

# *Characteristics of the Monterrey Metropolitan Area Vehicle Fleet and Its Estimated Emissions*

**Gerardo Mejía, Francisco Obregón, Jorge Sánchez, and  
Jean-Benoit Daumerie**

**Center for Environmental Quality, ITESM, Monterrey, México**

**Jedidiah Horne**

**Massachusetts Institute of Technology**

**Andrew Burnette**

**ERG, Austin, Texas**

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# OVERVIEW

- **Air pollution in the MMA.**
- **Objective.**
- **Methodology.**
- **Characteristics of the Fleet.**
- **Vehicle Emissions.**
- **Emission distribution in the MMA.**
- **Conclusions and Recommendations.**





# 1995 Emission Inventory for the MMA

	Particles	SO <sub>2</sub>	CO	NO <sub>x</sub>	HC	Total
	ton / year	ton / year	ton / year	ton / year	ton / year	ton / year
<b>Industry</b>	45,946	27,997	3,281	18,549	5,578	<b>101,351</b>
<b>Services</b>	16	0	8	458	36,660	<b>37,142</b>
<b>Transport</b>	5,941	2,469	904,473	34,268	83,137	<b>1,030,288</b>
<b>Soil</b>	763,725	ND	ND	ND	ND	<b>763,765</b>
<b>Total</b>	<b>815,628</b>	<b>30,466</b>	<b>907,762</b>	<b>53,275</b>	<b>125,375</b>	<b>1,932,506</b>

*Source: Gobierno del Estado de Nuevo León, Secretaría del Medio Ambiente, Recursos Naturales y Pesca, Secretaría de Salud, Programa para Mejorar la Calidad del Aire del Área Metropolitana de Monterrey 1997 – 2000, 1997.*



# 1995 Emission Inventory for the MMA

	Particles	SO <sub>2</sub>	CO	NO <sub>x</sub>	HC	Total
	ton / day	ton / day	ton / day	ton / day	ton / day	ton / day
Industry	125.87	77.70	8.98	50.81	15.28	277.67
Services	0.04	0	0.02	1.25	100.43	101.75
Transport	16.27	6.76	2478	93.88	227.77	2822.70
Soil	2092.39					2092.39
Total	2234.59	83.46	2487.01	145.95	343.49	5294.53

*Source: Gobierno del Estado de Nuevo León, Secretaría del Medio Ambiente, Recursos Naturales y Pesca, Secretaría de Salud, Programa para Mejorar la Calidad del Aire del Área Metropolitana de Monterrey 1997 – 2000, 1997*



# Percentage and number of days above 100, 150 y 200 IMECAS of Ozone in the MMA

*Source: Segundo Informe de Calidad del Aire en Ciudades Mexicanas, INE, 1998*

Year	≥100		≥150		≥200	
	%	No.	%	No.	%	No.
1993	10	37	0.8	3	0	0
1994	6	20	0	0	0	0
1995	2	6	0	0	0	0
1996	7	25	0.3	1	0	0
1997	10	36	0.3	1	0	0



# PM10 Annual Average Concentration in the MMA, 1997-2002

*Source: Tercer Informe de Calidad del Aire en Ciudades Mexicanas, INE, 1998*

Year	Concentration $\mu\text{g}/\text{m}^3$
1993	54
1994	62
1995	51
1996	55
1997	42
1998	56

