standard of living for the population. Once these efforts have succeeded, the government will feel pressure to make more progress against the pollution problem, increasing political will for environmental progress in all levels of government.

But, utilization of this political will is unlikely unless power is disseminated among different levels of the government and among different factions within it. Many of these issues are just now being explored as the Mexican political system makes the transition from one-party to two-party system. If power is devolved to lower levels of government, some of the institutional barriers to action will be lifted and it will be easier for one group to apply pressure to another. This diffusion of power makes it easier to develop a constituency for clean air and use that constituency for affecting positive change. One possibly important mechanism for this change is the court system. If a mechanism for forcing implementation of programs were available, the half-hearted efforts to implement current programs could be addressed.

But for any of these efforts to be successful, all sectors of the Mexican society need to see some significant level of economic growth. All of the success of the United States in cleaning the air has hinged upon the economic prosperity it has enjoyed. Without this affluence and development, none of the LA's efforts would have occurred. This situation creates an interesting juxtaposition. If industrialized countries wish to encourage environmental stewardship in developing countries, they need to assist those countries to develop strong economies and prosperous societies. If this development assistance is to occur through industrialization, then that growth needs to be accomplished in a manner consistent with the concern for the environment. It will not be sufficient to develop foreign economies by creating factories that do

little to improve the local standard of living and at the same time pollute the environment. These actions will serve to only exacerbate the inequities that exist and increase the pressure placed on the environment.

Ideas for Possible Solutions

There is also ample cause to be optimistic about the ability of the Mexican people to successfully deal with these changes. The dynamic political environment holds promise for a more participatory form of government. A governing process with clear, accessible roles for the average citizen will help generate the political will for a clean environment from the bottom up. The clear trend of the Mexican Government is in this direction. In addition, new industry and its related income continue to flow into Mexico. As one of the most stable societies in the developing world, Mexico will continue to enjoy increased foreign investment as the domestic market grows. Efforts to ensure that this development is compatible with the environment need to be made.

To this end, there are a number of steps to ameliorate the barriers to effective environmental protection in Mexico. First, there is a need for improved accounting of the costs associated with air pollution. While rudimentary studies have shown that the health care costs associated with air pollution are significant,¹⁷⁰ additional, more sophisticated studies may prove that addressing air pollution actually saves the government money in avoided health care costs. Consolidating these costs into the governmental accounting can provide the necessary political and institutional incentives to abate the air pollution.

Second, in this age of global business and environmental consciousness, Mexico may be able to harness the power of industry to help foster environmentalism as well as provide for

economic growth. Industries could be encouraged to install facilities in Mexico City that have similar pollution controls as those in the United States. (As discussed briefly in Chapter 1) Businesses could still take advantage of the labor and infrastructure that Mexico City provides while maintaining an environmentally friendly facility. Given the tremendous costs associated with the pollution problem in Mexico City, it may prove cost effective for the Mexican Government to provide additional incentives for industry to site clean facilities there. Businesses locating there can also benefit from positive publicity, casting themselves as firms that respect their employees and the environment.

Third, turning some of enforcement duties over to industry in return for the adoption of an environmental management system may be another incentive that the Mexican Government can use to reduce the costs of compliance and encourage better environmental performance. Because of the enormous costs associated with contingency shutdowns (where industry is forced to curtail production due to a severe pollution event), shutdown exemption could be used as a bargaining chip for further reductions. From the government's standpoint, it makes sense because if facilities reduce their overall emissions, contingencies may be less frequent. Subsequently, firms could be assured of the ability to operate their plants during contingencies in exchange for reducing everyday pollution levels even further.

A final idea for improving Mexico's environmental regulation is to semi-privatize the enforcement of environmental regulations. Relegating environmental regulatory duties to an independent agency capable of generating its own revenues (either through permit fees or enforcement actions) and forcing compliance through court action, creates an enforcement entity that has a vested incentive to harshly enforce environmental regulations. This agency could operate in a manner similar to the SCAQMD, which it is given a air quality target and the

¹⁷⁰ Presentation by Gustavo Olais, Ministry of Health, February 16, 1999. Mexico City

institutional powers to achieve it. The court system would need to become more independent in concert with the creation of this agency to create a dispute resolution mechanism. Yet, this transformation is already underway with the liberalization currently occurring in Mexico. If a strong, independent judiciary emerges from the transformation of the Mexican Government into a multiple system, an independent regulatory agency may become possible.

These measures, if carefully designed and implemented, may provide for enhanced environmental performance and air quality improvement within the context of Mexico City. As seen in chapter 4, reliance on a single governmental agency for environmental protection will not be effective in the Mexican context. Unless that context is significantly altered, the best solution is to create incentives for firms and society in general to protect air quality. Yet, assuming that the government of Mexico remains involved in the air pollution arena to some degree, its programs would benefit from additional focus and realism in formulating policies. By focusing on small parts of the problem that could be addressed given the limited resources in Mexico, the chances of success for these programs would be increased. Adopting a large, multi-faceted plan has proved unmanageable for Mexico, thus future governmental efforts, in addition to those possibilities mentioned above, should be more focused.

Implications for other Cities

The lessons learned from Mexico City can also be applied to other contexts. As megacities around the world grapple with air pollution problems, a number of insights from this analysis can be utilized to craft abatement strategies that are more appropriate to the context of that city and will be more successful as a result. The first insight is the adoption of an entire air pollution reduction program from another city is not likely to be successful. The institutional, political and economic dynamics vary enough between countries that the same program is unlikely to play out in a similar fashion when transported to a different country. As a result, if a

large city in a developing country, such as Buenos Aires, were to adopt the air pollution reduction program of Los Angeles, it might experience problems similar to those Mexico encountered. At the same time, Argentina and Mexico are different enough that the Mexican program would not be successful in Buenos Aires, either.

There is a need for thorough policy analysis before a program is formulated and implemented. Referring back to the diagram in chapter one, a careful analysis of the problem, the instruments and institutions available to address the problem (including other competing interests and institutional capacity) and a list of stakeholders likely to be effected by the problem is necessary before a program is formulated. Since the contexts in which policies operate are different in each country, this analysis step is indispensable, though often overlooked. The policies that are likely to be effective are those which build upon the strengths of the situation and implementing agency while minimizing the vulnerabilities of the program to unforeseen barriers.

The final insight does not concern environmental policymaking per se, but complex multi-stakeholder problems in general. In order to effectively address the barriers to success and realize the goals of the program, careful analysis of the operating environment is necessary. Even a technically sound, efficient and elegant solution to one of these complex problems will fail if it does not take subtleties into account. The stakeholder personalities, institutional capacity and conditions in the future (financial, political, etc) weigh heavily upon the outcome of initiatives and doom policies not crafted with them in mind. Individuals faced with complex problems should consider these factors and the manner in which they have played out in Mexico when making decisions.

Bibliography

- Baker, G. and van Aardenne, B. (1993). "CNG: A fuel for the future." *Business Mexico*. 3 (1): 48-49.
- Bardach, E. *The Eight-Step Path of Policy Analysis: A Handbook for Practice*. Berkeley, CA: Berkeley Academic Press, 1996.
- Beaton, S.P., Bishop, G.A. and Stedman, D.H. (1992). "Emissions Characteristics of Mexico City Vehicles." *J. Air Waste Manage. Assoc.* 42: 1424-1429.
- Carson, R. *Silent Spring*. Boston, MA: Houghton Mifflin Co, 1962.
- Cohen, R.E. *Washington at Work: Back Rooms and Clean Air*. Boston, MA: Allyn & Bacon, 1995.
- Collins, C. and Scott, S. (1993). "Air Pollution in the Valley of Mexico." *The Geographical Review*. 83 (2): 119-133.
- Cornelius, W and Craig, A. *The Mexican Political System in Transition*. San Diego, CA: Center for U.S.-Mexican Studies University of California, San Diego, 1991.
- DeNeufville, R. Presentation at Massachusetts Institute of Technology. Cambridge, MA: April 6, 1999
- Eskeland, G. (1992). "Attacking Air Pollution in Mexico City." *Finance & Development*. December 1992: 28-30.
- Farquharson, M. (1989). "Pollution Plan Targets Community." *Business Mexico*. 1: 50-54.
- Garza, G. (1996). "Uncontrolled Air Pollution in Mexico City." *Cities*. 13 (5): 315-328.
- Geyer, A. (1993). "Challenges for the Modern Metropolis." *Business Mexico*. 3 (10): 48-49.
- Grant, W. *Autos, Smog and Pollution Control: The Politics of Air Quality Management in California*. Brookfield, VT: Edward Elgar, 1995.
- Greve, M. and Smith, F. Eds. *Environmental Politics: Public Costs, Private Rewards*. New York, NY: Praeger Publishers, 1992.
- Hardie, R.W., Thayer, G.R. and Barrerea-Roldán, A. (1995). "Development of a Methodology for Evaluating Air Pollution Options for Improving the Air Quality in Mexico City." *The Science of the Total Environment*. 169: 295-301.
- Health Effects Institute (HEI) (1996). "Particulate Air Pollution and Daily Mortality." Phase I.B Report of the Particle Epidemiology Evaluation Project. Washington DC.

Health Effects Institute (HEI) (1998). "Characterization of Exposure to and Health Effects of Particulate Matter." Report RFA 98-1. Washington DC.

Hernandez-Garduno, E., Perez-Neria, J., Paccagenella, A.M., Pina-Garcia, M.A., Munguia-Castro, M., Catalan-Vazquez, M. and Rojas-Ramos, M. (1997). "Air Pollution and Respiratory Health in Mexico City." *The Journal of Occupational and Environmental Medicine*. 39 (4): 299-307.

Howitt, A and Altshuler. "The Politics of Controlling Auto Air Pollution." In *Essays in Transport Economics and Policy: A Handbook in Honor of John R. Meyer*, edited by Gomez-Ibanez, J.A., Tye, W.B. and Winston, C (pp. 223-255). Washington D.C.: The Brookings Institution, forthcoming 1999.

Instituto Nacional de Ecología, SEMARNAP (INE) (1998). *Avances en el desarrollo de indicadores para la evaluacion del desempeño ambiental en Mexico 1997*. Mexico City D.F.

Kretschmar, J.G. (1994). "Particulate Matter Levels and Trends in Mexico City, Sao Paulo, Buenos Aires and Rio de Janeiro." *Atmospheric Environment*. 28 (19): 3181-3191.

Landa, R.T. (1995). "Mobile Source Pollution in Mexico City and Market-Based Alternatives." *Regulation*. 2: 14-20.

Leautaud, J.A. and Pérez-Barnés, C. (1997). "Energy and Infrastructure Policies for Mitigating Air Pollution in Mexico City." Masters Thesis. Massachusetts Institute of Technology, Cambridge MA.

Lents, J.M. and Kelly, W.J. (1993). "Clearing the Air in Los Angeles." *Scientific American*. 269 (4): 32-39.

Levy, D and Székely, G. *Mexico: Paradoxes of Stability and Change*. Boulder, CO: Westview Press, 1987.

Lezama, J.L. and Urquidi, V.L. (1999). "Air Pollution Policy Issues in Mexico City: The Limits of the Environmental Construction in the Official Programs." Unpublished paper. El Colegio de México, Mexico City.

Los Alamos National Laboratory. *Mexico City Air Quality Research Initiative*. Los Alamos, NM: LANL, 1994.

Metropolitan Commission for the Prevention and Control of Environmental Pollution in the Valley of Mexico (MC) (1997). *Programa para Mejorar la Calidad del Aire en el Valle de México 1995-2000*. Mexico City D.F.: Pinacoteca 2000.

Miller, B. (1991). "Obedezco, Pero No Cumplo: Law, Transportation, Politics and Pollution in Mexico City" *Stanford Journal of International Law*. 28: 173-246.

Pezzoli, K. *Human Settlements and Planning for Ecological Sustainability: The Case of Mexico City*. Cambridge, MA: MIT Press, 1998.

