Estimation of Paved and Unpaved Road Dust Emissions in Mexico

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Mexico National Emissions Inventory - Characteristics

- Multi-year development
- 1999 criteria pollutant base year inventory for entire country at municipality level
- Multi-phase release
  - Draft inventory - released July 2003
  - Draft final inventory - expected Spring 2004
  - Final inventory - expected Summer 2004

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On-Road Mobile Sources in Mexico

- Mexico population - 97 million
- Vehicle population - 18 million
- VKT estimates needed for entire country at municipality-level, but limited data availability
- No existing estimates for VKT split between paved and unpaved roads

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Methodology Steps

- Traffic volume and congestion modeling for representative urban areas
- Determine daily per capita VKT for each representative urban area
- Link-specific traffic volumes combined with paved/unpaved road data to determine paved and unpaved VKT split

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Representative Urban Areas

City/Town Class	Population Range	Representative Urban Area
Small Town	<25,000	Castaños, Coahuila
Medium Town	25,000 – 100,000	Río Bravo, Tamaulipas
Large Town	100,000 – 250,000	Ensenada, Baja California
Small City	250,000 – 1,000,000	Hermosillo, Sonora
Medium City	1,000,000 – 2,000,000	Ciudad Juárez, Chihuahua
Large City	2,000,000+	Monterrey, Nuevo León
Mexico City		Mexico City

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Traffic Volume and Congestion Modeling

- Ciudad Juárez disaggregated trip generation rates
- Zone-level structure developed for each area
- Zone-level trip generations estimated using statistics
- Trip productions and trip attractions balanced
- Roadway network developed to distribute trips
- Links assigned function class, flow direction, link capacity, and average daily speed

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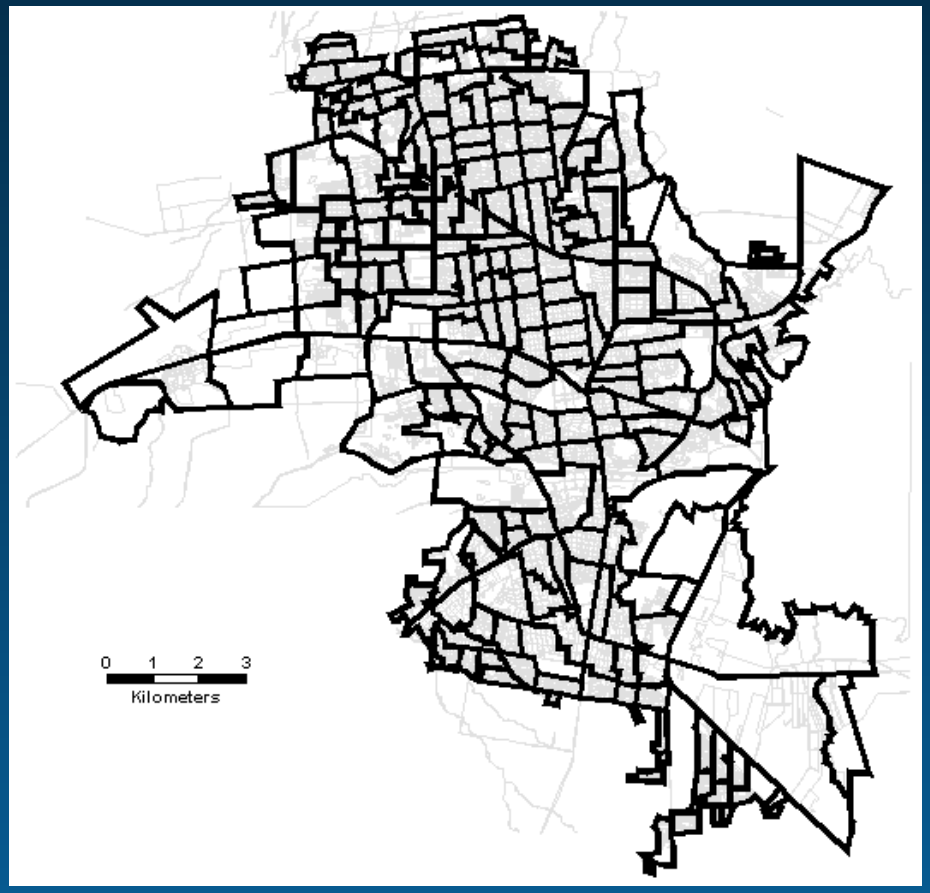
Zone-Level Structure - Hermosillo



Primary Roadway Network - Hermosillo

Traffic Volume and Congestion Modeling - Cont.

