Location Efficiency and the CDM

The Potential for Reducing Transportation Greenhouse Gas Emissions by Changing Patterns of Urban Development

Chris Zegras
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Center for Clean Air Policy

iisd International Institute for Sustainable Development / Institut International du Développement Durable

CCAD Consultores Cambio Climático y Desarrollo

Outline

1. The Concept
2. The Demographic and Geographic Context
3. The Transportation Planning Context
4. Methodological and Implementation Precedents
5. Challenges for CDM
6. Proposed Approach for Santiago (U. de Chile/LABTUS)

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The Concept

Premise:

Influencing urban land use patterns can produce fundamental changes in individual travel behavior (e.g., modes used, distances traveled) and thereby influence transportation GHG emissions.

- Not new idea – dating back at least to energy crises of 1970s…

- Influences are:

1. *Intra-metropolitan* (Meso)
   - relative location of urban development within a metropolitan area
2. *Neighborhood* (Micro)
   - form that the development takes (such as the density and diversity of land uses)

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Understanding the Concept

Behavioral, *not* "technological"

Emissions =

Activities
(pkm = trips x distance)

Determinants:

- Population
- Demographics
- Income
- ➢ **Urban Structure**
- ....

x

Mode Share
(% pkm)

Determinants:

- Income
- Motorization rate
- Infrastructure Conditions
- Service Provision
- ➢ **Urban Structure**
- ....

x

Fuel Intensity
(liters per pkm)

Determinants:

- Fuel Efficiency
- Engine Type
- Vehicle Load
- Vehicle Age
- Congestion Levels
- Capacity Mix
- ➢ **Urban Structure**
- ...

x

Fuel Choice
(emission per liter)

Determinants:

- Fuel type
- Fuel Quality
- Engine Type
- Vehicle Technology
- Vehicle Age
- Temperature
- Altitude
- ....

Sources: Based on Pargal & Heil, 2000; Schipper et al, 2001.

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The Concept

Examples of Possible Effects

- *Meso* scale: 6%-60% reduction in GHGs
- *Micro* scale: 4%-50% reduction in GHGs
- Critical role of modeling technique in results…

Technical Challenges

- Modeling complex behavior
  - Travel decisions, land use decisions, joint land use-travel decisions
- Baselines: What would have happened otherwise?

Implementation Challenges

- Potential long time-frame to realize results
- Multiple government layers, plus private sector actors
- Fighting more fundamental consumer desires/lifestyle choices?
  - Housing preferences, auto ownership
- Few truly effective, relevant policy precedents…

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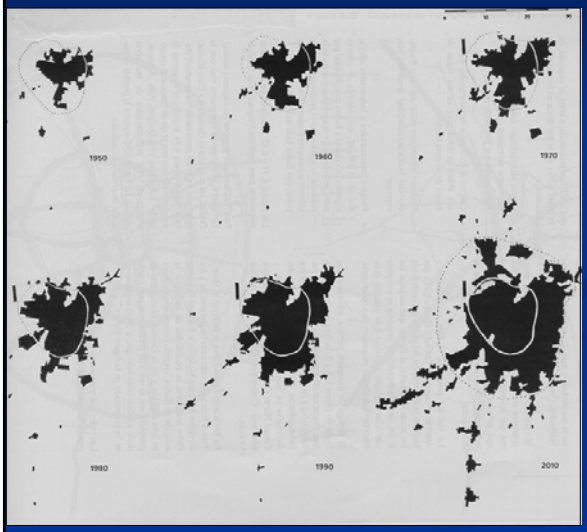
The Concept in Santiago's Context



- A 1.25% annual population growth rate for next 30 years would add nearly **1 million new households**
- *What form will this growth take?*
- Since 1980s, urban area expanding at 70% > than population