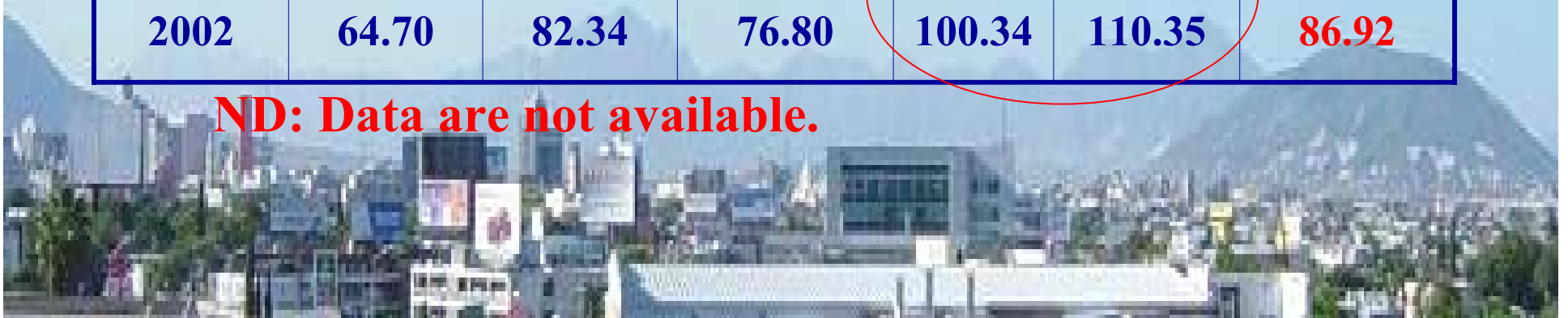


# PM10 Annual Average Concentration in the MMA, 1997-2002 *Source:*

*Sistema Integral de Monitoreo Ambiental (SIMA)*

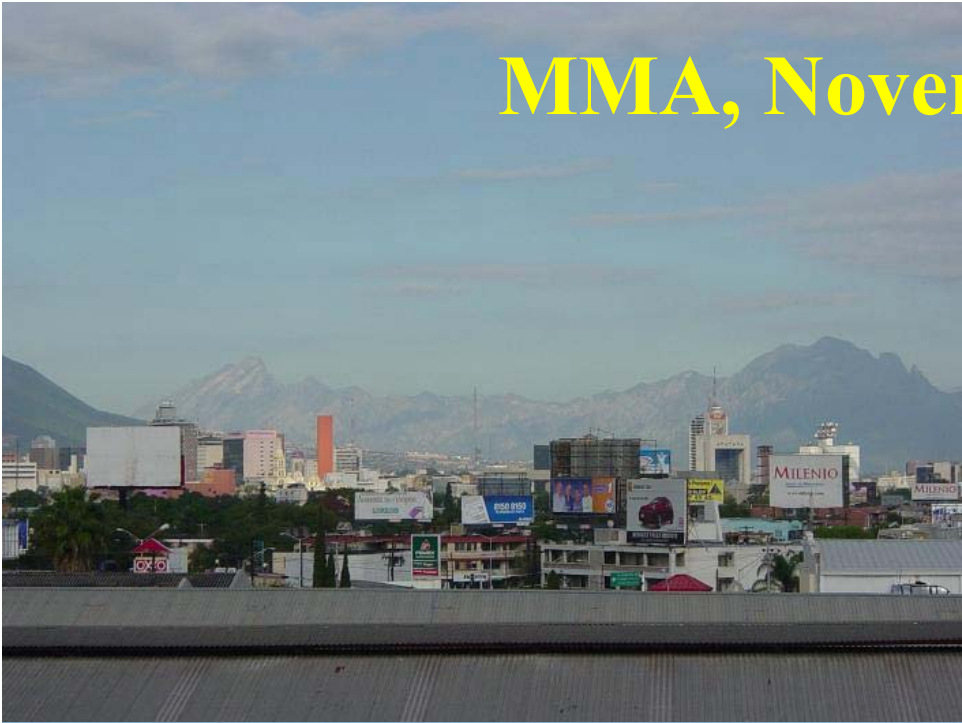
Monitoring station and average concentration in $\mu\text{g}/\text{m}^3$						
Year	SE	NE	Center	NW	SW	Average
1997	32.33	44.28	43.51	51.39	42.71	42.84
1998	48.68	58.90	53.90	52.93	64.18	55.72
1999	53.42	94.98	39.51	86.08	53.66	65.53
2000	42.69	ND	48.44	83.98	63.42	59.63
2001	59.53	95.48	74.62	95.55	102.45	84.12
2002	64.70	82.34	76.80	100.34	110.35	86.92

