Preferred citation style

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SustainCity: Advancing land use transport interaction models in Europe

BR Bodenmann

IVT, ETH Zürich

SCSAU
Zurich, July 2011

Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Content

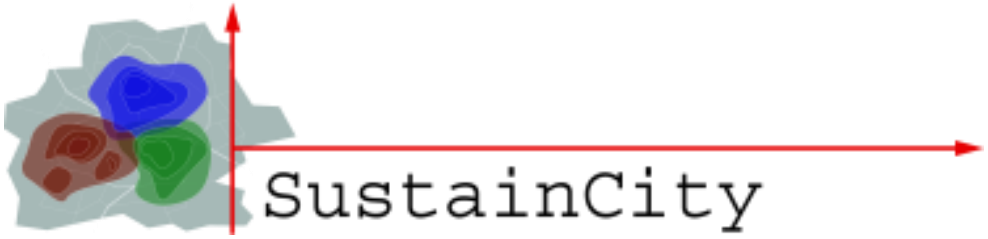
1. **SustainCity**
2. UrbanSim
3. Zurich case study
4. Results of related work
   a. Recidential location choice
   b. Firm‘s location choice
   c. Simulations 1: Testing options for authorities
   d. Simulations 2: Disaggregated Traffic flow
5. Conclusions

SustainCity

Micro-simulation for the prospective of sustainable cities in Europe

- part of the **7th Framework Programme for Research of the European Commission**
- January 2010 to December 2012

- Co-ordinator: **Prof. Kay W. Axhausen** (IVT, ETHZ)
- Scientific co-ordinator: **Prof. André de Palma** (ENSC)
- www.sustaincity.eu



SustainCity: Aim

- to address the modeling and computational issues of integrating modern **mobility simulations** with the latest micro-simulation **land use models**
- to advance the state-of-the-art in the field of the microsimulation of **prospective integrated models of Land-Use and Transport** (LUTI)

On the modeling side, the main challenges are

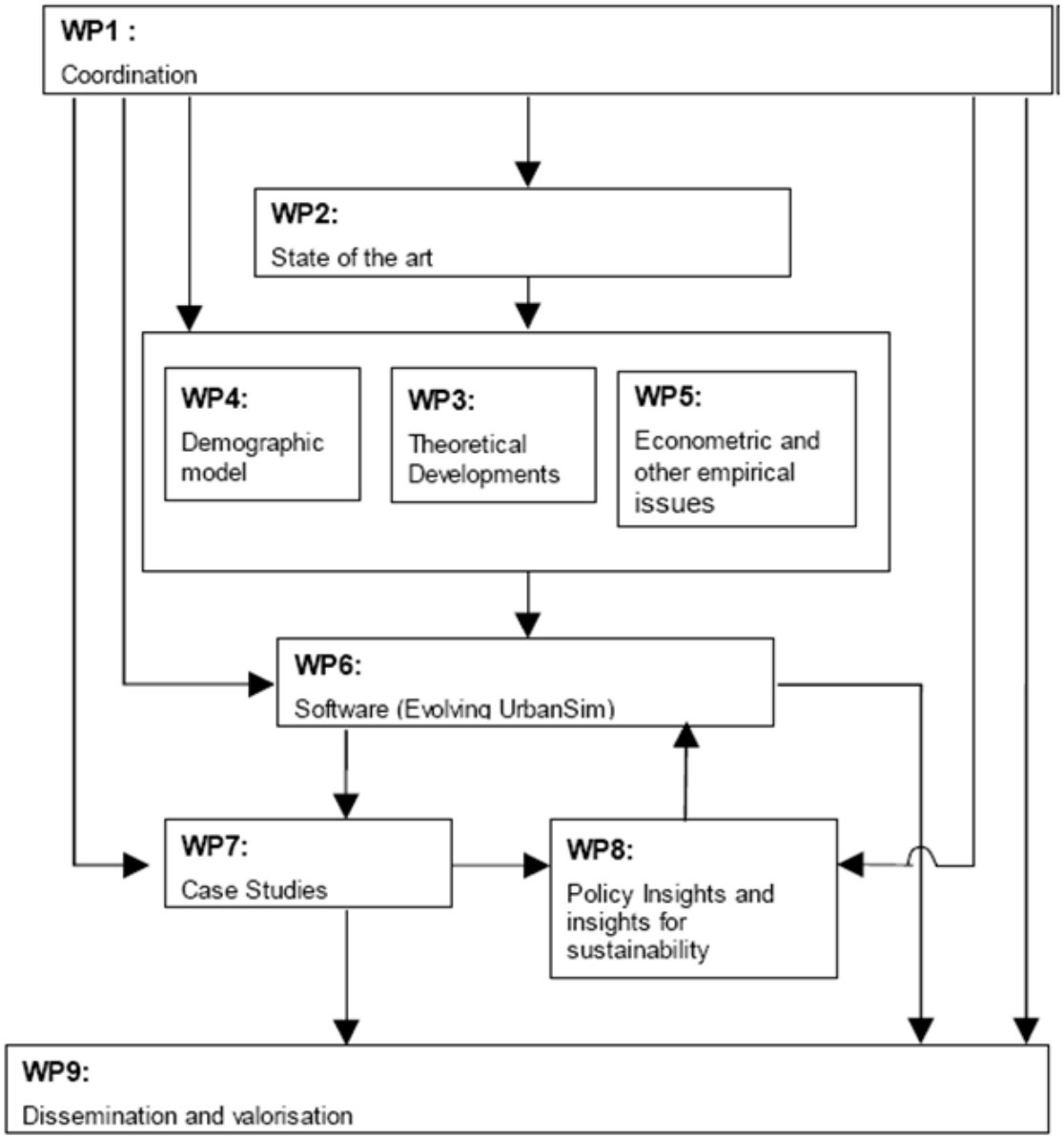
- to integrate a **demographic evolution module**
- to add an **environmental module**
- to improve the **overall consistency** and
- to deal with the **multi-scale aspects** of the problem: several time horizons and spatial resolutions

SustainCity: Partners

Swiss Federal Institute of Technology Zurich (ETHZ)
Ecole Normale Supérieure de Cachan, France (ENSC)

Institut National d'Etudes Démographiques, France (INED)
Université Catholique de Louvain, Belgium (UCL)
Katholieke Universiteit Leuven, Belgium (KUL)
STRATEC SA, Belgium (STR)
National Technical University of Athens, Greece (NTUA)
Technical University Berlin, Germany (TUB)
Ecole Polytechnique Fédérale de Lausanne, Switzerland (EPFL)
Bocconi University, Italy (BU)
Université de Cergy Pontoise, France (UCP)
University of California, Berkeley USA (UCB)

SustainCity: Work Packages



Content

1. SustainCity
2. **UrbanSim**
3. Zurich case study
4. Results of related work
   a. Recidential location choice
   b. Firm‘s location choice
   c. Simulations 1: Testing options for authorities
   d. Simulations 2: Disaggregated Traffic flow
5. Conclusions

UrbanSim

is an integrated **microsimulation model system** for planning and analysis of urban development, incorporating the **interactions between land use, transportation, and public policy**.