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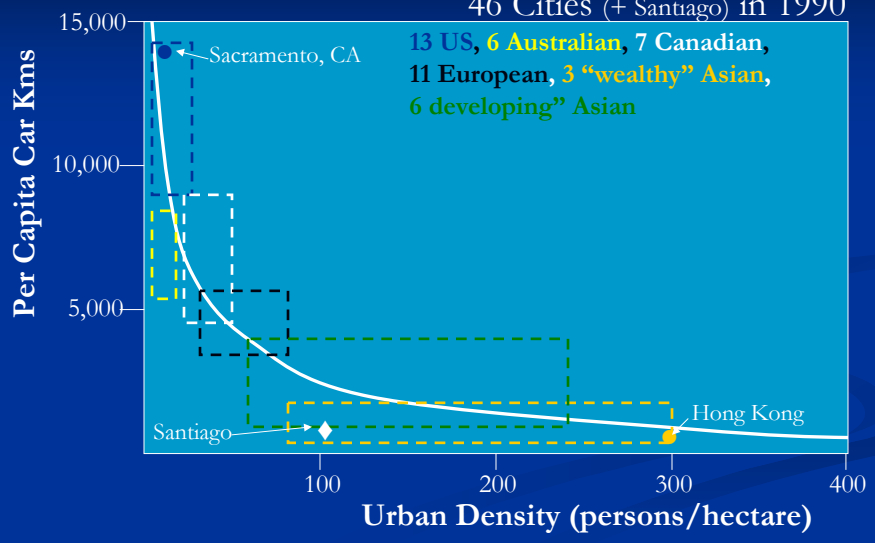
Metropolitan-Scale Effects



Sources: Kenworthy & Laube (1999) (except Santiago)

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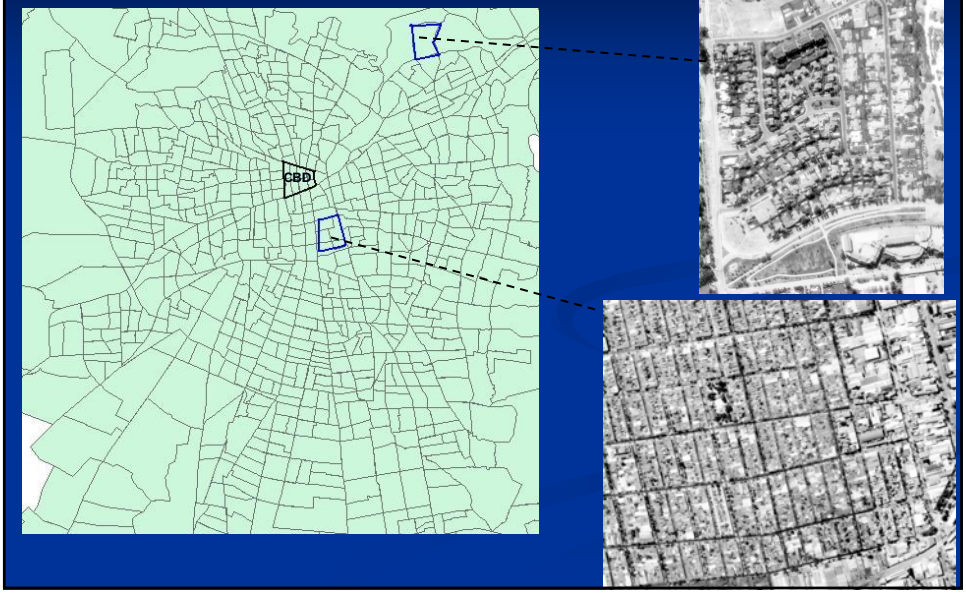
Land Use Effects:

Meso & *Micro*



Typical Travel Forecasting Process & Land Use Effects

Data Inputs

Inventories/forecasts of population, land uses, travel behavior, etc.

Land uses projected by TAZ

I. Trip Generation

Estimate the total trip productions and attractions for each TAZ

Land uses in TAZ influence trip production/attraction

II. Trip Distribution

Predict the distribution of trips b/w origin & destination (O-D) TAZs

Size of TAZ influences "intrazonal" trips (often NMT

III. Modal Choice

Predicts share of trips by available modes b/w each O-D TAZ pair

Presence of public transport stops, parking can influence mode choice

IV. Trip Assignment

Project the specific route the trips will follow between TAZs

No effects considered

System Outputs

Produces data such as traffic volumes, speeds, vehicle mix

Evaluation (incl., e.g., emissions, energy use, etc.)

