PRB

Household Transportation Use and Urban Air

POLLUTION

A Comparative Analysis of Thailand, Mexico, and the United States

By Roger-Mark De Souza

ACKNOWLEDGMENTS

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FOREWORD

In the last half of this century, the number of people living in cities has more than doubled. Because of this growth, the demand for transportation within cities has increased substantially. Yet transportation networks that often increase quality of life, may also constrain economic productivity, cause air pollution, and damage people's health.

Household Transportation Use and Urban Air Pollution examines this relationship among population, transportation, and urban air pollution. The analysis sheds light on ways that cities could expand transportation services in a way that minimizes air pollution and maximizes economic development.

PRB's Coordinator of Population and Environment Programs, Roger-Mark De Souza, and researchers from Thailand, Mexico, and the United States conducted the study using innovative methodology. They combined statistical analysis of national data sets with qualitative approaches to examine (1) the impact of household transportation use on urban air pollution, (2) how various household characteristics affect impact, and (3) city dwellers' and policymakers' attitudes toward pollution and transportation challenges. By clarifying the social and economic contexts in which consumption aspirations are formed, the researchers give policymakers insight to explore measures that have the greatest chance for success in reducing air pollution without sacrificing equitable economic opportunities.

This work was made possible with funding from the John D. and Catherine T. MacArthur Foundation and the U.S. Agency for International Development. PRB values this support and appreciates the hard work and collaborative spirit of the research teams that worked on this analysis. We hope that this study will inform policy decisions in the case-study countries and elsewhere and lead to further policy-relevant research on linkages between population and the environment. We at PRB will continue to address the crucial issues related to population and the environment. More information on our efforts to do so can be found on our Web site: www.prb.org.

Peter J. Donaldson
President
Population Reference Bureau

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FIGURE 1. **Map of Participating Countries**

	Mexico	Thailand	United States
Population (in millions)	99.7	61.8	272.5
Percent urban 1998	74	31	75
Percent urban 2030	82	39	85
Urban growth rate 1995-2000	1.89	2.33	1.06

Sources:
Population: Population Reference Bureau, *1999 World Population Data Sheet* (Washington, D.C.: PRB, 1999); percent urban 1998: Population Reference Bureau, 1*999 World Population Data Sheet* (Washington, D.C.: PRB, 1999); percent urban 2030: United Nations, *World Urbanization Prospects, 1996 Revision* (New York: UN, 1998); urban growth rate 1995-2000: United Nations, *Urban and Rural Areas 1996 Wallchart* (New York: United Nations, 1997).

EXECUTIVE SUMMARY

This report presents the results of a comparative case-study analysis of the impact of household transportation use on urban air pollution. The case studies were conducted in three cities that are known to have severe transportation-related problems: Bangkok, Mexico City, and Washington, D.C. Because these cities represent diverse economic, cultural, political, historical, and developmental contexts, the case studies provide interesting comparisons for understanding consumption and environmental linkages.

Teams of scientists from collaborating institutions analyzed nationally representative surveys to find trends regarding transportation, household expenditure, and air pollution. The teams supplemented this analysis with focus group interviews to determine consumer attitudes and intentions, and with in-depth interviews with policymakers to examine policy constraints. The researchers wanted to see what they could garner from information on household transportation behavior that would aid in developing policies to reduce urban air pollution. Specifically, they sought to understand the environmental impact of consumption patterns among different types of households—for example, households that differ in size, average household income, and the gender of the head of household. In addition, they wanted to know how much those living in urban areas knew about the impact of transportation on air pollution and whether that knowledge affected choices about what mode of transportation to use.

What did the research teams find? Their case studies revealed that various structural and behavioral factors influenced the contribution to urban air pollution. High income and education levels, usually associated with male heads of households, translated into increased household pollution levels. Larger households generated more pollution. And attitudes of individualism and consumerism constrained action that could reduce urban air pollution.

With these factors in mind, the research teams made four recommendations for reducing transportation-induced air pollution. All three country analyses suggest combining improvements in the public transportation system with regulations and incentives to encourage the use of less-polluting or nonpolluting alternatives. They also recommend that policies be tailored by socioeconomic group and gender to combat specific polluting behavior. The analyses reiterate the importance of educating the public about the impacts of transportation choices on the environment, and of using that awareness as a basis for encouraging community action in developing and using less-polluting options. Finally, based on the experience in this project, the country analyses urge that urban pollution be examined from a multidisciplinary perspective so that demographic and other relevant factors inform policy decision-making.

POPULATION DYNAMICS, TRANSPORT
INTRODUCTION AND BACKGROUND

Little internationally comparative research has been conducted on household consumption patterns and consumer aspirations, and on how these may affect the environment. This study examines current consumption levels and consumer aspirations in three cities: Bangkok, Mexico City, and Washington, D.C. (see Appendix 1 for country teams).* These cities represent economic, demographic, cultural, and ecological diversity. This diversity provides interesting insights (see Figure 2). To establish the context in which these insights come into play, this introduction highlights current and future urbanization and motorization trends; traces

Originally Mali was included in the study, but because of difficulties with data, it had to be excluded from the analysis.

the environmental, health, and social effects of these trends; and outlines how the research was designed to examine the impact of these trends (see p. 22 for a glossary of terms used).

URBANIZATION AND MOTORIZATION

As much as 90 percent of future population growth is expected to occur in cities.[1] This shift toward urban areas will improve quality of life

by bringing more people within reach of health care and education services, yet urbanization also will impose costs. For example, with urbanization will come the need for more housing and transportation services, the provision of which will have environmental, health, and social consequences (see p. 20).

Motorization—in particular the ownership of automobiles—rises sharply in response to urbaniza-

FIGURE 2. A Glimpse at the Cities Included in the Study

	Mexico City	Bangkok	Washington, D.C.
Population 1995 (in thousands)	16,562	6,547	3,685
Growth rate 1995-2000	1.81	1.96	1.27
Average household size	4.7	4.5	2.26

Sources:
Population 1995 and growth rate 1995-2000: United Nations, *World Urbanization Prospects, 1996 Revision* (New York: UN, 1998); average household size: UN Centre for Human Settlements, *An Urbanizing World* (New York: UN, 1996) and U.S. Census Bureau, *Statistical Abstract of the United States 1998* (Washington, D.C.: U.S. Department of Commerce, 1998).

tion. In view of projections on the growth of the urban population, World Bank analysts estimate the number of motor vehicles worldwide could grow from 580 million in 1990 to 816 million by 2010.[2]

Increased ownership of automobiles drives up air pollution. Cars are some of the worst air polluters: The transportation sector, which is dominated by motor vehicles, contributes 30 percent of all greenhouse gas emissions.[3] Moreover, the cities poised for greatest growth in car ownership are in countries where stringent environmental controls often are lacking.