It is intended to **explore the effects** of

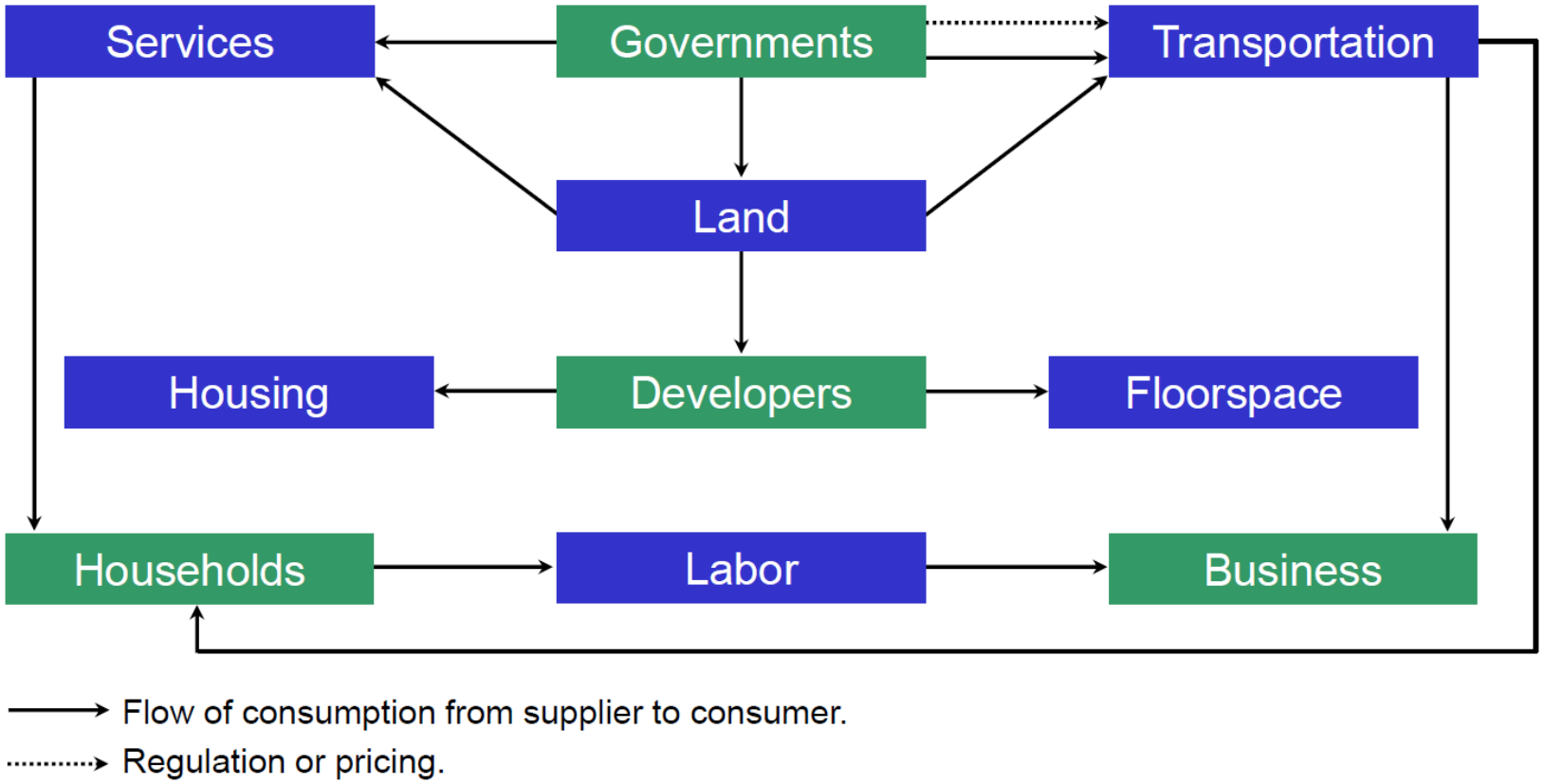
- **infrastructure**
- **policy choices**

on community **outcomes** such as

- motorized and non-motorized **accessibility**
- housing **affordability**
- greenhouse gas **emissions**
- protection of **open space**

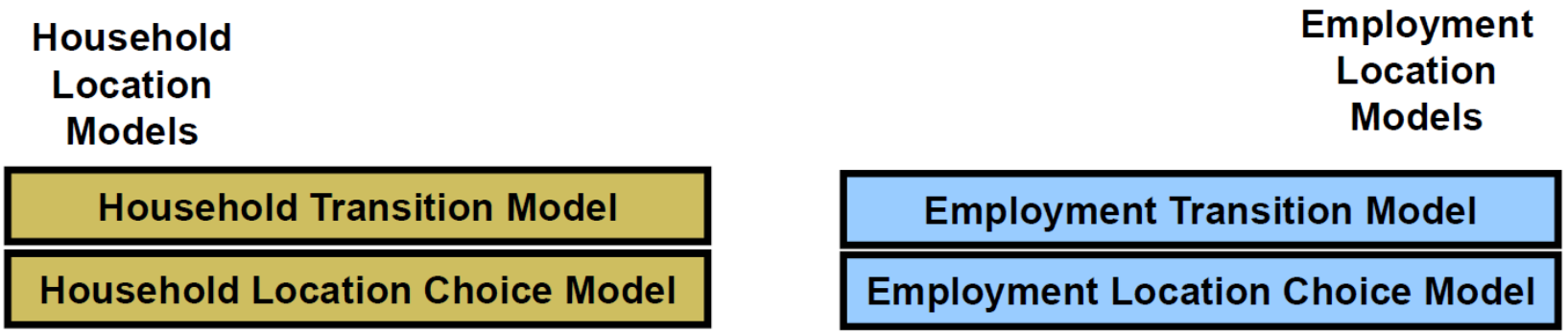
(www.urbansim.org)

UrbanSim: Framework



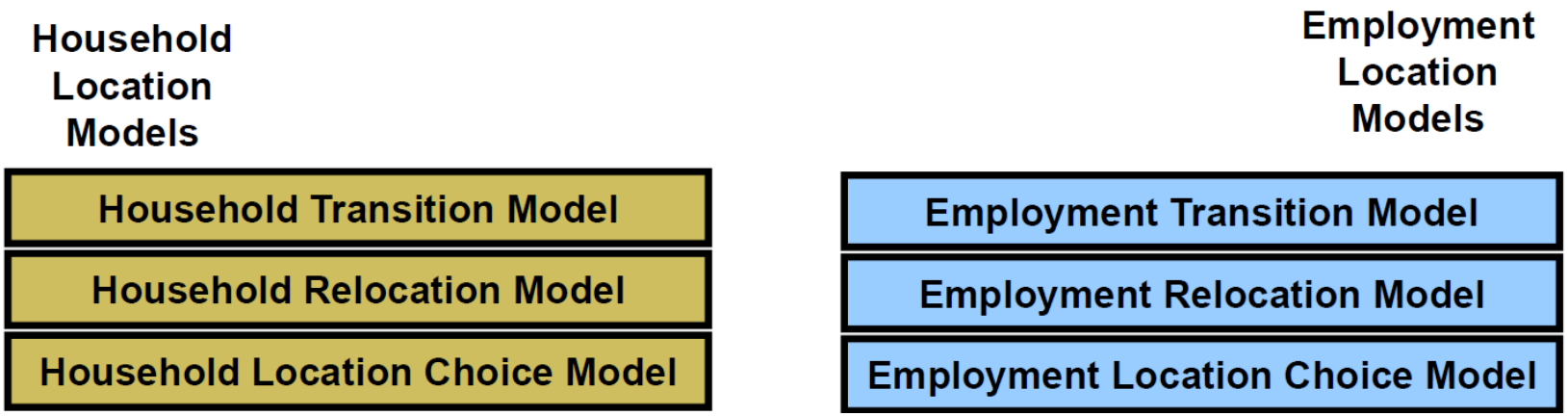
(Waddell, 2010)

UrbanSim: Models (over-over-simplified version)



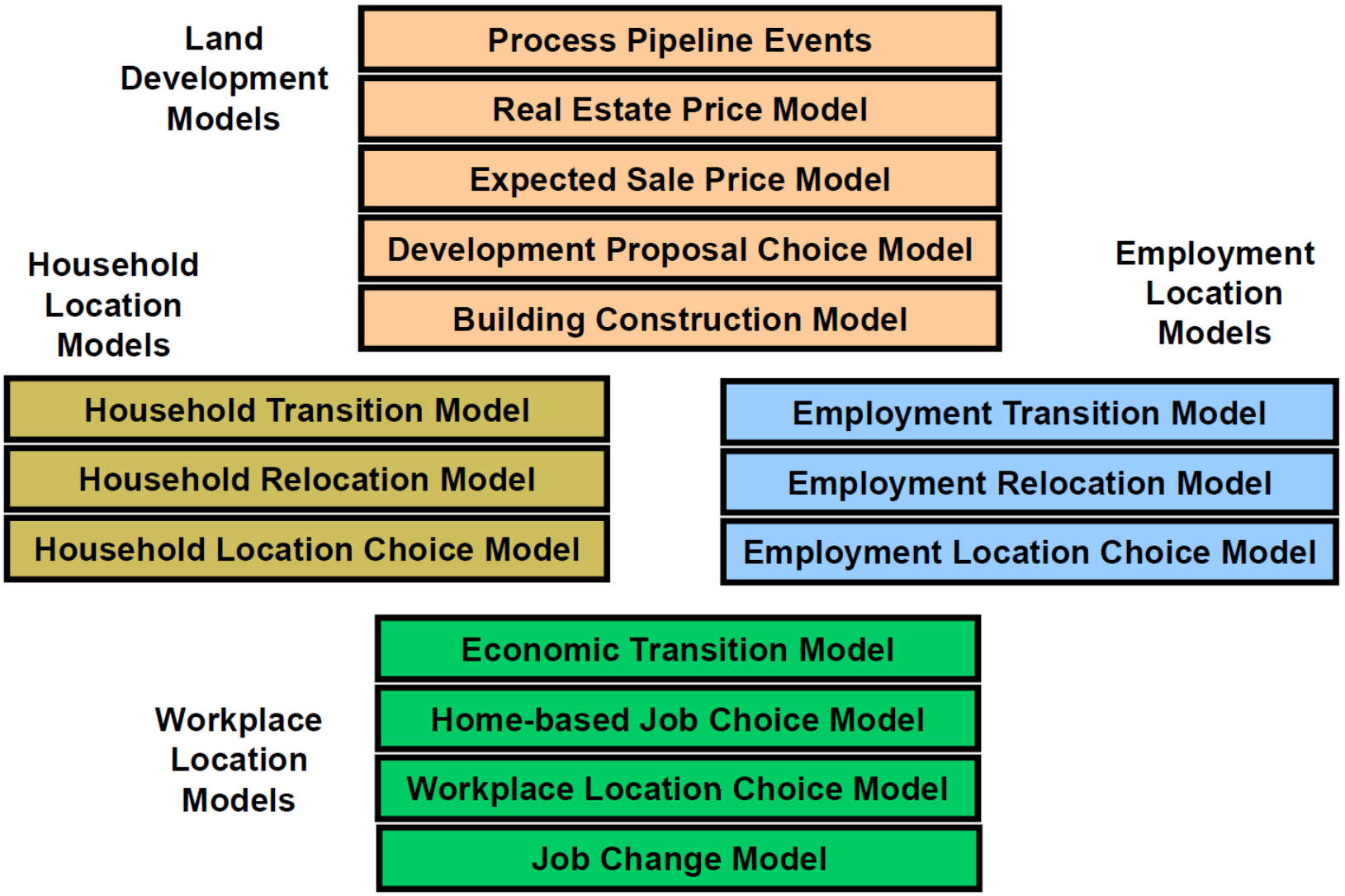
(Waddell, 2010)