- Pick, J.B. and Butler, E.W. *Mexico Megacity*. Boulder, CO: Westview Press, 1997.
- Powell, M.R. (1997a). "The 1987 Revision of the NAAQS for Particulate Matter and the 1993 Decision not to Revise the NAAQS for Ozone: Two Case Studies in EPA's Use of Science." Discussion Paper 97-07. Resources for the Future, Washington D.C.
- Powell, M.R. (1997b). "Three-City Air Study." Discussion Paper 97-029. Resources for the Future, Washington D.C.
- Preston, J. (1999). "Mexico City's Air: A Fatal Case of Fatalism." *New York Times*. February 14, 1999: p.40
- Ranger, E.M. and Alonzo, A. (1992). "Industrial Air Pollution Control Plan." *Business Mexico*. 2: 30-31.
- Reisner, M. *Cadillac Desert*. New York, NY: Penguin Books, 1986.
- Schuck, P. (1979). "Regulation: Asking the Right Questions." *National Journal*. April 28, 1979: 711-717
- Seinfeld, J. and Pandis, S. *Atmospheric Chemistry and Physics*. New York, NY: John Wiley & Sons, 1998.
- Selected Environmental Law Statutes: 1998-99 Edition*. St. Paul, MN: West Publishing, 1998.
- Simon, J. *Endangered Mexico: an environment on the edge*. San Francisco, CA: Sierra Club Press, 1997.
- South Coast Air Quality Management District (SCAQMD) (1997a). AQMP Control Strategy Los Angeles, CA.
- South Coast Air Quality Management District (SCAQMD) (1997b). "The Southland's War on Smog: A Half-Century of Progress Toward Clean Air." Los Angeles, CA.
- Switzer, J.V. *Environmental Politics: Domestic & Global Dimensions*. New York, NY: St. Martin's Press, 1998.
- Teichman, J.A. *Policymaking in Mexico: From Boom to Crisis*. Boston, MA: Allen & Unwin, 1988.
- Ward, P.M. *Mexico City*. New York, NY: John Wiley & Sons, 1998.
- Williams, M.E. (1996). "Shrinking the State in Mexico: The Puzzles of Successful Neo-Liberal Reforms." Doctoral Thesis. Harvard University, Cambridge MA.

Appendix 1: Background on Mexico City

*Historic Degradation*¹⁷¹

In the Valley of Mexico, located in central Mexico, environmental degradation has a long history. Man has abused the natural resources in the Valley of Mexico almost since the first human settlements of the area, and many of these abuses have led to disaster for the offending cultures. The Teotihuacanos, a tribe inhabiting the area after 100 AD, practiced slash and burn agriculture on the hillsides of the valley for many centuries. This deforestation handicapped the vegetation's ability to capture and retain water and return it to the aquifer underlying the valley. As the level of the aquifer declined, springs important for their irrigation purposes dried up. This led to a reduction in food production and eventually the Teotihuacanos had to abandon their city. Other tribes that assumed the land in the Valley, such as the Toltecs and Aztecs, suffered through similar ecological disasters. In each instance, the burdens that the civilization placed on the environment were too great.

The Spanish, after they made Mexico City their capital in the new world in 1521, nearly lost their city to erosion. After their arrival, the Spanish began to widely harvest the vegetation on the hillsides for domestic uses. This deforestation reduced the vegetation's natural ability to buffer rainfall. Instead of being absorbed by the flora and returned to the aquifer through the natural process, water from rainfall ran directly into Lake Texcoco, the lake which the Aztecs had built Mexico City, and caused widespread flooding. These floods became serious in the late 1500's and actually submerged parts of the city from 1629 to 1634. Instead of responding to this threat with a program for reforestation, the Spanish built an intricate system of waterworks to drain Lake Texcoco.

¹⁷¹ Info for this section from Cornelius, 1991., Garza, 1996., Levy, 1987., Lezama, 1999., Miller, 1991., Pick, 1997., Simon, 1997., Ward, 1998 and Williams, 1996.

While this did solve their flooding problem, the loss of moisture and increased pressure from population growth set the stage for the particulate problem that Mexico City currently faces. The parched lakebed of Lake Texcoco generates dust storms of fecal matter and soil that often inundate the capital, coating the city in a fine dust and causing a brown haze that reduces visibility. The anthropogenic activity of the day released smaller particles into the air from combustion and wear on hard surfaces. Even after the Spanish occupation had ended and the inhabitants began to rule themselves, this pattern of development continued. Modern Mexico City has similar problems to those of its historic predecessor, but they have been amplified by the additional stresses of industrial and population growth.

Modern Mexico City

Physical Characteristics

Modern Mexico City and its accompanying suburbs, called the Mexico City Metropolitan Area (MCMA), is the most populated urban area in Latin America and one of the most populated in the world. It is located at the southern end of the Valley of Mexico at an average altitude of 2,240 meters. It is a very large urban area, occupying 1,250 square kilometers. The heart of the city is contained in the Federal District (D.F.), an independent governmental area containing the federal capital, similar to the District of Columbia in the United States. The D.F. is surrounded by 17 municipalities within the State of Mexico.

Most of the MCMA is contained in the valley, which is surrounded by mountain ranges averaging 3,200 meters in height, but many of the recent settlements were built outside the Valley of Mexico. Some of the peaks in these mountain ranges exceed 5,000 meters in height yet development has taken place on almost all of the suitable land on these ranges (and even some land not suitable for development). Two valley channels, located in the northeast and

northwest of the city, funnel the air to the center and south-west of the city, where it is often becomes trapped by the surrounding mountains.

Mexico City is situated between 19 and 20 degrees latitude and 98 and 99 degrees longitude west. Because of its low latitude, the MCMA receives little rainfall outside of the summer and receives intense solar radiation all year round. Temperature usually ranges between 12 and 17.4 degrees Celsius, but additional hot-spots due to urbanization can contribute up to 12 degrees Celsius to the temperature above surrounding suburban and rural areas.

City Demographics¹⁷²

While it is no longer the largest single city in the world, Mexico City is still worthy of the moniker of "Mega-City." Mexico City is the heart of the nation, both for historical and modern Mexico. In 1900, Mexico City had 344,000 residents and was growing at 3.1 percent per annum. The civil strife in Mexico during the early part of the 1900's intensified its growth as people from outlying areas sought refuge in the city. Throughout the early part of the twentieth century, the city was growing at a rate of 4.6 percent per year, doubling in population every 15 years. The urban sprawl began in earnest in the early 1970's as the State of Mexico attracted increasing numbers of people from both the Federal District and the outlying rural areas. Increasing industrialization continued this trend and the population has grown consistently. Since 1980 the Federal District has actually been decreasing in population, with the difference being accommodated by growth in the municipalities in the State of Mexico.

Within the federal district, the northern half has always been more populous than the southern half. Instead of continuing to populate the federal district, the State of Mexico, especially the northeastern municipalities, underwent explosive growth in the 1980s and 1990s. This trend is consistent with the central city deconcentration trend many large cities experience,

with the population increases in the suburbs ranging from 60 to 120 percent for the 1970 to 1990 time periods. At the same time, the population density also grew rapidly from 1970 to 1990. In 1950, the average density was only 101 persons per square kilometer. By 1990, it had reached 791 persons per kilometer. The greatest density increases were found in the fastest growing sections of the city, the northeastern municipalities in the State of Mexico.

The age structure of the city reflects the age structure of Mexico as a whole. In 1970, the largest age category was those of children, 0-4 years old, after which it tapers off to the 60 to 64-year-old range. In 1990, the percentage represented as children has been reduced, with the 15 to 19 year old range now comprising the largest percentage of the population. This has serious implications as these teenagers are entering the work-force in the 1990's, necessitating an increase in employment and transportation options.

The socioeconomic profile of Mexico City is similar to most major cities in developing countries. Literacy is increasing for all citizens of Mexico, but Mexico City has a higher literacy rate than the average for the country. In 1990, Mexico City had an average literacy rate of 93 percent (defined as people who declare they know how to read and write a message) compared with a national average of 86 percent. This may be attributable to the accessible public education. Forty-one percent of the population reports at least a primary level education. Mexico City has a high variability in income. Seven percent of the population reports making five or more times the minimum wage, while about 20 percent of the population reports having income less than the minimum wage. The areas represented by a high percentage of low income are located primarily in the northeast and southeast suburbs of the federal district. These periphery areas are also the most likely to have housing and neighborhood deficits.

These housing deficits are of particular interest because of the link between housing shortages, development in marginal areas and particulate air pollution. Originally much of the city was surrounded by *ejidales*, or communal plots of land for use in agriculture. For much of the development period of Mexico City, sales of *ejidales* were forbidden. This led to the development of squatter settlements on them by their communal owners. These squatters, or *paracaidistas*, build where there are little or no basic urban services. In 1970, 43.6 percent of the population lacked housing with basic services. This rate has been decreasing but there are still many areas that lack services and these lie mostly on the periphery of the city. More than half of the housing in the city that does have basic services has been financed by low-income groups and much of this development has occurred on land that is of uncertain ownership. Housing deficits are highly correlated to population and social rank. The higher quality housing is located in the more populous and affluent areas of the city. The largest housing deficits occur in the State of Mexico, in the northeast and southeast suburbs.

Prevailing Attitudes

The prevailing attitudes towards the pollution problem are also typical of residents in a large city of a developing country. Because the standard of living is often so low (the minimum daily wage is approximately \$8), the residents often put air pollution at the bottom of their worries. With the housing deficits and lack of basic services that residents experience, clean air is a problem to be dealt with when other problems have been addressed. A Mexican sociologist, Jose Luis Lezama, summarizes the problem as follows: "The citizens and government share in a will to minimize the problem. Since the possibilities for change are so slight, the best solution is to ignore it. Mexicans have other priorities. They see pollution as a luxury item."¹⁷³

¹⁷³ Preston, 1999

Combined with previous failures to provide basic services, it is understandable why many residents of Mexico City have a fatalistic attitude towards air pollution. As sewer and electricity have been slow to make their way to the settlements, poorer residents do not see progress ever being made towards a problem as large as air pollution. They are reluctant to "think globally, act locally" because they believe that it can only hurt them. For example, much of the pollution comes from the collective system of buses known as RUTA 100. In many outlying areas, away from the Metro public transportation system, they are the only form of transportation readily available. Transportation is a vital service in Mexico City, bills need to be paid in person and shopping needs to be done almost daily. The inconvenience that using the subway would cause is just too much effort. Understandably there is little public backing for a reduction in RUTA busses, and the fatalistic attitude perpetuates itself.¹⁷⁴

In addition, the education and media perpetuate this "helpless" image. While the citizens of Mexico City are better educated than the rest of the Mexican population, their basic understanding of pollution issues is lacking. Without a formal scientific education in school, the residents of Mexico City educate themselves about the pollution issues by discussing the problem among themselves. In this manner of education, urban myths and misunderstandings are perpetuated. Most of the residents of Mexico City believe they can see ozone (they are actually seeing the particulate pollution that often accompanies it or NO₂) and that ozone is directly emitted from automobiles.¹⁷⁵ These types of myths are perpetuated by the media, which plays on people's concerns and lack of knowledge about the problem. The only pollutant that Media focuses on is ozone, which ignores the threat that PM-10 poses to general health. The citizens of Mexico City have not yet internalized the fact that a reduction in all types of air

¹⁷⁴ Discussion, Mexico City Workshop, February 16, 1999

¹⁷⁵ *ibid*

pollution is central to their well-being, but they do know that peak events can have drastic health consequences. Thus they have become "ozonized,"¹⁷⁶ and begin to feel bad every time there is a contingency without recognizing their chronic problems. This is another effect the media has on the treatment of the pollution problem.

This narrow view of air pollution and the citizen's power to affect changes has two consequences for the population's attitudes towards air pollution. The first is that if any progress is going to be made, the government will have to make it. This resignation makes public participation in pollution reduction programs difficult to garner.¹⁷⁷ Public participation in planning and regulatory programs has traditionally been of very limited scope. As a consequence there is a long-standing tradition of regulation absent of public participation. This absence leads citizens to believe that pollution is a governmental problem and if there is not significant progress, it is because the government is ineffectual.¹⁷⁸ This again acts as a negative feedback to reduce the role of average citizens and private sectors (such as transit groups) in governmental programs. This role is central to the success of many components of pollution reduction programs.

The second consequence is that there is very little environmental consciousness in the society as a whole. In contrast with the American tradition of an activist mindset, average citizens in Mexico have not had much of a role in developing policy and hence lack the activist mindset that would tend to develop a consciousness about issues such as the environment. Without a tradition of public participation, it is even difficult for those who have such a view to become activists who organize groups around environmental issues. The average citizens do not see that their input is welcomed or valued and tend not to develop groups to pursue particular

¹⁷⁶ *ibid*

programs. Much of the environmental movement in the United States was sparked by mothers who were concerned about the effects pollution was having on their children. In contrast, in Mexico, mothers are resigned to the health problems and do not see that they have a role in its reduction. Instead, they are resigned to the situation and see little they can do about it.¹⁷⁹ Environmental activists and government alike have recognized the need to foster non-governmental organizations (NGOs) and private sector activism around the air pollution issue. The current NGOs are seen as radical and argumentative, providing little valuable input to the policy process.¹⁸⁰

Local Institutions

Many of the problems that Mexico City experiences are common to almost any large city in the world, in varying degrees. Transportation, land use, housing, city planning and natural resource management are common challenges. Hence, all large cities have at least some institutional capacity to deal with these issues. All of these issue have a direct bearing on the air pollution problem and hence all warrant closer inspection. When examining the institutions, it is also useful to keep in mind that many of the problems common to all these cities are exacerbated in Mexico City because it deals with so many of these issues on a much larger scale.