Data for this decade show that most motor vehicles are in the world's wealthy regions. In 1994, for example, 81 percent of the world's automobiles were found in the devel-

oped countries of the Organization for Economic Co-operation and Development (OECD).[4] The United States had one of the highest household concentrations. Almost 60 percent of U.S. households owned two or more cars, and 19 percent owned three or more.[5]

In the developing world, car ownership rates are far lower. In 1994, they ranged from an average of 64 cars per 1,000 residents in Latin America and the Caribbean, to 15 cars per 1,000 residents in Asia, to 13 cars per 1,000 residents in Africa.[6] World Bank figures for 1997 show that average motor vehicle ratios in the three countries under study conform to the above patterns (see Figure 3). For most of the developing countries, primary cities will draw the largest concentration of vehicles. Mexico City and Bangkok already con-

tain about 50 percent of their respective countries' automobiles.

Foremost among the factors behind the urbanization and motorization trends discussed above are demographics. More households, changing household structure, and increasing household incomes have led to a rise in the number of cars.[7] The effect of household size varies. In some cases, large household size may have a greater effect on air pollution. In other cases, growing numbers of small households can lead to more pollution. In general, falling average household sizes have meant greater numbers of urban households. These households usually are home to the elderly, single adults, or couples, who rely on cars for convenience and security. Suburban house-

holds, which often include more than one child or extended family members, depend on the car because of limited public transport options. At the same time, rising household incomes have increased vehicle ownership and led to heightened travel and a drop in public transportation use.
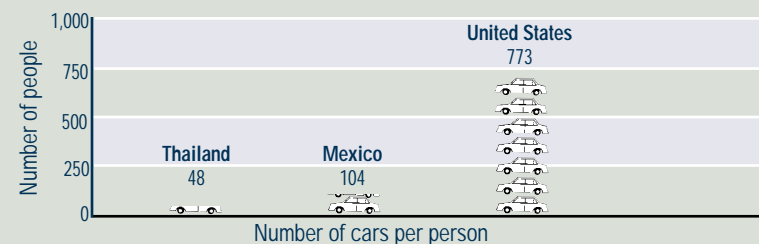
The rise of female-headed households, however, is one demographic pattern that does not seem likely to increase motorization. Such households comprise more than one-

> *"F*oremost among the factors behind urbanization and motorization are demographics.*"*

Vehicles emit greenhouse gases that contribute to smog.

In 1994, almost 60 percent of U.S. households owned two or more cars.

demand for cars, while at the same time the increase in cars makes it easier to expand cities. Since the 1950s, for example, the distribution of residential areas and workplaces in Bangkok has spilled over the city's boundaries into several adjacent provinces. Because new and popular housing estates are increasingly located far from the center of Bangkok, they lead to longer commutes and ultimately to higher levels of vehicular emissions.

A third factor is the relative cheapness of cars, especially in developed countries, compared with land. This cost differential motivates households to buy low-priced housing in urban peripheries, even though living there requires more travel. High land prices in Bangkok not only encourage relatively well-off residents to sell and relocate in new, less central areas of the Bangkok metropolitan area, but also force inner-

fifth of all households worldwide, and research has shown that they focus their spending on nutrition and education, not on private transportation. These households may therefore use more public transportation facilities, if available.[8]

A second key factor influencing the number of cars is city design. Sprawling cities increase the

city slum dwellers to peripheral locations. These developments lead to increasingly lengthy commutes in Bangkok and its environs.

INCREASING MOTORIZATION AND ITS ENVIRONMENTAL, HEALTH, AND SOCIAL IMPACTS

Environmental Impact

One result of increasing motorization is more fuel consumption, which increases pollution. When car dependence increases, fuel consumption rises exponentially because of growing road congestion, vehicles that use fuel inefficiently, and poor vehicle and road maintenance. Globally, 20 percent of all energy produced is used

for transportation. Of this, between 60 percent and 70 percent is devoted to moving people, and the rest to moving freight.[9] Transport-related energy consumption is expected to grow in both the developed and the developing world. From 1971 to 1992, worldwide energy use in the transportation sector grew on average 2.7 percent per year, faster than in the industrial or other sectors.[10]

Recent World Bank estimates suggest that energy demand in low- and middle-income countries, now one-third of energy demand in OECD countries, will match demand in OECD countries by the year 2015.[11] Bangkok is already plagued with notoriously

high levels of air pollution and congestion, despite low motor vehicle ownership per capita (72 vehicles for every 1,000 residents) compared with many developed cities (500 per 1,000 residents on average). In addition, an average car in Bangkok is estimated to spend the equivalent of 44 days per year stuck in traffic.[12] Even so, 300 to 400 more vehicles are being added to the streets of Bangkok every day.

The connection between vehicle emissions and global warming is becoming increasingly clear (see p. 20). Vehicles emit carbon dioxide, nitrous oxide, and carbon monoxide, which are referred to as greenhouse gases because they may contribute to global warming. In the United States, transportation sources are responsible for significant amounts of these gases as well as other ambient pollutants. In 1997, for example, they accounted for 77 percent of carbon monoxide emissions, 49 percent of nitrogen oxides, 40 percent of volatile organic compounds, and 24 percent of particulates.[13] However, the share of emissions from developing countries is expected to rise in the future because of the growing size of their motor vehicle fleets and their use of less-efficient fuel-burning technologies. In these countries, automotive air pollution is mostly a problem in large cities with high levels of traffic, such as Mexico City and Bangkok (see Box 1).

Health Impact

The health threats posed by transportation depend on the levels of three pollutants: suspended particulate matter (SPM), carbon monoxide, and lead. SPM is made up of molecules suspended in the air. Small molecules of SPM, less than 10 microns in diameter, are more dangerous than large ones because they may enter the respiratory system. Small molecules of SPM are found in smoke from diesel engines, burning, cigarettes, and some kinds of industrial activity. Inhaling SPM causes allergic reactions and respiratory diseases, and SPM in big cities contains cancer-related components. Rough estimates indicate that, if unhealthy levels of SPM were reduced to the average yearly level that WHO considers safe, between 300,000 and 700,000 premature deaths a year would be avoided in developing countries.[14]

Carbon monoxide, a colorless, odorless, and tasteless gas, is another pollutant hazardous to human health. It is produced from incomplete

combustion in vehicles using gasoline. Incomplete combustion occurs when the ratio of air to fuel is less than 14:1 or when there is a clotted filter. Inhaled carbon monoxide temporarily incapacitates hemoglobin, causes dizziness, and constitutes a

> "*The* challenge for cities is to manage urban travel demand without degrading the quality of life."

danger for patients with heart disease.

Motor vehicles also contribute significantly to emissions of lead, the third key pollutant. An estimated 80 percent to 90 percent of lead in ambient air is derived from the combustion of leaded gasoline. When inhaled or ingested, lead attacks the system that produces hemoglobin and may lead to anemia and nervous disorders, especially in children. Recognizing the health threat, most developed countries have reduced the lead content of gasoline over the past decade. In most cities of the developing world, however, ambient lead levels still greatly exceed the WHO standard of 1 microgram per cubic meter.[15]

Social Impact

In addition to the threats to the environment and to human health, urban transportation trends also raise equity questions. In cities where large segments of low-income groups live in the periphery of the urban area, questions of isolation and inaccessibility arise because opportunities for employment, advanced education, recreation, and shopping are often located in the city center. Members of poor households, for example, may spend a larger percentage of their income on public transport than do members of wealthy households. And in household budgets, the cost of the breadwinner's trip to work may be the top priority, sometimes meaning that trips for schooling or health services are sacrificed.[16]

With increasing population growth and growing economic activity, the challenge for cities is to develop more efficient transportation systems— systems that manage urban travel demand with-

Mexico City's high altitude results in worsening air quality.

out degrading the quality of life. One way to meet this challenge is to consider the potential pollution impact of consumer intentions. This study looks at these intentions and examines their policy and program implications.