UrbanSim: Models (over-simplified version)



(Waddell, 2010)

UrbanSim: Models (full parcel version)



(Waddell, 2010)

UrbanSim: Characteristics

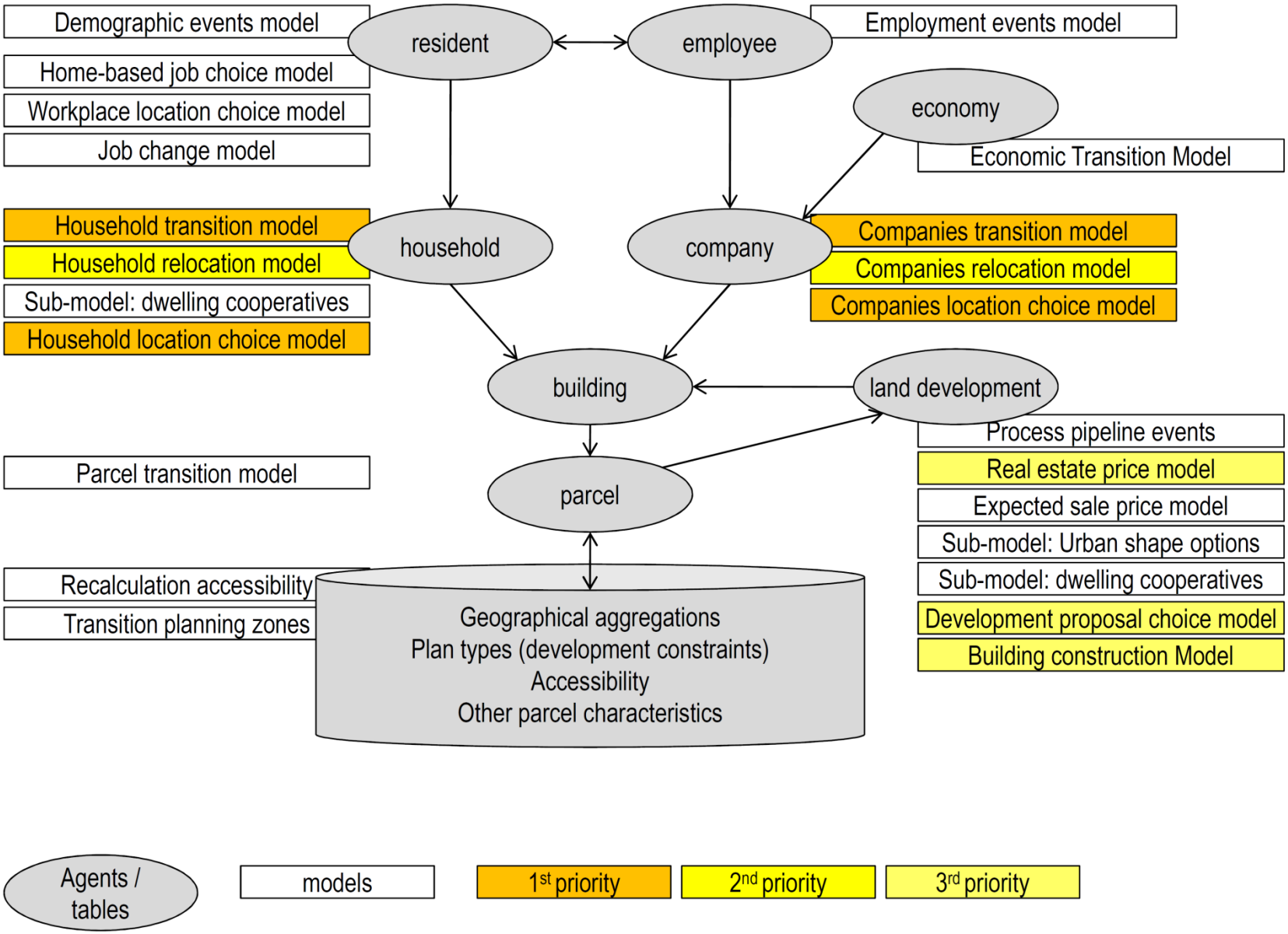
- **Modular** choice model system
- Using just **one database** (avoiding redundant data)
- **Open source** (based on Opus, Python)
- Possibility to use Opus **external libraries** (C/C++)
  (such as: R, Biogeme, MySQL, Postgres, QGIS, MATSIM)
- **Research work** in US

- Fill up database **time consuming** (requires consistency)
- Tight connection of models is **complex**
- **Research work** in Europe →UrbanSimE

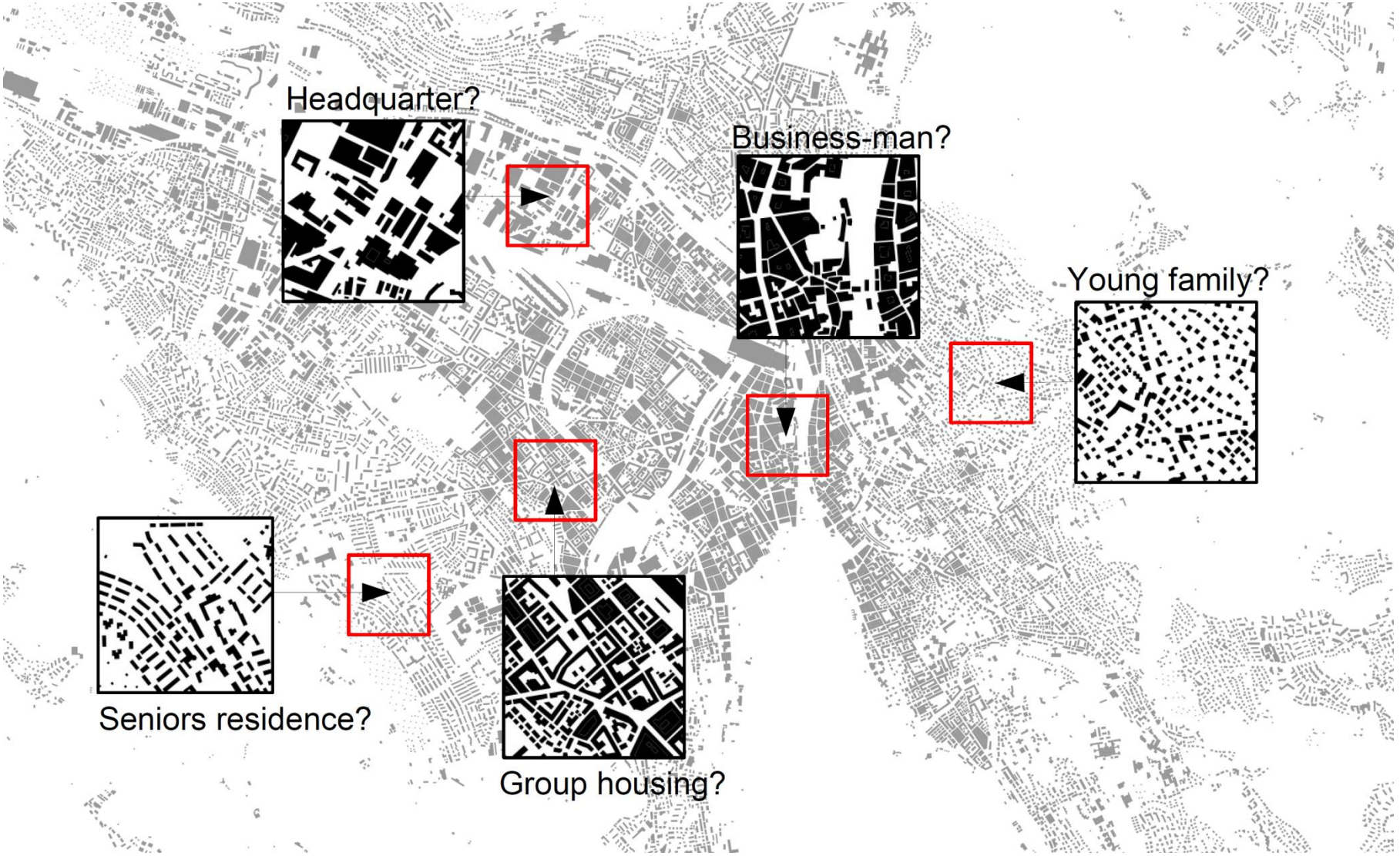
Content

1. SustainCity
2. UrbanSim
3. **Zurich case study**
4. Results of related work
   a. Recidential location choice
   b. Firm‘s location choice
   c. Simulations 1: Testing options for authorities
   d. Simulations 2: Disaggregated Traffic flow
5. Conclusions

