Development of prototype UrbanSim models

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Introduction

- Importance of integrated modeling
- UrbanSim (Wadell, 2002): appealing platform
- Most implementations done by UrbanSim's developers
- Effort required to develop an operational model? (very high, probably)
- Prototype models help to evaluate the application of a fully implemented UrbanSim model

Outline

1. Literature review
2. Brief UrbanSim description
3. Brussels case study
4. Lausanne case study
5. Developing a Prototype UrbanSim model
   - Familiarization
   - Data preparation
   - Sub-model estimation
   - Simulation and analysis
   - Evaluation
6. Conclusions

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Literature review

- Descriptions of UrbanSim
- Computer science (software and user interface)
- Discrete choice innovations related to location choice (UrbanSim as a tool to test hypotheses)
- UrbanSim applications (by developers)
- Independent UrbanSim applications (Nguyen-Luong, 2008)

Little information on how to evaluate UrbanSim as an integrated model

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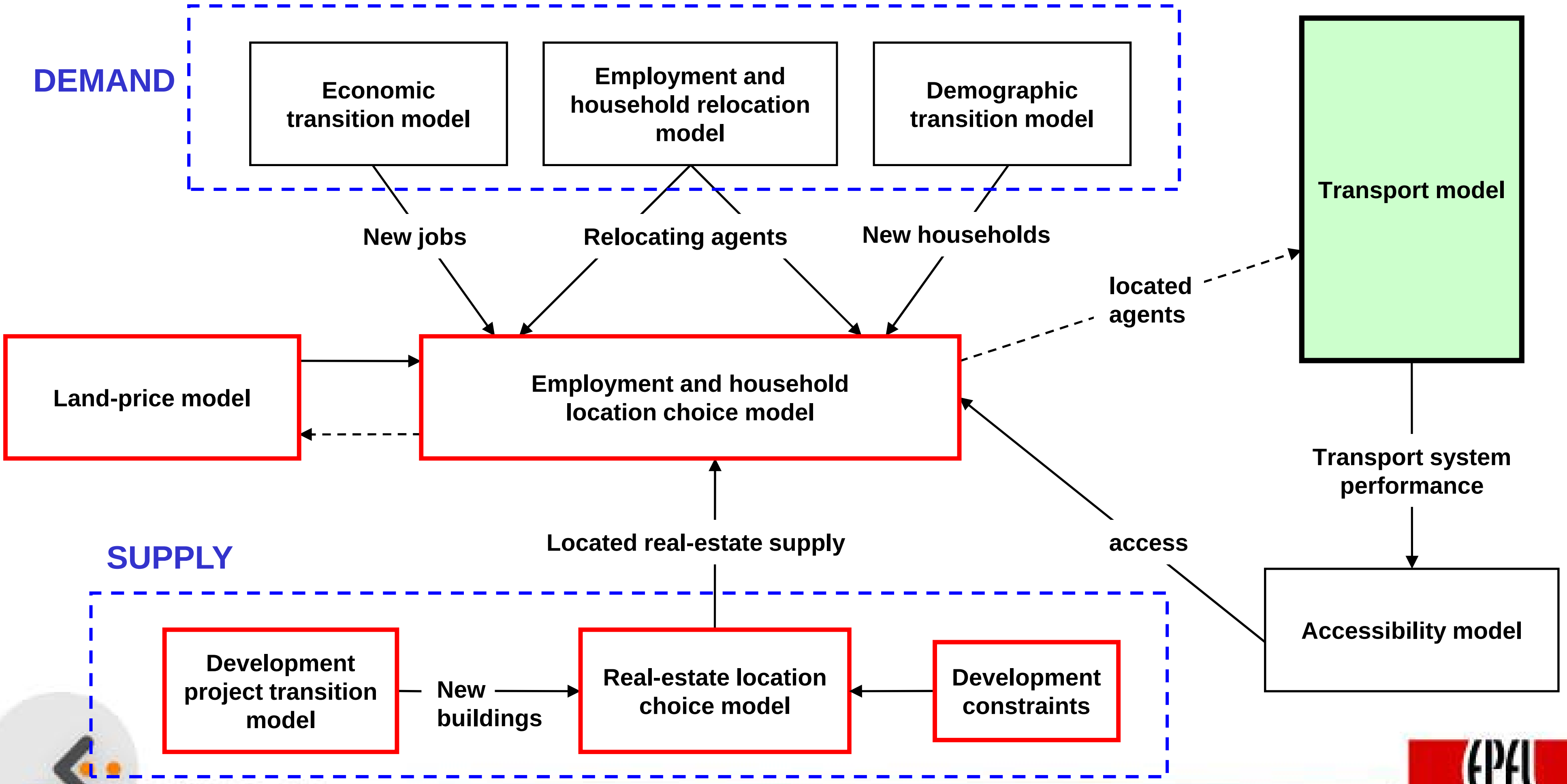
UrbanSim