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Land Use and the Typical Travel Forecasting Process: Shortcomings

- Regional (*meso*) focus reduces sensitivity to *micro* effects, particularly where TAZs are large (e.g. suburbs)
- Short trips (intra-zonal; adjoining zones) difficult to effectively model (and often neglected in surveys…)
- Potentially influential *micro* factors such as local street connectivity and pedestrian design amenities are not reflected
- Have been some advances to address these
  - LUTRAQ (Portland, OR, US), incorporate land use variables in several sub-models to reflect, e.g., "walkability"
  - Modeled a Land Use Alternative (65% future residential units & 78% percent of jobs located in transit oriented developments): estimated a 6% reduction in GHGs Relative to "No Build"

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Capturing Land Use Effects: Alternatives to Traditional Forecasting?

- Estimate travel outcomes (e.g., VKT, mode share, trip rate) based on socio-demographic, economic and land use characteristics
  - Travel = *f* (Demographics, Economics, Land Use)
  - Normally "ad-hoc" regression
  - Increasingly behavioral-focused (e.g, logit models)
  - Not yet generally embedded in travel forecasting processes
- More than 60 different studies since early 1990s
- Some efforts to use results (e.g., as "elasticities") to "post-process" travel forecasting exercises

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Precedents: Canadian Mortgage and Housing Corporation (CMHC)

GHGs and Urban Travel Evaluation Tool

- An econometric ("snapshot-in-time") tool.
  - Ad hoc estimation
- Estimated with data from 1996 Travel Survey
- Predict VKT/Household via 2-stage model:
  1. Auto ownership = *f* (Income, Demographics, *Urban Context*, *Local Land Use*)
  2. Auto VKT = *f* (Auto Ownership$_{predicted}$, Income, Demographics, *Urban Context*, *Local Land Use*)
  2. Public Transport (PKT) = *f* (Auto Ownership$_{predicted}$, Demographics, *Urban Context*, *Local Land Use*, Transit Service Levels)

Source: IBI Group, 2000.

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Land Use Variables in CMHC Models

Land Use Category	Specific Land Use Variables included in Each Model		
	Auto Ownership	**Auto VKT**	**Transit PKT**
Regional Context	• Distance to CBD	• Distance to CBD • Jobs w/in 5 km	• Distance to CBD • Distance^2 to CBD
Local Density	• # Stores w/in 1 km • Housing Unit Density		• Jobs w/in 1 km • Stores w/in 1 km • Housing Unit Density
Local Diversity	• Housing Type Mix • Avg. Unit Size	• Land Use Mix w/in 1 km	
Local Design	• Curvilinear Road Network • Bike Routes/Total Road Length	• Road Type (grid) • Intersections/Road-km • Wide Arterials/ Total Road Length	• Bike Routes in Neighborhood

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CMHC Study Area: Toronto

Source: IBI Group, 2000.

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Conventional Suburban Subdivision

Source: IBI Group, 2000.

