# Global Health Roadmap -- Quantifying Health Impacts from Transportation Policies

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# Roadmap Model

- The Roadmap is a tool to help policymakers worldwide identify and understand trends in the transportation sector, assess emission impacts of different policy options, and frame plans to effectively reduce emissions of both greenhouse gases (GHGs) and local air pollutants.

- **MODEL.** The core of the Roadmap model is a spreadsheet-based model developed in Microsoft Excel that calculates historical and future well-to-wheel (WTW) emissions from the transportation sector for different policy scenarios.

**Pollutants**
- Local air pollutants ($NO_x$, $SO_x$, CO, PM)
- GHGs ($CO_2$, $CH_4$, $N_2O$)

**Modes**
- On-road (LDVs, buses, 2 and 3 wheelers, HDTs)
- Rail
- Marine (domestic/international)
- Aviation (domestic/international)

**Regions**
- United States, EU-27, China, India, Japan, Brazil, South Korea, Canada, Australia, Mexico, Russia, Rest of Latin America, Rest of Europe, Rest of Asia-Pacific, Middle-East, and Africa.

**Years**
- 2000 to 2050 in 5-year increments

**Outputs**
- WTW/WTT/TTW emissions
- Energy consumption

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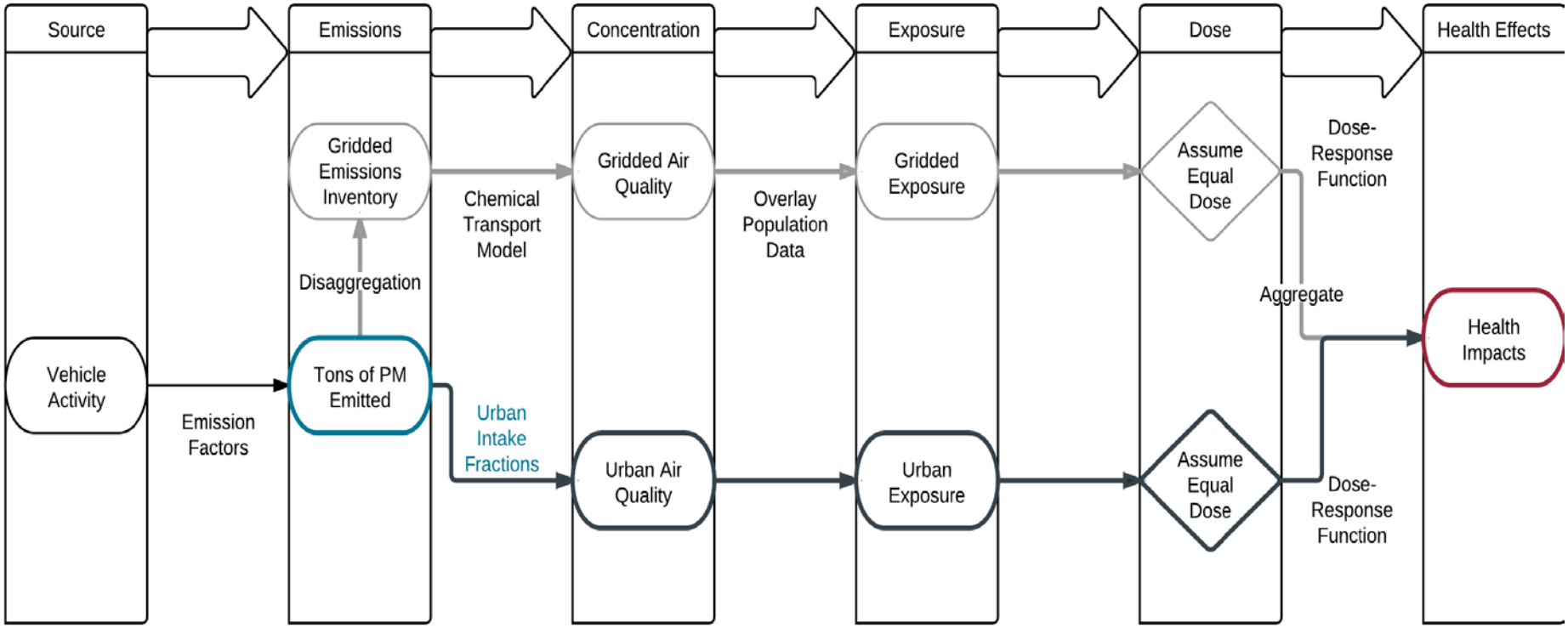
# From emissions to impacts: two pathways




Framework adopted from Smith, K.R. “Fuel Combustion, Air Pollution Exposure, and Health: the Situation in Developing Countries,” Annual Review of Energy and the Environment. 1993, 18(1):529–566.