- Why UrbanSim?
  - Open source
  - Very disaggregate
  - Dynamic disequilibrium approach
- Disadvantages:
  - High data requirements (because of disaggregation)
  - Learning costs
  - Complexity of model preparation, estimation and calibration

UrbanSim

- How UrbanSim works?



Fundamental Data

- Gridcells
- Households
- Jobs
- Buildings
- Development event history
- Development Constraints

"The Six Tables"

Two case studies

Brussels, Belgium

Lausanne, Switzerland

Brussels case study

- Data from an already implemented TRANUS model:
  - Households by zone and socio-economic cluster for 1991 and 2001
  - Employment by zone and economic sector (13) for 1991 and 2001
  - Land-value (3 land-uses) by zone for 2001
  - Interzonal travel time and logsums for 2001
  - GIS layer of road infrastructure
  - GIS layer of zoning

Brussels case study

- **Data preparation**
  - Standard gridcell of 150 x 150 meters
  - Households and jobs were disaggregated into gridcells
  - One building of each required type were created in each gridcell
  - Number of residential units and non-residential surface was adjusted to account for vacancy rates
  - Employment and population change between 1991 and 2001 was used to create a synthetic development event history
  - Development constraints were derived from “observed” development in the city

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Brussels case study

- Results (Household Location Choice Model)

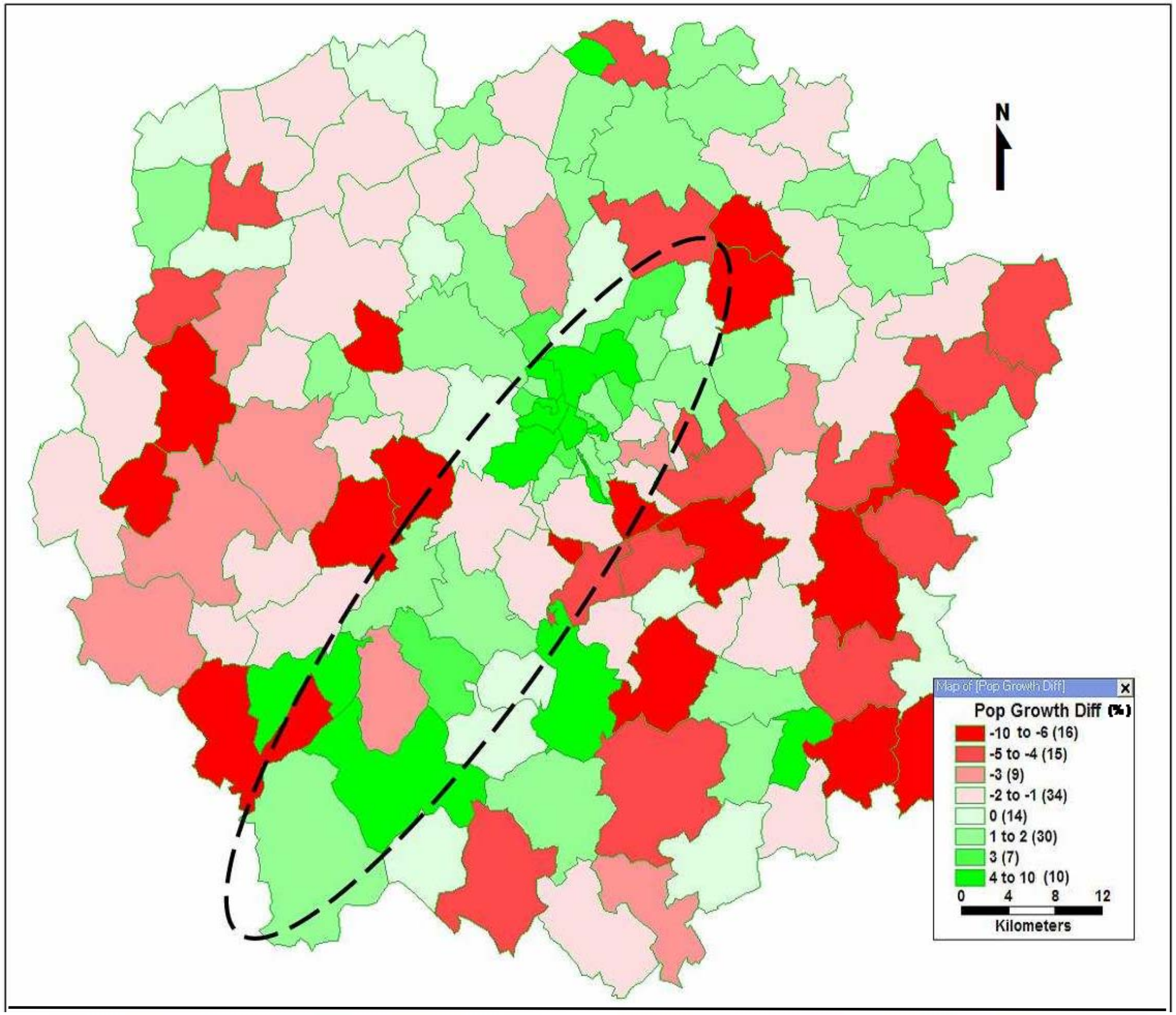
	Variable	Coefficient	Std. Error	t-value
1	Cos t: Income	-0.0661	0.0307	-2.2
2	% High Inc. If High Inc.	0.0334	0.00150	22.3
3	% Low Inc. If High Inc.	0.00400	0.00138	2.9
4	% Low Inc. If Low Inc.	0.0603	0.00109	55.4
5	Travel Time to CBD	-0.000622	0.000148	-4.2
6	In Flanders	-0.0267	0.00856	-3.1

