Developing a National Emissions Inventory for Mexico

On-Road Mobile Source Emissions Inventory

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Overview

- Data availability
- Representative urban areas
- Zone-level structure and roadway network
- Traffic volume and congestion modeling
- Estimation of vehicle kilometers traveled (VKT)
- MOBILE6-Mexico emission factors
- PrepinPlus software
- Per capita emission rates

On-Road Mobile Sources in Mexico

- Fleet population of 18 million vehicles in country of 97 million people
- Significant portion of overall emissions inventory
  - Metropolitan Zone of the Valley of Mexico
    - 40% of HC emissions
    - 98% of CO emissions
    - 81% of NOx emissions
  - Similar in other metropolitan areas with Air Quality Plans
- Emission estimates needed for entire country at municipality-level, but limited data availability

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On-Road Mobile Source Data Availability

- Travel demand models
- Vehicle registration statistics
- VKT
- Fuel sales data

Methodology for Generating Per Capita Emission Rates

- Daily per capita emission rates estimated for representative urban areas
- Assumption: Estimated emission rates for representative areas are transferable to other urban areas of similar size

Representative Urban Areas

- Mexico City
- Large cities (2,000,000+) - Monterrey, Nuevo León
- Medium cities (1,000,000 - 2,000,000) - Ciudad Juárez, Chihuahua
- Small cities (250,000 - 1,000,000) - Hermosillo, Sonora
- Large towns (100,000 - 250,000) - Ensenada, Baja California
- Medium towns (25,000 - 100,000) - Río Bravo, Tamaulipas
- Small towns (<25,000) - Castaños, Coahuila

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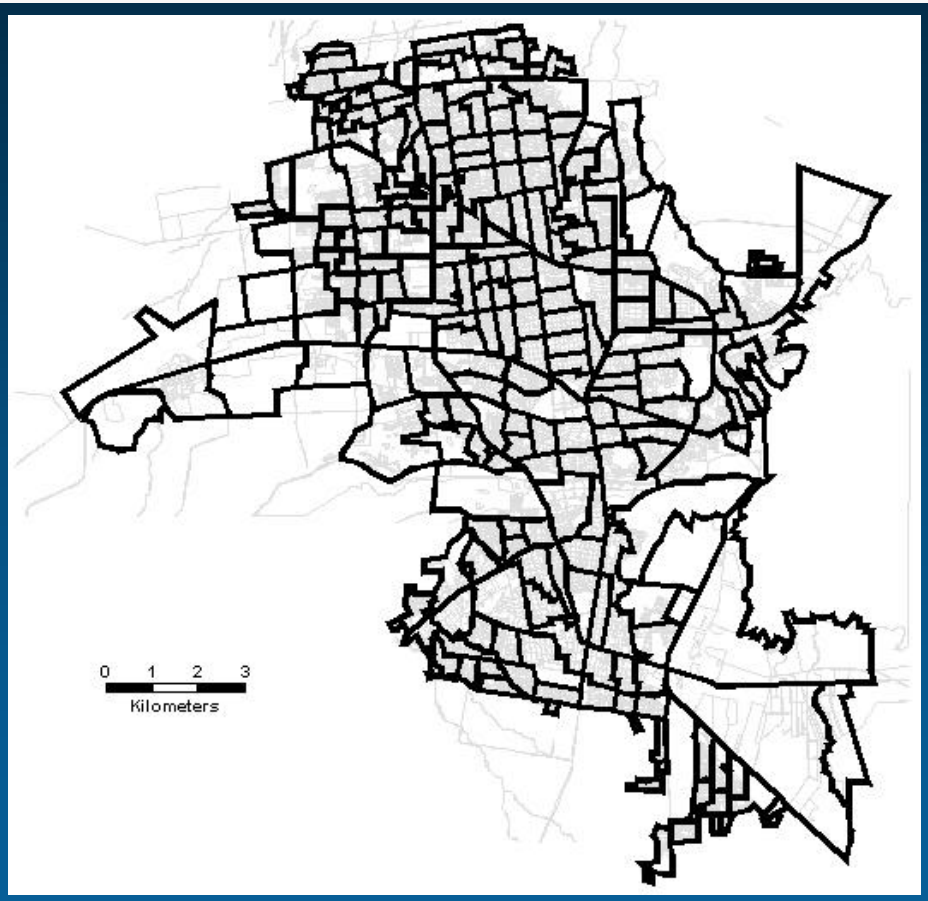
Methodology Steps

- Traffic volume and congestion modeling for each representative urban area
- Link-specific traffic volumes and congested speed emission factors combined to estimate link-specific daily emissions
- Link-specific daily emissions summed to estimate daily emissions and per capita emission rates
- Annual municipality-level emissions

Traffic Volume and Congestion Modeling

- Disaggregated trip generation rates from Ciudad Juárez
  - Trip productions (disaggregated by trip purpose, household income, and household size)
  - Trip attractions (disaggregated by trip purpose, area type, and employment type)
- Zone-level structure (based on AGEBs) developed for each representative area
- AGEB-level trip productions and trip attractions estimated using INEGI statistics

AGEB-Based Zone Structure - Hermosillo



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Traffic Volume and Congestion Modeling - cont.