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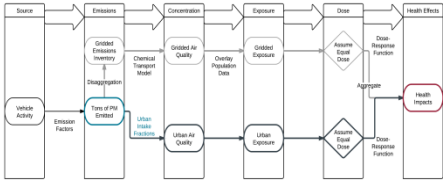


## Spatially Explicit Approach (Upper)

### Pro:

- Multiple pollutants and sources
- Detailed modeling

### Con:

- Complex
- Computationally intensive
- High data requirement

## Roadmap Approach(Lower)

### Pro:

- Simple
- Compare policy effects at a global level

### Con:

- Simplified
- Limits scope

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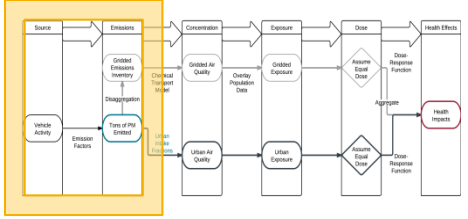
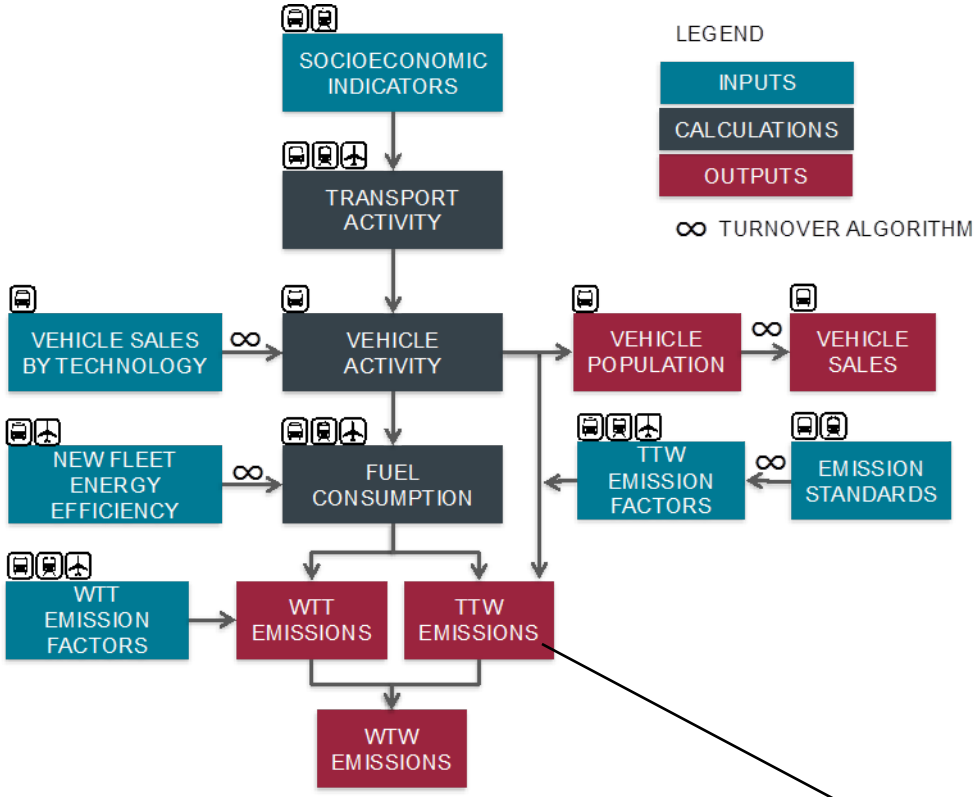
# Activity-based emissions model






**Pollutants**

- Local air pollutants ($NO_x$, $SO_x$, CO, PM)
- GHGs ($CO_2$, $CH_4$, $N_2O$)

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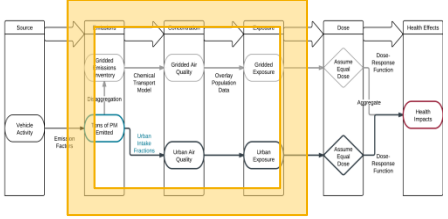
# Intake Fractions



$$iF = \frac{Population\ intake}{Total\ emissions} = \frac{\int_{T_1}^{\infty}\left(\sum_{i=1}^{P}(C_i(t) \times Q_i(t))\right)}{\int_{T_1}^{T_2} E(t)dt}$$

- 2011 study by Apte et al.[1] developed intraurban intake fractions for on-road sources for 3,646 cities
- Intake fractions applied to model urban concentrations, given urban emissions, population and breathing rate

$$C = \frac{iF \times E}{P \times Q}$$

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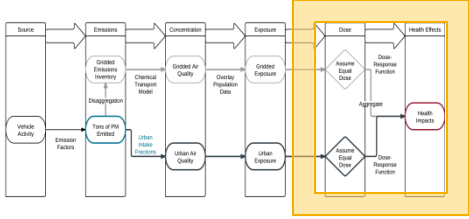
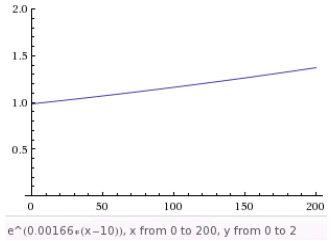
1 -- Apte, J.; Bombrun, E.; Marshall, J.D.; Nazaroff, W. “Global Intraurban Intake Fractions for Primary Air Pollutants from Vehicles and Other Distributed Sources,” Environmental Science and Technology. 2012, 46(6):3415-3423.