RESEARCH DESIGN

The research teams sought to answer three questions*:

1. How does consumption vary among households of different sizes with different demographic charac-

*See Appendix 2 for details on methodology.

teristics—such as income, age, and gender?

2. What are the environmental implications of current household consumption patterns, particularly those related to transportation use?

3. What is the level of awareness of the links among household size, consumption, and the environment, and how could this awareness shape strategies to reduce air pollution?

The teams decided to focus on one particular indicator of consumption patterns—transportation use—because of transport's economic, environmental, and social consequences, and because congestion and associated transportation problems are pervasive in these cities.

For the case studies, teams conducted both quantitative and qualitative research, using methods they developed (see Box 2). The quantitative analysis aided in determining statistically significant impacts of demographic characteristics on transportation consumption decisions. The qualitative analysis helped the research teams elicit from the residents of the three cities under study their attitudes and perceptions regarding the extent and causes of environmental pollution and their future consumption intentions.

To examine households' direct and indirect effects on transportation use, the teams viewed household variables as a multiplier of the effects of other factors that influence transportation use. The researchers linked household variables, transportation use, and air quality by using a simple causal model to incorporate and account for the effects of other factors such as socioeconomic changes and changes in technology.

Box 2
Notes on Methodology

The research for the case studies was done in two stages. In the first, the quantitative stage, teams of natural and social scientists analyzed household income and expenditure data from nationally representative surveys for each country. These data allowed the researchers to examine household expenditure patterns and levels of transportation use for groups with different demographic characteristics and income levels. Using these data, researchers developed estimates for implied environmental impact of household-level transportation use.

In the second stage, researchers formulated focus group interview guides that served as the basis for the qualitative analysis. Each research team targeted different socioeconomic groups of the urban population and conducted focus group interviews to determine:

■ current consumption levels;

■ aspirations to future transportation use; and

■ perceptions of the linkages between individuals' transportation choices and impact on the environment and human well-being, paying special attention to air pollution.

For Mexico City and Bangkok, in-depth interviews with policymakers supplemented focus group data. Appendix 3 contains country data sources.

LESSONS LEARNED

This section highlights the lessons of special interest from the country studies. The case studies themselves describe national trends in broad terms, then report on individual findings (case study summaries appear in Appendix 3, p. 28). The quantitative and qualitative work suggest that several structural and behavioral factors determine the level of impact households have on urban air pollution (see Box 3 for lessons on using this methodology).

STRUCTURAL FACTORS THAT CONTRIBUTE TO URBAN AIR POLLUTION

Quantitative analysis by the research teams of household-level data pointed to structural factors that influence air pollution. These factors are essentially household characteristics such as household size and the socioeconomic status and gender of the household head.

1 As income and education rise, the level of pollution generated by the household rises. The case studies confirm the detrimental effect of higher socioeconomic status on pollution. In Bangkok, white-collar household heads produced between 3.7 kilograms and 4.6 kilograms more of SPM per year than those who worked in the sales and service or production sectors. At the same time, an increase of 1,000 baht (about U.S. $26 at current rates) in monthly income led to a 0.1-kilogram increase in emissions per year. In Washington, D.C., people on average spent more on both gasoline *and* public transportation with additional income and education. Elderly households with higher income tended to spend more money on private travel. One-parent households tended to spend far more than two-parent households on public transportation. In Mexico, every additional year of formal education of the household head was linked to production of

*"**G**iven the choice between carpooling and driving alone, I'd rather drive alone and pollute the air."*

High-income focus group participant, Washington, D.C.

approximately 0.7 kilograms of SPM, 98 kilograms of carbon monoxide, 24 kilograms of hydrocarbons, and 126 kilograms of total emissions per year.

2 **Male-headed households engage in more polluting behavior than female-headed households.** The case studies provide interesting insight into the effect of the gender of the household head. In Bangkok, male-headed households emitted about 2.7 more kilograms of SPM per year than female-headed households did. Similarly, in Mexico City, male-headed households had a major impact on pollution per capita, regardless of the kind of transportation used by members. However, spending on public transportation by female-headed households in Mexico City also had a detrimental impact on air pollution. Two factors were responsible for this obser-

"What one person can do makes a difference. One person not driving reduces pollution."

Low-income focus group participant, Washington, D.C.

vation: Car ownership was less common among female-headed households than among male-headed households, meaning female-headed households relied more on public transportation, and the number of female-headed households in Mexico City was quite large.

Box 3
Methodology: Challenges and Lessons Learned

In this project, the research teams debated how to measure household transportation's impact on the environment. They decided to focus on expenditures, using them as a proxy for implied pollution impact. Because of this approach, the models that the research teams used do not predict travel behavior per se—that is, the decision to drive or to use public transportation. If the price of gasoline were to drop significantly, for example, one might observe a change in these relationships in the direction of greater public transportation expenditure, while the household could in fact be driving more than before. In spite of this limitation, the teams believe that, in the given timeframe, expenditures gave valid insight into household transportation use.

Data availability provided an additional challenge. The data sets on household income were selected on the basis of accessibility—that is, whether the data set was in the possession of one of the collaborating institutions or could be easily obtained. In addition, expenditure survey data for each country were selected based on the inclusion of household expenditure data. This was one of the greatest challenges for some of the researchers. In the final analysis, a research team from Mali, which was originally part of the project, had to be omitted from the study because of difficulty with appropriate data.

In some regards, this project was an experiment to test the efficacy of combining quantitative and qualitative methodologies to examine population-environment issues. This approach was difficult and rewarding. It was difficult because it was time consuming, required much planning and preparation, and was new for many of the researchers. Yet the additional insight it provided helped inform the policy recommendations and put a human face on the research questions. The strength of this approach lies in its relatively low cost (relative to polls or large-scale surveys), flexibility (the ability of focus group leaders to guide discussion based on the interests of participants), and originality (the possibility of turning up new or unanticipated findings that might not be elicited by a more rigid survey instrument). According to Debus (1991), one of the best uses of the focus group is to help understand the results of a quantitative study, in particular to understand the reasons for an unexpected finding, to gain some understanding about the reasons for certain trends, and to describe factors effecting an attitudinal change. The research teams believe that the focus group approach served these purposes in this research.

Appendix 3 contains further details on methodology.

Many Thai families rely on motorcycles for their transportation needs.

