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AIR POLLUTION ALONG THE UNITED STATES- MEXICO BORDER WITH EMPHASIS ON THE EL PASO-CIUDAD JUAREZ-LAS CRUCES AIR SHED

HOWARD G. APPLGATE* and C. RICHARD BATH**

Air pollution problems between the United States and Mexico have been delineated in two publications.¹ That problems do exist is evident to any one visiting either the San Diego-Tijuana area or the El Paso-Ciudad Juarez area. The binational problem is complicated by the laws of the six states in Mexico and the four states in the United States that abut the border. To complicate the picture, there is the La Frontera Zone in Mexico while in the United States there are 25 counties and two federal districts that are involved as distinct political entities.

AIR POLLUTION ALONG THE ENTIRE BORDER

An attempt was made in 1973 to quantify pollutants emitted into the air on both sides of the border. For the United States side Haneman (open burning),² Hanselka (agriculture),³ Shoultz (industry),⁴ and Russel (vehicles)⁵ presented the best available data; data from Mexico were presented by Garibay (burning),⁶ Sanchez (agriculture),⁷ Marquez (industry)⁸ and Barojas (vehicles).⁹

It is probably easiest to determine pollution from point sources. For that reason, some of the data from Shoultz are presented here in an effort to give an idea of the magnitude of the air pollution problem

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1. POLLUTION AND INTERNATIONAL BOUNDARIES (A. Utton ed. 1973); AIR POLLUTION ALONG THE UNITED STATES-MEXICO BORDER (H. Applegate & C. Bath eds. 1974) [hereinafter cited as Applegate & Bath].

2. Haneman, *Open Burning*, in Applegate & Bath, *supra* note 1, at 1.

3. Hanselka, *Air Pollution Potential From Agriculture Along the Texas-Mexico Border*, in Applegate & Bath, *supra* note 1, at 15.

4. Shoultz, *Air Pollution from United States Industrial Sources Along the United States-Mexico Border*, in Applegate & Bath, *supra* note 1, at 28.

5. Russel, *Vehicular Air Pollution in the United States Along the Border*, in Applegate & Bath, *supra* note 1, at 42.

6. Garibay M., *Contaminación del Aire en Las Ciudades Fronterizas Mexicanas*, in Applegate & Bath, *supra* note 1, at 7.

7. Sanchez Duran, *Contaminación del Aire por Actividades Agrícolas en México a lo largo de la Frontera*, in Applegate & Bath, *supra* note 1, at 22.

8. Marquez Mayaudon, *Contaminación del Aire por Industrias en México a lo largo de la Frontera Norte*, in Applegate & Bath, *supra* note 1, at 34.

9. Barojas Webér, *Contaminación del Aire por Vehículos en México a lo largo de la Frontera*, in Applegate & Bath, *supra* note 1, at 50.

along the border. Table 1 presents a summary of point source emissions while Table 2 compares the United States nationwide emissions with those from border counties. Sulfur oxides are by far the greatest in tonnage. Most of these are from smelters concentrated in a 360 mile linear distance extending from El Paso, Texas to Ajo, Arizona. Particulate emissions were second in tonnage. Chief contributors were quarrying, concrete, and asphaltic concrete batching and cement processing. Carbon monoxide is the third highest quantity with the principal contributors being petroleum refining, petrochemical and chemical process industries. Oxides of nitrogen and hydrocarbons are last in quantity. For oxides of nitrogen the chief contributors

TABLE 1

State Point Source Emissions Along the United States-Mexico Border—1970
(metric tons)

STATE	PA	SO _x	NO _x	HC	CO
TEXAS	38,286	256,187	34,147	23,590	112,247
NEW MEXICO	37,583	224,623	8,145	2,399	3,899
ARIZONA	35,294	525,345	6,215	642	4,033
CALIFORNIA	59,568	7,649	19,503	5,838	3,037
TOTAL	170,731	1,013,804	68,010	32,459	123,216

Only emissions from counties adjoining the border are included.

Source: Shoultz, *Air Pollution from United States Industrial Sources Along the United States-Mexico Border*, in AIR POLLUTION ALONG THE UNITED STATES-MEXICO BORDER 31 (H. Applegate & C. Bath eds. 1974).