# Health impacts



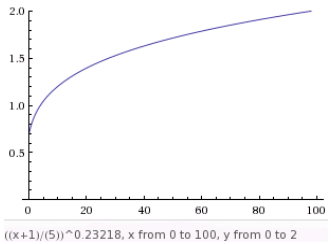

- Two concentration-response functions:
  - Linear (ARI):

$$RR = \exp[\beta(C_{obs} - C_{NE})]$$




  - Log-linear:

$$RR = \left[\frac{C_{obs} + 1}{C_{NE} + 1}\right]^{\beta}$$




- Premature mortality[1]
  - Lung cancer, adults over 30
  - Cardiopulmonary disease, adults over 30
  - Acute respiratory infection (ARI), children under 5

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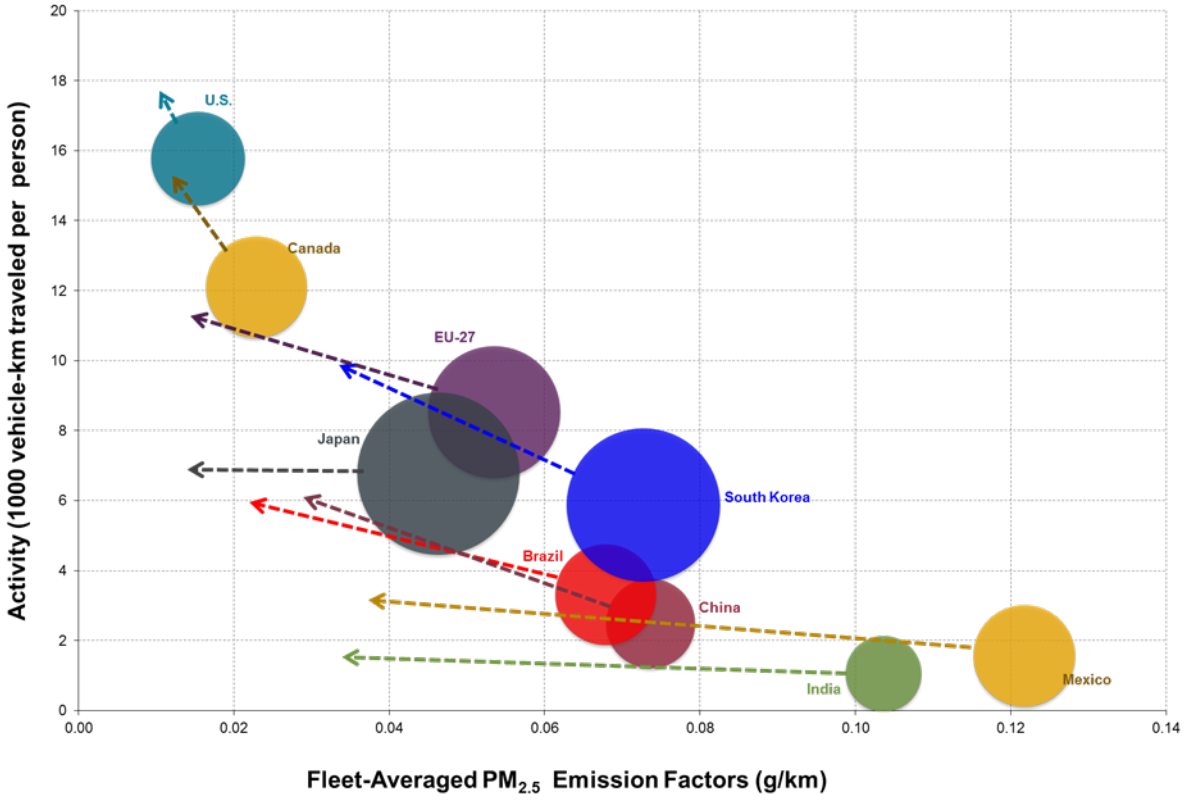
1-- Ostro, B. *Outdoor Air Pollution: Assessing the Environmental Burden of Disease at National and Local Levels.* No. 5 in Environmental Burden of Disease Series. World Health Organization; Geneva, Switzerland, 2004.

# Health Impact Trends

Per-capita Annual Mortality, year 2010

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# Future improvements

- Expand modes
- Include well-to-tank emissions
- Include morbidity
- Include effects of other pollutants