SILO Land Use Model

SESYNC Workshop
3-5 August 2015
Land-use/transport feedback cycle

Accessibility → Transport → Activities → Land use

Wegener (1994)
Ideal integration of land-use/transport

Zonal data: Population and employment

Travel time and travel costs matrices
Actual integration of land-use/transport

Back-casting ← Scenario Forecasting
Geography

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Model Overview

Components of the Sustainability Scenarios

Scenario Assumptions
- Economic & Political Assumptions
- Demographic and Societal Assumptions
- Technological and Behavioral Assumptions
- Technological & Environmental Assumptions

Model Elements
- Economic Projections from various sources
  - Transportation – MSTM Travel Demand Model
  - Growth – SILO Land Use Model
    - Moving Emissions – MEM Model
    - Building Emissions – BEM Model
    - Water Quality – CBay Land Cover Change Model
SILO Integration

Model | Data | Model | Data | Model
--- | --- | --- | --- | ---
MSTM | Travel times | SILO | Housing stock | CBLCM
| Migration projections | | | Population distribution | |
| Employment projections | | | | |

Building emissions model
MSTM – SILO Interactions

**MSTM**
- Skimming
- Trip Generation
- Trip Distributions
- Mode choice
- Assignment

**SILO**
- Auto-ownership model
- Auto availability
- Household relocation
- Developer location choice

**Interactions**
- Auto/Transit travel time
- Households by zone
- Auto-operating costs
- Auto/Transit travel time
• Microscopic land-use model
• Fully integrated with travel demand model
• Open source: www.silo.zone
Events simulated in SILO

**Population**
- move
- inmigrate/outmigrate
- aging
- birth of a child
- leave parental household
- get married/cohabitate
- get divorced/separate
- death
- find or quit a job
- change of income
- buy or sell cars

**Dwellings**
- build new dwellings
- renovate dwelling
- dwellings deteriorate
- demolish dwelling
- price adjustment

---

Spatial

Aspatial
Events simulated in SILO

**Spatial Events**
- Use logit models
- Utilities calculated based on location factors

**Aspatial events**
- Use Markov models
- Transition probabilities based on national statistics
Moves: Location Factors

**Region Selection**
- Regional price
- Regional accessibility
- Regional school quality

**Dwelling Selection**

*Replaceable factors*
- Dwelling size
- Dwelling quality
- School quality
- Auto accessibility
- Transit accessibility
- Crime index
- Neighborhood’s racial composition

*Essential factors*
- Housing costs
- Travel time to work locations
- Travel costs
Regional Location Factors

Price by region

Accessibility by region

School quality by region
Evaluation of location factors

- **School Quality**
  - Income Quartile 1: 0.26
  - Income Quartile 2: 0.29
  - Income Quartile 3: 0.32
  - Income Quartile 4: 0.35

- **Accessibility**
  - Income Quartile 1: 0.65
  - Income Quartile 2: 0.5
  - Income Quartile 3: 0.35
  - Income Quartile 4: 0.2

- **Price**
  - Income Quartile 1: 0.09
  - Income Quartile 2: 0.21
  - Income Quartile 3: 0.33
  - Income Quartile 4: 0.45

**Income Quartiles**

1. **SILO**
Regional Utilities

Income Quartile 1

Income Quartile 4
Local Location Factors

- Auto accessibility
- Transit accessibility
- School quality
## Replaceable Location Factors

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<th>HH Type</th>
<th>Location Factors</th>
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## Essential Location Factors

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Move to a less expensive dwelling
Move to another dwelling with lower transportation costs
Compensate by cutting back other costs
Household expenditures

Source: BLS Consumer Expenditure Survey
Household expenditures

Source: Own estimation based on U.S. BLS Consumer Expenditure Survey
Commute distance

Source: 2007-2008 TPB/BMC Household Travel Survey

- Urban (Average commute: 40.47 min)
- Suburbs (Average commute: 36.42 min)
- Outer suburbs (Average commute: 34.77 min)

All (Average commute: 37.26 min)
Commute Travel Time
Crime Index

Crime Indicator
[by county]
- 0.030
- 0.031 - 0.095
- 0.096 - 0.132
- 0.133 - 0.174
- 0.175 - 0.214
- 0.215 - 0.244
- 0.245 - 0.269
- 0.270 - 0.387
- 0.388 - 0.546
- 0.547 - 0.906
Back-casting

Validation
Validation against 2012 census data
Population Distribution 2040
SCENARIO REVENGE OF THE NERDS
Population Growth

Driven by exogenous assumptions in in-/outmigration

In line with employment growth: 6.7% more population by 2040
Average age

Driven by exogenous assumption on survival rates

Women

Men

Base RoN
Area Type
Development Capacity

Exogenous input

Development Capacity (Housing Units)

- Base
- RoN

Urban

Suburban

Rural

Exogenous input values:
- Base
- RoN
Population Growth

- Urban Base
- Suburban Base
- Rural Base
- Urban RoN
- Suburban RoN
- Rural RoN
Difference in Employment Density

Exogenous input

Jobs: Change from 2000 to 2040

RoN < Base
RoN > Base
Difference in Population Density

Population: Change from 2000 to 2040

RoN < Base
RoN > Base
Resulting housing price increase

Average Price: Change from 2000 to 2040

RoN < Base
RoN > Base
TOD Stations

Scenario:
Add 8,475 dwelling units near Metro Stations by 2025
## Scenario definition

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Median Income near Metro Stations

Income of households living within 10 miles of Metro stations
Income distribution by scenario

Income of households living in TOD dwelling units
Side Effect of Housing Restrictions

Inmigration

Existing housing stock

New housing stock

Existing housing stock

2015

2040
Median income of households in TODs

- TOD Unrestricted
- TOD Rent Controlled
- TOD 15e0
- TOD 15e15
- TOD 50e0
- TOD 50e50
- TOD 100e0
- TOD 100e100

Median Income:
- $64,246
- $58,660
- $21,784
- $9,038
OPEN QUESTIONS
Questions to workshop participants

• How can we model telework? Both the land-use and the transportation models need to be adjusted.
• SILO attempts to preserve the income distribution of the base year. How can we microsimulate scenarios of increased or reduced income segregation?
• Should the land-cover model CBLCM affect SILO?
Relevance of SILO’s shortcomings

• SILO does not validate perfectly in 2012. How relevant is this deviation?
• SILO does not cover redevelopment (i.e. create new housing in already developed areas). How relevant is this shortcoming?
• SILO does not model employment. How relevant is this shortcoming?