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## Air Quality in the Paso del Norte Airshed: Historical and Contemporary

*N. J. Parks, W. Li, C. D. Turner, R. W. Gray, R. Currey, S. Dattner, J. Saenz, V. Valenzuela, and J. A. VanDerslice*

### ABSTRACT

This chapter provides an overview of the Paso del Norte airshed region, which is comprised of Ciudad Juárez, Chihuahua; El Paso, Texas; and Doña Ana County, New Mexico. Stakeholders are identified and a framework for industry, academia, non-governmental advocates, and government agencies at various levels to collaborate on air issues is provided.

Visible air pollution has historically been a focal point for interaction among various constituencies concerned about health effects, economic and social attractiveness, and regulation in the Paso del Norte Airshed (PdNA). The authors have collaborated primarily on the evaluation of visibility degradation by air pollutants and its relationship to priority pollutant levels prescribed by the United States Environmental Protection Agency (EPA) for air contaminants (Parks 1998). This is of special interest because the sizes (0.4 $\mu$ m to 0.8 $\mu$ m) of particulate matter (PM) in the ambient aerosol that scatter light in the visible range are retained in the lungs after inhalation. These visible air pollutant particles are believed to be most hazardous if

they originate from urban sources. They typically vary in concentration with invisible air pollutant gases from urban sources in the PdNA because prominent temperature inversions trap the various urban air pollutants.

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## Calidad del Aire en la Cuenca Atmosférica Paso del Norte: Histórica y Contemporánea

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### RESUMEN

Este capítulo proporciona una visión general para la región de la cuenca atmosférica del Paso del Norte, la cual comprende a Ciudad Juárez, Chihuahua; El Paso, Texas; y el Condado Doña Ana, Nuevo México. Los sectores involucrados son identificados y se proporciona un marco para la colaboración en asuntos relacionados con el aire para la industria, academia, organizaciones no gubernamentales y agencias de gobierno en varios niveles.

La contaminación atmosférica visible ha sido históricamente un punto central para la interacción entre varias comunidades preocupadas sobre los efectos en la salud, la atracción económica y social y la regulación en la cuenca atmosférica del Paso del Norte. Los autores han colaborado principalmente en la evaluación de la degradación de la visibilidad causada por contaminantes del aire y su relación con los niveles de contaminantes criterio prescritos por la Agencia de Protección Ambiental de los Estados Unidos (EPA, por sus siglas en inglés) para contaminantes del aire. Esto es de especial interés porque los tamaños ( $0.4 \mu\text{m}$  a  $0.8 \mu\text{m}$ ) de materia particulada (PM, por sus siglas en inglés) en el aerosol ambiental que dispersan luz en el rango visible, son retenidos en los pulmones después de su inhalación. Se cree que estas partículas visibles contaminantes del

aire, son las de mayor riesgo si provienen de fuentes urbanas. Varían típicamente en concentración con gases invisibles contaminantes del aire que provienen de fuentes urbanas en la Cuenca Atmosférica Paso del Norte (PdNA, por sus siglas en inglés) debido a las grandes inversiones térmicas que atrapan los diversos contaminantes del aire urbano.

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## AIR QUALITY ISSUES: PAST AND PRESENT

Several historical and currently important issues are conveniently introduced in the Charles Binion photograph (El Paso Public Library archives) in Figure 1. This illustration of historical sites, geography, meteorology, industrial pollution abatement, and urban demographics was used by Willis Webb on the cover of his seminal monograph, *Mesometeorology* in El Paso (Webb 1971).

Figure 1. Easterly View of “The Pass” Between the Franklin Mountains to the North and the Sierra de Juárez Mountains to the South



(The international border marker is the white diamond in the middle foreground with New Mexico in the lower left corner, Texas across the river, and Chihuahua, Mexico, beyond the marker and to the right of the river. The stack is 828 feet high with the plume injected above inversions [typically]. Downtown El Paso and Ciudad Juárez appear in the distance.)

Beyond the smoke stacks of the ASARCO, Inc., smelter, downtown El Paso, and Ciudad Juárez (about 3km), a monument stands representing Capitán-General Don Juan de Oñate, who led a Spanish colonial expedition across the river in 1598. He named this location “El Paso del Río del Norte,” which was later shortened to “Paso del Norte.” Some 370 years later, in about 1968, the local research community that resided in the PdNA began to work on air quality issues, stimulated by their observations of poor air quality and the then-recent appearance of the American Association for the Advancement of Science report from its Air Conservation Committee (AAAS 1965).