Land Use¹⁸¹

It is clear that some planning of development in Mexico City would be useful. It would protect important national treasures and sensitive ecological areas. It may help prevent development on land not suitable for building and guide development to the land that is most suitable for that use. Yet in most of Latin America, land use planning is a relatively new

¹⁷⁷ Adrián Fernández interview

¹⁷⁸ Lezama, 1999

¹⁷⁹ Preson, 1999

¹⁸⁰ Discussion, Mexico City Workshop, February 16, 1999

¹⁸¹ Ward, 1998

phenomenon. Mexico avoided formal planning for a long time because it usurped a degree of control that the top leadership enjoyed. To give power to a stable, technocratic group that would likely continue past the *sexenio* (6 year term of the president) is to undermine some of the executive authority.

Hence, before 1970 the only planning in Mexico referred to the economic planning and modeling that occurred in different agencies within the federal government. The Echeverría administration (1970 to 1976) instituted programs designed to promote decentralization of industry and to promote industrial development outside the city. This led to the Human Settlements Law of 1976, the law which gives the state the power to intervene in development for the purpose of land use planning. Throughout the past twenty years, this law has been used to promote development outside the three largest metropolitan areas by restricting their growth. These policies are aimed at reducing the apparent disparities between urban and rural industrial growth. Yet despite this ostensible activity, most of the planning has remained passive and has been overridden by the economic mandates of the day.

Consistent with the trends of the country, most of the planning has been done at the federal level. After 1976, there were various plans at the national level, called National Urban Development Plans. They were dependent upon the goodwill of the other ministries for implementation, and the actual implementing ministry bounced around in each new *sexenio*. In the De la Madrid administration (1982 to 1988), the land use portion of the program was almost entirely abandoned in favor of economic measures in response to the economic crisis. Although only some areas were slated for economic growth, the planning aspects took a back seat to the need for widespread economic development. Then, in 1985, a major earthquake rocked Mexico City and planning was again important as large amounts of resources were available for distribution. Due to political consideration, most of the money was spent to rebuild the damaged

areas to their previous uses instead of relocate people and industry outside of the Metropolitan Area.

Until 1988, Mexico City had been growing rapidly and most of the new development was funneled into urban sectors. Under Salinas (1988-1994), the focus was growth for export and free trade, so some of the development pressures on Mexico City were decreased. Yet the growth continued and the plans for the metropolitan area focused primarily on population and economic growth away from the urban centers. These initiatives were underfunded and lacked any authority, so they were largely ineffective.

The next wave of planning, the one that continues today, is a focus on cross-jurisdictional planning for the entire metropolitan area. In 1989 the Federal Government proposed that the Federal District and the State of Mexico combine agency activities for water, transport and police services in the Metropolitan Area into a Metropolitan Council. This Metropolitan Council was never realized but it laid the basic framework for cross-jurisdictional activities that would become important later for pollution control activities. Planning functions continued to be undertaken within jurisdictions with some partial consideration of their effects on other jurisdictions.

Land use planning has taken place within this institutional context. The latest development program (SEDESOL 1996) has many of the same characteristics of the plans of the past. It includes consolidation of Metropolitan areas, territorial planning and promotion of public participation. The major improvement of this most recent program is the fact that it is vested in a relatively powerful ministry, the ministry of Social Development (SEDESOL). Yet even at this high level, SEDESOL is not powerful enough to ensure coordination between the land use plans of different municipalities. It has been able to issue some broad goals for the land

use process. The Master Plan for the City of Mexico is aimed at improving access to the centers of economic activity and increase housing, infrastructure, services and utilities. One of the most interesting features of the plan is that, for the first time, land-use restrictive zoning will be implemented. In the non-urban areas, the plan has strict controls to prohibit development in the conservation areas that ring the city and temporary development in the "buffer-zones."

The actual implementation of this most recent plan reflected the highly politicized process that runs in the face of planning. While the plan was completed and different zones clearly demarcated, there was virtually no implementation. Flyers were distributed with each municipality's land use map. These were complex and difficult for much of the population to understand, so they ignored it. When it began to look like enforcement actions were going to be taken on properties in violation of the zoning, the political process took over and the plan was emasculated. Also, the multiplicity of offices with partial jurisdiction over a land-use question (e.g. Ministry of Social Development and Ministry of Commerce) makes any question of policy an inherently political struggle.

Irregular Settlements and De-Forestation

Of particular interest from a pollution standpoint are the squatters settlements, known as "irregular settlements" (*Colonias populares*) These villages are normally built upon public land, either set aside as unsuitable for development, as an ecological preserve or as communal farmland (*ejidos*). The residents, having nowhere else to live because of the housing shortage, set up tent villages on any open land. Over time, as they can collect additional funds, the dwellings are improved using whatever materials they can find/afford. These "self-help" housing units are gradually improved until they have obtained some sort of permanent structure. This is often done in violation of the law and most often without regard to the applicable

building and fire codes. It is estimated that 29 percent of Mexico City's total urbanized area currently has an illegal land tenure status, inhabited by 6.6 million low-income people.¹⁸²

Attendant to these settlements is quite a bit of private development. One of the first actions residents take is to utilize all available resources nearby. This includes collecting wood for fires, harvesting edible plants nearby, and even establishing small gardens. At the same time, dirt roads are established so informal services can be offered to the residents. Fuel and wood is delivered by private truck, often at high markups. Transportation is also often provided by private vehicle. Over time, these settlements become permanent.

Once the residents of these irregular settlements have been living in them for a while, they are difficult to remove. An eviction would involve destroying the settlement and displacing the population, which often then establishes yet another irregular settlement. It is also very politically untenable to resort to a mass eviction campaign as it elicits large amounts of negative publicity. Therefore, public authorities are forced to recognize these settlements until alternative housing becomes available. Under the explosive growth that Mexico City has been experiencing, this is very unlikely. So eventually, the irregular settlements are provided with sewage, piped water and electricity, legitimizing their existence.

The environmental implication of these settlements is threefold. They tend to increase urban sprawl since most land of this type is available only on the periphery of the city. Once urban sprawl is established, it becomes more difficult to provide transportation services, and emissions from vehicles increase due to their expansion. Second, the pressure placed on the natural resources of a certain area is increased as well. Even though it is illegal to fell a tree in many of the irregular settlements, it is a great temptation for a family that does not have enough money for food and fuel. Nearby water resources are also taxed as more people are using the

¹⁸² Pezzoli, 1998

same common resource. And, since sewage and proper sanitation is a huge problem in these areas, the areas are quickly contaminated with feces and garbage. Finally, increased development is accompanied with a reduction in vegetative ground cover. This reduction decreases the water in the soil and in the dry air of Mexico City. Therefore, dust is easily suspended in the air by the wind, increasing particulate pollution.

Transportation Planning

With the explosive growth that Mexico City is experiencing, there is a particular need for effective, efficient transportation systems. Getting workers from the peripheral settlements into the factories is a necessity and mobility becomes a major issue for quality of life. Yet before 1968 there was little development of any public transportation system. The Metro public transit system was created in 1968 but wasn't expanded greatly until 1977. At this point, the culture of the automobile had firmly entrenched itself in the Mexican consciousness. As a consequence, the transit system is dominated by individual, private transit options.

Forty-five percent of the vehicles in the country are registered in the metropolitan area and seventy-one percent of those are private cars.¹⁸³ As a consequence, any effort towards transportation planning has to deal with a system with not only incredible momentum towards low-capacity vehicles (defined as cars, taxis, collective taxis and minibuses) but also an industry with vested political interests in maintaining the status quo in transit demographics. Greater than one-half of the population is carried in these low-capacity vehicles, a staggering number considering the poor population of Mexico City. Most of these trips occur in the *colectivos* (Private Minibuses) or taxis.

¹⁸³ Ward, 1998

The trend away from high-capacity conveyances also creates a congestion problem for transportation planners. At peak hours, the roads in Mexico City become so congested that the average speed dips to about 16 kilometers per hour. Efforts to alleviate this congestion, by building additional roads, only exacerbate the problem. Combine the focus on road construction with low fuel costs, low repair costs and cheap car-licenses with the status symbol that the car represents in the Mexican society, and the focus of transit in the metropolitan area remains firmly on the automobile.

Yet despite the apparent importance of transportation planning, conveyance options developed in an ad hoc manner until late in the 1960's. Before this time, transportation decisions were made largely to suit several powerful special interests: The Collective Taxis (or combis) and Bus drivers. In 1981, the bus service, called Ruta-100, was created by presidential decree. Before, it had been run by private individuals and small firms in a politically powerful alliance. The combis also enjoy a large degree of political power due to the fact that there is a shortage of transportation options and abolishing the collective taxi system would have dire consequences for mobility in Mexico City. They have traditionally organized themselves very well and are associated with the PRI (the main political party in Mexico) through a group called the National Confederation of Popular Organizations. (For additional detail to the political structure see Obedezco, Pero No Cumplo).

In this highly charged political environment, a number of transportation organizations have been developed. The primary transportation planning organization is the Metropolitan Secretariat for Traffic and Highway Management. They are a part of the government of the Federal District and responsible for transportation planning and infrastructure improvements. The Secretariat has a professional, dedicated staff but a number of factors conspire against

success in reducing congestion¹⁸⁴ Educating the drivers about the need to follow the regulations is a big priority. Many flow improvement policies have been rendered ineffective because drivers do not follow the regulations. Another problem, similar to those of many cities in the United States, is the underutilization of automobiles. Cars with an average of 1.2 occupants make 20 percent of the trips in the city, contributing to congestion and road-maintenance expenditures. Efforts to increase car occupancy have been largely ineffective.

In an effort to alleviate some of these problems, the government has heavily promoted (and subsidized) the Metro and this emphasis has been somewhat successful. Ridership is up and it is heavily utilized during peak periods of the day, but additional expansion is needed to provide citizens on the periphery access to the Metro. Currently, it is mainly used as a conveyance into the downtown area, while buses are used to transport residents from their homes to other transportation options. Lack of resources has constrained expansion of the system and until services are extended to more areas of the city, it will be view as a secondary transport option for many people.

Until the Metro system can be expanded, efforts will continue to be aimed at behavior. The political power of the private transportation groups is such that it is unlikely that consolidation of the public transport system is a viable program. Political interests still favor the wealthy citizens of the city, and because they are the people that are most likely to use private automobiles, focus on expanding the automobile infrastructure is likely to continue. The *Hoy no Circula* program (discussed in Chapter 3) was aimed at drivers behavior by forcing them to not drive one day a week. Unfortunately, it was largely unsuccessful. Efforts in the near future will likely focus on making car trips cleaner and reducing congestion through improved traffic

¹⁸⁴ Mexico City Workshop, February 16, 1999

policing and planning. Additional infrastructure investments are unlikely in the near future due to budgetary constraints.

Politics of the Mexico City Metropolitan Area

The politics of Mexico City are really the politics of the country of Mexico. The important role that the city plays in the national economy and identity ensures that issues that affect the city have a national importance. Accordingly, the changes in the national government have been reflected in the city government in recent years and to understand the governing structure and politics, one needs to understand the politics of Mexico as a whole.

National Political Structure

On inspection, the structure of the Mexican government strongly resembles the system in the United States. It is a federation of states with a division at the federal level among three branches: the executive, legislative and judicial. According to the constitution, each has autonomy from the other branches and act as checks upon one another. On paper, officials are locally elected, similar to the process in the United States. In actual implementation, political autonomy at local levels is practically non-existent because of centralism at both the party and governmental level. Due to this centralism and its relationship to financial matters (the purse strings reside at the highest level), local agencies have traditionally had little or no hand in developmental or regulatory activity.

The power of the PRI as the single governing party dates back to the 1930's when it began as the National Revolutionary Party. At this stage, the Party shed its traditional ties with the military and began co-opting local leadership structures, in effect making them part of the party. President Cárdenas was the principal architect of land reform, creating the ejidos that surround Mexico City today. By 1945, the party had evolved to its current form. Until the late

1980s, the PRI was the only form of government, traditionally co-opting opposition groups whenever possible. The professional and peasant organizations (similar to unions in the United States except membership is widespread among all different sectors) are both intimately linked to the Party (The National Confederation of Farmworkers, Confederation of Popular Organizations). Its association with Cárdenas has traditionally garnered its support among the poor and lends its association with the leftist ideals. Its incorporation of the existing power structure and system based on patronage have traditionally endured it to the middle and upper class citizens with political interests.