**ND: Data are not available.**

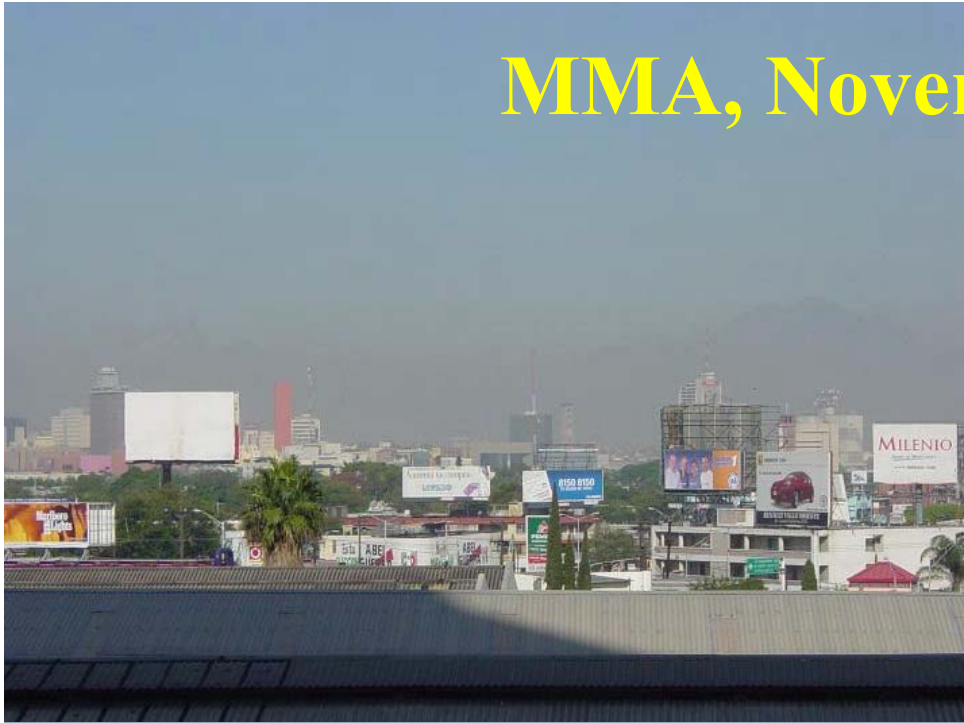




# MMA, November 6, 2002



# MMA, November 8, 2002



# PROBLEM

- **High concentration of PM10 and ozone.**
- **Increase in industrial activities.**
- **Fast growing population and vehicle fleet.**
  - **Population: 2.6 million in 1990 to more than 3.8 million in 2002.**
  - **Vehicles: 456 000 in 1989 to more than 1.1 million in 1993.**
  - **Vehicles/person: 0.174 in 1990 to 0.268 in 2001.**
- **Legalized vehicles.**
- **Unregistered vehicles.**



# OBJECTIVE

- **As part of an Air Quality Program for the MMA, characterize the MMA vehicle fleet and estimate the emissions by municipality.**



# METHODOLOGY

- **Classify vehicles in the MMA.**
- **Obtain distribution of models for each municipality.**
- **Adjust to consider unregistered vehicles.**
- **Obtain emission factors (Mobile5 AMM).**
- **Estimate emissions of the vehicle fleet for each municipality.**



# Vehicle Registration Data: 1,121,333

Manufacturer	Type	Model
VOLKSWAGEN	POINTER 4 PTAS STD	2001
FORD	FAIRMONT GUAYIN 6 CIL	1979
PEUGEOT	206 XR SEDAN 4 PTAS STD A/A	2001
GENERAL MOTORS	CUTLASS 4 PTAS P/H AUT EQUIP A/A	1992
CHRYSLER	TOWN COUNTRY FWD AUT 6 CIL	2001
PLYMOUTH	HORIZON 4 PTAS 4 CIL	1989
CHRYSLER	LE BARON 2 PTAS 8 CIL	1981
GENERAL MOTORS	CITATION COUPE 2 PTAS	1982
VOLKSWAGEN	CARIBE GAS 2 PTAS	1979
NISSAN	TSURU SEDAN 4 PTAS T/M TIP	1993



# Vehicle Classification

<b>Classification</b>	<b>Vehicle type</b>
<b>LDGV (Light Duty Gasoline Vehicles )</b>	<b>Automobiles and taxicabs</b>
<b>LDGT1 (Light Duty Gasoline Trucks 1)</b>	<b>Pick-up and small utility trucks used for light load</b>
<b>LDGT2 (Light Duty Gasoline Trucks 2)</b>	<b>Vans and utility trucks of two or three axes used for medium load</b>
<b>HDGV (Heavy Duty Gasoline Vehicles)</b>	<b>Large trucks used for heavy load</b>
<b>LDDV (Light Duty Diesel Vehicles)</b>	<b>Light service vehicles</b>
<b>HDDV (Heavy Duty Diesel Vehicles)</b>	<b>Passanger buses, big vehicles for heavy load and hardwork, trailers</b>



# Unregistered Vehicle Study

- **Sampling Sources:**
  - Data from parking lots.
  - Remote sensor data.
- **Identifiers:**
  - Tenencia (sticker in rear plate).
  - Plate (sticker in rear windshield).