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3 **Large households spend more money on transportation and, as a result, generate more pollution.** Not surprisingly, the case studies illustrate that household size is an important variable. In Bangkok, extended families produced about 5.3 more kilograms of SPM per year than one-adult households did, and nuclear families produced about 3.5 more kilograms. In Washington, D.C., two-parent households tended to spend more on private transportation than smaller households, and their

"…we look for convenience. So, we buy a car. We know that when our car is added, the traffic would increase… but the traffic would be already congested if our car hadn't been added." Middle-income focus group participant, 18-to-29 age group, Bangkok

average total transportation expenditures were higher as well. Elderly households spent less than other types of households on total transportation, but their expenditures were also heavily biased toward private transportation. One-parent or one-adult households, in contrast, tended to divide their expenditures more equally between public and private transport.

The contribution to pollution was higher among Washington, D.C., households that used public transport than among those that did not use public transport because the former had larger households. In Washington, on average, two-parent households spent the greatest amount on private (automobile)

transportation, while one-parent households spent the most on public transportation.

BEHAVIORAL FACTORS THAT INCREASE URBAN AIR POLLUTION

The qualitative analysis allowed the research teams to further explore why urban dwellers make the transportation choices they make. Behavioral factors center on attitudes of

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individualism and consumerism, reflected partly in the priority placed on convenience and flexibility in transportation options.

1 **Individualism and consumerism hinder action that could reduce urban air pollution.** Many focus group respondents felt that Bangkok's civil society organizations did not yet work together in community-driven strategic planning to tackle issues that affect their lives, such as sprawl. Interestingly, most participants from Washington, D.C., admitted that individual choices were responsible for the level of air pollution in the area. Most immediately identified the automobile as a major cause of air pollution and their decisions to drive or not to drive as contributing factors. However, not many accepted responsibility for

reducing the amount of air pollution by choosing not to drive or by changing their behavior in other ways. The medium- and high-income Mexico City participants believed that authorities made it appear as if cars were the major cause of air pollution, whereas participants felt it was not. High-income groups in Mexico City and Washington, D.C., seemed less committed to taking personal action to tackle the problems of urban air pollution.

2 **Although they perceive that urban air pollution has an adverse effect on health,** many urban dwellers continue to use their cars because of convenience. Participants in all three case studies indicated that, even though they perceived that they might be contributing to air pollution (see Box 4), they relied on their cars for convenience or to meet their professional commit-

ments. At the same time, poor public transportation contributed to a reliance on the private car. In the three case studies, the use of private cars was recognized as one of the major sources of air pollution. The Washington, D.C., case study revealed that, per dollar of expenditure, automobiles on average produced four times more particulate emissions than buses do. In all three cities, however, car owners were reluctant to give up the use of their cars because they believed that public transportation was insufficiently widespread, unavailable at times they needed it, or unsafe. Bangkok participants found public transportation to be slow, overcrowded, and unreliable.

Box 4
The Perceived Effects of Urban Air Pollution

Focus group participants in all three case-study cities had similar perceptions of the effects of urban air pollution.

■ **Urban air pollution affects quality of life.** Most focus group participants either directly identified air quality as a quality-of-life issue or established a causal relationship between air pollution and other quality-of-life issues, such as illness or insecurity.

■ **Various health problems are related to air pollution.** Only participants in Bangkok perceived air pollution as a major threat, although participants in all three cities perceived some relationship between health problems and air pollution. Yet all appeared willing to accept this impact in the absence of evidence showing that it is a major threat. In essence, individuals seemed to be adapting to the situations imposed by the air pollution risks. Still, these participants saw air pollution as a nuisance. Medium- and high-income groups from Mexico City, for example, spoke of the inconvenience of having to have their car engines inspected and of the annoyance they felt when the government imposed driving bans on highly polluted days. In contrast, Bangkok participants were particularly sensitive to the impacts of air pollution on health.

■ **Little information is available to the public on connections between air pollution and health.** Despite mounting evidence of the effects of air pollution on health, particularly in Bangkok and Mexico City, few participants felt that the public was aware of the connection. Most participants thought that, if air pollution's detrimental effects on health were proven, obvious, and widespread, they would be more willing to change their behavior. They noted the effectiveness of public information and education initiatives, incentives, and legal and social pressures applied in anti-smoking and household recycling campaigns and recommended using similar tactics in the effort to reduce air pollution.

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POLICY RECOMMENDATIONS

The findings of the case studies lead to four recommendations for policies to reduce transportation-associated air pollution.

1 Combine improvements in the public transportation system with regulations and incentives to encourage the use of less-polluting or nonpolluting transportation alternatives such as walking, cycling, and telecommuting. The variety of solutions suggested by the urban dwellers and policymakers in this project clearly indicates that there is no single answer (see Box 5). Reducing air pollution will require a mix of activities including incentives (high-occupancy-vehicle lanes, recycling) and regulations (emission controls, new technologies, and penalties).

Improving public transport was seen as being of primary importance. In all three case studies, focus group participants said they would use public transport more if it offered comfort, security, adequate speed, and enough routes—among other characteristics.

Generally individuals were willing to engage in non-polluting types of transport where possible. Walking, however, did not seem feasible to many, due to the long distances that they traveled daily and to safety concerns. Yet among participants in the medium- and low-income

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"If I knew that bad air was going to affect my health in the next 20 years, if it was linked to something concrete, I might do something about it."

High-income focus group participant, young group, Washington, D.C.

groups, who often use public transportation, walking short distances from transit point to final destination was acceptable.

2 Tailor policies by socio-economic group and gender to combat specific polluting behavior. The results of the quantitative analysis consistently show that the higher the socioeconomic status, the greater the probability to contribute to air pollution through transportation use. The qualitative analysis shows that willingness to participate in programs to reduce air pollution also varied by socioeconomic status (see Box 6, p. 18, for details on Mexico City). In Mexico City and Washington, D.C., participants in high-income focus groups exhibited a greater reliance on government to solve air pollution problems. Members of medium- and low-income groups felt

that individuals in their daily lives could do more to reduce air pollution. Policymakers should bear in mind socioeconomic status when developing specific policies and when projecting how those policies might be received. Although the qualitative findings were not disaggregated by gender, the evidence from the quantitative analysis that male heads of household pollute more supports a similar tailoring of policies by gender.

3 Educate the public about the impact of transportation choices, particularly on air pollution, and encourage community involvement in education efforts. The results of the focus group analysis suggest that many urban dwellers are unsure about the impacts of transporta-

tion use. If reliable, objective, peer-reviewed scientific work has clearly shown a negative impact of transportation choices on the environment, and ultimately public health, those results should be disseminated to the public through education cam-

paigns. If such research is lacking or inadequate, such studies should be commissioned (see Box 7, p. 19).

Many of the focus group participants did not feel they had control over

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Box 5
Measures Recommended in the Case Studies

Short Term
■ Encourage carpooling by designating more high-occupancy-vehicle lanes, more park-and-ride spaces, and more bike paths.

■ Increase public safety measures within the public transport system to reduce incidents such as robberies that discourage the use of this kind of transport.

■ Ban vehicular traffic in certain areas of the city.