TABLE 2

Percent Contribution of United States Counties Bordering on
Mexico to Total United States Pollution—1970
(10⁶ metric tons)

	PA	SO _x	NO _x	HC	CO
United States— nationwide	12.07	5.44	0.18	4.99	10.34
United States-Mexico border counties	0.17	1.01	0.06	0.03	0.13
Percent emission along Border	1.41	18.56	37.77	0.66	1.25

Source: Shoultz, *Air Pollution from United States Industrial Sources Along the United States-Mexico Border* in AIR POLLUTION ALONG THE UNITED STATES-MEXICO BORDER 33 (H. Applegate & C. Bath eds. 1974).

are industrial and electric power fuel combustion; for hydrocarbons, chemical process industries and petroleum refining are the principal contributors.

EL PASO-CIUDAD JUAREZ-LAS CRUCES

The El Paso-Ciudad Juarez-Las Cruces complex (EPJAZ) is one of the most populated and greatly industrialized areas of the border. The three cities have recognized the fact that they share a common air shed, underground aquifer, and economy. They have a long history of cooperative efforts to solve common problems. The success of these efforts is due, in a large measure, to the impartial efforts of the field office of the Pan American Health Organization (PAHO) located in El Paso.

From February 1972 until December 1976 the three cities, under the leadership of PAHO, undertook a survey of their common air shed.¹⁰ The data are presented in Tables 3 through 10. An inspection of the data allows the following conclusions to be drawn.

1. There are eight major point sources of air contaminants—a primary copper, lead, and zinc smelter; a municipal solid waste disposal site; two cement plants; two petroleum refineries; and two large brick plants.
2. There are two line sources of pollution: unpaved streets and vehicular transportation.
3. Commercial areas are more polluted than residential areas, which, in turn, are more polluted than rural areas.

TABLE 3

Industrial Process Losses for 1972 in AQCR XI

<i>Pollutant</i>	<i>Tons/Year</i>
Oxides of Nitrogen	50219
Sulfur Dioxide	771269
Hydrocarbons	857180
Carbon Monoxide	2710431
Particulates	467589

Source: S. Gomez, R. Flores Herrera, R. Kretzschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 11 (mimeograph 1975).

10. S. Gomez, R. Flores Herrera, R. Kretzschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974 (mimeograph 1975).

TABLE 4
1972 Industrial Point Source Pollutants—Dona Ana County

<i>Pollutant</i>	<i>Tons/Year</i>
Particulates	1084
Sulfur Dioxide	329
Oxides of Nitrogen	1623
Hydrocarbons	233
Carbon Monoxide	18

Source: S. Gomez, R. Flores Herrera, R. Kretzschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 12 (mimeograph 1975).

TABLE 5
Major Stationary Sources of Pollution in Cd. Juarez

<i>Industry</i>	<i>Production</i>
Hot mix asphalt plant	400 tons per day
Cement plant	300 tons per day
Brick plant	500000 bricks per month
Municipal disposal site	?

Source: S. Gomez, R. Flores Herrera, R. Kretzschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 12 (mimeograph 1975).

TABLE 6
Mobile Sources of Pollution

<i>Area</i>	<i>Amount</i>
El Paso County	227000 Registered vehicles (est)
Las Cruces	59000 Registered vehicles (est)
Cd. Juarez	97000 (est)
Military Reservations	20000 (est)

Border Crossings	12 million per year (into U.S.)

Source: S. Gomez, R. Flores Herrera, R. Kretzschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 13 (mimeograph 1975).

TABLE 7
Suspended Particulate Levels in Commercial Areas
($\mu\text{g}/\text{M}^3$)

	El Paso			Cd. Juarez			Las Cruces		
	Min.	Max.	Geo. Mean	Min.	Max.	Geo. Mean	Min.	Max.	Geo. Mean
1972	59	416	146	79	686	229	44	203	125
1973	47	366	129	136	874	340	10	184	73
1974	31	423	139	100	1480	342	11	229	71

U.S. National Primary Ambient Air Standard For Particulates: $75 \mu\text{g}/\text{M}^3$, Annual Geo. Mean.
Source: S. Gomez, R. Flores Herrera, R. Kretzschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 18 (mimeograph 1975).

TABLE 8
Suspended Particulate Levels in Rural Areas
($\mu\text{g}/\text{M}^3$)

	Clint, Tx.			Cd. Juarez			Anthony, N.M.		
	Min.	Max.	Geo. Mean	Min.	Max.	Geo. Mean	Min.	Max.	Geo. Mean
1972	32	80	49	(not in operation)			58	296	141
1973	17	157	42	43	925	100	19	751	143
1974	20	879	102	31	257	86	13	398	94

U.S. National Primary Ambient Air Standard For Particulates: $75 \mu\text{g}/\text{M}^3$, Annual Geometric Mean.
Source: G. Gomez, R. Flores Herrera, R. Kretzschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 22 (mimeograph 1975).