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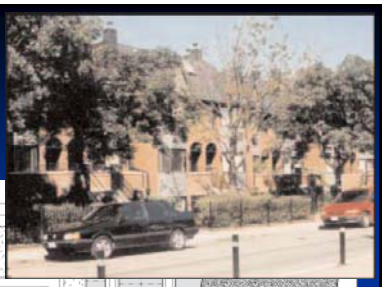
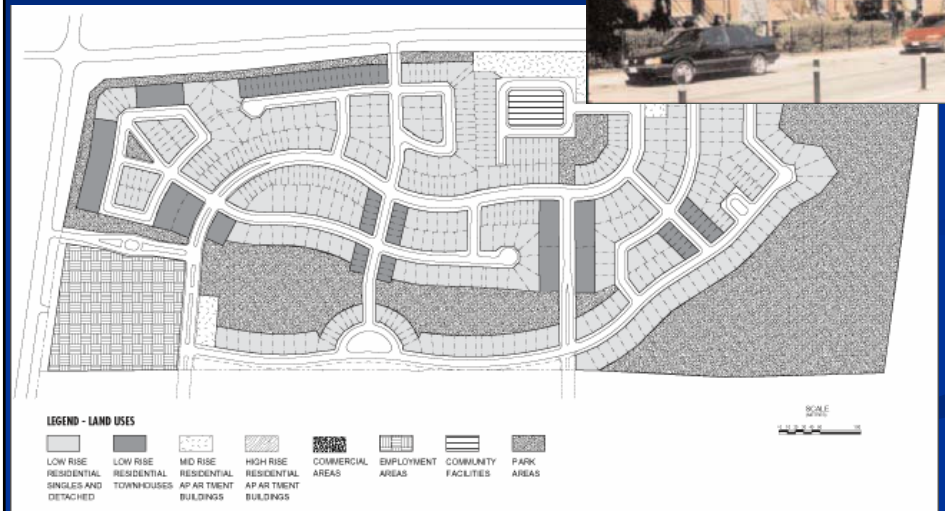
Medium Density Development





Source: IBI Group, 2000.

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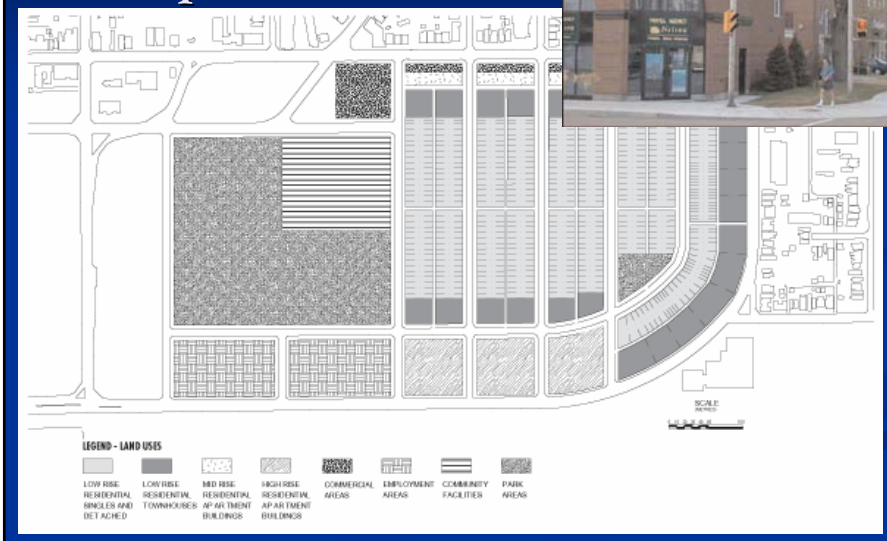
"Neo-Traditional" Development



Source: IBI Group, 2000.

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Basic Characteristics of Development Types

Development Type	Units/ hectare	Uses	Transport Network
Conventional	3.6	Single-use (resident.)	Wide, curvilinear, discontinuous, long NMT distances
Medium-Density	21	Some mix use	Mostly curvilinear, increased connectivity, some NMT facilities
Neo-Traditional	43	High mix	Grid circulation, short blocks, narrow streets

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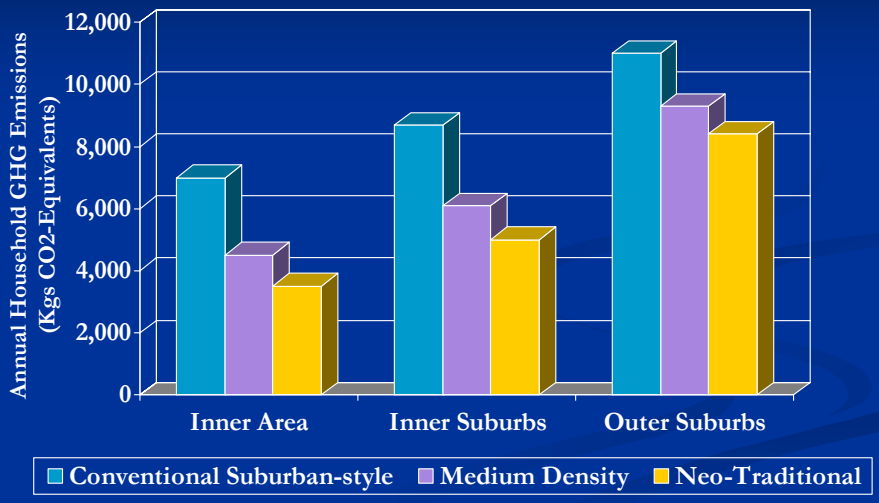
CMHC Results: Transport GHGs



Source: IBI Group, 2000.