# Unregistered Vehicle Study

- **Vehicles in the MMA:**
  - Registered in data base.
  - **Non registered: 12.95%**
    - Other state
    - Other country
    - Taxis
    - Private from NL
    - Other

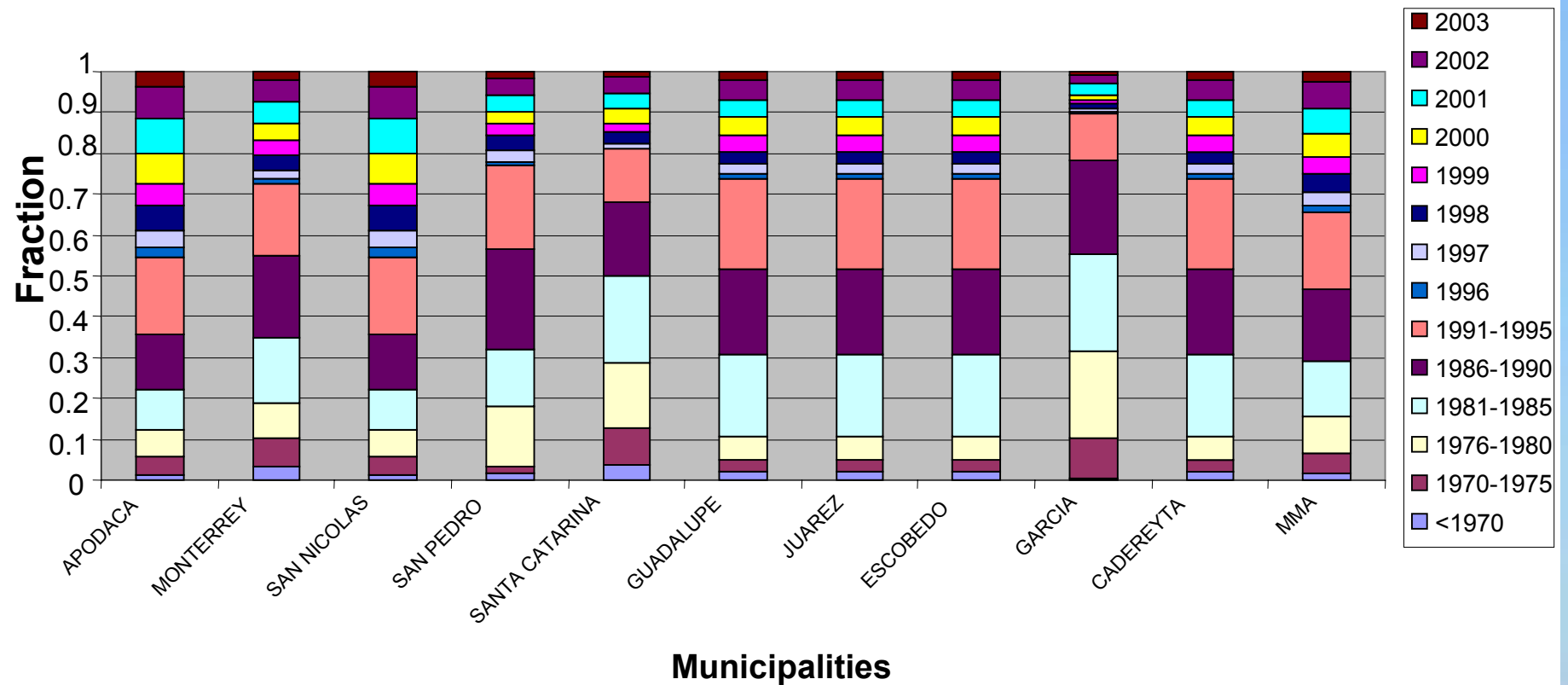


# Results of the unregistered vehicles study in the MMA

	Registered vehicles			Non Registered vehicles				
<b>Parking lots</b>	Private	Taxis	Other state	Other country	Taxis	NL	Other	Total
Guadalupe	582	7	31	4	0	4	6	634
Centro	497	1	76	4	0	18	2	598
Santa Catarina	571	16	45	7	0	8	2	649
ITESM	511	0	212	8	0	1	0	732
Escobedo	445	38	38	2	1	5	2	531
San Nicolas	533	3	59	4	0	14	1	614
<b>Subtotal</b>	<b>3139</b>	<b>65</b>	<b>461</b>	<b>29</b>	<b>1</b>	<b>50</b>	<b>13</b>	<b>3758</b>
	Registered vehicles			Non Registered vehicles				
<b>Remote sensor</b>	Private	Taxis	Other state	Other country	Taxis	NL	Other	Total
San Nicolas (Feb 18)	305	47	11	1	0	2	6	372
San Nicolas (Feb 19)	317	29	30	7	0	2	9	394
San Nicolás (Feb 21)	269	42	16	1	0	1	6	335
Apodaca (Jan 30)	376	29	26	7	2	0	0	440
Apodaca (Feb 12)	290	13	25	8	1	6	5	348
Escobedo (Nov 5)	392	98	16	3	0	0	7	516
Santa Catarina (Jan 22)	236	57	10	1	0	2	0	306
Santa Catarina (Jan 28)	314	97	14	5	1	2	5	438
<b>Subtotal</b>	<b>2499</b>	<b>412</b>	<b>148</b>	<b>33</b>	<b>4</b>	<b>15</b>	<b>38</b>	<b>3149</b>
<b>TOTAL</b>	<b>5638</b>	<b>477</b>	<b>609</b>	<b>62</b>	<b>5</b>	<b>65</b>	<b>51</b>	<b>6907</b>