■ Limit parking options and strictly enforce time limits on parking meters.

Short-to-Medium Term
■ Institute flexible working schedules, permitting government employees to arrive and leave earlier or later, to mitigate congestion during the rush hours. Encourage companies to adopt similar policies.

Long Term
■ Explore the possible trade-offs between information travel and human travel—for instance, telecommuting.

Box 6
An Ideal Form of Transportation—Perspectives From Mexico City

The private car was the preferred method of transport in the high-income group, although focus group participants acknowledged that traveling by car typically means enduring traffic and struggling to find a safe place to park. Participants mentioned, however, that they would use public transportation if it were well organized, comfortable, and could meet current demand. However, many participants feared robberies and violence and saw a lack of safety as an obstacle to using more public transportation.

Participants in the medium-income group thought that the subway and tramway were ideal transportation for Mexico City. They said they would rather not have to spend money on gasoline and could benefit from reading or sightseeing while on public transport. They shared the safety concerns of the high-income group, expressed reluctance about having a subway station near their homes (since stations are always accompanied by street sellers and the consequent dirt of the streets), and felt that the current subway system in Mexico City is inadequate to cover public demand for transportation.

The low-income group favored increasing the number of minibuses and buses to ensure that they were more frequent. The group suggested that large buses should replace small buses and that the number of trams should be increased to reduce air pollution.

Excerpted from the Mexico City case study

their impact on air pollution, yet the quantitative analysis clearly demonstrates that the collective impact of personal choices regarding transportation use had a significant impact on air pollution. Although some participants believed that the action of one individual could influence others' actions, most thought the impact of one person would be minimal. Groups in Mexico City and Washington, D.C., believed that collective action by citizens could have an impact in the local area or in their particular counties. Ultimately, therefore, city authorities should encourage active community participation in promoting nonpolluting behavior, particularly in reducing reliance on the private car.

4 Examine urban pollution from a multidisciplinary perspective so that demographic and other relevant factors inform policy decisionmaking. This study illustrates the value of linking demographic and environmental phenomena because it shows specific effects of demographic variables—such as population growth, density, and distribution as well as household size and structure—on urban pollution problems. Additionally, the study illustrates the value of combining quantitative and qualitative analyses. Canvassing urban dwellers to gain insight into what policies might be successful in addressing urban pollution problems is as important as quantifying these problems. Focus groups helped those who conducted this study understand the behavior that contributes to urban air pollution, whereas analysis of household data provided insight into the structural factors that influence transportation choices and contribute to urban air pollution.

The findings in this study reveal intertwining cause-and-effect relation-

ships among household structure and needs, city design, travel behavior, and pollution impacts.

In addition, there are almost certainly strong personal motives for driving a car, even when other options exist and despite the increasing inconvenience and health risks associated with traffic congestion. The strong individualism demonstrated by many of the focus group participants, and the perception frequently heard among them that individual action cannot affect the environment, are important components of the persistent decision to drive in the face of more environmentally healthy options.

Given the interplay of these factors, combining infrastructure improvements with incentives and regulation, targeted education campaigns, and informed multidisciplinary study would hold the greatest promise for reducing transportation-induced pollution.

"*T*he use of vehicles in our country is due… to necessity and [to]… the status attached to it. We have to take these two causes of the problem into consideration."

In-depth interview, male member of parliament, Bangkok

Box 7
Potential Results: Public Education and Community Participation

Short term
■ Mass media campaigns increase public awareness and a sense of mutual responsibility.
■ Community groups such as schools, universities, churches, and companies encourage carpooling.

Medium term
■ Reputable scientific studies make clear the connection between air pollution and disease. These studies provide evidence that behavior change (less driving) can lead to health benefits (decreased incidence of headaches, heart attacks, lung cancer, and the like).

Long term
■ Dissemination of the results of these studies increases knowledge among citizens of the effects of air pollution and leads to behavior change—self-discipline, respect for the rights of others, and a willingness to fight for protection of community interest.

Excerpted from case studies

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BACKGROUND NOTE:

INTERNATIONAL CONFERENCES ON POPULATION, TRANSPORTATION, AND AIR POLLUTION

The relationship among transportation, urban air pollution, and household dynamics captures three essential components of a sustainable transportation agenda: economic viability, environmental integrity, and social equity. Transportation has been dealt with at international conferences on sustainable development held throughout the 1990s (see box below). Three of these meetings have focused specifically on urban transportation issues: the 1992 UN Conference on Environment and Development (UNCED) held in Rio de Janeiro, the Conference of Parties (COP) meetings held from 1992 to the present surrounding the UN Framework Convention on Climate Change (UNFCC), and the 1996 UN Conference on Human Settlements (Habitat II) in Istanbul. Two other meetings referred to the linkages: the International Conference on Population and Development (Cairo, 1994) recognized the linkages between transportation and demographic variables, while the World Summit for Social Development (Copenhagen, 1995) situated transportation in a social policy context.

Agenda 21, UNCED's Programme of Action, highlights three important points relating to urban transportation. The first is that there are economic, environmental, and social components to transportation dynamics. The document notes, for example, that while transportation is necessary for economic development, it has negative impacts, particularly on marginalized urban groups, through pollution, injuries, congestion, and loss of productivity.[17] The second point is countries' responsibility for sound development. Agenda 21 states, for example, that developing countries are faced with the need to increase their energy production to accelerate development and raise the living standards of their populations, but at the same time they need to reduce energy production costs and energy-related pollution. The third point in Agenda 21 is the speci-

International Conferences With References to Household Dynamics, Pollution, and Transportation

Conference	References
UN Conference on Environment and Development, 1992	Programme of Action (Agenda 21), Chapters 7 and 9
UN Framework Convention on Climate Change, 1992 to 1999 Berlin (1995), Geneva (1996), Kyoto (1997), Buenos Aires (1998)	The Convention Treaty, Protocol documents from Berlin (1995), Geneva (1996), Kyoto (1997), Buenos Aires (1998)
International Conference on Population and Development, 1994	Programme of Action, Sections 3, 5, and 9
World Summit for Social Development, 1995	Programme of Action, Sections 31(a) and 34 (c)
UN Conference on Human Settlements (Habitat II), 1996	The Istanbul Declaration on Human Settlements, The Habitat Agenda, Preamble and Chapter 7

ficity of urban pollution: The document recognizes that many metropolitan areas suffer from transport-related air-quality problems.

UNFCC, endorsed by 166 countries at UNCED, also provided the basis for ongoing international negotiations to decide on a protocol of commitments to help stabilize atmospheric concentrations of greenhouse gases. UNFCC built on two earlier global agreements. In 1985, the world's nations agreed to take strong action to stop depletion of stratospheric ozone by entering into the Vienna Convention for the Protection of the Ozone Layer. This treaty was strengthened in 1987 by the Montreal Protocol on Substances that Deplete the Ozone Layer. By 1993, 150 nations ratified UNFCC, and in 1994 the treaty entered into force, committing industrialized nations to reduce their

emissions of greenhouse gases not controlled by the Montreal Protocol to 1990 levels by the year 2000.[18] International negotiations are now underway among the UNFCC signatories to define a protocol that will limit emissions of these gases after the year 2000.