To perpetuate the PRI leadership's control, the candidates for office are hand-picked by party leadership for each election and historically those candidates have run virtually unopposed. An individual's chances of nomination for a position are directly tied to his personal relationships with others in the party, creating a patronage system. The President is the head of this system, and is able to imprint his personal style and implement his agenda freely (his system is referred to as his *camarilla*). Below the President, the system can be viewed as consisting of interlocking chains of patron-client relationships. The *patron*, is member that his higher political status and can provide benefits to his "clients" in return for their loyalty. Many of the clients act as a *patron* for someone with less status than they, and so on. The flow of services back up the chain primarily consists of loyalty, voter mobilization and problem-solving. An interesting observation is that the links between members of the government are directly based on personal loyalty rather than loyalty to any particular ideology or geographic region. This limits policy innovation from below because governmental agencies are bound by the system to implement the platform of the President. Since the *camarilla* is replaced with each presidential succession, bureaucrats often have more than one *patron* over their lifetimes as a politician, but only one at any given time. When a person moves in the government, his clients move with him, creating

little stability in the upper levels of government. The President is limited to a small number of major programs due to his limited political capital (his camarilla is about to disappear so future "favors" are unlikely).¹⁸⁵

Recently, this tradition has been eroded to some degree. Efforts of the Salinas and Zedillo administrations to restore power to the local levels have brought additional funding directly to the municipal level. This funding has been attended by additional political power for the local levels in determining their own programs and policies. This devolution of power away from the central government has also manifested itself in a divestiture of power at the executive level of the PRI to more local levels.

This move was prompted by waning legitimacy of the PRI Government. Due to the economic and social difficulties of the 1980's, the PRI had been losing its popular support. It had become increasingly difficult to reconcile the two different bases of support, the peasants and professionals, in the face of growing economic inequities. The PRI was seen as a self-perpetuating, unresponsive bureaucracy and accordingly other parties were gaining in popular support.¹⁸⁶ Popular media accounts of election-fraud and political oppression have not helped the PRI to regain their primacy and they are currently attempting to reconstruct the party and political system of Mexico to restore their popular support.

The Link to Local Politics

The federal district has had a special relationship to the national government since it was created as a special political entity in 1928 (Before 1928 it was a state and series of municipalities). The reasons for the transition were twofold: The municipalities were in major financial difficulty and intense political infighting between the various parties was being fought

¹⁸⁵ Cornelius, 1991

¹⁸⁶ Ward, 1998

out through local government. Instead of local representative government, a mayor was appointed by the president, as well as 16 local mayors for the delegations (political subunits of the federal district). Since the president has always elected the leadership for the city, he has always been, in effect, the mayor. Thus Mexico City became intimately linked to the federal government and the various political initiatives of the president at that time. In 1988, a new, local congress was formed of local party-political representatives. The effect of this organization has been little more than as an oversight group to monitor budgets and policy.

In keeping with the Camarilla Structure, the mayor of the city takes office and delegates key posts to personnel he has brought with him. The mayor position enjoys a high cabinet status and has been seen as a grooming-ground for presidential successors due to its high profile and national importance. Due to its large population, and the effect that it has on political support, the position is also a highly politicized one. The mayor needs to appease the citizens of the federal district so that they will continue to vote for the president. To this end, a disproportionately large share of national resources has been spent on the federal district. This diversion of resources has come at the expense of the rest of the Mexican population and has caused tension between the residents of the city (called *Chilangos*) and the outlying areas.

The environmental regulators in the Federal District Government have traditionally followed this pattern. For example, Manuel Camacho Solís was appointed mayor by President Carlos Salinas in 1988. Solís had been the head of SEDUE (the agency in the Federal government responsible for environmental protection) prior to Salinas' term and seemed to be a good match for the mayoral position. Solís brought with him a new organization and people within his own *camarilla*, to oversee it. It retained the dedication to the environmental program that Solís had created when he was at SEDUE and was overseen by one of his closest subordinates from SEDUE, Fernando Garza, in a new subagency that he had created.

Yet political structure of the federal district is changing to reflect the political pressures placed on the PRI in recent years. 1998 ushered in the first popularly elected mayor of Mexico City, Mayor Cárdeñas. Interestingly enough, he is a member of the PRD, one of the opposition parties. His role is still the same, to maintain the peace in the city and to garner popular support for his party. Only time will tell what effect this will have on politics in the nation, but Mexico City was paralyzed a number of times in 1998 by large strikes, demonstrations that Cárdeñas was unwilling to stop for fear of being viewed as too authoritarian.

State of Mexico

The relationship between the State of Mexico (State as province not as Nationality) and the federal district has been described as "Rich Uncle, poor cousin." As the federal district receives a disproportionate fraction of the federal funds, the State of Mexico (EM) often has to go without. Federal tax funds are distributed through shared revenue accounts called *participaciones* to the states based on a complicated formula of population, level of poverty and revenue contribution. The states are then obliged to split the money and give some to the municipalities within that state. For purposes of revenue distribution, the federal district counts as a state so it may also collect from these funds. Due to its size and importance in the national economy, the *participaciones* are distributed in a way favoring the Federal District. In 1989, 22.4 percent of the national total went to the D.F., while only 9.3 went to the entire EM. Yet this, combined with local revenue generation activities, still is not enough to support the D.F. and so it has also been the target of budgetary subsidies by the nation of Mexico.

This lack of funding is symptomatic of the problems the State of Mexico experiences. Because it receives so little of the benefits of Metropolitan District of Mexico City while incurring significant expenditures, it is overwhelmed by the demands placed on it by the growing

mega-city. It has not had the funds to really expand its institutional capacity for dealing with the problems of the MCMA and have consequently not been very effective in planning or implementing improvements around Mexico City. This lack of institutional capacity also manifests itself in the lack of coordination between the agencies of the D.F. and thus potential improvements have fallen by the wayside because of missing coordination.

Metropolitan Commission

In an effort to address the needs of coordination between the different levels of government, Salinas created the Commission for the Prevention and Control of Environmental Pollution in the Mexico City Metropolitan Area (Metropolitan Commission). Recognizing that the pollution problem in Mexico City was a multi-jurisdictional problem, Salinas enjoined the State of Mexico, Federal District, Secretariats of Health, Energy, Finance, Transport and Environment, as well as the parastatal oil company, PEMEX, to serve on a commission to coordinate efforts to combat pollution. It was charged with five main duties:

1. Define Goals for the Pollution Reduction Activities in the MCMA.
2. Coordinate efforts between the Federal, State and Local Agencies with jurisdiction over the problem.
3. Design, Monitor and Evaluate Pollution Abatement programs.
4. Establish Standards and Guidelines for the MCMA.
5. Secure and Distribute Funding for the Programs.

The Metropolitan Commission does not meet full time. The council only meets a few times a year. The actual day-to-day operations are done by a technical secretary. The technical secretary reports directly to the President, which is a rotating position with three year terms filled

by the mayor of Mexico City, the governor of the State of Mexico and the head of SEMARNAP (the ministry that regulates environmental quality).

It comes as no surprise that while this institution was designed to overcome institutional barriers, the key characteristics of government would continue. The first president of the Metropolitan Commission was Camacho, the Mayor of the D.F.. The president then selected Fernando Garza (the director of the DDF's General Coordination) as technical secretary.

As an organization, the metropolitan commission is very well funded and hence has tremendous power. It is the organization that designed the most recent plan, PROAIRE, to improve the air quality in Mexico City. It also has political strength. Any of the presidents have tremendous political clout and power. It also has a legal mandate to do something about the problem and to pressure other ministries and agencies to act in accordance with the plans it develops.

Appendix 2: Environmental Programs

Guiding Legislation Overview

The first environmental legislation in Mexico was the **1971 Federal Law for the Prevention and Control of Environmental Pollution**. As discussed in Chapter 3, it established the Ministry of Health as the lead agency to deal with air pollution problems. It included provisions for sanctions against polluters and the authority to close noxious facilities. The regulations crafted to implement the 1971 law defined air pollution solely in terms of smoke and dust. This precluded examining the important pollutant of the time, lead, as well as the other criteria pollutants. Subsequently, only one enforcement action was ever taken based on the 1971 Federal Law.

The next piece of environmental legislation was the **Federal Law of Environmental Protection** as introduced in January 1982 and amended in 1984. This revision of the 1971 law was driven by the shortcomings of the previous legislation, especially its narrow definition of air pollution. The 1982 Federal Law obligated the state and municipal governments to cooperate with the federal ecology agency (SEDUE was created at the same time to oversee the implementation of the law and to increase the political power brought to bear on the problem – SEDUE is a cabinet level ministry). The law was amended in 1984 to include an air quality monitoring system and to address some ambiguity in the goals of the program. The financial crises of the early 1980's precluded SEDUE from issuing new regulations, hence many of the regulations from the 1971 law remained on the books. Thus, the Federal Law of Environmental Protection of 1982 had little effect on air pollution regulation as the standards and enforcement procedures remained the same.

The third piece of legislation to address air pollution in Mexico is the one that remains in force today, the **General Law of the Ecological Equilibrium and Environmental Protection**. It was the first comprehensive piece of legislation and current abatement efforts work within its legal framework. The General Law (*Ley General*) changed the distribution of power to deal with environmental problems. It divested many of the powers that SEDUE had previously held exclusively to state and local authorities.

In Mexico City, The Federal District (D.F.) was given the responsibility of being the primary regulatory authority in Mexico City. SEDUCE retained only the responsibility to regulate industry while the D.F. was given jurisdiction over mobile and non-industry fixed sources within the Federal District. The State of Mexico (EM) was given powers similar to those of the D.F. over mobile and non-industrial fixed sources within the State of Mexico.

The Ley General also contained proscriptions for alternative policy processes, such as the polluter pays principle (see Chapter 3) and laid the foundation for cost-benefit analysis in environmental policy making. It outlined the structure of SEDUE (although only a few of the branches were actually implemented) and redefined SEDUE's mission in the Mexico City Metropolitan Area.

General Law of Ecological Equilibrium and Environmental Protection

Some pertinent articles of the *Ley General*:

ARTICLE 109 BIS

Establishes the requirement for an emissions inventory and emissions permit system

ARTICLE 110

Gives SEDUE the statutory mandate to achieve and maintain ambient air quality standards on both a health and welfare basis.

ARTICLE 111

Grants SEDUE the following powers

10. To establish health based ambient air quality standards
11. To maintain an emissions inventory with the help of local authorities
12. To establish emissions limits based by activity type

13. To formulate and establish national programs to reduce emissions based on the ambient standards, the current air quality and available regulatory instruments
14. To provide technical support to achieve those air quality goals
15. To enforce the emissions limits promulgated in 3
16. To establish an air quality monitoring system
17. To create an enforcement authority to oversee implementation of emissions limitations
18. To promulgate, in coordination with the Secretariat of Commerce and Industrial Promotion, health based standards for mobile source emissions and the manufacture of automobiles
19. To define airsheds and limit the emissions in each to ensure maintenance of air quality standards
20. To establish, in coordination with the applicable authorities, a system of transferable emissions permits
21. To oversee local efforts to combat air pollution
22. To disseminate new pollution abatement technologies
23. To establish a system to predict environmental emergencies and enact contingency plans during emergency conditions to protect the public health and wellbeing.

ARTICLE 112

Requires local governments to:

1. Regulate fixed sources of air pollution when the Federal government is not forced to
2. Consider air pollution effects in their urban development plans
3. Enforce emissions limits
4. Maintain an emissions inventory
5. Establish a mobile source permitting program
6. Monitor local air quality with the help of SEDUE
7. Establish a contingency plan for environmental emergencies to restrict vehicle circulation
8. Take necessary measures to avoid environmental emergencies
9. Prepare information for SEDUE about the air quality of the region
10. Comply with other parts of this law (including SEDUE regulations)
11. Establish programs to attain the air quality standards established by the national government
12. Retain all other powers expressly granted to them.

ARTICLE 113

Any emissions to the atmosphere must be permitted or otherwise reflect the requirements of this law

ARTICLE 114

The applicable authorities must promote, in areas near inhabited areas where additional emissions are acceptable, facilities that generate minor emissions increases.