- AGEB-level trip productions and trip attractions balanced
- Roadway network developed to distribute trips
  - Freeways
  - Main arterials
  - Collectors
  - "Connectors" (artificial links connecting zone centroids and roadway network to represent local traffic)
- Links assigned function class, flow direction, link capacity, and average daily speed

Primary Roadway Network - Hermosillo

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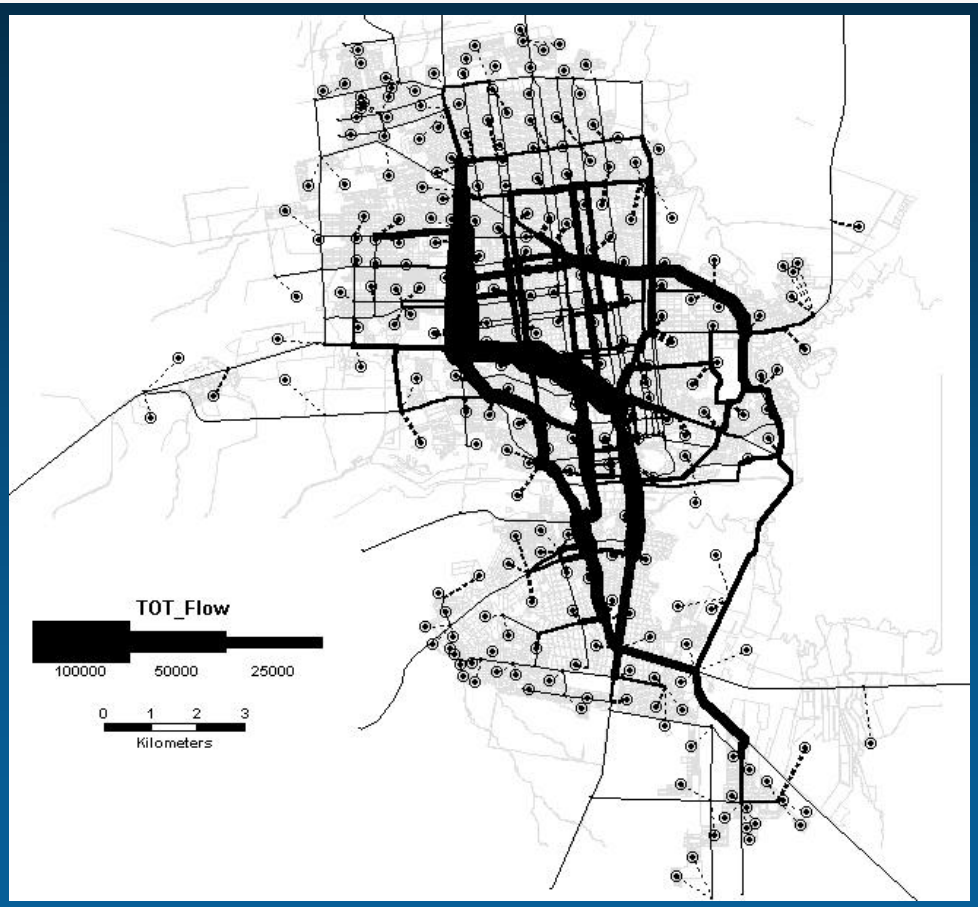
Traffic Volume and Congestion Modeling - cont.

- Transportation engineering gravity model applied
- Vehicle occupancy and transit mode use statistics used to convert person-trips into vehicle-trips
- Traffic assignment iteratively solves gravity model equations
  - Accounts for effects of impedance (i.e., traffic congestion)
  - Ensures that trip productions and trip attractions are equal
- Link-level loaded network

Loaded Network - Hermosillo



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Estimation of VKT

- Link-level VKT =

  Daily Traffic Volume × Link Length

- Total VKT =

  Σ (Individual link-level VKT)

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

Estimation of Per Capita Emission Rates

- Per capita emission rates estimated using:
  - Link-level VKT estimates
  - MOBILE6-Mexico (currently under development)
  - PrepinPlus software

Estimation of Per Capita Emission Rates - cont.

- PrepinPlus is used to:
  - Convert daily traffic volumes to hourly traffic volumes
  - Determine hourly link-specific speeds
  - Match speeds to corresponding MOBILE6-Mexico emission factors
- MOBILE6-Mexico emission factors:
  - Estimated for each representative urban area size for various scenarios (temperature ranges, altitudes, and fuels)
  - Emission factors for range of 4 to 100 km/hr with 2 km/hr bins

Estimation of Per Capita Emission Rates - cont.

- Link-level hourly emissions calculated from hourly traffic volume, link length, and link-specific emission factor
- Daily emissions calculated by summing up hourly emissions
- Annual municipality-level emissions estimated by combining per capita emission rates for different temperature/altitude/fuel scenarios with population

Conclusions

- Provides first comprehensive municipality-level national on-road mobile source emissions inventory
- Uses innovative method as a first estimate of on-road motor vehicle activity that may be applicable in other developing countries