Zurich Case Study: Model structure



Zurich Case Study : Urban Typology



(Schirmer et al., 2011)

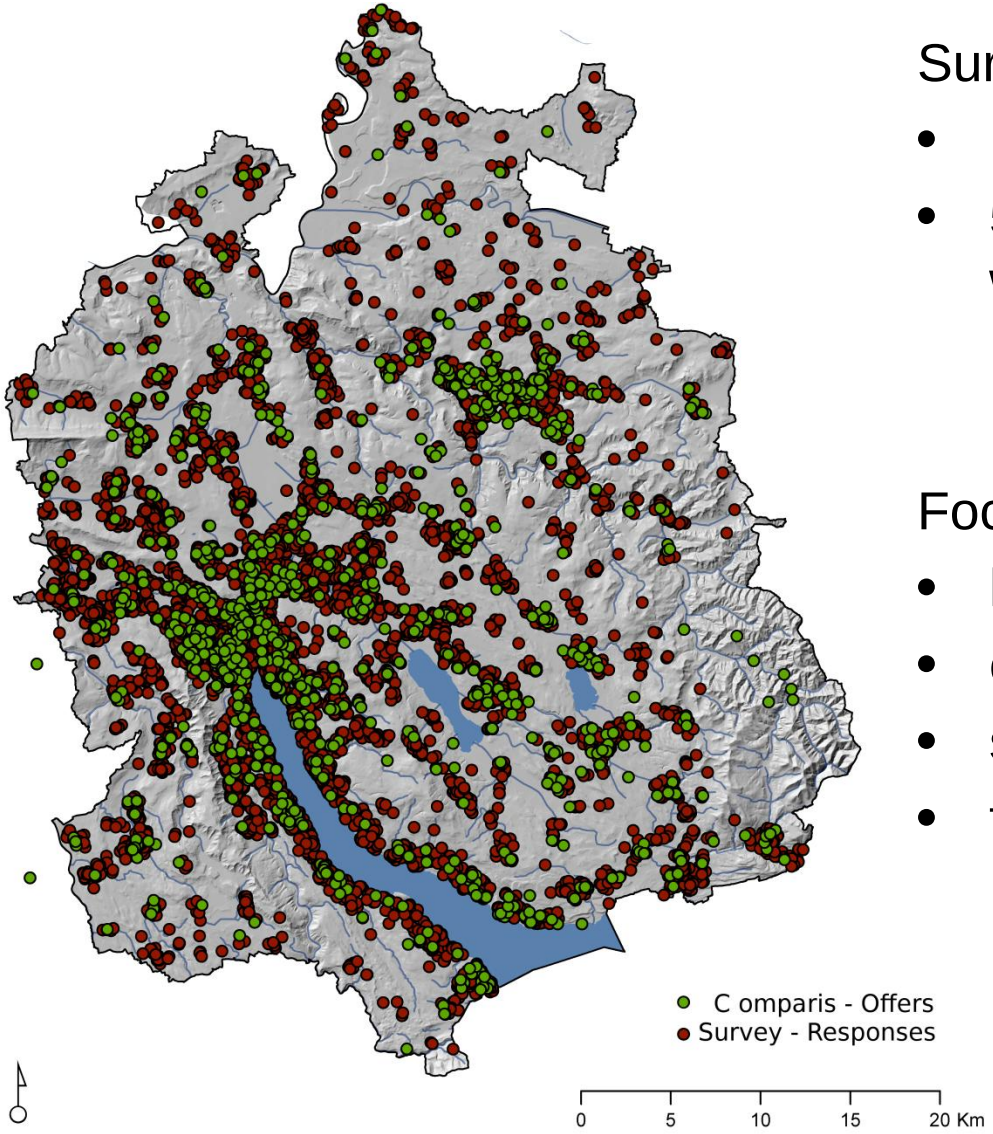
Zurich Case Study: Status

• First run with dummy variables	done
• First run with simplified model	summer 2011
• First run with overall model	December 2011
• Analyses with UrbansimE	from March 2012
• End of project SustainCity	December 2012

Content

1. SustainCity
2. UrbanSim
3. Zurich case study
4. **Results of related work**
   a. Recidential location choice
   b. Firm‘s location choice
   c. Simulations 1: Testing options for authorities
   d. Simulations 2: Disaggregated Traffic flow
5. Conclusions

HH location choice: Discrete choice model



(Schirmer et al., 2011)

Survey in the canton of Zurich

- 1030 responses
- 5500 alternatives from www.comparis.ch

Focus on

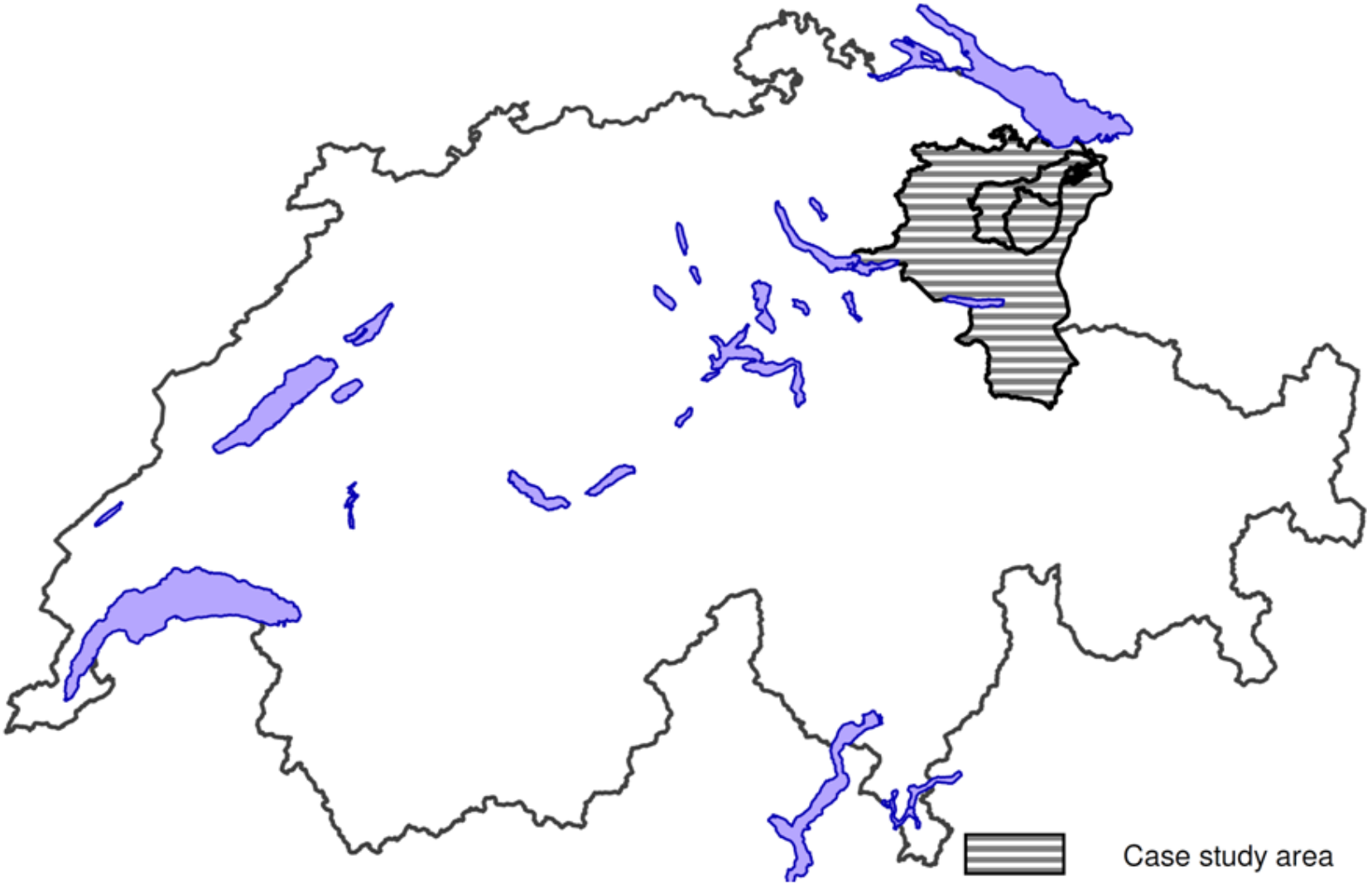
- household
- current/previous residence
- social network
- type of lifestyle