Null Log-likelihood is:	-440982.247
Log-likelihood is:	-439242.311
LR Test:	3479.871
Number of observations:	129655
Convergence statistic is:	7.617E-05

Brussels case study

Results:

Difference between observed and predicted population growth by comune (2000 – 2007)



Lausanne case study

- Available data
  - Swiss census of households (2000)
  - Swiss census of enterprises (2001)
  - GIS layers for geographical data
  - Transportation model (EMME)

- No info on land prices
- Imperfect data on household income

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Lausanne case study

- Data preparation
  - Households: directly from census
  - Jobs: a record for each job in each enterprise
  - Buildings: from households and jobs tables
  - Development event history: directly from census
  - Development constraints were derived from observed development in the city

Lausanne case study

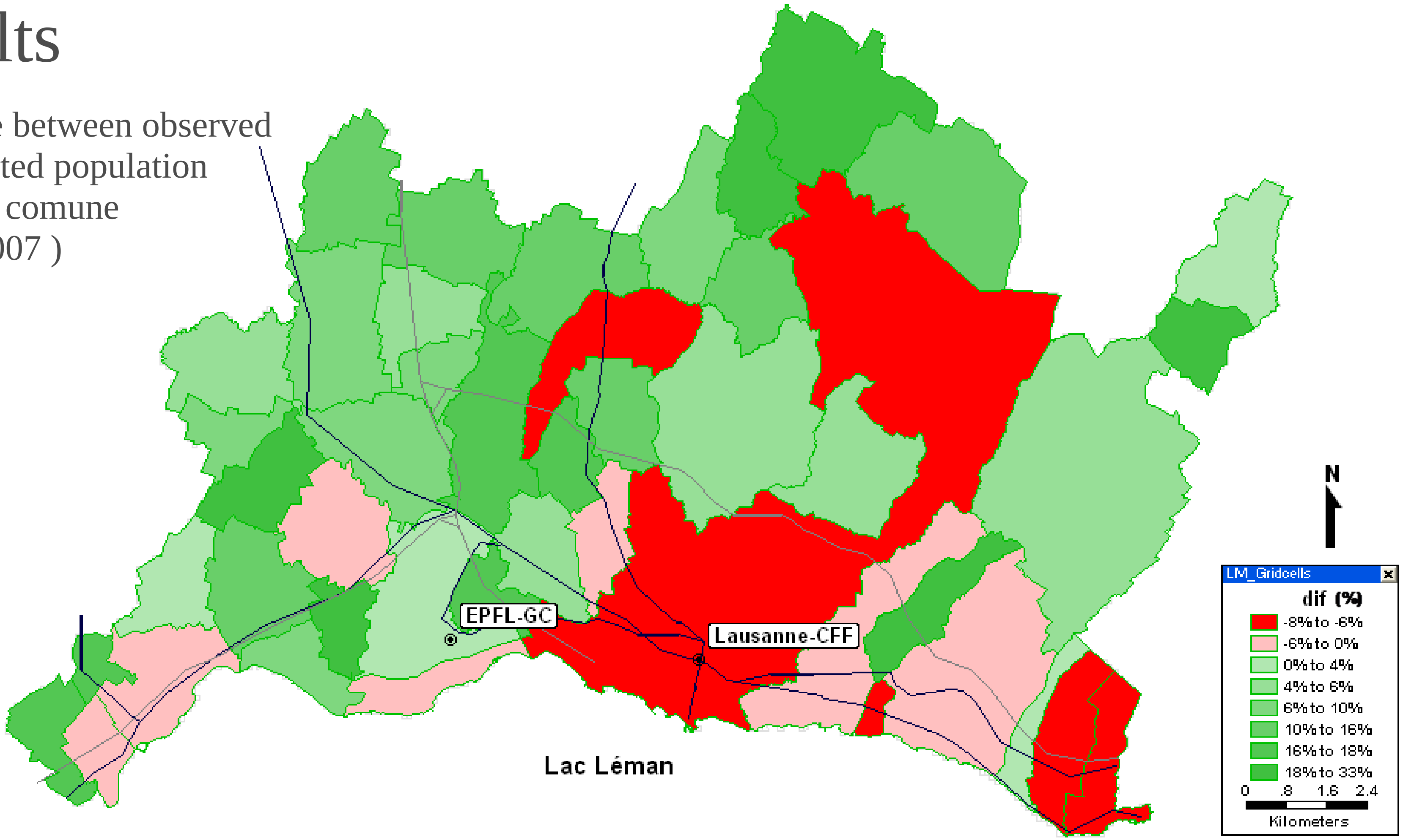
- Results (Household Location Choice Model)

	Variable	Coefficient	Std. Error	t-value
1	Cost: Income	-5.935	0.747	-7.9
2	Retail Employment WWD	0.0298	0.00328	9.1
3	% High Inc. If High Inc.	0.0298	0.000616	48.4
4	% Low Inc. If Low Inc.	0.0236	0.00113	21.0
5	High Density if Young	0.428	0.0177	24.1
6	Mixed Use if Young	0.454	0.0217	21.0
7	Res. Units with Children	-0.00472	0.000103	-45.6
8	Accessibility to Population	0.400	0.0455	8.8
9	Travel Time to CBD	-0.0211	0.00259	-8.1
10	Travel Time to Station	0.0320	0.00210	15.2
	Log-likelihood is:	-440830.606		
	Null Log-likelihood is:	-444383.444		
	LR Test:	7105.676		
	Number of observations:	130655		
	Convergence statistic is:	5.398E-04		