TABLE 9
Suspended Particulate Levels in Residential Areas
($\mu\text{g}/\text{M}^3$)

	<i>El Paso</i>			<i>Cd. Juarez</i>		
	<i>Min.</i>	<i>Max.</i>	<i>Geo. Mean</i>	<i>Min.</i>	<i>Max.</i>	<i>Geo. Mean</i>
1972	51	1884	119	64	708	199
1973	25	739	112	42	698	129
1974	31	249	110	57	671	107

U.S. National Primary Ambient Air Standard For Particulates: $75 \mu\text{g}/\text{M}^3$, Annual Geo. Mean.

Source: S. Gomez, R. Flores Herrera, R. Kretschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 21 (mimeograph 1975).

TABLE 10
Benzene Soluble Levels—1974
($\mu\text{g}/\text{M}^3$)

<i>Location</i>	<i>Concentrations</i>		
	<i>Min.</i>	<i>Max.</i>	<i>Arith. Mean</i>
<i>Cd. Juarez</i>			
Aeropuerto (rural)	1.5	15.0	4.4
Centro de salud B (commercial)	7.8	107.7	28.8
Compestre (residential)	1.1	60.8	9.7
<i>El Paso County</i>			
Clint (rural)	2.4	15.9	6.8
Tillman (commercial)	2.1	5.6	3.9
Thomas Manor (residential)	1.2	3.3	1.9
<i>Dona Ana County</i>			
Anthony (rural)	0.2	7.0	2.3
Las Cruces (commercial)	0.2	5.3	2.3

Source: S. Gomez, R. Flores Herrera, R. Kretschmar, R. McKeag, J. Shoults, G. Sanchez Trujillo & G. Davila, Progress Report on Air Pollution Survey in El Paso-Ciudad Juarez-Las Cruces Area: February 1972-December 1974, at 23 (mimeograph 1975).

4. In general, the air of Ciudad Juarez is more polluted than the air of El Paso, which, in turn, is more polluted than the air of Las Cruces.

The report concluded with an assessment that the binational program was a success and recommended further action of a similar nature in the future.

UNIVERSITY CONSORTIUM

There are five universities within the EPJAZ area: The University of Texas at El Paso (UTEP), New Mexico State University in Las Cruces (NMSU), Instituto Tecnológico de Cd. Juarez (ITCJ), Universidad Autónoma de Cd. Juarez (UACJ), and Escuela Superior de Agricultura "Hermanos Escobar." UTEP took the lead in suggesting they work jointly on common environmental problems within the EPJAZ area. After a series of meetings, the chief officers of each university signed the following agreement on January 22, 1976:

BASES OF COLLABORATION ON INTER-UNIVERSITY PROGRAMS CONCERNING ENVIRONMENTAL IMPROVEMENT IN THE EL PASO-JUAREZ AREA

1. *Definition of Goals*

The goals to be achieved by this plan are the following:

- 1.1 To promote local student awareness of the need for studying and preserving the environment by using the resources of the five participating universities.
- 1.2 To complement the professional training of graduate students in this field.
- 1.3 To contribute to the institutional development of the universities in the environmental field.
- 1.4 To contribute to environmental improvement in the region by collaboration with competent authorities.

2. *Statement of Activities for the achievement of these goals.*

- 2.1 To investigate the need and the possibility of establishing the required curriculum in order to conduct courses on environmental improvement.
- 2.2 To interchange information, publications and experiences.
- 2.3 To utilize in a mutually advantageous manner joint facilities and services devoted to these activities.
- 2.4 To conduct seminars, workshops and lectures.
- 2.5 Faculty interchange.
- 2.6 Student interchange.
- 2.7 To conduct studies and research in order to define and to resolve the environmental problems of the region.

- 2.8 To offer services, advice and technical orientation to the competent organizations.
3. The activities of this plan will be implemented in accordance with the adoption of semester programs which will run in the common academic sessions already established by all the participating institutions.

Prior to the official signing, however, joint research had already been initiated. UTEP and UACT had set up seven sampling stations in Juarez to help determine diffusion patterns within the air shed. The data have been the basis of one doctorate degree and a research proposal to further study the diffusion patterns. Another study is being prepared on viruses in water for the 77-78 irrigation system.