ARTICLE 115

SEDUE will promote that future development programs consider the site and the effects of development on air quality

ARTICLE 116

For the granting of fiscal stimuli, the applicable authorities must give preference to those who:

1. Acquire, install and operate emissions reduction equipment
2. Manufacture or sell emissions reduction equipment
3. Research emissions reduction equipment
4. Locate its facilities to minimize the pollution of urban areas

Regulations to Implement the General Law

For Actual Details of the fixed source regulations (downloadable files) see:
http://www.ine.gob.mx/normas/cont_at/industria/index.html

NOM-039-ECOL-1993	22-oct-93
Establishes the measurement methods to determine the concentrations of sulfur dioxide, sulfur trioxide and sulfuric acid mist in sulfuric acid manufacturing plants.	
NOM-040-ECOL-1993	22-oct-93
Establishes the maximum permissible atmospheric emission levels of solid particulates, as well as the requirements for the control of fugitive emissions from cement manufacturing fixed sources	
NOM-043-ECOL-1993	22-oct-93
Establishes the maximum permissible atmospheric emission levels for solid particulates from fixed sources	
NOM-046-ECOL-1993	22-oct-93
Establishes the maximum permissible atmospheric emission levels of sulfur dioxide, sulfur trioxide mixed in sulfuric acid from dodecylbenzenesulfonic acid production processes in fixed sources	
NOM-051-ECOL-1993	22-oct-93
Establishes the maximum permissible level of sulfur by weight in industrial liquid gas fuel used in fixed sources in the Mexico City Metropolitan Area.	
NOM-075-ECOL-1995	26-dec-95
Establishes the maximum permissible atmospheric emission levels of volatile organic compounds from the water and oil separation process in petroleum refineries.	
NOM-085-ECOL-1994	2-dec-94
Atmospheric pollution – Fixed Sources – Using solid, liquid, gas or any combination thereof of fossil fuels. Establishes the maximum permissible emission levels of smoke, total suspended particulates, sulfur dioxide and nitrogen oxide, the requirements and conditions for the operation of indirect heating by means of combustion as well as the maximum permissible levels of sulfur dioxide in direct heating equipment by means of combustion.	
NOM-086-ECOL-1994	2-dec-94
Atmospheric pollution – Environmental protection specifications that must be met by liquid or gas fossil fuels that are used in stationary or mobile sources.	
NOM-092-ECOL-1995	6-sep-95

Regulations atmospheric pollution and establishes the requirements, specifications and parameters for the installation of vapor recovery systems for gasoline stations in the Valley of Mexico.

NOM-093-ECOL-1995 6-sep-95
Establishes the testing method to determine laboratory efficiency of the vapor recovery systems in gasoline service stations.

NOM-097-ECOL-1995 1-feb-96
Establishes maximum permissible atmospheric emission levels of particulate matter and nitrogen oxide in glass manufacturing processes

NOM-105-ECOL-1995 02-apr-98
Establishes the maximum permissible atmospheric emission levels of sulfur oxides from the recovery processes of cellulose manufacturers.

NOM-121-ECOL-1997 14-jul-98
Establishes the maximum permissible atmospheric emission levels of volatile organic compounds (VOCs) and methods of calculating the emissions from automobile painting operations.

For Actual Details of the mobile source regulations (downloadable files) see:
http://www.ine.gob.mx/normas/cont_at/vehiculos/index.html

NOM-041-ECOL-1996 25-feb-97
Establishes the maximum permissible limits for polluting emissions originating from mobile sources using gasoline

NOM-042-ECOL-1993 22-oct-93
Establishes the maximum permissible limits for unburned hydrocarbons, carbon monoxide and nitrogen oxides originating from newly built mobile automobile sources and vaporizing hydrocarbons from combustible systems using gasoline, liquid gas (L.P. gas), natural gas and alternative fuels for vehicles with a gross weight of 400 to 3,857 kilograms.

NOM-044-ECOL-1993 22-oct-93
Establishes the maximum permissible limits for smoke opacity in hydrocarbon, carbon monoxide, nitrogen oxide and suspended particulate emissions originating from new motors using diesel as fuel with a gross weight of more than 3,857 kilograms.

NOM-045-ECOL-1996 22-apr-97
Establishes the maximum permissible limits for smoke opacity in diesel emissions from circulating vehicles

NOM-047-ECOL-1993 22-oct-93
Establishes the equipment characteristics and measuring procedures to verify pollution levels in emissions from vehicles using gasoline, liquid petroleum gas, natural gas and other alternative fuels.

- NOM-048-ECOL-1993 22-oct-93
Establishes the maximum permissible limits for smoke opacity in diesel emissions from circulating vehicles
- NOM-049-ECOL-1993 22-oct-93
Establishes the equipment characteristics and measuring procedures to verify pollution levels in emission by circulating motorcycles using gasoline or an oil-gas mixture
- NOM-050-ECOL-1993 22-oct-93
Establishes the maximum permissible limits for gas emissions from vehicles using gasoline, liquid petroleum gas, natural gas and other alternative fuels.
- NOM-076-ECOL-1995 26-dec-95
Establishes the maximum permissible limits for gas emissions for unburned hydrocarbons, carbon monoxide, and nitrogen oxide, such as evaporating hydrocarbons originating from combustible engines using gasoline, liquid petroleum gas, natural gas and other alternative fuels used in newly manufactured vehicles with a gross weight greater than 3,857 kilograms
- NOM-077-ECOL-1995 13-nov-95
Establishes the equipment characteristics and measuring procedures to verify smoke opacity levels in emissions for vehicles using diesel fuel.

Pollution Abatement Programs

Efforts prior to the General Law of 1988

The first concerted programs to achieve air pollution reductions were devised in the mid 1980s. On February 14, 1986, after several pollution episodes, 21 measures to control air pollution in the MCMA were published in a presidential decree. The measures were announced by the National Commission of Ecology (CNE). Approximately a year later, in January 1987, 100 actions to fight against water, air, and soil pollution were announced by the Mexican President. These were directed not only towards the problem within the MCMA, but were country-wide in scope. The CNE was in charge of these actions and remained responsible for air pollution regulation until the 1988 General Law was passed. Most of the 21 measures and most of the air control options for the MCMA within the “100 Actions” program are mentioned below to provide examples of the kind of pollution mitigation options that were proposed:

21 Measures

Public Transportation, Traffic and Land use.

- 2,800 new buses for Ruta-100 with new engines and pollution controlling devices.
- Improvement of the public electrical transport.
- Encouragement of public transportation in the downtown area and enlargement of pedestrians zones.

Cars and Gasoline

- Pollutant emission inspections on 300,000 private and official vehicles during 1986 and 1987.
- Reduction of the lead content in gasoline sold in the MCMA from 2.5 to 1.0 ml/gal.
- Distribution of gasoline with oxygenated additives in the MCMA starting in June 1986.
- Requirement for new vehicles to use emission control devices.

Energy

- Gradual substitution of fuel oil by compressed natural gas (CNG) in the “Valle de Mexico” power plant.
- 60 % of the fuel distribution tanker trucks improved with turbochargers.
- Industry and Services
- Construction of two industrial parks to relocate industries affected by the 1985 earthquake
- Negotiations to move high-polluting and water- intensive industries out of the city within three years.

Land and Urban Development

- 36 million new trees for the MCMA.
- Closure of about 6,500 clandestine open dumps and distribution of more than 1,000 trash containers.
- Education programs to protect forests in the MCMA.
- New housing developments in the MCMA restricted to medium and small apartment buildings.
- Street maintenance work during night shifts to avoid traffic congestion.

100 Actions

Mobile Sources

- Application of new technologies to reduce emissions in new vehicles.
- Implementation of mandatory engine inspection for the vehicular fleet.
- Tax incentives for shops to acquire equipment to inspect and diagnose engines.
- Production of better fuels.
- Expansion of nonpolluting public transport.
- Maintenance and tuning of Ruta-100 buses.
- Incentives to promote collective transportation in schools, unions, enterprises, and public offices.
- Certification of industrial and commercial fleets required before winter season.
- Campaign to reduce the number of vehicles on the streets. Programs to improve traffic such as synchronizing traffic lights.

- New traffic scheme to improve circulation in the downtown, San Angel, and Coyoacan sectors.
- Special night schedules for goods delivery.

Stationary Sources

- Require new industries to comply with new emissions standards.
- Establish pollution controls for each type of industry.
- Offer tax-incentive mechanisms to promote acquisition of pollution prevention technologies and equipment.
- Supervise combustion processes.
- Establish permanent CO, PST, SO₂, NO_x, and HC control program for those industries participating in the contingency plan.
- Relocate polluting industry outside the MCMA
- Establish regulations and standards to control industrial emissions.
- Improve the stationary sources emissions inventory in the MCMA.
- Perform emissions inventory for the 300 most hazardous industries in the MCMA during 1987
- Use CNG instead of fuel oil in the power plants in the MCMA.
- Mandate electric energy savings.
- Disallow expansion of the 18 de Mayo refinery and establish control of the emissions from storage tanks.
- Relocate foundries to outside the MCMA
- Improve publication of the IMECA index.
- Continue air quality monitoring
- Implement by March 1987 the Secretaría de Desarrollo Urbano Y Ecología (Urban Development and Ecology Secretariat—SEDUE) central laboratory, the information system, and the models to predict high pollution episodes.

PICCA

In 1989, after the General Law set the stage for a new air pollution abatement program, the Integrated Program Against Air Pollution in the Valley of Mexico (PICCA) was developed by the Intergovernmental Technical Secretariat.¹⁸⁷ Each participating agency was included in a working group along with national scientists and specialists from the environmental agencies of Japan, Germany, England, France, Canada, and the U.S. The Intergovernmental Technical Secretariat analyzed national and international scientific and technological advances in the field and canvassed opinions from citizens, environmental groups, the Federal District Council of

¹⁸⁷ Consisting of the Secretariats of Ecology and Urban Development; Treasury and Credit; Programming and Budget; Commerce and Industrial Development; Communications and Transport; Energy, Mining and Parastatal

Representatives, and the Mexican Congress. Each working group assessed the trends in air pollution and studied projects to reduce the pollution growth rate in its area of responsibility. The groups reviewed existing options within a strict analytical framework defined by health risks, cost/environmental benefits, technical possibility, and financial feasibility. The actions that were recommended as a result of these studies were not intended to restore the air quality the city had half a century ago. The population in the Valley of Mexico had increased from 1.5 million inhabitants to 15 million and because of the change from agriculture and mining to an economy sustained by industry, transportation, and services, restoration was impractical at that time.

1. PICCA recommended that 41 specific actions be taken to learn more about and to reduce the air pollution in Mexico City. These actions were targeted at:
2. Reducing emissions by improving the quality of fuels being supplied in Mexico City
3. Reducing emissions from the production and distribution of fuels Reducing the emissions from the vehicular fleet by relieving congestion, requiring conversions to cleaner-burning fuels and implementing emission control measures for public transport and industry
4. Beginning a program to reforest the Valley of Mexico.

The program also called for the development of in-house technical expertise in air quality in Mexico and for studies to determine the best policy for attacking the air pollution problem. In 1989 the program was estimated to cost 2.5 billion dollars and would have reduce emissions of most pollutants by 26% to 80% over its lifetime. Subsequent revisions to PICCA added more actions, increasing the cost but also projecting a greater improvement in the air quality.

ProAire

The most recent program to combat air pollution in Mexico City is the *Programa para Mejorar la Calidad del Aire en el Valle de México 1995-2000* (Program to improve the quality of the air in the Valley of Mexico 1995-2000, or ProAire) ProAire represents the latest efforts to Combat Air pollution focused around the Mexico City Metropolitan Area. The efforts of

Industry; Agriculture and Hydraulic Resources; Health; the DF; the EM; the municipal governments of the urban

ProAire are focused around four areas: cleaner industry, cleaner vehicles, efficient transport and a new urban order and ecological restoration.

ProAire proposes the following strategies to achieve these goals:

- Incorporation of new (or improved) technologies into industry and the service sector
- Incorporation of new (or improved) technologies into automobiles
- Substitution of improved power sources into industry and the service sector
- Substitution of improved power sources into automobiles
- Provision of an ample and efficient supply of public transport
- Integration of metropolitan policies (urban development, transport and environmental protection)
- Provision of economic incentives for environmental protection
- Improving industrial and vehicular Inspection and monitoring
- Provision of additional Environmental information, education and social participation.

Using these strategies and goals, the Metropolitan Commission created 94 measures to improve the air quality in the Valley of Mexico These include:

Instruments and actions of PROAIRE

- New standards for oxides of nitrogen and volatile organic compounds for industry and the service sector.
- Regeneration for the nitrogen oxide control in the Valley of Mexico thermoelectric plant and gradual substitution of the Jorge Luque thermoelectric plant with more efficient systems of generation.
- Standards for better quality fuels for industry and the service sector (LP gas, gasohol etc.).
- New price structure and industrial fuels market reforms to favor fuels with fewer air pollution impacts (like the natural gas).
- Use of fiscal instruments such as tariffs, exemptions and new international loans to finance the technology-based emissions control equipment.
- Use of the *Hoy no Circula* and *Double Hoy no Circula* programs to promote technological modernization of the vehicle fleet
- Increasingly strict emissions standards for new vehicles and those in circulation.
- Expansion of the Inspection and Monitoring program
- Progressive overhaul of the standards for gasoline formulation.
- Incorporation of medium and long term environmental costs in the prices of automotive fuels.
- Reconstruction and extension of the public transport infrastructure.

zone; PEMEX; the CFE; and the IMP

- Extension of the nonpolluting collective transport systems like trolley buses and high speed trains.
- Reorganize the operation of the transit and public transport systems.
- New urban development policies to promote environmental efficiency, diversification of land use, the urban renewal, protection of ecological conservation zones and the revitalization of the central Mexico City.
- Reforestation and ecological restoration of the suburban zones in the eastern part of the Valley of Mexico.