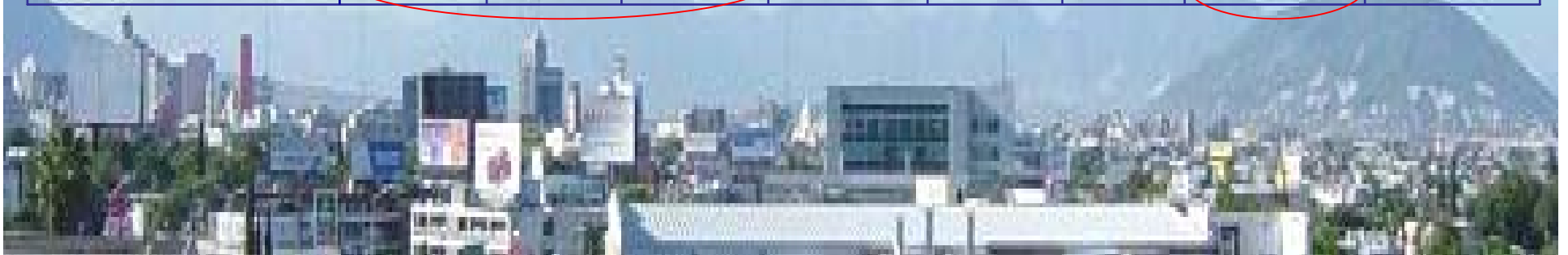


# Model Fractions Distribution in the MMA



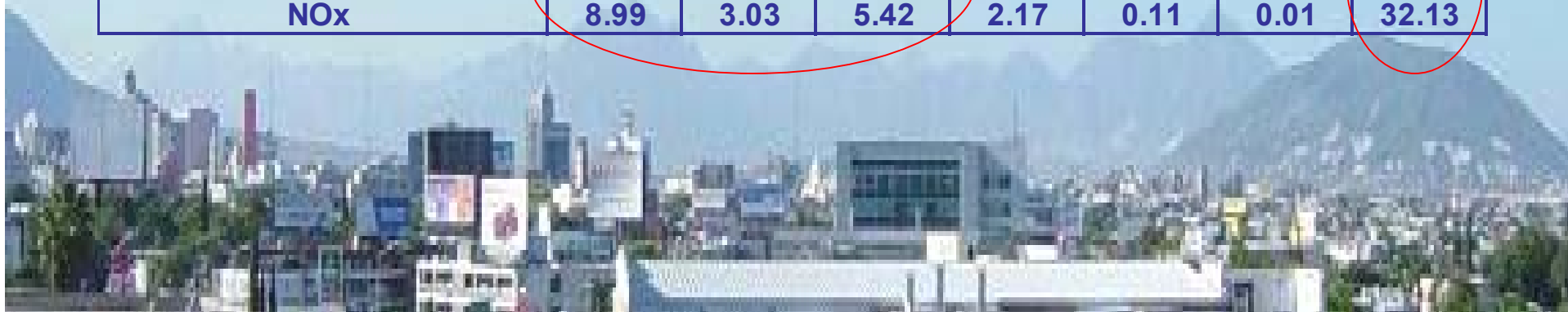
# Vehicle distribution in the MMA

MUNICIPALITIES	LDGV (Cars)	LDGV (Taxis)	LDGT1 (Pick-ups)	LDGT2	HDGV	LDDV	HDDV (Buses and Heavy vehicles)	TOTAL
APODACA	32936	1554	17543	5406	28	8	1768	59243
MONTERREY	307398	11126	138299	48119	270	51	16749	522012
SAN NICOLAS	115697	5408	62898	19306	115	28	6156	209608
SAN PEDRO	55059	429	24092	8382	47	9	2918	90936
STA. CATARINA	29208	1809	17217	5093	35	11	1467	54840
GUADALUPE	120772	5891	66939	21011	115	35	6401	221164
JUAREZ	6038	209	3177	979	5	1	320	10729
ESCOBEDO	23253	1226	14409	4192	27	10	1073	44190
GARCIA	2667	44	1379	425	2	1	139	4657
CADEREYTA	16966	921	8629	2659	14	4	870	30063
<b>TOTAL</b>	<b>709994</b>	<b>28617</b>	<b>354582</b>	<b>115572</b>	<b>658</b>	<b>158</b>	<b>37861</b>	<b>1247442</b>