Since 1995, four COP meetings have taken place to guide negotiations for a protocol requiring further action for the early 21st century. In 1995, at COP1 in Berlin, the parties agreed to the so-called "Berlin Mandate," because they found that developed countries' commitments to curb greenhouse gas emissions were not adequate to meet UNFCC's goals. As such, the parties set a schedule for negotiating a protocol to toughen these commitments after 1997. Around this time, new scientific evidence convinced parties to the Montreal Protocol to control addi-

tional ozone depleters and accelerate the phase-out of those already included in the protocol. On January 1, 1996, the world's industrialized countries ceased production of chlorofluorocarbons, carbon tetrachloride, and methyl chloroform (with a few essential uses exempted). Later that year, at COP2 in Geneva, the United States supported a report on climate change that had just been released by an international panel of climate experts, the Intergovernmental Panel on Climate Change. The United States announced that it would support binding targets to reduce greenhouse gas emissions.

In 1997, at COP3 in Kyoto, industrialized countries agreed to work on measures to limit or reduce transport-related greenhouse gas emissions not controlled by the Montreal Protocol. In 1997, at COP4 in Buenos

Aires, more than 160 countries agreed on deadlines and an action plan to guide efforts to fight global warming. The countries agreed to set rules for enforcing the Kyoto pact by late 2000, including tough measures to guard against cheating and penalties for countries that fail to comply.[19] These efforts all affect the transportation sector because many of the greenhouse gas emissions are from transportation sources.

Habitat II, also referred to as the "City Summit," reaffirmed the results from UNCED and recognized the specific impacts of urban transportation problems. In Istanbul, participants mentioned three major elements that must be addressed to improve the quality of life within human settlements. These were unsustainable con-

sumption and production patterns, particularly in industrialized countries; unsustainable population changes, including changes in structure and distribution (giving priority consideration to excessive population concentration); and environmental degradation.[20] Habitat II's Programme of Action, the Habitat Agenda, recognizes a number of urban problems that directly relate to the transportation sector. These include increased poverty and a widening gap between rich and poor, growing insecurity and rising crime rates, improper land use, rising traffic congestion, increasing pollution, lack of green spaces, and uncoordinated urban development.[21]

GLOSSARY

Agenda 21. The plan of action to achieve sustainable development that was adopted by world leaders at the UN Conference on Environment and Development held in Rio de Janeiro, Brazil, in June 1992.

Air pollution. The presence of contaminant or pollutant substances in the air that do not disperse properly and that interfere with human health or welfare, or produce other harmful environmental effects.

Carbon dioxide (CO_2). A colorless, odorless, and nonpoisonous gas that results from fossil fuel combustion and is normally a part of ambient air. It is also produced in the respiration of living organisms (plants and animals). CO_2 is considered to be the main greenhouse gas contributing to climate change.

Carbon monoxide (CO). A colorless, odorless, and poisonous gas produced by incomplete fossil fuel combustion. Carbon monoxide combines with the hemoglobin of human beings, reducing its oxygen-carrying capacity and causing dizziness and other symptoms.

Elderly household. A household maintained by one or more persons over age 64.

Emission. Discharge of pollutants into the atmosphere from stationary sources—such as smokestacks, other vents, and surface areas of commercial or industrial facilities—and from mobile sources such as motor vehicles, locomotives, and aircraft.

Female-headed household. A household headed by an unmarried, divorced, separated, or widowed woman or a household headed by a grandmother or other woman who lives alone or with other women.

Global warming. Phenomenon that occurs as a result of the build-up of carbon dioxide and other greenhouse gases. Scientists have identified global warming as a major global environmental threat.

Greenhouse gases. Carbon dioxide, nitrous oxide, methane, ozone, and chlorofluorocarbons that occur naturally, result from human (production and consumption) activities, and contribute to the greenhouse effect.

Habitat Conference. UN Conference on Human Settlements. The first conference was held in Vancouver, British Columbia, from May 31 to June 11, 1976; the second conference was held in Istanbul, Turkey, from June 3 to June 14, 1996 (this conference is also referred to as the "City Summit").

Household. Usually defined as one or more persons who occupy a single housing unit. Households consist of unrelated persons or persons related by birth, marriage, or adoption.

Metropolitan area. A large concentration of population, usually an area of 100,000 or more people, with an important city at its core and suburban and exurban areas surrounding the city that are socially and economically integrated with it.

Ozone (O3). A pungent, colorless, toxic gas that contains three atoms of oxygen in each molecule. It occurs naturally at a concentration of about 0.01 parts per million (p.p.m.) of air. Levels of 0.1 p.p.m. are considered to be toxic. In the stratosphere (or upper layer of the atmosphere), ozone provides a protective layer shielding human beings and other living organisms on Earth from the harmful effects of ultraviolet radiation. In the troposphere (layer of atmosphere extending about 10 kms. upward from Earth's surface), ozone is a major component of photochemical smog, which seriously affects the human respiratory system.

Population density. Usually expressed as the number of people per unit of land area.

Population policy. Explicit or implicit measures instituted by a government to influence population size, growth, distribution, or composition.

Quality of life. Notion of human welfare (well-being). Quality of life is measured by social indicators rather than by quantitative measures of income and production.

One-adult household. Household that does not contain children and is maintained by one adult.

One-parent household. Household that contains children and is maintained by one parent as a result of an out-of-wedlock birth, divorce, separation, or the death of a spouse.

Smog. Combination of smoke and fog in which products of combustion such as hydrocarbons, particulate matter, and oxides of sulfur and nitrogen occur in concentrations that are harmful to human beings and other organisms.

Suspended particulate matter (SPM). Finely divided solids or liquids that may be dispersed through the air from combustion processes, industrial activities, or natural sources.

Two-adult household. Household that does not contain children and is maintained by two adults.

Two-parent household. Household that contains children and is maintained by two parents.

Urban population. The population living in urban areas. Countries differ in the way they classify population as urban or rural. Typically, population living in a community or settlement with 2,000 people or more is considered urban.

Sources: United Nations, *Glossary of Environmental Statistics*, 1997; PRB, *Population Handbook, International Edition,* 1998; UN Centre for Human Settlements, *An Urbanizing World* (New York: UN, 1996): 12.

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APPENDIX 1:
COUNTRY TEAMS

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APPENDIX 2:
NOTES ON METHODOLOGY

QUANTITATIVE:
Statistical Analysis

Research teams ran a series of multiple regressions to determine statistically significant relationships among household structure, consumption, and environmental impacts. To accomplish this, the teams calculated pollution coefficients using information on different pollution emissions types, total household expenditures on gasoline and public transport, total household income, and household size. Based on the different pollution coefficients, the teams then constructed dependent variables (measures of transportation expenditures) and selected a set of household socioeconomic variables as independent variables. These included household size, percentage of household members in certain age categories (those under age 2, those under age 18, and those over age 64), years of education of the head of household, and after-tax household income. Finally, the teams employed different regression models to examine the net effect of each variable and regression equation as a whole on the dependent variables.