Institutions

(From LANL, 1994)

SEDESOL / SEMARNAP

The SEDESOL is headed by the secretary and consists of three undersecretariats, three institutes and one attorney's office. One of the institutes and the attorney's office are the entities within SEDESOL that are in charge of all environmental affairs.

The General Law of Ecological Equilibrium and Environmental Protection and the Organic Law of Public Administration assign to SEDESOL the responsibilities and facilities for environmental and ecological management in Mexico. Two organizations in SEDESOL, the National Institute of Ecology (Instituto Nacional de Ecología—INE) and the Federal Attorney's Office for Environmental Protection PFPA (Procuraduría Federal de Protección al Ambiente) are responsible for environmental affairs. The INE responsibilities are to establish the national policy for ecological matters, standards for the environment, national environmental restoration policy; to report environmental impacts that fall under federal providence; to study and analyze environmental risks; and to perform research and development. The PFPA is in charge of citizen participation and the enforcement of environmental and ecological regulations.

Parastatal—SEMIP

The SEMIP was created in December 1982 and its Internal Law was modified in July 1993. The new Internal Law appeared in the Official Diary of the Federation (Diario Oficial de

la Federación, Julio 1 de 1993). Among the most important responsibilities of SEMIP is the surveying and dictating of guidelines to state-owned companies, the most important ones being PEMEX and the CFE. It is also in charge of approving the issuing of concessions, authorizations, permits, licenses, and in general any document that allows the use, exploitation, tap-ping of the nonrenewable natural resources, and the cancellation of these permits. SEMIP is also in charge of approving the installation and operation of plants for exploiting radioactive minerals and the fabrication of components for nuclear systems, as well as the decommissioning of nuclear and radioactive facilities.

The DDF

The DDF is headed by the mayor of Mexico City and is in charge of the government of the DF. The DF was created by the 1824 constitution, and in 1941 the Organic Law of the DDF designated Mexico City as the capital of the DF.

The General Law of Ecological Equilibrium gives the DDF legal power to prevent and control stationary and mobile emission sources in the DF, as well as the capability to collaborate with other secretariats. In January 1992 the Mexico City Metropolitan Commission for Pollution Prevention and Control was created by presidential decree; all the environmental affairs for the DDF are now managed by the commission with the collaboration of the DDF and other official entities, as explained in Section D.1.g.

PEMEX

By constitutional mandate, PEMEX has the responsibility as a decentralized public institution of controlling, handling, and managing all the HCs in Mexico's territory. It controls the activities of exploration, exploitation, refining, transformation, transportation, storage, distribution, and selling of petroleum and natural gas, as well as products derived from petroleum used as basic

raw materials for industry. The *Petróleos Mexicanos Organic Law* of July 16 1992, gives the basic guidelines for the reorganization:

- To keep state control of the petroleum industry and its property;
- To modernize the organizational structure, providing centralized strategic planning and guidance appropriate to an integrated petroleum enterprise; and
- To institute all the required changes in the basic legal framework.

Within PEMEX the organization responsible for industrial security auditing, environmental protection, and energy savings will be responsible for the lead in environmental policy. This organization will undertake strategic planning, setting guidelines for emissions, developing standards and environmental guidelines, reviewing and promoting better practices and new technologies, and consolidating information for the evaluation of goals and institutional objectives. The setting of goals will be in support of the General Directorate for Early Detection and Correction of Deviations from Programs. This responsibility will be carried out with a series of actions. The most important of these actions are

- Evaluation of performance of the subsidiary organizations;
- Development and establishment of information systems for executives; and
- Establishment of formal auditing programs.

CFE

On August 14, 1937, the law created the CFE and provided it with a legal and economic basis.

On January 14, 1949 the decree in which CFE was given legal status as a decentralized parastatal organization was issued. On April 21, 1960 the nationalization process of the electrical industry began, finishing on December 29 of the same year. Today CFE is a parastatal organization in the Federal Administration and is governed by the *Law of Electrical Energy Public Service*, published in the “*Diario Oficial de la Federación*” (Official Federal Journal) on December 22, 1975, and modified by decrees published in the same journal on December 27, 1983; December 31, 1986; December 27, 1989; and December 23, 1992. Article 8 of this law defines CFE status. The CFE mission in Mexico is to ensure electrical energy supply for the

entire nation and to provide quality service; at the same time it is to promote social development, protect the environment, and respect people's customs and moral values wherever CFE works.

1. Environmental Protection and CFE Evolution.

Until the 1970s all environmental protection matters were controlled by the engineers in charge of projects, construction, and production. In the early 1980s, the first environmental protection office was formed. From 1982 to 1985, the offices of environmental protection for thermoelectric, hydroelectric and geothermoelectric plants were formed. The strategic program for the electrical sector states that the priority of this sector is to use natural resources rationally and to protect the environment. The CFE created the Environmental Protection Management Office in April 1992 to provide environmental protection for its projects.

2. Organization.

The Environmental Protection Management Office is a separate office in the CFE. There are also groups in the areas of construction, production, and distribution, which are responsible for environmental protection and are the direct responsibility of the offices they belong to. The Environmental Protection Management Office sets standards and assesses and supports the work of these groups. It is the office in the CFE that is in charge of collaborations with SEDESOL and the other authorities on environmental protection issues. The Environmental Protection Management Office's mission is to insure that agreements established by the CFE are acted upon both inside the CFE and in areas outside of its purview. The principal objective of this office is to minimize the negative impact of CFE activities on the environment while taking into account costs and social benefits of each option. The office is also required to pay special attention to human health and environmental impacts in the planning and execution of projects.

3. CFE Environmental Policy.

CFE environmental policy includes the following:

- To consider the environmental impact of each CFE action and quantify it in order to assure a favorable balance between benefits and costs, internal and external.
- To treat the national standards for ecological protection as the minimum level to which the environment should be protected, and whenever it is rationally justified to provide more protection than is required.
- To collaborate with authorities in order to develop or improve standards and methods for environmental protection.
- To incorporate in the conception, design, and application of CFE environmental protection activities the points of view and recommendations of external experts.
- To take into account the opinions of groups with legitimate interests in the areas of impact of CFE projects.
- To support education, research, and technological development in the field of environmental protection within the capabilities of CFE.

4. Principal Functions of The Environmental Protection Management Office.

- To define standards, criteria and procedures;
- To ensure the observance of those standards;
- To coordinate the institutional program for environmental protection;
- To encourage education and development of personnel;
- To perform or supervise environmental impact studies and define preventive and compensatory actions for CFE activities;
- To manage SEDESOL's approval of studies of environmental impact and restoration; and
- To be the corporate representative of CFE in environmental protection affairs.

The EM

Within the government of the EM the Secretariat of Ecology is the entity in charge of pollution control in the whole state. Therefore it has pollution control responsibility for the part of Mexico City that is in the EM. The Secretariat of Ecology was created in January 1992 with the General Law of Environment Protection for the State of Mexico. The secretariat has the responsibility to set regulations to control and prevent atmospheric and water pollution, taking into account their impact and environmental risk, as well as the Internal Regulation in which the organization and structure of the secretariat is defined.

The structure of the secretariat includes one secretary, one undersecretary, and four general directors: the General Director of Standards, Regulations and Environmental Impact, the General Director of Ecological Studies and Projects, the General Director of Prevention and Restoration, and the General Director of Citizen Concerns and Participation. The General Director of Standards, Regulations and Environmental Impact has the duty and power to institute projects, measures, and directions for environmental protection, as well as to preserve the ecological equilibrium. This General Director also has the power to institute programs for environmental restoration, to evaluate the environmental impact and possible risks caused by construction activities, to evaluate legal aspects of actions, to impose administrative sanctions, to establish emissions inventory and residual waters discharge records, to establish monitoring systems for water and air quality, and to authorize and control operation of vehicular verification centers in all the municipalities and urban zones of the DF except where it is superseded by federal law.

Mexico City Metropolitan Commission for Pollution Prevention and Control.

The Mexico City Metropolitan Commission for Pollution Prevention and Control was created by presidential decree in January 1992. The commission's objectives are to define and coordinate environmental policies, programs, and projects in the Valley of Mexico and to verify the execution of air pollution control actions. The commission is a permanent organization and consists of the secretaries of the National Departments of Social Development; Treasure; Energy, Mines and State-Owned Industry; Communications and Transportation; and Health. The commission also works with the local authorities involved (the DDF government and the EM Government), the General Director of PEMEX, and other government bodies as needed. Mexico City's mayor was appointed President of the Metropolitan Commission for the first two years. The Governor of the State of Mexico will assume the post for the next two years, beginning in

1994, and the Urban Development Secretary will succeed to the position for the third term. The commission has a council in charge of analyzing opinions and proposals for coordinating programs, projects and actions performed by the commission. The council is formed by representatives from the scientific community, environmental specialists, representatives of private social organizations, and members of the Mexican Congress.

The commission includes a technical secretariat that issues the annual program of the commission and prepares programs and projects to obtain donations, credits, and governmental economic support for actions to prevent and control pollution in Mexico City. The commission also surveys these actions and reports periodically about their status and accomplishments. The head of this secretariat is appointed by the President of Mexico.

Appendix 3: Social Pressures Analysis

“In the beginning, the Aztecs believed, the sun had been stillborn, lifeless. It had hung motionless from the sky. Then Cihuacoatl, the demonous earth mother, had pulled an obsidian knife from her loins and cast it upon the earth. Humans used the knife to give their blood to the sun, and only then did the orb begin its slow journey across the heavens. The sun was sustained by offerings of human hearts, without them it would stall again and the earth would perish. The Aztecs believed that their world was created in violence, that it was a fragile place in which their existence was precarious. They believed that nature could not be depended upon to function without their guidance and assistance. It was an awesome responsibility – and one that their conquerors never assumed.”¹⁸⁸

Thus from the ancient roots of civilization in the Valley of Mexico, the precarious balance between man and the environment was implicitly acknowledged by the residents. The ruins of previous civilizations litter the valley floor, a testament to societies that could not manage their relationship with nature. Yet the modern Valley of Mexico, the home of Mexico City, is one of the greatest ecological disasters of the twentieth century. The dormant volcanoes and mountain ranges that provide a majestic backdrop for the city are hidden by polluted air much of the year. In 1996, health-based standards for suspended particles were violated on half of the days and tropospheric ozone levels were above recommended levels almost all year. During days with particularly hazardous air quality, the city is paralyzed. Schools are closed, automobiles restricted from circulation and industries are forced to suspend activity to protect the health of the children and elderly of the city.

In the face of such a health hazard, the citizens of Mexico City (*Chilangos*) might be expected to rise in revolt, demanding that the government do something about pollution levels. Yet the population is quiet, neither demanding the government take action nor doing much to improve air quality on its own. This is in stark contrast to Los Angeles during the 1940s, when bike messengers were issued gas-masks as standard equipment and public sentiment forced the government to regulate industrial, mobile and agricultural sources of air pollutants.

The efforts against air pollution in Los Angeles can be deemed one of the United States' greatest achievements towards clean air. Air pollution levels in the city have been reduced measurably in the face of tremendous industrial and population growth. Much of this success can be credited to the environmental interest groups and individual citizens that have acted against the pollution problem. To affect this change, environmental organizations formed around individual beliefs about nature and mobilized to pursue public policies consistent with those views. They pressured the government to curtail the sources of air pollution, often in the face of other powerful political interests, creating an effective and powerful lobbying force in the US government.

Yet a similar environmental consciousness does not exist in Mexico. Environmental activism is seen as a luxury and the participants in environmental organizations are the intellectual and affluent citizens of Mexico City. Common citizens have a more fatalistic attitude towards air pollution. While they want clean air, they feel powerless to pursue a solution to a seemingly intractable environmental problem in the face of a political process hostile to public participation.

"Of course (*the air pollution problem*) bothers us, but we don't do anything about it. No one in power would pay any attention to us if we did." stated a fairly typical *Chilango*.¹⁸⁹ This fatalistic attitude can be attributed to four factors: cultural relationship with the environment, access to government, access to education and affluence. These four attributes contribute to form an environmental consciousness in Mexico City that is significantly different than that in Los Angeles. A Mexican sociologist, José Luis Lezama, summarizes it when he states:

"The citizens and the government share in a common will to minimize the air pollution problem. But since the possibilities to effect it are so slight, the best solution for the vast majority of citizens is to ignore it, so they can focus on other

¹⁸⁸ Simon, J. *Engangered Mexico: an environment on the edge*. San Francisco, CA: Sierra Club Press, 1997.