A review of the salient background literature and symposia proceedings is intended to be representative rather than exhaustive. All work is referred to in at least one of the references herein. An important report was the previously cited monograph on mesometeorology, which Webb (1971) defined as meteorology on an intermediate scale—about the size of the metropolitan area in the PdNA. Webb was privy to the results of more than 3,900 rocket radiosonde shots from White Sands Missile Range, just north of El Paso. These shots collected wind data, ozone ( $O_3$ ) concentrations, and ambient air samples in liquid neon traps at 25,000 feet (8,000m) elevation. Webb observed that, despite the PdNA being one of the most meteorologically studied areas at high altitude, explanations of complex ground level meteorological phenomena controlling air pollution was inadequate (1971). This situation was little improved until August 1996 when the Paso del Norte Ozone Study (Roberts 1996) was performed and re-visited in 1997 because few ozone exceedences were observed in 1996. August 1997 also proved to be relatively free of high ozone levels. This underscored the difficulties of matching an intense meteorological study period to an overlapping period of high levels of pollutants of interest. Pollutants of interest include ozone precursors and intermediates in the chemical cycles characteristic in ambient atmospheric aerosols that form ozone.

The second major symposia and proceedings publications were organized by Professors Applegate and Bath from the University of Texas at El Paso. This was *Air Pollution Along the United States-Mexico Border* (1974). This first binational symposium on air pollution was held on the University of Texas at El Paso (UTEP) campus in

September 1973. It was sponsored by two international health agencies, United States and Mexican environmental agencies, various universities, state health and environmental agencies, and municipal health and environment departments. Vehicular pollution, open burning, industrial sources, regulation, and future monitoring needs were central themes.

## HEALTH ISSUES OF CONCERN

At a 1973 symposium, L. P. Jones, of UTEP's biology department (Jones 1973) noted, "Medical studies have clearly related contaminated air to a broad variety of respiratory problems in man such as asthma, bronchitis, lung cancer, and emphysema. In El Paso-Ciudad Juárez, we have the pollution, and we have the patients with respiratory disorders. I think the time has come for a study to analyze the effects of air on the people of this community." The lag time between this clarion call for health effects studies and the appearance of the first one in 1999 by VanDerslice and co-workers (Hart 1999) on pediatric asthma was 26 years. With the added information about air pollution health effects in other western areas (Heflin 1994; Schwartz 1999), health effects studies are even more important today. At present, no studies on even the mortality rate correlation with air quality have been performed for the PdNA. This report will argue for the appropriate support from public agencies such that the lag time between a 1999 call for health effects studies and actual performance of one falls in a "near term" time frame (i.e., one year to five years rather than 26).

The 1980s were a time when attention focused on numbers of vehicles, waiting time at the international bridges, vehicle emissions, general air pollution, and health effects for people in and around the international bridges. A collaboration of El Paso city and county officials and academics led to the summarizing publication of much of the 1980s air quality effort in the PdNA. The book, *Vehicular Traffic and Air Pollution in El Paso-Ciudad Juárez* by R. Gray, J. Reynoso, C. Diaz Q., and H. Applegate, appeared in 1989. This publication included a wealth of original data and analyses over several years for carbon monoxide (CO), ozone, and total suspended particulates (TSP). El Paso was out of federal compliance during

this time while no data existed for Ciudad Juárez. Carbon monoxide, in particular, had been found to have dramatically high values for hourly maxima—nearly 200ppm at some times at the inspection stations. This ultimately led to the re-design of a clean air supply system for inspection booths on international bridges.

Other issues addressed by Gray et al. (1989) were the subjects of various symposia, proposals for international accords, and impacts of the new treaty, the La Paz Agreement, which was signed in 1983 by Mexican President Miguel de la Madrid and United States President Ronald Reagan. The La Paz Agreement and future annexes, which also have the standing of the treaty in United States law, specified that the EPA and the Mexican Secretaría de Desarrollo Urbano y Ecología (SEDUE) were the designated federal agencies, and that local officials were to be included. This agreement permitted the EPA to spend money for air pollution studies or abatement programs that would take place in border areas—which were perceived to be of lower priority, at the time, for the Mexican government than the markedly more serious air quality problems in Mexico City. In the 1990s, the La Paz Agreement expedited the process for acquiring air pollution data by the various responsible Mexican agencies in the PdNA. Today, CO, O<sub>3</sub>, oxides of nitrogen (NO<sub>x</sub>), and particles less than 10 microns in diameter (PM<sub>10</sub>) are routinely measured on both sides of the border.