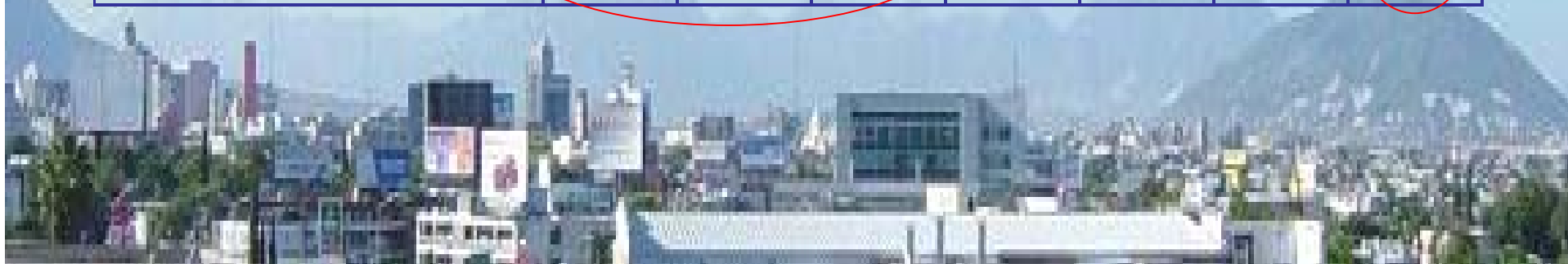
# Mobile Source Emissions in the Municipality of Monterrey

MONTERREY	Vehicle type						
	LDGV	LDGV (Taxis)	LDGT1	LDGT2	HDGV	LDDV	HDDV
Average speed (km/hr)	25	25	25	20	10	10	10
Traveled distance (km/day)	25.8	240	25.8	30	120	120	120
Pollutant	Emission factor (g/km)						
HC	2.65	2.65	3.39	3.55	9.55	2.22	3.09
CO	22.80	22.80	27.70	28.56	123.59	5.62	17.11
NOx	1.13	1.13	1.52	1.50	3.33	1.67	15.98
Amount of vehicles	307398	11126	138299	48119	270	51	16749
Pollutant	Total emissions (Ton/day)						
HC	20.98	7.06	12.10	5.13	0.31	0.01	6.21
CO	180.83	60.88	98.82	41.23	4.00	0.03	34.40
NOx	8.99	3.03	5.42	2.17	0.11	0.01	32.13



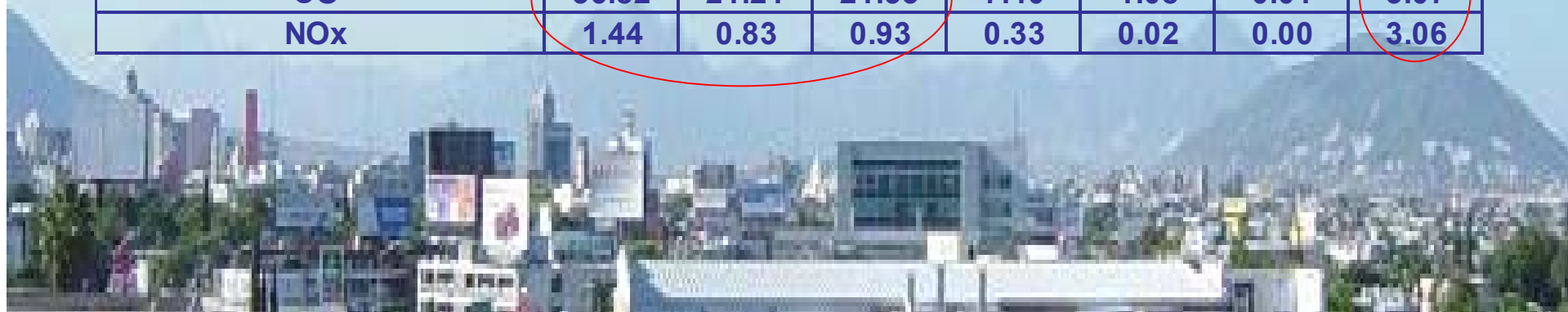
# Mobile Source Emissions in the Municipality of Guadalupe