HH location choice: Estimated parameters

Parameter	Standarised β	t-test	p-value
ratio rent/income	-5.510	-11.070	
log(net-area per household-member)	0.982	8.010	0.00
distance to workplace [km]	-1.590	-2.760	0.01
Distance to social contacts	-8.160	-1.810	0.07
Exponent of distance to workplace	0.374	4.720	0.00
Exponent of distance to social contacts	0.223	2.660	0.01
portion of households of same size (r=1km)	0.016	1.770	0.08
traveltime (by car) to Bürkliplatz in min	0.020	4.380	0.00
log(accessibility of PT[6]) * dummy „no car“	0.410	3.770	0.00
log(accessibility of PVT[7]) * dummy „car available“	-0.298	-3.990	0.00
population density in r=1km [Personen/ha]	0.010	4.370	0.00
rent vacancy in municipality	-0.106	0.052	0.04
number of obsercations			683
ρ^2			*0.2128*

(Schirmer et al., 2011)

Firm location choice: Case study area



(Bodenmann, 2011)

Firm location choice: Discrete choice model

Commercial Registers

- Cantons of St.Gallen and Appenzell
- 1991-2006
- 21‘000-32‘000 companies per year

Business Register (BUR)

- Swiss Federal Statistic Office FSO
- 2003-2006
- 29‘000-31‘000 companies per year

Alternatives

- Swiss municipalities

COMMERCIAL REGISTER OF CAN

Identification number	Legal status	Entr
CH-300.3.012.284-7	**Limited or Corporation**	30.0

All datas

In	Ca	Business name
1	7	~~Realbau AG für Immobilien- und Projektmanagement~~
7		**regioConcept AG**

In	Ca	Share capital (CHF)	Paid in (CHF)	Shares
1		200'000.00	200'000.00	200 Namenaktien zu j

In	Ca	Purpose
1	7	~~Planung und Realisierung von Bauvorhaben aller Art, Verwaltung, K von Immobilien. Sie kann sich an anderen Unternehmungen beteilig schäfte abschliessen, die direkt oder indirekt mit ihrem Hauptzweck gen.~~
7		Zweck der Gesellschaft ist die Führung eines Dienstleistungsbetrieb und Verkehrsplanung, Architektur, Immobilienentwicklung und -verw mation sowie verwandte Tätigkeitsgebiete wie IT, Entwicklung, Bes beitung und Verkauf von Geodaten, kartografischen Produkten sow der Software. Die Gesellschaft kann Grundstücke erwerben, verwal sern, sich an andern Unternehmungen beteiligen und alle Geschäft die direkt oder indirekt mit ihrem Hauptzweck zusammenhängen.

In	Ca	Remarks
6		Mitteilungen erfolgen mit Brief, Telefax, E-Mail oder andern Übertra den Nachweis durch Text ermöglichen.
6		Gemäss Erklärung des Verwaltungsrates vom 23.06.2009 untersteh keiner ordentlichen Revision und verzichtet auf eine eingeschränkte
7		Die Übertragbarkeit der Namenaktien ist nach Massgabe der Statut

Firm location choice: Ranking of estimated parameters

all	Parameter	Manu-fact.	Whole-sale	Bus. service	Pers. service
1*	**Alternative is a city**	3*	2*	2*	1*
2*	**Cantonal business development**	2*	3*	3*	2*
3*	**Tax burden for joint stock comp.**	4*	4*	4*	4
4	**Previous site is in a city**	1*	1	1*	8
5*	**Municipality with a rail connection**	6*	5*	8*	3*
6*	**Index of diversity in sectors**	5*	9*	5*	11
7*	**Population with graduate degree**	8*	14*	5*	14
8*	**highway connection**	10*	6*	9*	6
9*	**Tax burden for partnerships**	7*	8*	7*	10
10*	**Accessibility to employees**	9*	10*	10*	5*
…	**…**	.	.	.	.
18	**Land price for commerce**	17	18	18	16

* Sigificant according to t-test

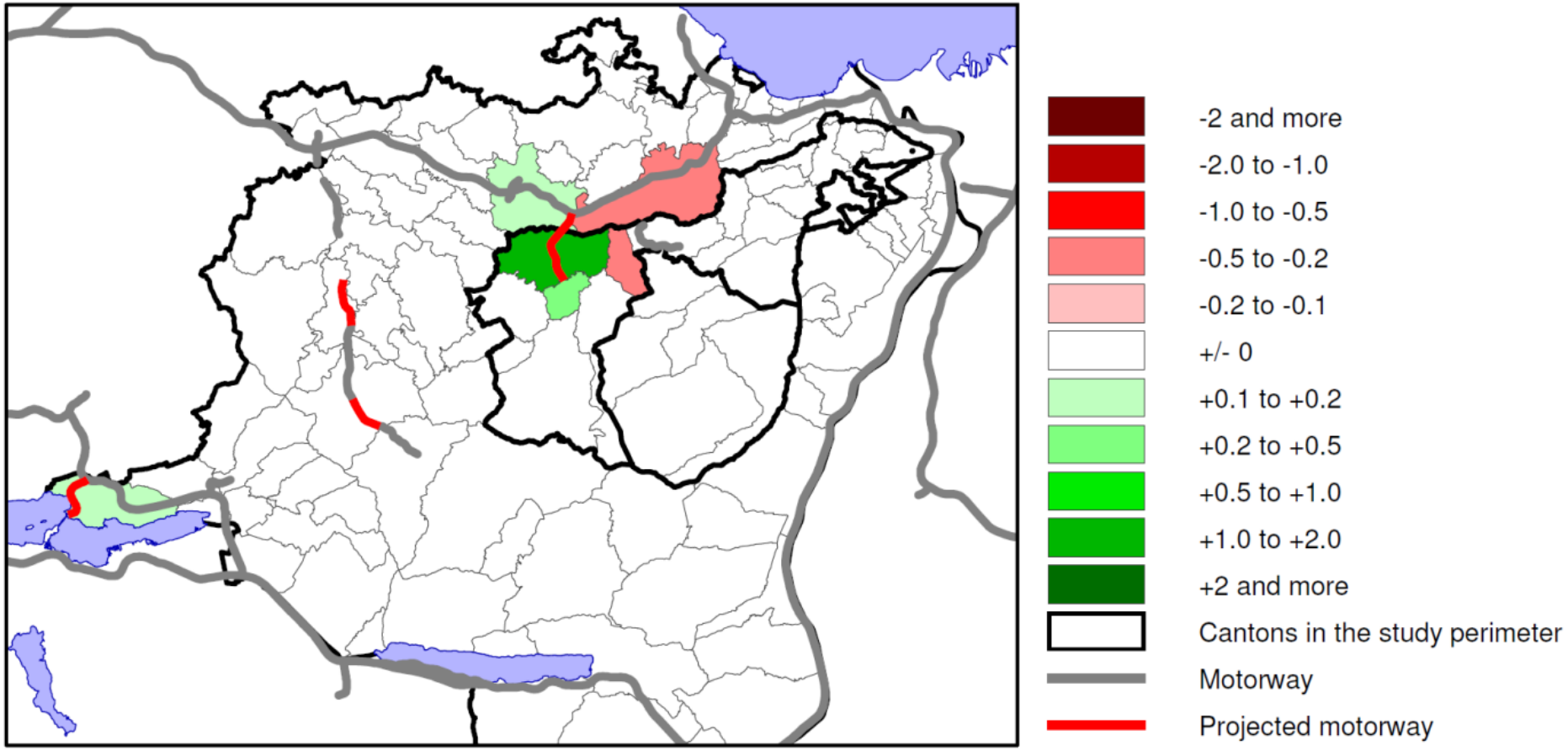
NL-Modell, observations: 10'700, LL(0): -51'400, LL(max) -31'200, Adj. Rho-square 0.392

Simulations 1: Aim

Testing options for cantonal and municipal authorities' intent on attracting firms, such as:

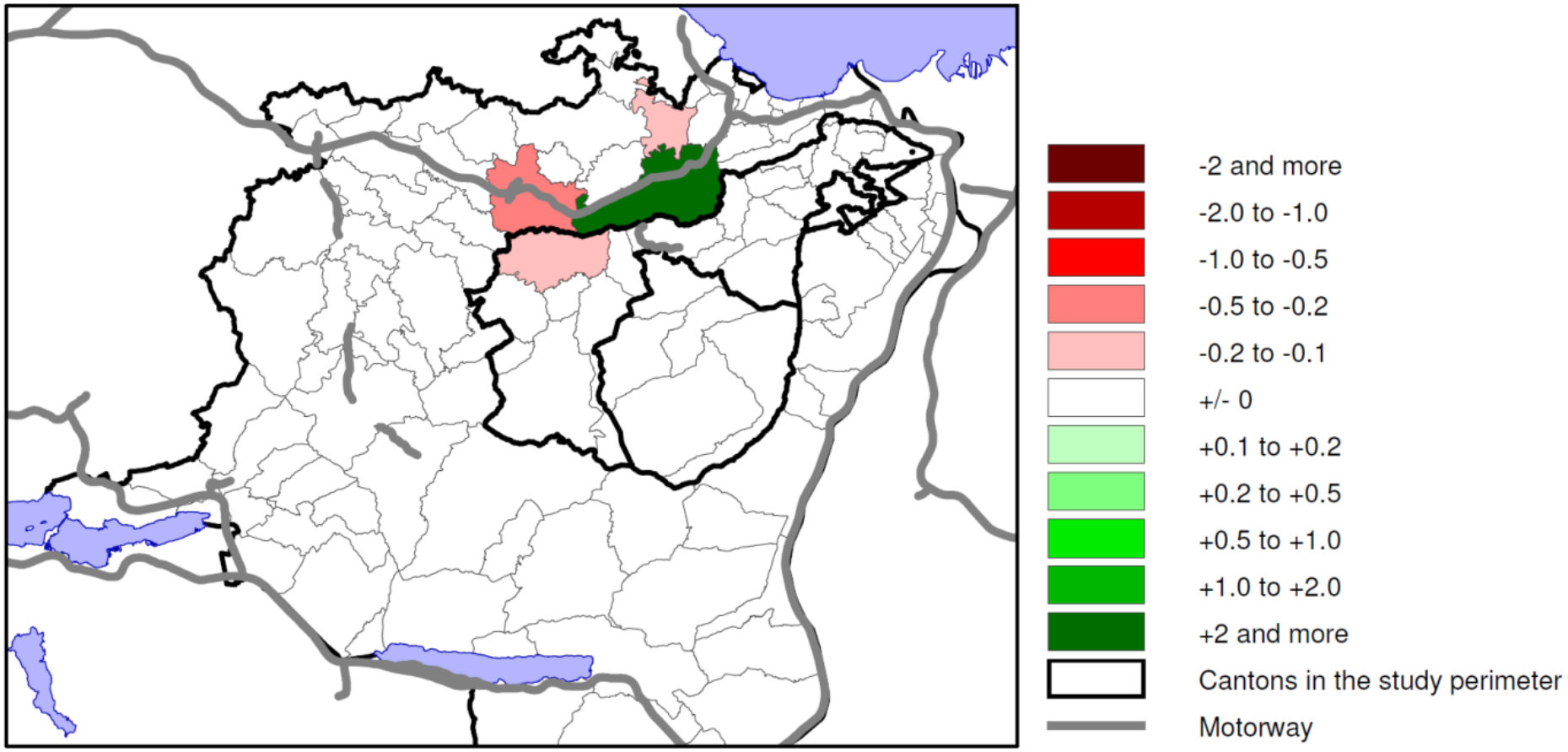
- improvements in **transport infrastructure**
- designation of **new building zones**
- **tax reductions**

Simulations 1: Improvements in transport infrastructure



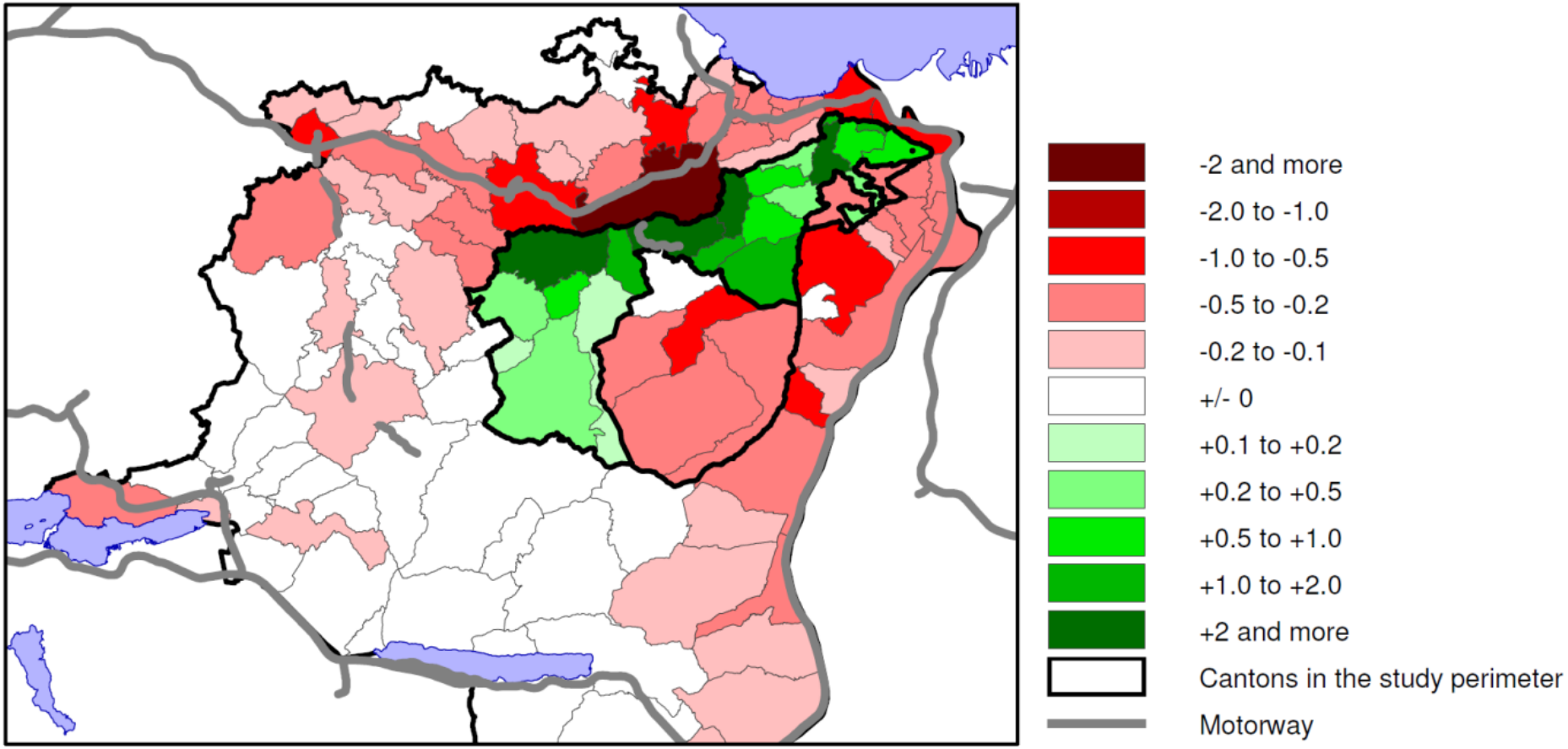
Real projects according to cantonal directive plans (see Bodenmann, 2011)

Simulations 1: Tax reductions for natural persons



Reduction in the City of St. Gallen, -1sd or CHFk 14, income CHFk 500

Simulations 1: Tax reductions for legal persons



Reduction in AR, -1sd or CHFk 25, taxable profit CHFk 1’000

Simulation 2: Traffic flow with MATSim

Disaggregate simulation of **car traffic**

- Detailed traffic control
- Detailed parking facilities
- Detailed recharging facilities for electric vehicles