## INSTITUTIONS INVOLVED WITH AIR QUALITY

The 1990s in the PdNA were characterized both by more research and by a much higher level of citizen and nongovernment agency participation in air quality issues. For several years, the Paso del Norte Air Quality Task Force has been quite active as a forum for debate and presentation of issues on both sides of the border. It typically alternated meeting sites between El Paso, Ciudad Juárez, and less frequently, Sunland Park, New Mexico. Typically, representatives of all local, state, and federal agencies with a vested interest on both sides of the border attended. The academic research community has been well represented by local non-governmental organizations such as the Clean Cities Coalition and by international non-governmental organizations such as Environmental Defense.

The Task Force advocated the formation of an International Joint Advisory Committee for the improvement of air quality in the Airbasin that covers Ciudad Juárez, Chihuahua; El Paso, Texas; and Doña Ana County, New Mexico. The International Joint Advisory Committee now meets regularly to address air issues in the basin. This committee has not existed long enough to estimate its effectiveness. The meeting notifications and minutes distribution are managed through the Texas Commission on Environmental Quality (TCEQ) Region 6 office in El Paso (Valenzuela 1999).

Another Task Force issue was lobbying for commuter lanes to speed up bridge crossing. Various “fast identification” methods for pre-registered drivers and the commuter lane have been developed, according to a report to the Joint Air Quality Advisory Committee. Yet another issue is the export of United States automobiles that fail United States emissions tests to Ciudad Juárez. This results in a conflict between economic incentive to export them and efforts to reduce mobile source emissions. Another issue is whether United States oxygenated fuels are exported to Ciudad Juárez and what replacements exist in the United States if the oxygenator MTBE (methyl-tertiary-butyl-ether) is banned. Grassroots political action and citizen participation in *ad hoc* groups concerned about air quality have been important in raising public awareness in the PdNA.

Air quality research in the 1990s first focused on the component of the usually measured respirable fine particles that are less than 2.5  $\mu\text{m}$  in aerodynamic diameter, or  $\text{PM}_{2.5}$ . The TCEQ project, *El Paso-Juárez 1990 PM-10 Receptor Modeling Feasibility Study* (Dattner 1994) obtained  $\text{PM}_{2.5}$  and the total  $\text{PM}_{10}$  using dichotomous samplers. The values, up to 100  $\mu\text{g}/\text{m}^3$  in parts of the PdNA, are comparable to the  $\text{PM}_{2.5}$  maxima coming out of the U.S. EPA-sponsored pilot study in 1998.

With more health effects data showing excess mortality from urban air pollution in other western metropolitan areas now available (Schartz 1996), the 30% to 75% of the  $\text{PM}_{10}$  that turned out to be in the respirable “fine” fraction reported by Dattner is of greater concern than before. In Dattner’s report, he noted that established dogma at that time (1994 and some years before) argued that the fine fraction penetrates into the lower respiratory tract, the process creating the fine particles differs from those creating the

rest of  $PM_{10}$ , and that the fine mass is frequently more toxic than coarse mass. These statements remain unchallenged. The other research studies of the 1990s will be discussed in a separate section, but the first reports in that decade point out the anticipated health effects of the findings.

A variety of public and private groups and organizations are now involved in air quality in the PdNA. Some companies and utilities have participated in ways that have both present and future value through their environmental divisions. Two organizations with facilities on the Rio Grande have made their engineers available to display the most sophisticated modern air pollution control equipment to the students in area academic institutions. One such company is ASARCO, Inc. Their facilities (Figure 1) essentially eliminated the hundreds of tons per day of sulfur oxides flowing from their smoke stack with "ConTop" smelting reactors, installed around 1993. The former waste product was then marketed as sulfuric acid. This facility is presently idled as a consequence of low copper prices and thus, for the first time in 100 years, is contributing no air contamination to the PdNA. El Paso Electric Company has two plants in the PdNA that burn clean natural gas but must have sophisticated temperature feedback control to prevent the  $NO_x$  emissions from exceeding regulatory limits. This utility has a pro-active environmental education program and successfully interacts with academic institutions in the area. The various public institutions involved in air quality in the PdNA are listed in Table 1.