Sources of Data

Thailand

For Thailand, two sources of data were used. The first was the *Household Socioeconomic Survey, 1994*, conducted by the National Statistical Office. The survey is conducted every two years. It is a nationally and regionally representative survey. The second was the *Report on Thailand's Pollution Situation* by the Department of Toxic Control, Ministry of Sciences, Technology and Environment. Data on the amount of air pollution emission by mode of transportation measured in tons per year were taken from the second source of data.

Mexico

The Mexican analysis was based on a combination of two sources of data: the *National Income and Expenditure Survey (NIES)* and the *Emissions Inventory*, both for 1994. The NIES is nationally representative with a total of 12,815 respondents and also represents the Metropolitan Area of Mexico City (MAMC), with 1,738 cases. The sample selected for the NIES was weighted to produce estimates for the entire population. The weighting procedure entailed multiplying each case by a statistical factor that was included in the same survey. Thus, the research team was able to obtain direct measures for MAMC household expenditure on gasoline and public transportation as well as for a set of selected sociodemographic variables such as household income, household size, head of household's schooling, head of household's gender, and private cars per household. It was also possible to relate the NIES MAMC household data to the pollutant emissions data for the entire area of Mexico City. Pollutant emissions data were obtained from the *Emissions Inventory* for 1994, included in the *Program for Air Quality Improvement in the Valley of Mexico, 1995-2000*. This program has official data measured in terms of tons per year. In its analysis, the team used only data on particulate matter, carbon monoxide, hydrocarbon, and total emissions associated with both private and public transportation.

United States

The primary source of data on consumer expenditures in the United States was the *1995 Consumer Expenditures Survey (CES)*, published by the Bureau of Labor Statistics (BLS). The BLS releases survey responses to questions such as wages and income, demographic and household information, and amount expended on different types of commodities. The CES also includes national averages for different commodities, which were used to construct the emission coefficients. The U.S. Environmental Protection Agency (EPA) is the major source of information on particulate emissions. EPA's *1995 National Air Pollutant Emission Trends* contains emissions for the six criteria pollutants for different on-road transportation sources, including light-duty gas vehicles (automobiles), motorcycles, and heavy-duty diesel vehicles (including buses). Additional data were needed to disaggregate the expenditure data on motor fuel into automobile and motorcycle categories, and to disaggregate the heavy-duty diesel emissions into buses and trucks. Data for these estimates were derived from the Bureau of Transportation Statistics' 1997 National Transportation Statistics series.

QUALITATIVE: Focus Group Interviews

Focus group interviews supplemented the quantitative data and provided insights into the dynamics

of household transportation use among various demographic and income groups in each country. The interviews examined current consumption levels, consumer aspirations, and perceptions of the link among household size, consumption patterns, and environmental problems. Focus group participants were drawn from important subgroups of the national populations—urban elites, urban working class, and the urban poor. The participants were selected and the groups organized by age and income levels. In the case of the United States, the participants were also screened to ensure racial and ethnic diversity. The Mexican and Thai research teams also conducted in-depth interviews with policymakers and city authorities to ascertain their attitudes and perceptions of the urban air pollution problem.

THE STUDY OF POPULATION-CONSUMPTION-ENVIRONMENT LINKS: The Case of Air Pollution in Bangkok

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Background

The level of air pollution in Bangkok frequently exceeds national air-quality standards, particularly for suspended particulate matter. This is largely the result of activities in the transport, industry, and power sectors. In addition, severe congestion and the particular mix of vehicle types in Bangkok accelerate vehicular air pollution. The average traffic speed in Bangkok is about 10 kilometers per hour, resulting in a notable amount of

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unnecessary emissions. In the Bangkok Metropolitan Region, vehicles contribute from 60 percent to 70 percent of air pollution, while industry and domestic sources contribute the rest.

Because most of Bangkok's workers live in the periphery, there is a great demand for commuting. Today, small, numerous households—that include few children, a high proportion of household members in the labor force, and slightly more members who are elderly—increase transportation demand. Private transport already accounts for 51 percent of all daily trips, the highest in any Asian city. The high growth rates of private-vehicle ownership may be decreasing, however, given the region's recent economic downturn.

Findings From the Quantitative Analysis

The quantitative analysis showed strong links between household characteristics and contribution to air pollution.

■ Male-headed households emitted about 2.7 kilograms more suspended particulate matter (SPM) per year than female-headed households.

■ Households whose heads worked in the sales and service and production sectors produced about 3.7 and 4.6 kilograms less SPM per year than households headed by professionals or those with administrative occupations.

■ Each increase of 1,000 baht (about U.S. $26 at current rates) in monthly income caused an increase in emissions of 0.1 kilogram per year.

■ Extended- and nuclear-family households produced approximately 5.3 and 3.5 kilograms more SPM per year, respectively, than did one-person households.

Findings From the Qualitative Analysis

Following is a summary of the findings from the qualitative analysis:

■ Bangkok inhabitants regarded various health problems caused by air pollution as major concerns. All participants clearly felt that air pollution was having adverse effects on their health and that this might be affecting their quality of life.

■ People at all income levels of society recognized the impact of the individual on air pollution. Yet this recognition did not seem to affect commuting choices. While high- and medium-income families use their cars or motorcycles, the majority of the low-income population used the government's mass transit system or private companies' bus services. The last group also rode their own motorcycles or used the hired ones (motorcycle taxis). Regardless of income level, families sent their children to the most prestigious schools possible. Because these schools were located in the city center, and because of safety concerns, parents reported driving or accompanying their children to school often.

■ Individualism and consumerism were seen to delay the development of community participation. Many focus group participants felt that Bangkok's civil society organizations were not yet working together in community-driven strategic planning to tackle issues that affected people's lives, such as sprawl. Participants indicated that a lack of socialization and a lack of empowerment made it difficult for citizens to reassess development objectives and to collectively define long-term quality-of-life issues.

■ For Bangkok's inhabitants, poor public transportation, work-related needs, and convenience led to a reliance on the private car.

■ A lack of coordination of transportation policy was seen to hinder implementation of recommendations. Focus group participants perceived that the formulation of a comprehensive transportation policy had long been delayed because of the absence of any authoritative organization with clear responsibility for the coordination of various transportation projects. Focus group participants also perceived a lack of political interest manifested in a lack of accountability, transparency, honesty, and coordination across different departments.

POPULATION-CONSUMPTION-ENVIRONMENT LINKS:
Air Pollution and Transport Use in Mexico City

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Background

Air-quality problems in Mexico City are created by a combination of social and natural factors, such as the technology used to control emissions in the transport, industrial, and service sectors; rapid population growth with inadequate infrastructure; and Mexico City's high altitude, which results in inefficient fuel combustion. According to the 1994 emissions inventory for the Metropolitan Area of Mexico City, more than 4 million tons of pollutants are discharged into the atmosphere yearly. SPM represents 11.3 per-

cent of the total amount of these pollutants.