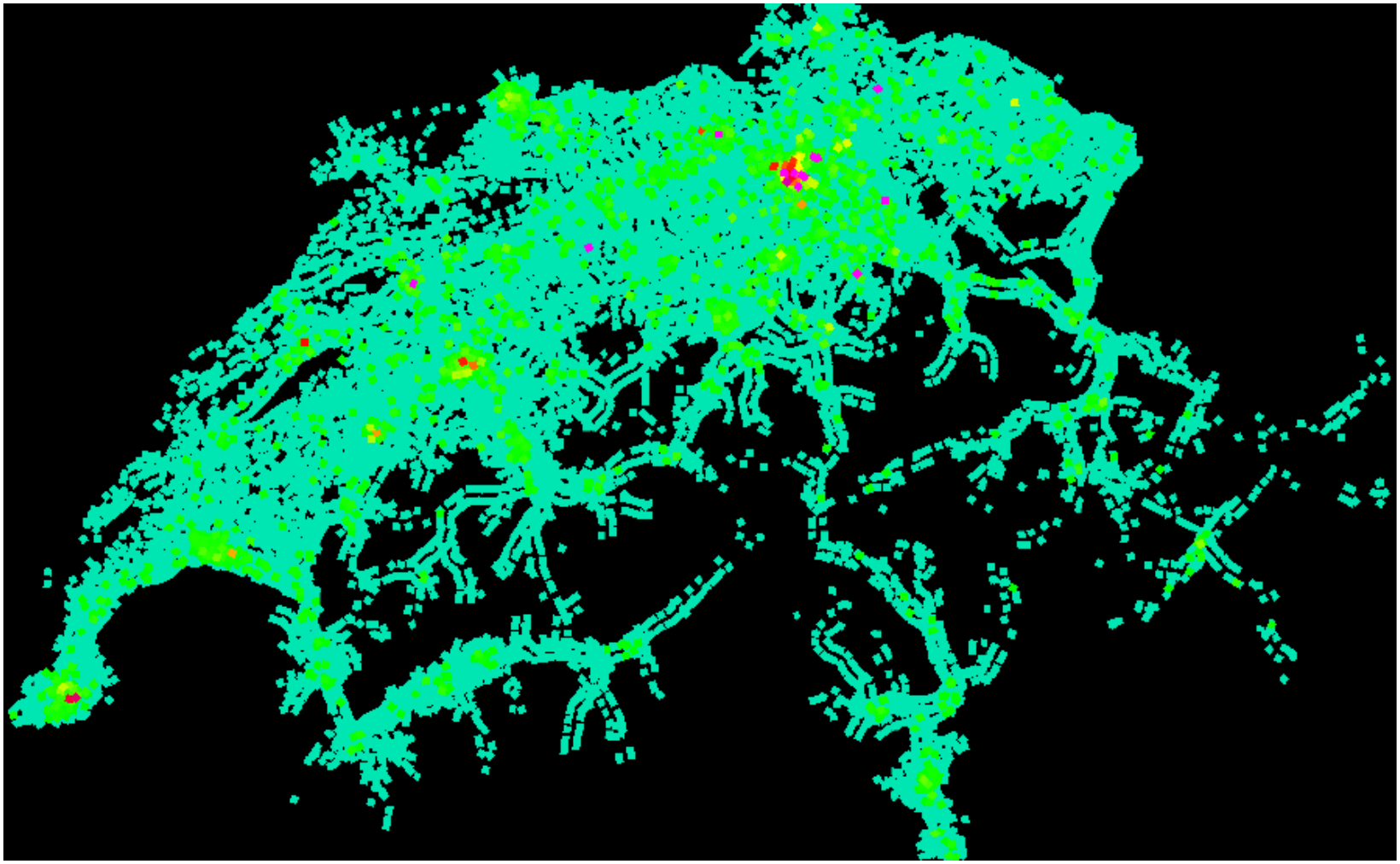
Disaggregate simulation of **public transport**

Disaggregate simulation of **cyclists**

Disaggregate simulation of **pedestrians**

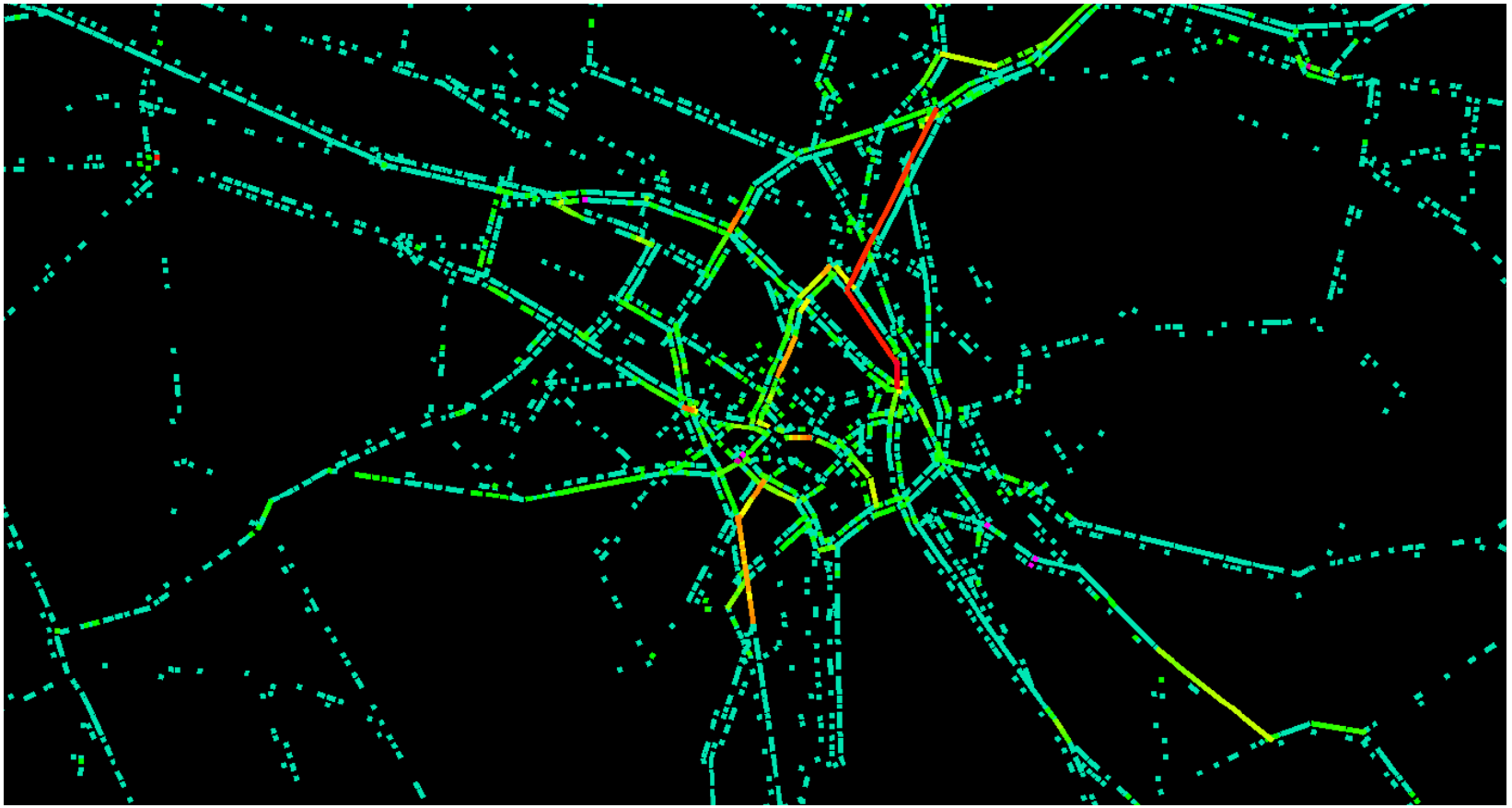
Simulation 2: Activity chain of „agents“

Simulation 2: Traffic flow in Switzerland (06:30)