¹⁸⁹ Preson, J. (1999). "Mexico City's Air: A Fatal Case of Fatalism." *New York Times*. February 14, 1999: p.40.

priorities. Most residents of Mexico City see pollution as a luxury problem that can only be considered when basic needs are met.”¹⁹⁰

Cultural relationship with the Environment

The Aztec roots of the Mexican population are evident in their attitudes towards the environment. The Aztec myth of origin, a land built upon cataclysm, was not far wrong for the Valley of Mexico. The plateau that Mexico City lies on was created in violent geologic upheavals that sealed swampy lowlands within a mountainous ring of earth. During the Aztec’s reign, the volcanoes that surround the valley periodically spewed ash and smoke, further reinforcing the dominant relationship between nature and the people that lived in the volcanoes’ shadow.

Before settling in the valley, the Aztecs were a nomadic people, wandering the desert in search of small game and prickly pear. By the time they had settled on Lake Texcoco, the site of Mexico City, the valley was already dotted with the ruins of previous civilizations. The Aztecs were well aware of the experience of the Tula and Zapotec, civilizations that were destroyed by drought. Thus the fear of an eminent environmental collapse signaling the end of the world remained as a persistent reminder of their fragile relationship with the environment. While most citizens of Mexico City are Roman-Catholic and heavily influenced by the Spanish culture introduced during the 1500s, their Aztec past undoubtedly shapes the *Chilangos*’ relationship with the environment. The Aztec influence may partially explain the Mexican tendency to be resigned to environmental problems rather than attempt to subdue the environment through technology.

Contrast this with the views of western cultures towards the environment as presented by Lynn White’s “The Historical Roots of our Ecological Crisis”¹⁹¹ or Kirkpatrick Sale’s *The*

¹⁹⁰ Personal Communication, February 16, 1999.

Conquest of Paradise.¹⁹² These works portray the western relationship with nature as shaped by the Christian-European experience during the middle ages. During this period, man began to see the environment as for his benefit and sought to dominate it through the use of technology. Translated to the modern context, this view is illustrated in the predominantly technical approach towards ameliorating air pollution in the United States and Europe. Behavior modification policies have rarely been successful in western countries and modern air pollution control is based on the premise that humans have a right to use the atmosphere to dispose of their wastes.¹⁹³

When this cultural background is applied to understanding the Mexican environmental consciousness, the difference in the response to environmental issues makes sense. The western European tradition has heavily influenced the United States' response to air pollution: effluent reduction technologies on mobile and fixed sources that allow for unrestricted use of the atmosphere. The Spanish influence on Mexico's development ensures that this attitude is also manifested in Mexican society. But due to the effect that the beliefs of their Aztec ancestors have had upon their culture, the Mexican society is more willing to live with environmental problems.

Access to Government

In general, the participation and views of the public towards governance issues are directly correlated to their role in influencing their government's actions. The environmental consciousness of the residents of Mexico City is directly shaped by their lack of access to the government to influence policy-making. Because there is only one political party (the PRI) in Mexico, there is only one candidate for any public office and elections mean very little. When

¹⁹¹ White, Lynn T Jr. (1973). The Historical Roots of Our Ecological Crisis, Western Man and Environmental Ethics: Attitudes Toward Nature and Technology, 18-31. Addison-Wesley Publishing Co. (MA)

¹⁹² Sale, Kirkpatric. (1991). Conquest of Paradise, The: Christopher Columbus and the Colombian Legacy, Alfred A Knopf Inc.

combined with the PRI's tradition of co-opting opposition into the party, the single party system results in an amorphous party platform and no meaningful debate regarding public issues.

Without these two pillars of representative government, the avenues for participation in the Mexican political system are insufficient to allow average citizens to effect the policy-making process.

Compounding this lack of participatory opportunities, Mexico does not have public disclosure requirements (like the US sunshine laws) and consequently little information about governmental affairs is released to the public. Without such information, it is very difficult for the public to become informed about issues that effect them. As a result, the Mexicans do not have a tradition of activism within governmental affairs and view the government as being insulated from their concerns.

In contrast, the US system is highly participatory and there are many levels in which individuals can get involved. As a consequence, the United States has a large politically active population that influenced air pollution mitigation programs in major urban areas. Numerous public advocacy and non-governmental groups have been formed around air quality and health issues, in large part because the political system empowers these groups to influence the regulatory outcomes. The ability of environmental groups to force government action through law suits granted average citizens the standing to compete with much more powerful forces in the political process.

It is no surprise that environmentalists in the United States were also politically active. Henry David Thoreau wrote Walden and Civil Disobedience. His reverence for nature and political action molded a number of the great environmentalists in the United States. It is

¹⁹³ There are many citizens in western countries that do not share this view and protest against the abuse of the atmosphere in this manner. Nonetheless, air pollution continues to be a serious problem because the western capitalist system continues to use the atmosphere as a dumping ground for its wastes.

unlikely that John Muir would have been as successful in disseminating environmentalist ideas if the US political system was as closed to public input as the Mexican system is: the Hetch Hetchy controversy would have never happened because the government would have just built the damn anyway.¹⁹⁴ Hence, the environmental movement in the United States drew power from its access to the decision-making process.

Without the ability to influence government, it is not surprising that the environmental consciousness of Mexican citizens is not as strong. Mobilizing average citizens around action and improving their lives is much easier than rallying them around the idea of a clean environment. The activist nature of politics in the United States has exposed the public to environmental issues and gotten them involved. Without a political system that has a role for public activism, the citizens of Mexico City are unlikely to become engaged in a fledgling environmental movement.

Access to Education

There is one well-known environmental activism group in the Mexico, *El Grupo de Cien*. Aside from this organization and Miguel Angel de Quevedo (Mexico's most famous tree hugger), there are only a handful of environmentalists of any importance. The important trait binding these people together is education. *El Grupo de Cien* (Group of 100) is an loose aggregation of Mexico's most prominent artists and intellectuals and has been one of the few groups willing to speak out about the role that limited democratic accountability to the public has played in the environmental problem. Yet this group represents the elite of Mexico. They are well educated and successful enough in their various disciplines to gain public attention when they criticize the government's environmental record.

¹⁹⁴ The most important river in Mexico, the Chapala, has been damned, diverted and polluted so at its terminus it only flows as a trickle. When President Salinas tried to rally support for its restoration, the proposal was only weakly received and supported by the Mexican population.

The environmental activists in the early stages of the American environmental movement were of a similar background. For example: Thoreau was educated at Harvard and Pinchot went to Dartmouth. They were both members of the upper class and chose to adopt the environment as their cause. Silent Spring, Rachael Carson's work that sparked the environmental movement, was first published in the *New Yorker*, a magazine targeted at the intellectuals in the northeast. After its publication, concern spread first among the educated upper class on the eastern seaboard, then spread around the country. Literacy was the key to sounding the alarm about the environmental danger posed by pesticides. Because Carson's prose was so powerful, by the high level of education in the United States aided the rapid dissemination of Carson's ideas. This bias remains to this day as well educated, middle and upper class citizens dominate environmental organizations.

The implications of the effect of education on the environmental movement for Mexico are apparent. The lower level of education in Mexico directly effects the success of the environmental movement garnering support among *Chilangos*. Many of the citizens of Mexico City cannot read and subsequently the mass media is their only source of information about the air pollution problem. The media itself is not informed about pollution issues and consequently spreads misinformation about the sources and consequences of the air pollution problem.¹⁹⁵ Under these conditions, mobilizing the population, even in a participatory government, would be difficult. Environmental concern is likely to remain the province of organizations such as The Group of 100 until the citizens of Mexico City have a greater level of education. Because air pollution issues are highly complex, education would provide the necessary context for information about air pollution issues so that the residents of Mexico City can think about the tradeoffs and consequences involved in an air pollution reduction program.

Levels of Affluence

Unfortunately, educational attainment is directly correlated with affluence. In Mexico City, many people can not afford an education. Even where public schools are available, the opportunity cost of attending class versus working to support the family is too high for much of the population. Subsequently, children work to earn money instead of learning about government, basic science, and how to read. In the United States, this tradeoff is less common, and mandatory school attendance through primary levels promotes a basic level of knowledge for the population as a whole.

Demand for a clean environment is also directly related to income. In Los Angeles, pressure for clean air rises and falls with the economic cycles of southern California. During times of recession, the public is less inclined to make the economic tradeoff that environmental protection often requires. The citizens of LA are less willing to make the economic sacrifices for clean air when their economic situation is less certain. Mexicans are faced with the same dilemma. As an industrializing country, the focus of development efforts is to raise the standard of living for the population. During the 1970s and late 1980s, much of this progress came at the expense of the environment. Since emissions abatement equipment represents a capital cost but does not add value to the product, fledgling industries are reluctant to install the technologies to reduce air pollution. The Mexican government is reluctant to force companies to install the equipment for fear of stifling the growth they are trying to promote. Thus demand for pollution control technologies only becomes prominent in countries with a strong economy.

At a more basic level, individuals begin to desire a clean environment only when their other, more basic needs are fulfilled. In surveys, the population of Mexico City puts the environment in their top three concerns, after income and personal security. It is unrealistic to

¹⁹⁵ Lezama, J.L. and Urquidi, V.L. (1999). "Air Pollution Policy Issues in Mexico City: The Limits of the

expect Mexicans to want a clean environment if their needs for shelter, food and security are not being met. Thus clean air does not rank among the “vital” needs of *chilangos* and in their personal actions they are likely to choose to fulfill one of their vital needs over secure environmental protection.¹⁹⁶ The “irregular settlements” of Mexico City are a good example of this.

“Irregular settlements” are illegal squatters villages around the outskirts of Mexico City. Driven away from the core of the city by a deficiency in affordable housing, immigrants build shelter on the first available lands they can find. The most common locations for these settlements are in the ecological preserves that ring the city. The squatters realize they are harming the environment by building their houses on ecological preserves, lands chosen for preservation because of their delicate environment. Yet their need for shelter is more pressing and they continue to improve their dwellings over time. Eventually, the housing units in the irregular settlement become permanent in nature, made of brick or concrete. Then, the city government has little alternative but to supply the settlements with electricity, sewer and piped water, essentially condoning the settlement process.¹⁹⁷

Conclusion

When examining the status of the environmental consciousness in Mexico City, four factors differentiate it from that of the environmental lobby in the United States. First, the Aztec heritage of Mexico City has influenced their culture such that residents of the Valley of Mexico have a more fatalistic attitude towards environmental problems. Living in the shadow of a dormant volcano at the whim of unpredictable weather, this implicit belief is perpetuated through

Environmental Construction in the Official Programs.” Unpublished paper. El Colegio de México, Mexico City.

¹⁹⁶ Pezzoli, K. *Human Settlements and Planning for Ecological Sustainability: The Case of Mexico City*. Cambridge, MA: MIT Press, 1998.

¹⁹⁷ There are numerous political and practical reasons that the city government cannot prohibit this settlement pattern. See *ibid* for more information.

cultural interactions. Thus Mexicans see their relationship with nature as less in their control, more in the hands of fate.

The lack of access points to the government reinforces this belief. *Chilangos* lack a means of effectively contributing to the governing process. So, even if they feel that the PRI is ineffective and out of touch with their needs, there are not many avenues for the public to remedy this condition. The lack of access serves to further reinforce the fatalistic attitude towards the environment. Even if a group of average citizens felt very strongly that the government needed to address the air pollution issue, it is unlikely that they could affect any real change.

A significant environmental movement in Mexico City is unlikely to form, even with governmental reforms, without an increase in the level of education of the citizens. Without a common knowledge base, environmentalists need to educate the population in basic science in addition to informing them about the specific sources and solutions to the air pollution problem. Communicating this amount of information is difficult in a society with a low literacy rate.

Finally, to persuade the citizens and government to act against the air pollution menace requires an increase in income for the citizens of Mexico City. It is unrealistic to expect individuals to worry about the health effects of air pollution when they do not have enough to eat. Thus efforts to reduce air pollution may need to treat poverty and lack of education as well, complicating the task.

It is no surprise that the environmental consciousness is much different in Mexico City than it is in the United States. Mexicans live in a much different context and are subject to a much different set of pressures than those facing Americans. Surveying the literature that helped form the American environmental consciousness, education, affluence and political power significantly contributed to its formation. Efforts to raise environmental awareness in Mexico

should take these factors into account and attempt to heal Mexico City in a holistic manner. No real environmental progress will be made without also addressing poverty, crime, education and empowerment.

Appendix 4: Health and Science Issues

(Taken From Los Alamos National Laboratory MARI Report, 1994)

Air Quality criteria have been set by the Mexican government as a way to evaluate the extent to which health is currently endangered. The IMECA (Indice Metropolitano de la Calidad del Aire—Metropolitan Air Quality Index) value of 100 corresponds to the Mexican Air Quality Standard for each pollutant. An IMECA value of 500 corresponds to levels that have significant evidence of damaging health effects.

The primary air pollution problem that has been identified in the MCMA is the formation of photochemical smog, primarily ozone. Particulates are also a problem in the MCMA, but they have not been studied as extensively historically and hence efforts to control particulates for health reasons are just becoming prevalent.