The most important cause of air pollution in Mexico City is the urban transport system. Vehicle emissions account for 75 percent of the total amount of pollutants expelled into the atmosphere. Private cars alone emit over half this amount. Data for 1991 show that, although private cars accounted for only 15 percent of all the journeys per person per day that took place in Mexico City, they consumed 67 percent of all the energy used, emitting 5 to 6 more grams of pollutants per journey per day than petrol-fueled public transport and the highest amount of pollutants in the transport sector.

Nearly 45 percent of the 3 million cars in Mexico City are over 10 years old. At present around 36 million trips take place in Mexico City, 21.4 percent of which are made by private cars. The transport system has

a very low average speed (36 kilometers per hour), which leads to greater emissions and more pollution.

Findings From the Quantitative Analysis

There are three general findings from the quantitative analysis:

■ Higher education and income levels increased the household's contribution to air pollution. A high correlation was found between education and income, suggesting that those households were in a better financial position to afford private transport, and that they contributed more to air pollution.

■ Female-headed households' expenditure on public transportation had a greater impact on air pollution. This might be explained by the greater use of this kind of transportation among female-headed households, where car ownership is less common than in male-headed households. There was, however, a major impact on pollution

per capita in male-headed households, regardless of the kind of transportation used by members. This is because most households in Mexico City are headed by males.

■ Larger households spent more money on transportation, but households that used a private car generated a greater share of pollution. The impact on pollution was great among households that used public transport (65 percent of households accounting for 30 percent of total atmospheric pollution), a finding explained by the fact that larger household sizes were involved. Households that owned at least one car—35 percent of all households in the metropolitan area of Mexico City—contributed 35 percent of household pollution.

Findings From the Qualitative Analysis

The following findings are based on focus group discussions:

■ Mexico City inhabitants perceived various health problems due to air pollution, but did not regard these as a major concern. Despite the recognition of a growing impact on health, participants seemed willing to live with air pollution. Low-income individuals seemed to be adapting themselves to the situations imposed by the air pollution risks. Medium- and high-income groups saw air pollution as a nuisance because it imposed additional tasks, such as the inspection of car engines, and triggered driving bans (under the *Hoy no circula* program) that limited the use of cars to once—or in case of emergency twice—a week.

■ The perception of personal impact on air pollution varied according to income level. Low-income group participants for the most part used public transport. They did not view themselves as

contributing to air pollution in using this mode of transport and perceived private cars to be a major cause of air pollution in Mexico City. Medium- and high-income participants recognized that using their cars did contribute to the air pollution problem, but they did not see it as a major contributor.

POPULATION-CONSUMPTION-ENVIRONMENT LINKS:
Air Pollution and Transport Use in the Washington, D.C., Region

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Background

Since the 1970s, Washington, D.C., has been one of the fastest growing metropolitan areas in the United States. The region has a rapidly diversi-fying, post-industrial, service-based economy, and an increasingly decentralized pattern of urbanization. Growth in the District of Columbia proper has not been nearly as large or as rapid as growth in the region as a whole. Suburbs have seen the bulk of the new growth, both in population and employment. This pattern has had important implications for a transportation system that was designed to carry workers within the city, or from suburban houses to downtown jobs. People increasingly live in the suburbs and work in the suburbs, and for most people, these suburbs are not the same ones; cross-suburb commuting is a major cause of traffic congestion and extended commuting, and consequently air pollution, in the region. It is not merely growth but the location and type of growth that are partially responsible for the air-quality problem in the region.

Washington, D.C., also suffers from high, albeit declining, concentrations of ground-level ozone, a major source of urban air pollution. Ground-level ozone is produced by the combination of nitrous oxides and volatile organic compounds in the presence of sunlight. Transportation is the leading source of volatile organic compound emissions in the area, and the second leading source of nitrous oxide emissions. Automobile use, in terms of vehicle-miles traveled per year, has increased faster than population. Congestion, which results in more pollutant emissions per trip, has increased as well, despite the construction of over 400 miles of new freeways in the region since 1982.

A significant factor in the urban transportation trends in Washington, D.C., is the growing affluent population attracted by the growing number of high-paying jobs in the region. This translates into increasing expenditures on automobiles and private transportation. In a highly dispersed, low-density settlement pattern, automobiles are increasingly indispensable for access to work and leisure activities. Thus, every household must have an automobile or risk being socially marginalized. If the household has two workers, the standard in most of the country, then having two automobiles becomes increasingly important.

Findings From the Quantitative Analysis

Household variables affected decisions on the mode of transportation used. On average, two-parent households tended to spend the greatest amount on private (automobile) transportation, while one-parent households tended to spend the most on public transportation. Elderly households with higher incomes showed a distinct preference for private as opposed to public transportation, perhaps because of personal safety concerns or because of the greater convenience of automo-

biles. Generally, higher education, income, and household size increased transportation demands.

More households relied on private than on public transportation. On average, two-parent households tended to spend more on more-polluting private transportation than did the other types of households, and their average total transportation expenditures were higher as well. Although elderly households spent less than others on total transportation, their expenditures were also heavily biased toward private transportation. One-parent or one-adult households, on the other hand, tended to divide their expenditures more equally between the two modes. The desire to drive an automobile appears to be embedded in the culture of many Americans and was reflected in the focus groups. Changing the culture of driving presents a great challenge that, in the absence of a major crisis, will require a long education process.

Findings From the Qualitative Analysis

A review of the input across the focus groups revealed the following opinions and ideas:

- Air quality was seen as contributing to quality of life. Most participants either directly identified air quality as a quality-of-life issue or established a causal relationship between air pollution and illness.

- Individuals did not feel as if they had control over their means of transport. Most participants believed they needed to drive their own cars, especially for work or shopping. They did not think public transportation was sufficiently widespread, available at times they needed it, or safe enough to provide a credible option.

- Individuals did not feel they had control over their impact on air pollution.

Most thought the impact of one person changing his or her behavior would have a minimal impact on pollution. Some groups believed that collective action by citizens could have an impact in the local area or in their particular counties.

- Most individuals accepted some responsibility for their choices impacting air pollution. People from all income levels admitted that individuals were responsible for the level of air pollution in the Washington area and that their choices caused air pollution. Most immediately identified the automobile as a major cause of air pollution and their own decisions to drive as a contributing factor. However, few took steps to reduce the amount of air pollution by choosing not to drive or changing their behavior in other ways.

- Individuals believed there was little public information connecting air pollution and health. Only

one group—older, low-income residents—made a clear connection between air pollution and health risk or disease and felt air pollution had a dramatic impact on quality of life. Others saw some ill effects in their own experiences—allergy problems, breathing difficulties—but felt that there was no clear connection. Most participants thought that, if air pollution's detrimental effects on health were proven, obvious, and widespread, they would be more willing to change their behavior. They noted the effectiveness of public information and education initiatives, incentives, and legal and social pressures applied in anti-smoking and household recycling campaigns and recommended using similar tactics in the effort to reduce air pollution.

ORDERING INFORMATION

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