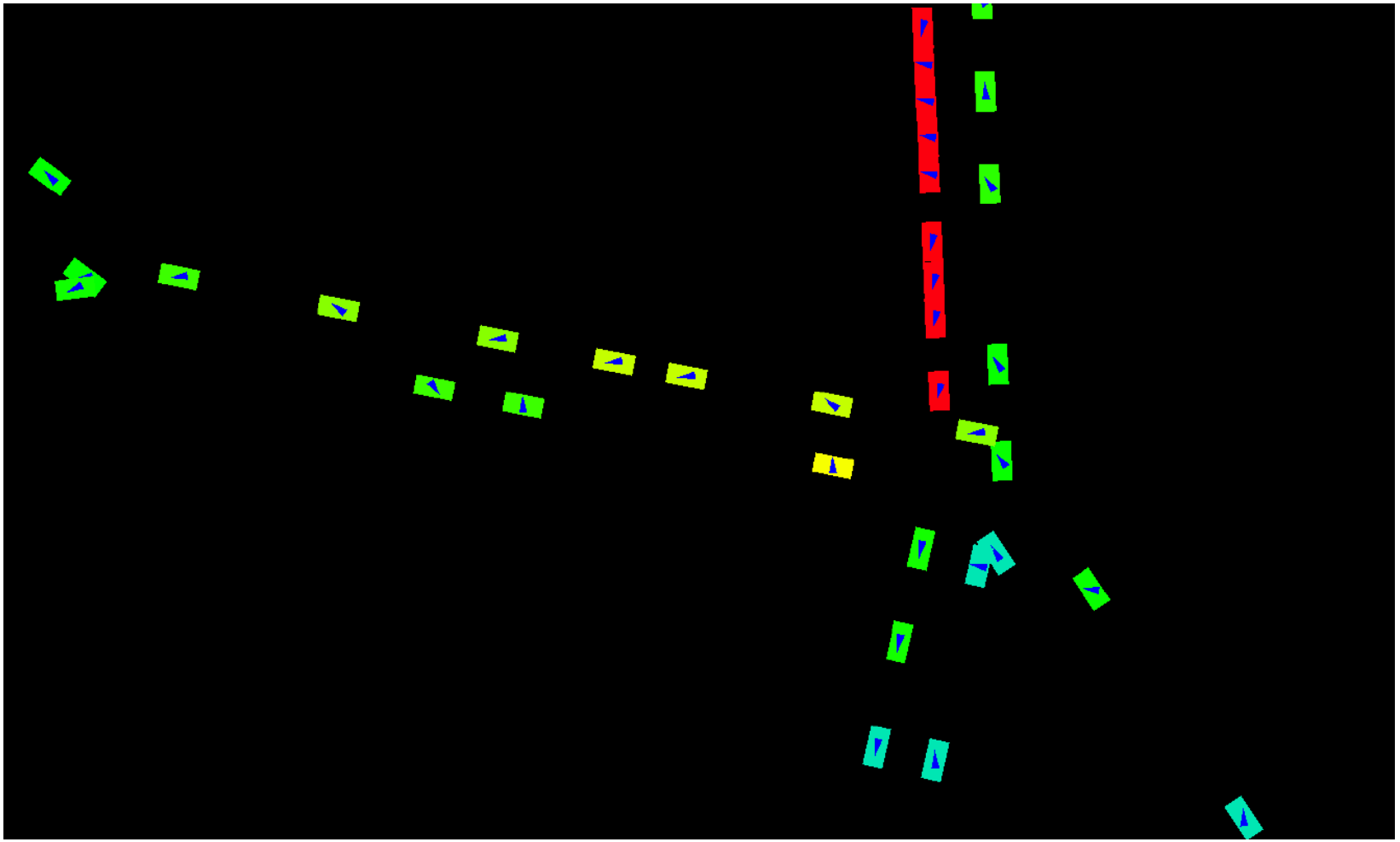


http:// matsim.org

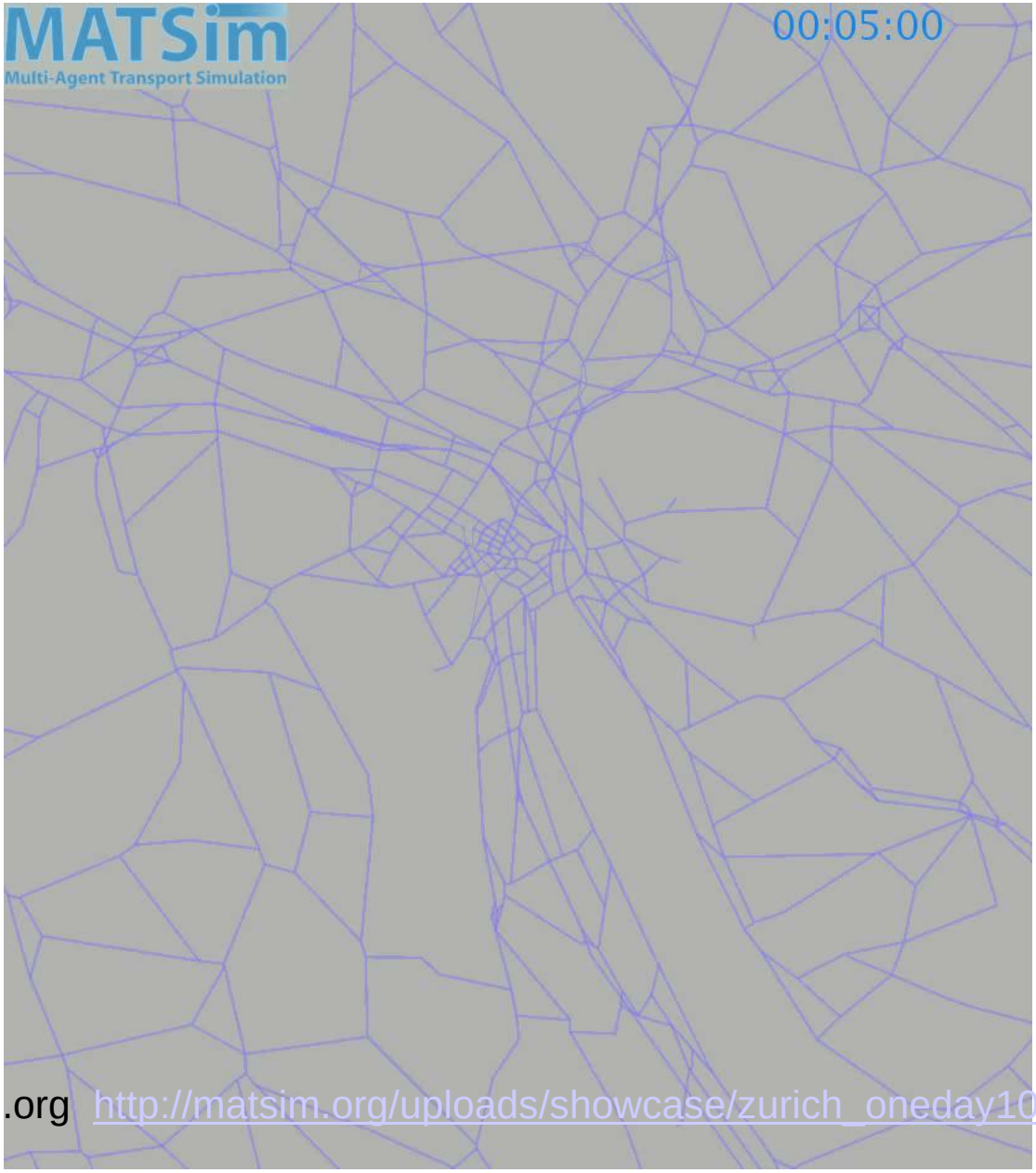
Simulation 2: Traffic flow in Zurich (06:30)



Simulation 2: Traffic flow at intersection (06:30)



Simulation 2: Traffic flow in Zurich (during a day)



http://matsim.org http://matsim.org/uploads/showcase/zurich_oneday10pct.avi

Content

1. SustainCity
2. UrbanSim
3. Zurich case study
4. Results of related work
   a. Recidential location choice
   b. Firm‘s location choice
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Conclusions

Modelling integrated **land-use on micro-level**

- provides **more options**
  (e.g. modelling transitions of hh, firms, parcels)
- allows simulations not only of **effects**,
  but also of **side effects** and **crowding-out effects**
- is **data-intensive** and **time-consuming**

Discrete choice models and simulations prove

- effects of **distances**
  (to social contacts, work, customers, previous location)
- effects of **taxes** on capital and benefit / **business friendliness**

- **side effects** decrease with **distance**
- **Cities** are more affected (also over **long distances**)

Conclusions

Finaly, these models help to **answer** crucial questions regarding sustainable urban patterns:

- Future **spatial segregation** between industries and residential use
- Development of the future **commuting distances** and routes
- Effects of **authorities interventions**

And , deduced from these results:

- Estimation of produced **greenhouse gasses**
- Future aspects of **urban and rural landscapes**
- **Infrastructure** utilization and need for additional infrastructures (e.g. schools, water and energy supply)

Thank you for your attention

Literature

Belart, B. (2011) Wohnstandortwahl im Grossraum Zürich, Master Thesis, , ETH Zurich, Zurich.

Bierlaire, M., 2003. BIOGEME: a free package for the estimation of discrete choice models. In: Proceedings of the Third Swiss Transportation Research Conference, Ascona, Switzerland, www.strc.ch.

Bierlaire M., D. Bolduc and D. McFadden (2008) The estimation of generalized extreme value models from choice-based samples, *Transportation Research Part B*, **42** (4) 381-394.

Bodenmann B.R. (2007) Modelle zur Standortwahl von Unternehmen, in T. Bieger, C. Lässer und R. Maggi (Hrsg.) Jahrbuch 2006/2007 Schweizerische Verkehrswirtschaft, SVWG, St. Gallen.

Bodenmann, B.R. and K.W. Axhausen (2008) Schweizer Unternehmen - quo vaditis? Firmendemographische Trends am Beispiel des Wirtschaftsraums St. Gallen, *Raumforschung und Raumordnung RuR*, **66** (4) 15-28.

Bodenmann, B.R. (2011) Micro-simulation of firm's location choice, presentation at the *11th Swiss Transport Research Conference*, Ascona, May 2011.

Löchl, M., M. Bürgle and K. W. Axhausen (2007a) Implementierung des integrierten Flächennutzungsmodells UrbanSim für den Grossraum Zürich – ein Erfahrungsbericht, *disP*, **168**, 13–25.

Maoh, H.F. and P.S. Kanaroglou (2005) Agent-Based Firmographic Models: A Simulation Framework for the City of Hamilton, *PROCESSUS 2nd International Colloquium on the Behavioural Foundations of Integrated Land-use and Transportation Models: Frameworks, Models and Applications*, Toronto, June 2005.

Picard, N. and C. Antoniou (2011) Econometric guidance, Technical Report, 5.1, SustainCity project, University of Cergy-Pontoise, Cergy-Pontoise.

Schirmer, P., B. Belart and K. W. Axhausen (2011) Location choice in the greater Zurich area, paper presented at the *11th Swiss Transport Research Conference*, Ascona, May 2011.

Schirmer, P., C. Zöllig, B. Bodenmann, K. Müller and K.W. Axhausen (2011): Current works on UrbanSim at the IVT, *UrbanSim Workshop: Developing Common Data Structures for Urban Modeling and 3D-Visualisation,* Zurich, February 2011.

SustainCity (2011) The SustainCity project, www.sustaincity.org.

UrbanSim (2011) Open Platform for Urban Simulation, www.urbansim.org.

Waddell, P. A. (2010) Overview of UrbanSim and the Open Platform for Urban Simulation, presentation, *UrbanSim Tutorial*, Zurich, May 2010.