Table 1. Institutions Involved in Air Quality in the PdNA

Local Government	Air Group, El Paso City-County Health Department Dirección de Desarrollo Urbano y Ecología del Gobierno del Municipio de Juárez
State Governments	Dirección General de Desarrollo Urbano y Ecología del Gobierno del Estado de Chihuahua New Mexico Environment Department Texas Commission on Environmental Quality Western Governors Association
Federal Government	Instituto Nacional de Ecología of México Secretaría de Medio Ambiente y Recursos Naturales U.S. Environmental Protection Agency U.S. Centers for Disease Control and Prevention
International; U.S.-Mexico	Joint Advisory Committee for the Improvement of Air Quality in the Ciudad Juárez, Chihuahua; El Paso, Texas; Doña Ana County, New Mexico Airbasin
Academic Institutions	Arizona State University New Mexico Institute of Technology New Mexico State University University of Texas at El Paso University of Utah San Diego State University Universidad Autónoma de Ciudad Juárez Southwest Center for Environmental Research & Policy
Non-Governmental Organizations	Border Health Research Center of the Paso del Norte Health Foundation Environmental Defense Clean Cities Coalition Physicians for Social Responsibility Paso del Norte Air Task Force

## GEOGRAPHY AND DEMOGRAPHICS

The physical situation of El Paso and Ciudad Juárez is shown in Figure 2, which also shows typical winter morning inversion height at a few hundred feet. On this day in December 1997, the sharply defined pall of dust and co-existing urban pollutants is most visible between downtown El Paso (tall buildings) and the foot of the Sierra de Juárez Mountains. Downtown El Paso is within three blocks of the international border; consequently, most of the area under heavy visible pollution on this day is in Ciudad Juárez. Additional details of topography are provided at [www.ozonemap.org](http://www.ozonemap.org) (Gray 1999).

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Figure 2. South-Westerly View Taken from the End of the Franklin Mountains (Scenic Drive) above El Paso



## REFERENCE MATERIALS

A project by the ATR Institute of the University of New Mexico (Cockerill 1998) catalogued reference material for transportation-related issues along the border. It included most studies of any description performed in El Paso through 1997. This reference source was catalogued by the authors, funding agency, and performing institution. More recent El Paso studies since the ATR publication were compiled but are not included. However, they are referenced in subsequent sections herein.

Direct access to ozone data in the PdNA (Gray 1999) is provided by the Center for Environmental Resource Management (CERM) at the UTEP website [www.ozonemap.org](http://www.ozonemap.org). This site is linked to related web pages for other projects at CERM/UTEP.

### *Geography, Meteorology, Demographics, and Air Quality*

#### *Local Topography*

The PdNA is part of the basin-range geography of the southwestern United States and northern Mexico. It includes three cities: El Paso, Texas; Ciudad Juárez, Chihuahua; and Sunland Park, New Mexico. El Paso is bisected by the narrow north-south trending Franklin Mountains in El Paso and the southwest trending Sierra de Juárez Mountains south of the Rio Grande (Figures 1 and 2).

### *Local Climate Conditions*

The climate and the meteorology have a profound influence on the air quality situation. The annual rainfall varies from 5 inches to 12 inches. The dry top layers of soil contain fine particles that are entrained by wind currents. The health effects of the mix of urban and crustal material—which, contrary to some expectations is well within the respirable size range, is unknown.

### *Non-Uniform Ambient Air Quality*

The PdNA is classified as “nonattainment” for particulate matter, carbon monoxide, and ozone. As noted earlier, the most obvious evidence of air quality degradation in Paso del Norte is the frequent, well-defined haze hanging over the region during the morning hours (Figure 2). Parts of El Paso County fail to meet the United States National Ambient Air Quality Standards (NAAQS) for PM<sub>10</sub>, carbon monoxide (CO), and O<sub>3</sub>. Sunland Park, New Mexico, exceeds the NAAQS for ozone and PM<sub>10</sub>. Ciudad Juárez air pollution levels exceed the Mexican ambient air quality standards for PM<sub>10</sub> (150µg/m<sup>3</sup> for a 24-hour average and 50µg/m<sup>3</sup> for an annual average), ozone (0.11ppmv for a one-hour average), and CO (11ppmv for an eight-hour average). The Mexican longer-term averaged standards are comparable or more stringent than those of the United States.