Lausanne case study

Results

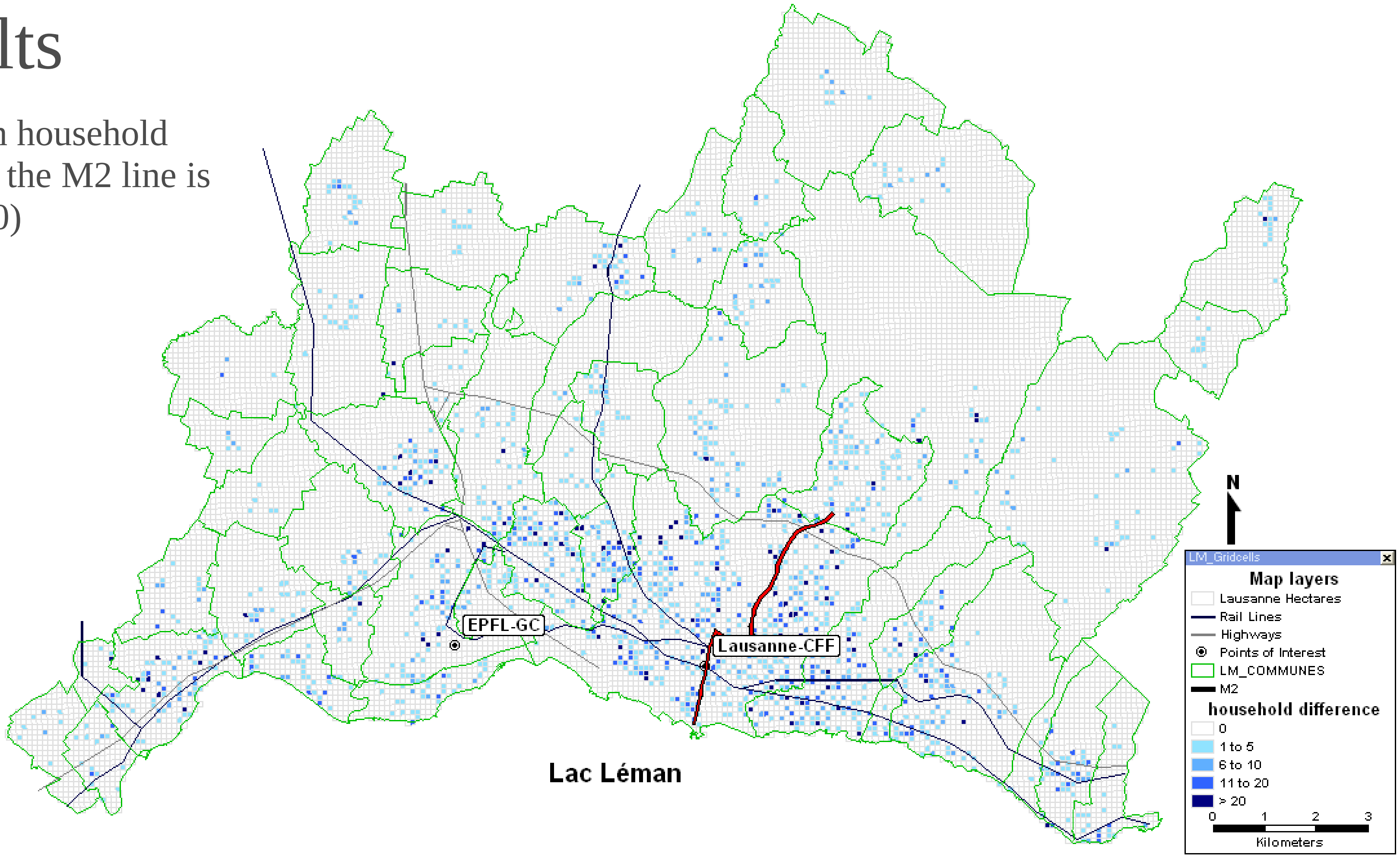
Difference between observed and predicted population growth by comune (2000 – 2007)