Formation of Photochemical Smog

Photochemical oxidants are gaseous substances formed in the atmosphere by chemical reactions involving nitrogen oxides (NO_x) and organic compounds in the presence of solar radiation. The main photochemical oxidant is O_3 , whose formation is accompanied by a range of other secondary pollutants photochemically generated including aldehydes, organic peroxyacyl nitrates, nitric acid, hydrogen peroxide, sulfate and nitrate aerosols.

Higher levels of O_3 and other photochemical oxidants are frequently observed in urban and rural areas as a result of the emission of precursor compounds. This level of photochemical oxidants was first observed in the Los Angeles basin during the 1940s. Photochemical pollution

episodes (also called photochemical smog) are frequently observed during summer and can cause eye irritation, respiratory disorders, crop damage and increased deterioration rate of material.

Oxidant concentrations are generally higher in non-urban locations than in urban locations, and are found to cause damage to some crops and trees. A reduction in visibility is also associated with photochemical aerosols. Because of their oxidizing properties, photochemical oxidants accelerate the conversion of the SO_2 into sulfate. Ozone acts also as a “greenhouse gas,” and it has been calculated that the doubling of the tropospheric O_3 content may increase the surface temperature by nearly 1°C .

Role of Volatile Organic Compounds

Organic compounds are important primary air pollutants, emitted both from natural and man-made sources. The organic compounds involved in photochemical air pollution include HCs (those compounds containing hydrogen and carbon only) and their derivatives; the term “volatile organic compounds” (VOC) is frequently used to include hydrogen and carbon and their derivatives. Natural emissions include methane, produced by the anaerobic fermentation of organic matter, and ethene, isoprene, and monoterpenes emitted by vegetation. Natural emissions mostly occur during the vegetation period, but there is considerable controversy regarding their magnitude on a worldwide level. The VOC emitted by human activities include linear and cyclic saturated and unsaturated HCs, aromatic HCs, aldehydes, ketones, esters, ethers, acids and their halogenated derivatives.

The most important man-made sources of non-methane VOC result from incomplete combustion of fuel in motor vehicle exhaust. The chemical composition and the concentration of VOCs in the atmosphere vary considerably (in time and space). Emissions from man-made activities are predominant in urban and industrialized zones, where concentrations of VOCs are well above the natural level. There is uncertainty about the relative contribution of man-made

VOCs in rural areas. The most frequently used approach to assess the impact of VOCs on the formation of photo-chemical pollution is based on the use of models. Their design includes the modeling of the physicochemical and meteorological process involved in the formation of photochemical pollutants.

Model studies are limited by the accuracy of precursor emissions, meteorological data availability, and the adequacy of the chemical mechanism used to represent the formation of O₃ and other secondary pollutants. Models must also be validated using air quality data. Modeling studies have shown the nonlinearity of phenomena related to photo-chemical pollution (there is not a direct relationship between precursor concentrations and the quantity of O₃ formed), and have indicated the importance of the meteorological conditions, the chemical structure of the organics, and the VOC/NO_x ratio in the atmosphere, which is linked to the characteristics of industrial and urban emissions.

Pollutant Trends and Evolution

Ozone

Ozone is a highly reactive form of molecular oxygen that resides in organic and biological compounds. Ozone is not a pollutant that is emitted from a pollution source. Rather, it is formed, in the presence of sunlight, by the combination of volatile organic compounds (VOC) and NO_x. The formation of O₃ is based on the photochemical dissociation of nitrogen dioxide (NO₂) by ultraviolet light. In the presence of HCs, the reactions involved are very complex, and the final product is a mixture of O₃, organic compounds with oxygen in their molecular structure, NO_x.

The main factors in the formation of O₃ are the chemical reactivity of the HCs involved, the intensity of the solar radiation, and the ratio of VOCs to increase the ultraviolet radiation. In

the case of MCMA, the latitude and altitude of the city are factors that increase the ultraviolet radiation. Ozone and NO_2 levels in the atmosphere are closely related. Early in the morning, NO_x emissions from vehicles, combustion sources, and processes, start increasing. By the middle of the morning, the sunlight starts the dissociation process, and the O_3 level that was very low in the early morning begins to increase. This situation is very important because of the synergistic effect of these pollutants.

The ratio of VOCs to NO_x in the ambient air determines the predominance of the HC or NO_x emissions in the O_3 formation. The VOC/ NO_x ratio is the subject of much debate in the U.S. Many atmospheric scientists believe that if VOC/ NO_x ratio is greater than 10, O_3 production is limited by NO_x , and reductions in VOC levels, unless they are very large, result in relatively little reduction of O_3 . On other hand, if the VOC/ NO_x ratio is less than 8, O_3 is thought to be VOC-limited, and controlling reactive VOCs should give the maximum benefit. Air quality criteria have been set by the Mexican government as a way to evaluate the extent to which health is currently endangered. The Mexican one-hour criterion for O_3 is 0.11 ppm. By comparison, the one-hour ambient O_3 standard set by the U.S. EPA is 0.12 ppm, and the World Health Organization (WHO) advisory criterion is 0.10 ppm.

Ozone levels in Mexico City are high. From 1986 to 1992, the Mexican criterion for O_3 levels was exceeded 71% of the days in 1986 and increased in 1992 to 98% of the days in the year. Individual occurrences exceeded the standard by up to 300% (three days in 1991, and 8 days in 1992). The highest concentration ever recorded in MCMA was in March 16, 1992 with a value of 398% of the standard. This value was measured in the southwest zone of the city. The air in Mexico City violated international health norms 254 out of 273 days (January-September 1992). Unlike the majority of the cities in the northern hemisphere, where the tropospheric O_3 phenomenon is only present during the summer days (when the solar radiation is significantly

higher than the rest of the year), the MCMA presents favorable conditions for the formation of O₃ throughout the year. High concentrations of O₃ are observed at the end of the winter and the beginning of the spring. This explains why there was such a high number of days in which the standard was exceeded.

Particulate Matter

Particulate matter includes a variety of suspended particles, such as aerosols, organic and metal vapors, combustion particles and road dust. The PM-10 particles pose a greater threat to health because they penetrate deeper into the lung. Major types of PM-10 are those produced by combustion (diesel and stationary sources), vapors, and aerosol particles (organic, sulfate, and nitrate) formed by photochemical reactions. PM-10 has been associated with various effects such as reduced visibility, soiling, and acid deposition damage to materials and buildings. In the MCMA, the reduction in visibility is one of the most important effects detected by the public. In the past, the most common view of Mexico City was a landscape with hills and mountains behind it, but since the 1950s, the reduction in visibility has become very apparent in the city. The soiling of construction materials, trees and other vegetation, and the deterioration of historical and colonial buildings downtown is also very important.

In the MCMA current measurements of particulate matter are made by the high-volume method that only measures TSP without any classification according to size. For this reason, it is impossible to know if the very high particulate matter concentrations measured include a high or low concentration of PM-10 particles. Theoretical evaluations based on possible sources of the particulate matter show that the portion of PM-10 in the total quantity of suspended particles measured in the MCMA is between 10% and 60%.

To protect against short-term health effects, Mexico has a 24-hour health advisory criterion of 270 mg/m³. Mexico's criterion is based on TSP. In 1987, the U.S. changed its

standard for TSP to a PM-10 standard in order to focus on the respirable fraction. Before the change to PM-10, the U.S. EPA 24-hour standard was 260 mg/m^3 , and its annual average standard was 75 mg/m^3 . Mexico does not have an annual average standard. Ambient levels of TSP in the MCMA exceed the criterion even more extensively than O_3 levels. In recent years, the 24-hour highest recorded values ranged from 1100 mg/m^3 to 1300 mg/m^3 (these values correspond to the period from 1990 to 1991 when particulate concentrations were measured). These values were recorded in an industrial zone located in the northeast sector of MCMA. The TSP ambient levels exceeded the Mexican standard more than 90% of the time. All the monitoring stations in the MCMA record annual average values that far exceed the old EPA annual average of 75 mg/m^3 . These stations reported annual averages ranging from 150 to 520 mg/m^3 .

The highest concentrations measured in the MCMA correspond to the northeast sector during the dry season when high winds occur. For this reason, the TSP concentrations measured are probably mostly soil particles, which are larger than 10 micrometers in diameter. However, it is important to consider that in the wet months the standards are also exceeded, and this suggests that the contributions of particulates by vehicles and industry sources are contributing significantly to the particulate matter levels.

Nitrogen Oxides

Nitrogen oxides include a variety of species of which the most prevalent and the most injurious to health is NO_2 . Other negative effects of NO_x pollution are a reduction in visibility and an increase in acid deposition (acid rain). The reduction in visibility is due to NO_2 's absorption of light and also to the nitrates present in atmospheric aerosols. In the case of Mexico City, the reduction in visibility from NO_x is very important, producing the smog over the city that is the typical brownish color of NO_2 . The acid deposition of nitrates affects vegetation and some

materials. In the case of vegetation, the main effect is tissue damage by necrosis; in the case of materials, it is corrosion and loss of cement in limestone and other construction materials. However, all (NO_x) species contribute to the formation of O_3 . Nitrogen oxides combine with VOCs to form O_3 in the presence of sunlight.

To protect against short-term health effects, Mexico has a one-hour advisory level for NO_2 of 0.21 ppm. This is the same as the WHO standard and is more stringent than the State of California's one-hour standard of 0.25 ppm. The EPA has set an annual average standard of 0.053 ppm. The concentrations of the background NO_x are attributed to the transportation sector and to a lesser extent, the industrial sector. Daily behavior of NO_x includes emissions from both of these sectors and also participation in the different photochemical processes that form secondary pollutants. In the winter there is a higher incidence of days on which NO_2 levels exceed standards. From April to September the rains, along with higher rates of solar radiation and temperature, increase the reactivity, thereby reducing NO_2 levels. Ambient levels of NO_2 in the MCMA are highest in downtown Mexico City. At a down-town monitoring site, the highest one-hour value recorded in recent years was 0.32 ppm. This site has also recorded annual averages of 0.13 ppm.

Sulfur Oxides

Sulfur oxides (SO) are emitted during the combustion fossil fuels that contain sulfur. The dominant species within SO is SO_2 . It is a color-less gas that reacts with a variety of airborne particles and water droplets to form sulfates, aerosols, and acid precipitation. To protect against short-term health effects, Mexico has a 24-hour advisory limit for SO_2 of 0.13 ppm. This is slightly more stringent than EPA's 24-hour standard of 0.14 ppm. The EPA has also set an average annual standard of 0.03 ppm. Mexico does not have an average annual standard.

Ambient levels of SO₂ in the MCMA have been declining, probably in response to the reduced sulfur content in fuels. In recent years very few excesses of the 24-hour standard have occurred. During the second half of the 1980s, the annual average concentration of SO₂ decreased from 0.062 to 0.049 ppm.

Carbon Monoxide

Carbon monoxide is a colorless, tasteless gas that is slightly lighter than air. The most important source of CO is the incomplete combustion of gasoline in motor vehicles.

Concentrations of this pollutant in Mexico City vary according to the time of day and are in direct proportion to traffic variations; street-level concentrations may be much higher than monitoring data indicate. The highest daily pattern of CO concentrations occurs at 8:00 a.m. and just after 10:00 p.m.

Because CO is emitted near to the ground, and in general in canyon-type streets, the dispersion pattern of CO-produced ambient concentrations at the monitoring stations, usually located on rooftops, are several times lower than the peak values measured in the streets. For this reason the values measured at the monitoring stations do not represent the levels to which people in vehicles and on the streets are exposed. It is not possible, therefore, to produce an isopleth map for this pollutant because the values measured do not represent the actual conditions encountered at street level.

Carbon monoxide is emitted in the MCMA in greater amounts than all other pollutants combined. It is emitted primarily by mobile sources. Mexico has an 8-hour standard for CO of 13 ppm. The U.S. EPA has a 40% more stringent standard of 9 ppm, as well as a 1-hour standard of 35 ppm. The WHO standard for 8 hours is also 9 ppm. The highest recent 8-hour levels monitored in the MCMA were found near very busy traffic intersections in the downtown area. These values reached levels of 24 ppm.

Lead

The presence of ambient lead is largely a result of the combustion of leaded gasoline in motor vehicles. The lead concentration in the MCMA has decreased as a consequence of successive reformulations of gasoline. As a result, ambient lead concentrations in 1987 were 50% lower than they were in 1982. Only in the northeast sector are lead levels higher than the ambient lead standards set in the U.S. In Mexico people ingest lead from other sources: high concentrations of lead salts leached from metal cans containing acidic products (fruit juices, chili sauces, and chili preparations) and from lead enamel on pottery used for drinking and eating. No data exist for the relative contribution of the several sources of lead to the exposed Mexican population.