- Transportation engineering gravity model applied
- Person-trips converted to vehicle-trips
- Iterative solution for gravity model
- Generate link-level loaded network

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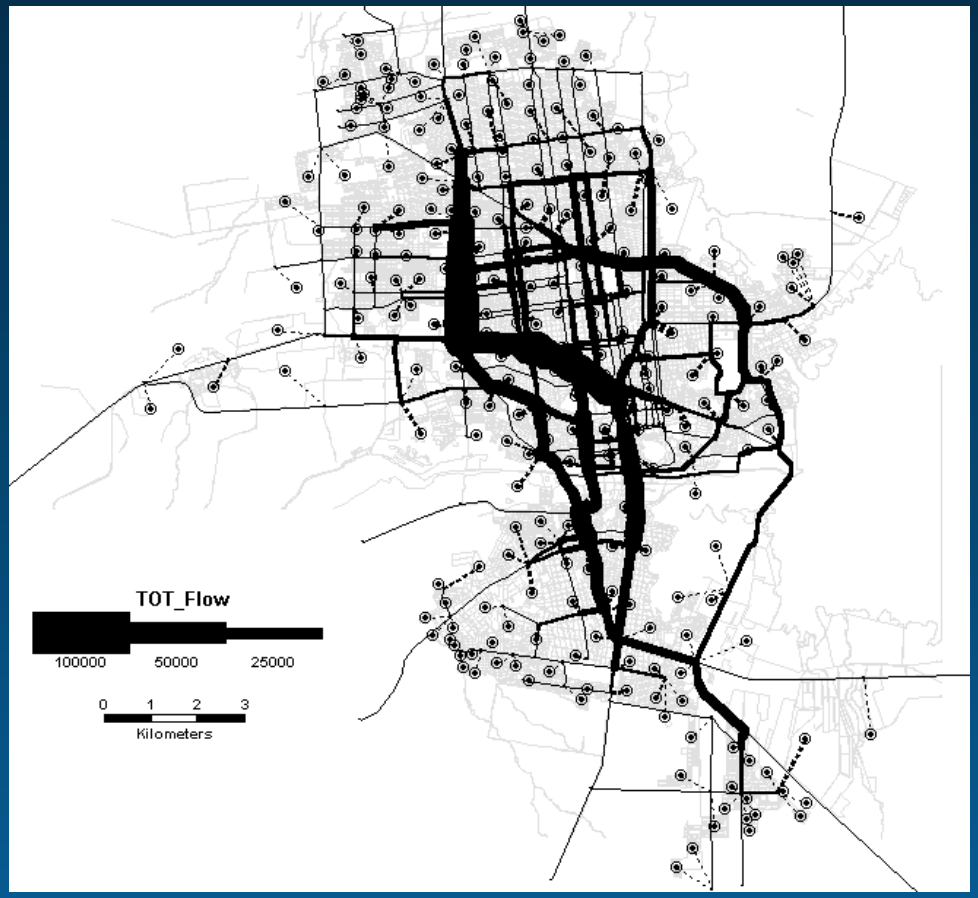
Loaded Network - Hermosillo



Estimation of Per Capita VKT

- $VKT_{link} = Volume_{link} \times Length_{link}$
- $VKT_{Total} = \Sigma(VKT_{link})$
- Per Capita VKT = VKT_{Total}/Population

Per Capita VKT

Representative Urban Area	Daily Per Capita VKT
Castaños	1.9
Río Bravo	1.6
Ensenada	4.3
Hermosillo	5.2
Ciudad Juárez	6.2
Monterrey	9.4
Mexico City	6.3

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Methodology for Estimating Paved/Unpaved Road VKT Split

- Link level VKT estimated for representative urban areas
- Paved/unpaved road information obtained for each representative urban area
- Link level VKT and paved/unpaved road information overlaid to determine paved/unpaved road VKT split

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Paved/Unpaved Road Information

- Existing GIS - Ciudad Juárez
- Field Mapping - Castaños and Río Bravo
- Satellite Images - Ensenada and Hermosillo
- Aerial Photographs - Monterrey and Mexico City

Paved/Unpaved Roads - Hermosillo

unpaved
paved

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Paved/Unpaved VKT Splits

Representative Urban Area	Paved/Unpaved Surface Area Split	Paved/Unpaved VKT Split
Castaños	0.16/0.84	0.74/0.26
Río Bravo	0.46/0.54	0.83/0.17
Ensenada	0.50/0.50	0.92/0.08
Hermosillo	0.65/0.35	0.97/0.03
Ciudad Juárez	0.49/0.51	0.95/0.05
Monterrey	pending	pending
Mexico City	pending	pending

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Mexico VKT Estimates

- Total VKT = 155.0 billion VKT/year
- Paved Road VKT = 144.4 billion VKT/year (93.1%)
- Unpaved Road VKT = 10.7 billion VKT/year (6.9%)

Emission Factors

- Estimated using AP-42 emission factor equations (Sections 13.2.1 and 13.2.2)
- Silt loading, vehicle weight, silt content, soil moisture - currently using values from Ciudad Juárez
- Working to incorporate the effects of precipitation and transport fraction

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Comparison of Paved and Unpaved Road Dust Emissions

Inventory Area	PM_{10} (Mg/yr)	$PM_{2.5}$ (Mg/yr)
U.S. Border Paved	389,303	97,326
Mexico Border Paved	100,581	24,052
U.S. Border Unpaved	2,183,916	327,588
Mexico Border Unpaved	469,935	68,683

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Summary

- Methodology useful for areas with limited vehicle activity data
- Emissions can be developed for a large number of municipalities, while focusing data collection on small number of representative areas
- Different types of paved/unpaved road information can be used
- Emission estimates can be improved with more location-specific data

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