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Precedents: US Local AQ Conformity Credits for Land Use

Atlantic Steel: Brownfield Redevelopment in Atlanta, GA

- 138-acre former steel mill, linked to rapid rail station (via proposed bridge construction)
- Mixed use: 17,483 jobs and 6,000 residents
- City in non-attainment for pollution, which prevents infrastructure expansion
- Developer proposes project as a pollution control measure
- Attempt to measure the *meso* and *micro* influences

Sources: Walters et al, 2000; US EPA, 2001.

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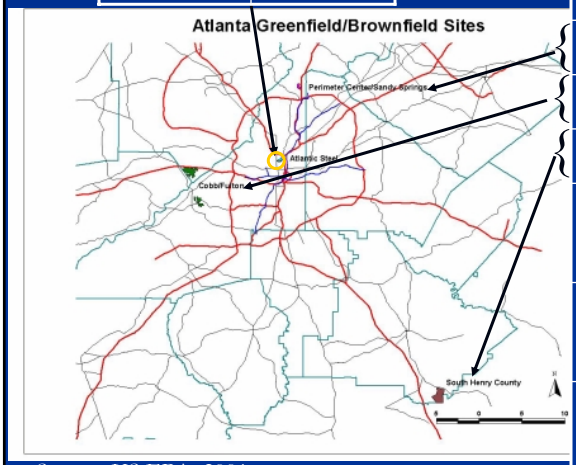
Atlantic Steel: Location Alternatives

(or the "Meso-Effects" Baseline)

Vehicle Kilometers Traveled per Day

Infill Site	544,480



Baseline Meth.	Relative to Infill
All to Site 1	+14.5%
All to Site 2	+49.1%
All to Site 3	+52.3%
20 Fast Growth TAZs	+20.3%
Land Use Model	+66.8%
Proportional Growth	+45.8%

Source: US EPA, 2001.

Atlantic Steel: Design Alternatives

(or the "Micro-Effects" Baseline)

	VKT per Day	Relative to "Generic" Design
1	523,822	-3.8%
2	512,704	-5.8%
3	516,464	-5.1%

Source: Walters et al, 2000.

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Atlantic Steel: Monitoring and Verification

- Developer commits to annual data collection
  1) Average daily VKT per resident
  2) Average daily VKT per employee at the site
  3) Mode choice by residents/employees
  4) Origin & destination data for trips made to, from, and on site by residents and employees
- Performance Goals, at two-thirds build out:
  1) Average daily VKT per resident will be less than 43 kms
  2) Average daily VKT per employee of the development will be less than 17.6 kms
  3) Average daily total vehicle (non public transport) trips to and from the site will be less than or equal to 72,000

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Atlantic Steel: A Lesson in Challenges

- US Economy since 2001…
- Atlanta commercial real estate market has soured
- Rail station opening delayed
- Several major tenants reneged
- But, development *is* underway
  - July 2003: first 600 units of apartments begin to lease up and receive certificates of occupancy.
  - May, 2004: first office building opens…

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Initial Conclusions

- Ongoing urbanization trends signify important opportunity to influence future travel patterns
- Precedents suggest potentially significant effects
- Predicting impacts is not straightforward and is highly data- and capacity-intensive (role for ODA?)
- Monitoring difficult, but possible
- Current CER value likely provide little incentive relative to urban development costs
- Potential co-benefit synergies (e.g., local pollutants, open space preservation, etc.) may increase attractiveness
- Metro-area sectoral targets a viable approach?

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