The current population in the combined community of El Paso, Ciudad Juárez, and Sunland Park exceeds 2 million, about one-third of those residents live in El Paso. It is anticipated that the El Paso population will grow by 18,000 people to 20,000 people per year and the Ciudad Juárez population will grow at about 40,000 people per year. According to the El Paso Metropolitan Planning Organization, approximately 200,000 vehicles are registered in El Paso and 350,000 vehicles in Ciudad Juárez. The average number of vehicles crossing the border each day is approximately 40,000.

## *Ambient Air Monitoring and Emissions Inventories*

### *State of Texas and El Paso City-County*

TCEQ, El Paso City-County, Ciudad Juárez municipal government, and the New Mexico Environment Department (NMED) operate air

monitoring stations in the PdNA. Most of these stations also have PM<sub>10</sub>, CO, and NO<sub>x</sub> monitoring. Non-methane hydrocarbons are monitored at the Chamizal site in El Paso. The total number of monitoring stations, exclusive of the new PM<sub>2.5</sub> EPA program, is 13 in the United States and six in Ciudad Juárez, Chihuahua.

There are eight PM<sub>2.5</sub> monitoring stations running or being made operational in the Texas portion of the PdNA and two run by the NMED, totaling 10 in the PdNA in the United States. The expectation is that the fine fraction of PM<sub>10</sub> may be more important for health risk assessment. The first report of PM<sub>2.5</sub> sampling in Texas, including one sampler downtown at the Tilman Health Center, appeared in December 1998 (Tropp 1998). The proposed regulation is that the 24-hour average PM<sub>2.5</sub> should not exceed 65µg/m<sup>3</sup> for a three-year average of annual 98<sup>th</sup> percentiles at any population-oriented monitoring site. The El Paso preliminary results show maxima above this level.

Emissions inventories and models have been much more intensely examined in the 1990s than ever before. TCEQ periodically produces the El Paso Industrial Emissions Inventory. The most recent monitoring data is available on the TCEQ website at [www.tceq.tx.us](http://www.tceq.tx.us). This information and the hydrocarbon source apportionment portion of the 1996 Paso del Norte Ozone Study (Fujita 1998) was combined with the development of a gridded emission inventory for the entire PdNA (Haste 1998).

### *Health and Air Pollution Levels*

Risk assessment of exposure to inhalable fine particles in the Paso del Norte Airshed has received little attention. Adverse health effects are commonly anticipated after exposure to inhalable fine particles produced by urban air pollutant sources, sandstorms, or combinations of the two (Hefflin 1994; U.S. EPA 1995; Pope 1996).

In other western areas, the urban particle fraction alone has been shown to increase the mortality rate (Pope 1999). The only study of the adverse effects of inhalable fine particles in the PdNA has appeared recently. Hart et al. (1999) modeled pediatric emergency room admissions in 1994-1995 for respiratory illness as a function of ambient levels of PM<sub>10</sub> and ozone. In the PdNA, an increase in

asthma-related emergency room visits was found to be associated with a decrease in dew point temperature on the same day and an increase in PM<sub>10</sub> two days before.

## FUTURE ISSUES OF POLICY AND RESEARCH

The health issues addressed in the previous section depend on socio-economic factors as well as scientific work. In the development of *Characterization of Ambient Particulate Matter in the Paso del Norte Region* (Li 1999) for the Southwest Center for Environmental Research and Policy (SCERP), the investigators noted:

In order to understand the factors controlling particulate concentrations in the Paso del Norte Airbasin, one needs to take into consideration an international, tri-state setting with different environmental laws, regulations, standards, enforcement, and monitoring operations in the various jurisdictions at the federal, state, county, and city level; frequent and lengthy periods of intense traffic congestion at the international border crossings; atmospheric and topographic conditions which foster the development of inversions, regularly trapping pollutants and facilitating the build-up of ozone precursors, CO, PM, and other potentially hazardous air pollutants; rapid industrial and population growth that has outpaced the supporting infrastructure; and several zones of high population density which lead to traffic congestion with in El Paso and Ciudad Juárez.

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