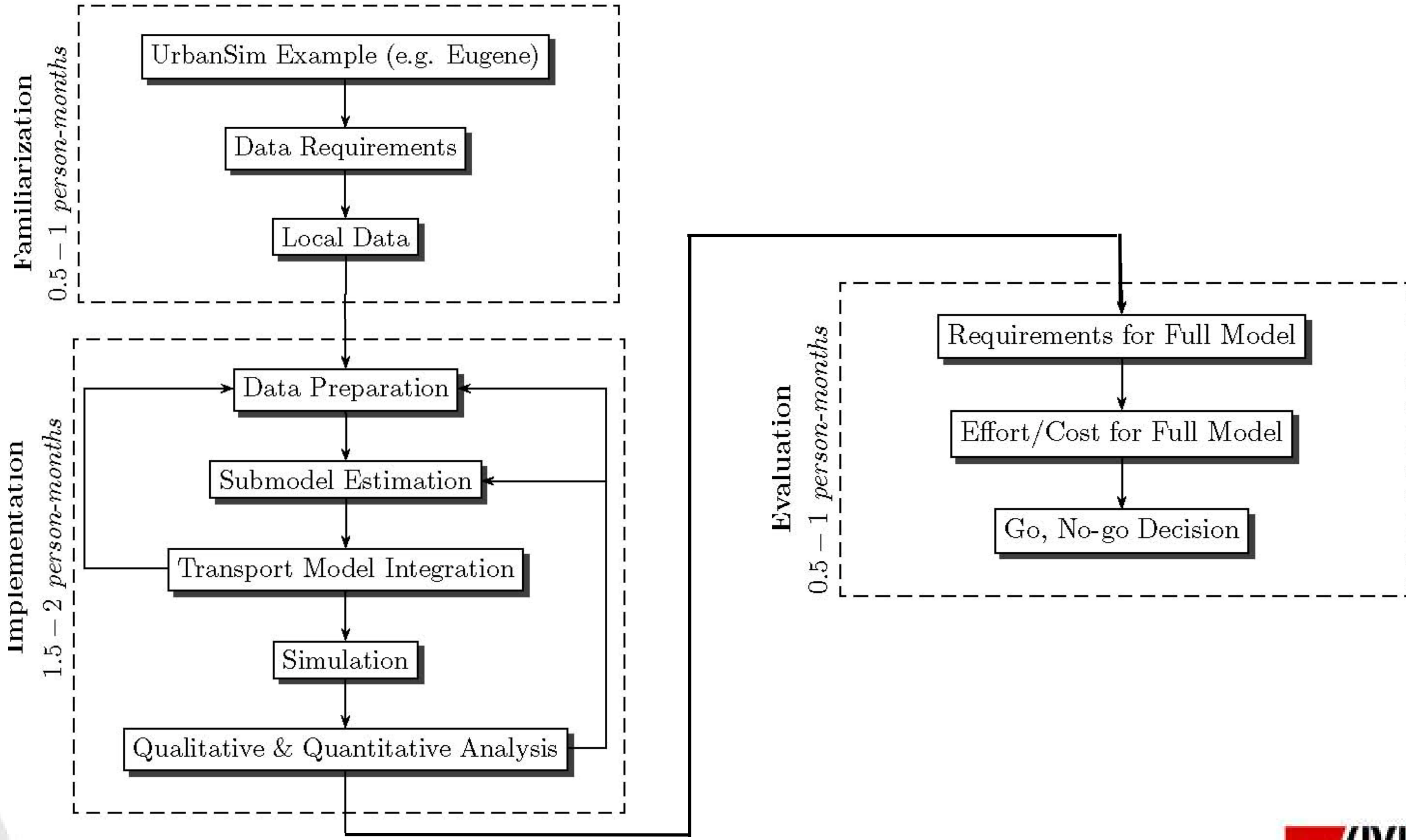
Lausanne case study

Results

Increase in household location if the M2 line is built (2020)



Developing a Prototype UrbanSim model



Developing a Prototype UrbanSim model

- **Familiarization**
  → With UrbanSim
  → With local data

  – Run simulations with provided example (Eugene)
  – Explore data of provided example
  – Identify required data
  – Analyze “fit” between required and available data

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Developing a Prototype UrbanSim model

- **Data preparation**
  - Concentrate on the “six tables”
  - Build tables starting from available examples
  - Focus on readily available data
  - Identify missing data
  - If necessary, use simulated data or simplifying assumptions

Developing a Prototype UrbanSim model

- **Submodel estimation**
  - Quality of models is difficult to evaluate without seeing simulation results
  - ⇨ Estimate quickly in order to be able to run simulations soon (models can be improved later)

- **Transport model integration**
  - Continual interaction is not strictly necessary
  - Clearly identify inputs and outputs of the transport model
  -

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Developing a Prototype UrbanSim model

- **Simulation**
  - Start to run simulations early, even if data is incomplete (helps to identify possible errors and improvements)
  - Use the latest stable release
- **Analysis**
  - Population growth by area?
  - Simulation results comply with expectations?
  - Problems with data?
  - Problems with submodels?

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Developing a Prototype UrbanSim model

- **Evaluation**
  - Desired characteristics of the operational model
    - Level of disaggregation (Data requirements)
    - Interaction with transport model
  - Effort required to implement a complete model
    - Data gathering
    - Submodel estimation
    - Transport model (Is there an appropriate, available model?)
  - Priority identification
    - Disaggregate projections ➔ UrbanSim
    - Aggregate projections ➔ Other models may be better (easier)

Conclusions

- Best way to evaluate UrbanSim is developing a prototype model
- Even with incomplete data results can be reasonable
- Developing a prototype model is possible within 3 – 5 months of one person’s effort

Conclusions

- Recommendations:
  - Learn by doing
  - Start with provided examples and available data
  - Concentrate on the “six tables”
  - Continual interaction with transport model is not strictly necessary
  - Run simulations early, even if data is incomplete
  - Concentrate on general results
  - Identify desired characteristics and data requirements for an operational model

Questions?