GUADALUPE	Vehicle type						
	LDGV	LDGV (Taxis)	LDGT1	LDGT2	HDGV	LDDV	HDDV
Average speed (km/hr)	25	25	25	20	10	10	10
Traveled distance (km/day)	25.8	240	25.8	30	120	120	120
Pollutant	Emission factor (g/km)						
HC	4.39	4.39	5.46	6.15	15.79	2.28	3.30
CO	38.87	38.87	42.41	44.72	208.81	5.77	17.52
NOx	1.65	1.65	1.94	2.01	3.81	1.69	16.92
Amount of vehicles	120772	5891	66939	21011	115	35	6401
Pollutant	Total emissions (Ton/day)						
HC	13.68	6.21	9.43	3.88	0.22	0.01	2.53
CO	121.11	54.96	73.25	28.19	2.88	0.02	13.46
NOx	5.14	2.33	3.35	1.27	0.05	0.01	13.00



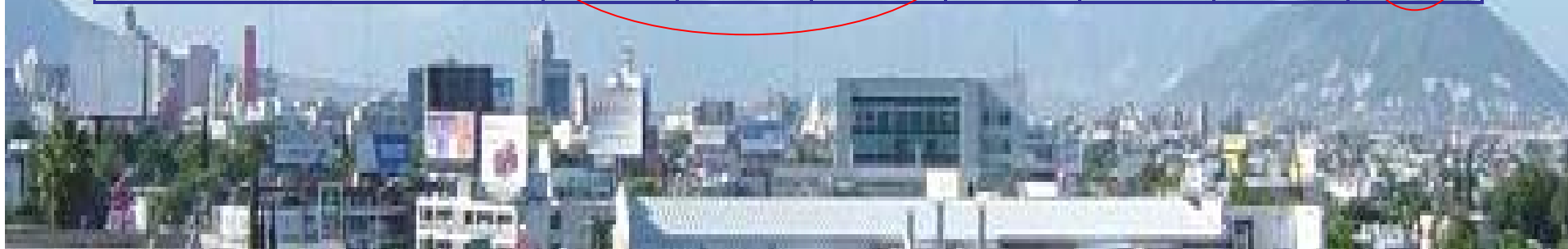
# Mobile Source Emissions in the Municipality of Santa Catarina

SANTA CATARINA	Vehicle type						
	LDGV	LDGV (Taxis)	LDGT1	LDGT2	HDGV	LDDV	HDDV
Average speed (km/hr)	25	25	25	20	10	10	10
Traveled distance (km/day)	25.8	240	25.8	30	120	120	120
Pollutant	Emission factor (g/km)						
HC	5.41	5.41	6.28	6.90	19.33	2.26	3.46
CO	48.86	48.86	48.46	48.46	256.11	5.72	17.42
NOx	1.90	1.90	2.09	2.18	4.09	1.68	17.40
Amount of vehicles	29208	1809	17217	5093	35	11	1467
Pollutant	Total emissions (Ton/day)						
HC	4.07	2.35	2.79	1.05	0.08	0.00	0.61
CO	36.82	21.21	21.53	7.40	1.08	0.01	3.07
NOx	1.44	0.83	0.93	0.33	0.02	0.00	3.06