CONSORTIUM-GOVERNMENTAL INTERACTIONS

Heavy metals as air pollutants have been investigated both individually and jointly by the university consortium and governmental agencies. These elements were brought to everyone's attention during the trial of the American Smelting and Refining Company on violating air quality standards in El Paso. It was shown that the smelter emitted 1,012 metric tons of lead, 508 metric tons of zinc, and 1 metric ton of arsenic into the air from 1969 through 1971. The El Paso City County Health Unit determined ambient concentrations of cadmium, arsenic, lead, and zinc from May 1972 to April 1976. These data are in the process of being readied for publication. A brief summary of some of the data are given in Table 11.

Some concept of the seriousness of these values can be gained from the following comparisons:

1. Five year minimum value of cadmium at Highland Elementary School was three times the concentration (0.007 ug/m^3) believed to lead to increased deaths due to cardiovascular disease.
2. The threshold limit value for arsenic for industry is 0.5 mg/m^3 ; the 24-hour maximum value over a five year period for the International Boundary and Water Commission shop was 0.1 mg/m^3 .
3. When the air lead concentrations exceeds 2 ug/m^3 , a statistical correlation can be established between lead in the air and lead in the blood; over a five year period, air lead concentrations at the IBWC shop consistently exceeded 2 ug/m^3 , and concentrations at the Tillman Health Center usually exceeded 2 ug/m^3 .
4. The present recommendation by the American Conference of Governmental Industrial Hygienists for zinc is 5 mg/m^3 per 8 hours; no site approached this level.

TABLE 11

Ambient Concentrations of Cadmium, Arsenic, Lead and Zinc
from May 1972 to April, 1976

Site	24 Hr. Max.	Five Year		
		Mean	Max.	Min.
<i>Cadmium</i>				
IBWC ^a	5.451 ^d	0.408	0.563	0.348
Highland School ^b	0.190	0.027	0.034	0.021
Tillman ^c	0.307	0.050	0.060	0.040
<i>Arsenic</i>				
IBWC	10.766	0.616	0.962	0.296
Highland School	0.154	0.034	0.045	0.023
Tillman	2.187	0.080	0.099	0.067
<i>Lead</i>				
IBWC	67.8	7.220	10.0	5.0
Highland School	5.1	0.586	0.6	1.8
Tillman	9.21	1.664	1.5	4.0
<i>Zinc</i>				
IBWC	48.1	5.5	8.3	3.9
Highland School	2.0	0.2	0.28	0.20
Tillman	5.9	0.7	0.74	0.56

a. IBWC = International Boundary and Water Commission Shop, approximately 270 feet from ASARCO.

b. Highland Elementary School, approximately 4 miles east of ASARCO.

c. Tillman Health Center, approximately 4 miles south southeast of ASARCO.

d. Micrograms per cubic meter of air.

A year long study of diffusion patterns within the EPJAZ air shed was carried out by the consortium and environmental units of the respective cities. As might be expected, the mountainous terrain caused very complex diffusion patterns. There appear to be pockets of circling air masses within certain areas that lead to high concentrations of pollutants. In addition, microbial populations in the soil can biotransform the inorganic forms of the metals into organic compounds most of which are quite toxic.

RESUMEN

La regulación efectiva de los recursos del aire a lo largo de la frontera estadounidense-mexicana dependerá de la percepción del problema del fondo. Hay tres diferentes niveles de análisis y modos de plantear que se puede emplear para resolver el tipo de institución de la que se puede manejar los recursos naturales fronterizos: 1) el análisis mundial-ecosistémico; 2) el análisis internacional o bi-

nacional y; 3) el análisis simplemente nacional. Parece en este momento que el análisis (y resolución) mundial es imposible. El análisis internacional/bi-nacional parecerá basado en la falta de percepción de que la polución es un problema crítico. Hay otros problemas más críticos y más importantes a lo largo de la frontera y, por eso, la cooperación entre los dos gobiernos deberá ser al nivel bajo con costos mínimos. Una agencia existente que se puede emplear para facilitar tal cooperación es la Comisión Internacional de Límites y Aguas México-Estados Unidos, aunque es necesario aumentar los poderes oficiales de la comisión para manejar los problemas del medio ambiente. Al nivel nacional cualquier esfuerzo debe estar hecho para hacer cumplir las regulaciones existentes sobre los problemas del medio ambiente. En este momento, y en el futuro cercano, el modo de plantear más productivo debería ser la cooperación en el entrenamiento y la investigación científica por los grupos privados, individuos, universidades, y otros.