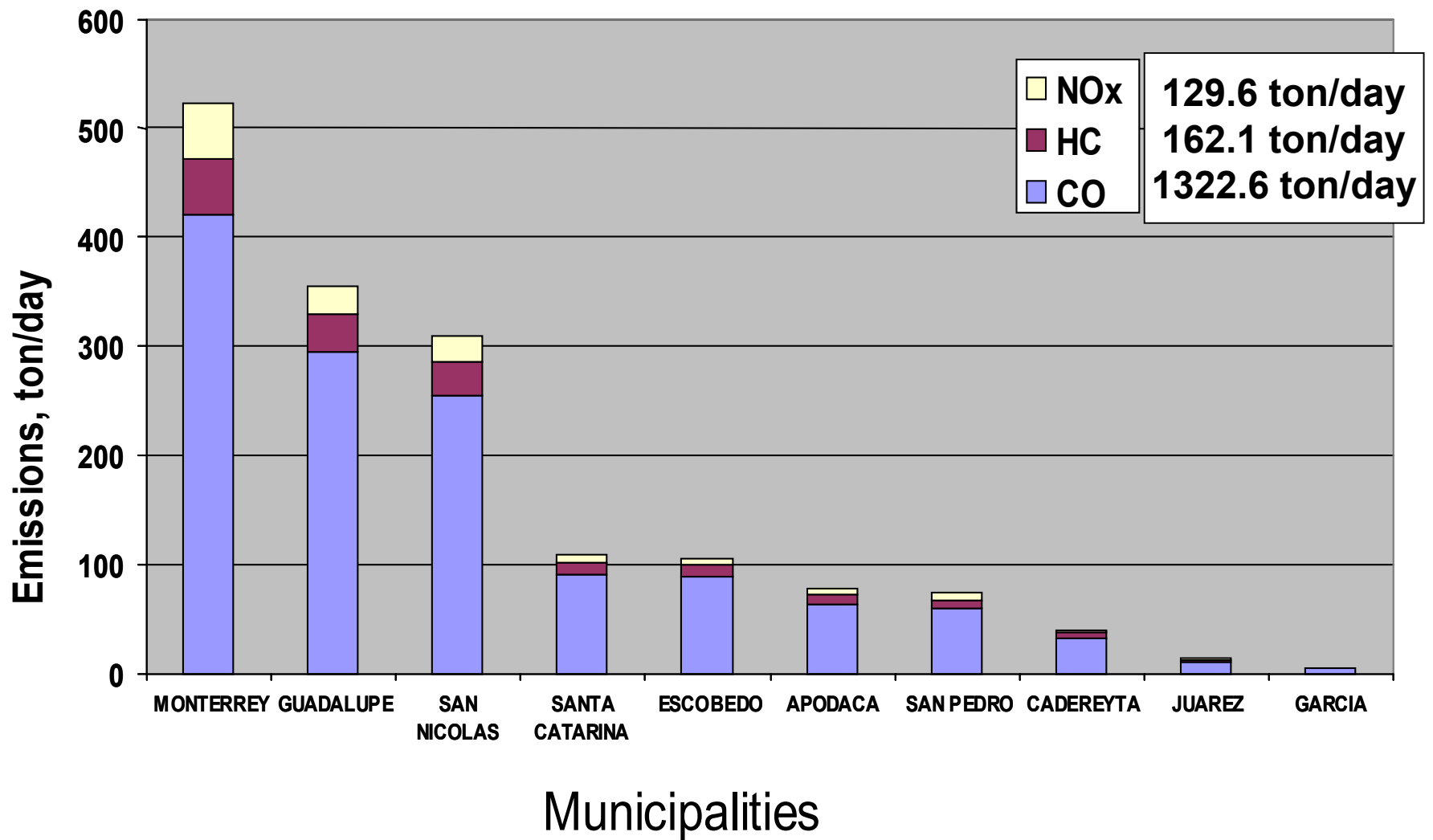
# Mobile Source Emissions in the Municipality of Juárez

JUAREZ	Vehicle type						
	LDGV	LDGV (Taxis)	LDGT1	LDGT2	HDGV	LDDV	HDDV
Average speed (km/hr)	25	25	25	20	10	10	10
Traveled distance (km/day)	25.8	240	25.8	30	120	120	120
Pollutant	Emission factor (g/km)						
HC	3.55	3.55	4.76	5.08	11.02	2.18	3.15
CO	30.77	30.77	36.94	37.51	141.53	5.55	17.14
NOx	1.43	1.43	1.79	1.76	3.45	1.65	16.17
Amount of vehicles	6038	209	3177	979	5	1	320
Pollutant	Total emissions (Ton/day)						
HC	0.55	0.18	0.39	0.15	0.01	0.00	0.12
CO	4.79	1.54	3.03	1.10	0.08	0.00	0.66
NOx	0.22	0.07	0.15	0.05	0.00	0.00	0.62





## Mobile Source Emissions in the MMA



# Conclusions and Recommendations

- **NO<sub>x</sub> emissions have increased, CO and HC emissions have decreased compared with 1995.**
- **Initial vehicle distribution by age and municipality.**
- **Initial emission distribution by municipality.**
- **Improve emission factors.**
- **Evaluate driving patterns in the MMA and VKTs.**



# Conclusions and Recommendations

- **Estimate  $\text{NH}_3$ ,  $\text{PM}_{10}$  and  $\text{PM}_{2.5}$  emissions.**
- **Use Mobile 6 Mexico. Obtain data for vehicle classification.**
- **Use other methodologies and check consistency of data.**
- **Integrate with other air quality studies.**



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