Preferred citation style for this presentation

Schirmer, P., C. Zöllig, K. Müller, B. Bodenmann and K.W. Axhausen (2012)

Landuse simulation on the Canton of Zurich using UrbanSim
– Results of the first run

presented at *ERSA 2012 Congress*, Bratislava, August 2012.

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Landuse simulation on the Canton of Zurich using UrbanSim-

Results of the first run

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SustainCity

EUROPEAN COMMISSION
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Introduction

UrbanSim

Opensource software developed by P. Waddell and colleagues (www.UrbanSim.org)

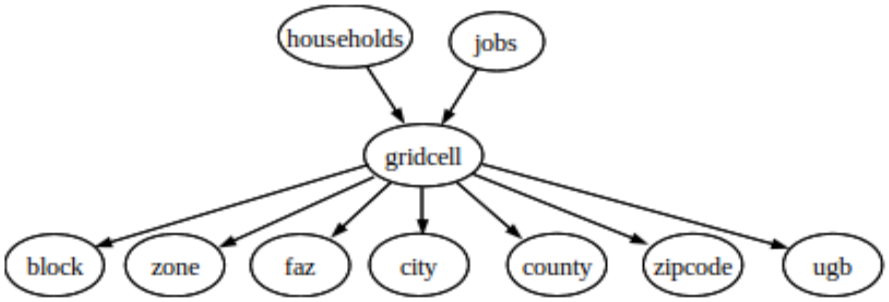
Simulation of land use development with interaction to traffic and accessibility

Microsimulation representing the choice of households, businesses and landowners

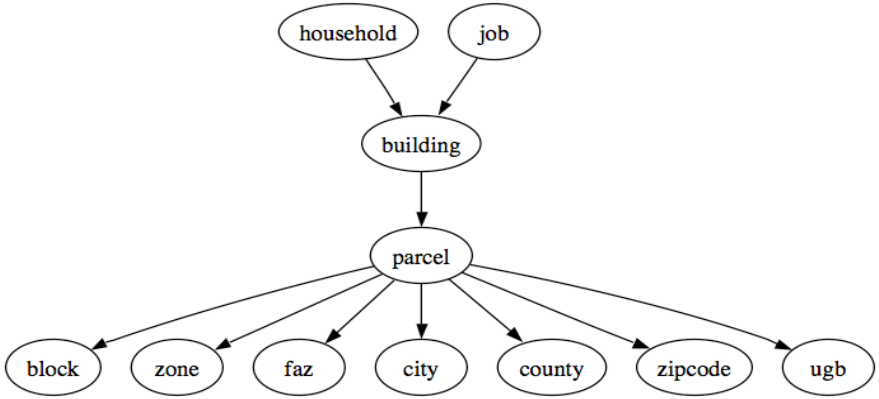
Previously gridcell-based approach, now geometries (zoning and parcel) as reference objects

Various case studies world wide (in Zurich: Zukunft Urbaner Kulturlandschaften, 2007)

(a) Basic model structure of grid cell versionv



(b) Basic model structure of parcel version



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

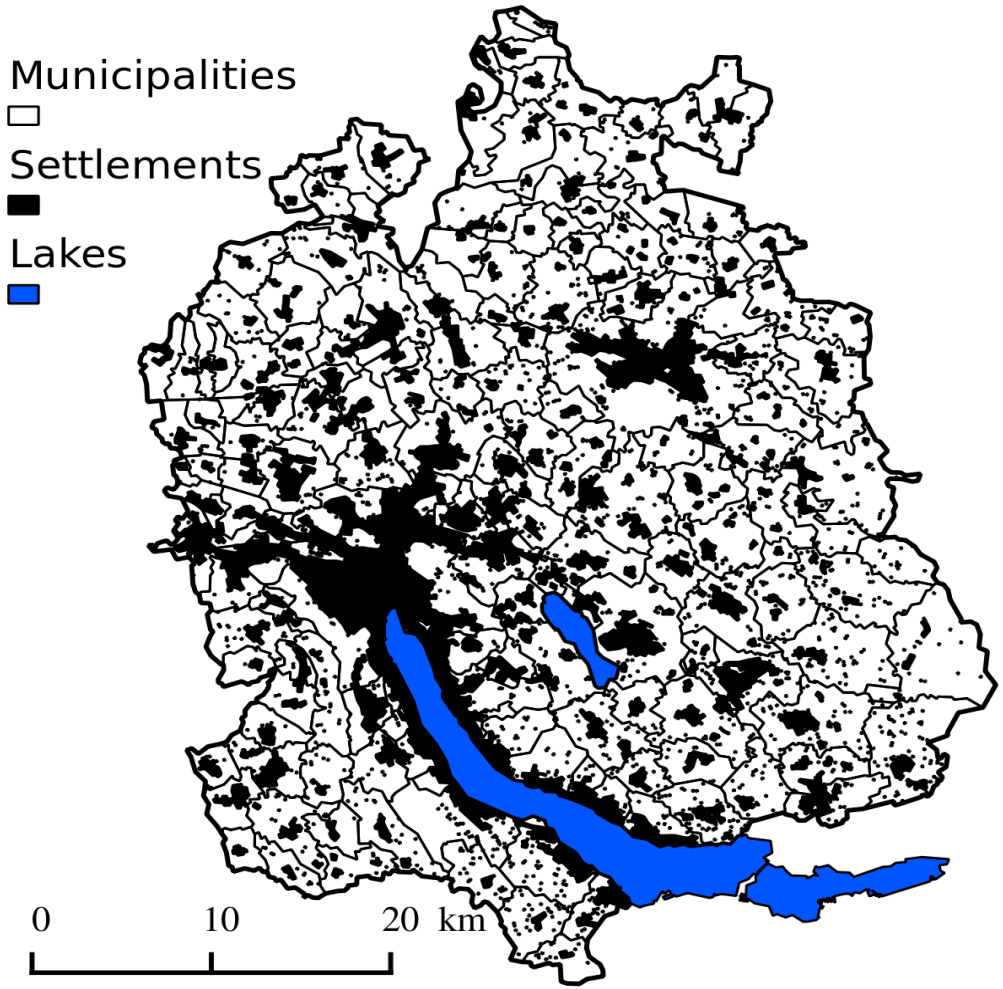
Simulation

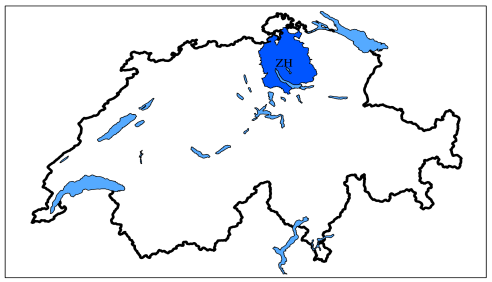
Simulation area and time period

Simulation start: 2000

Evaluation period: 2000-2010

(Simulation period: 2010-2030)





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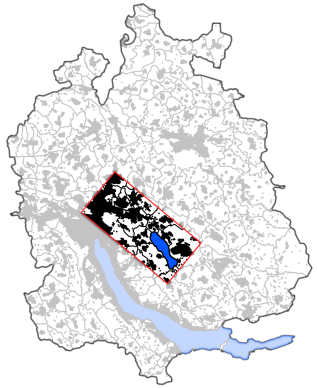
Motivation

Zurich Agglomeration, Glattal: Projekt “Krokodil”

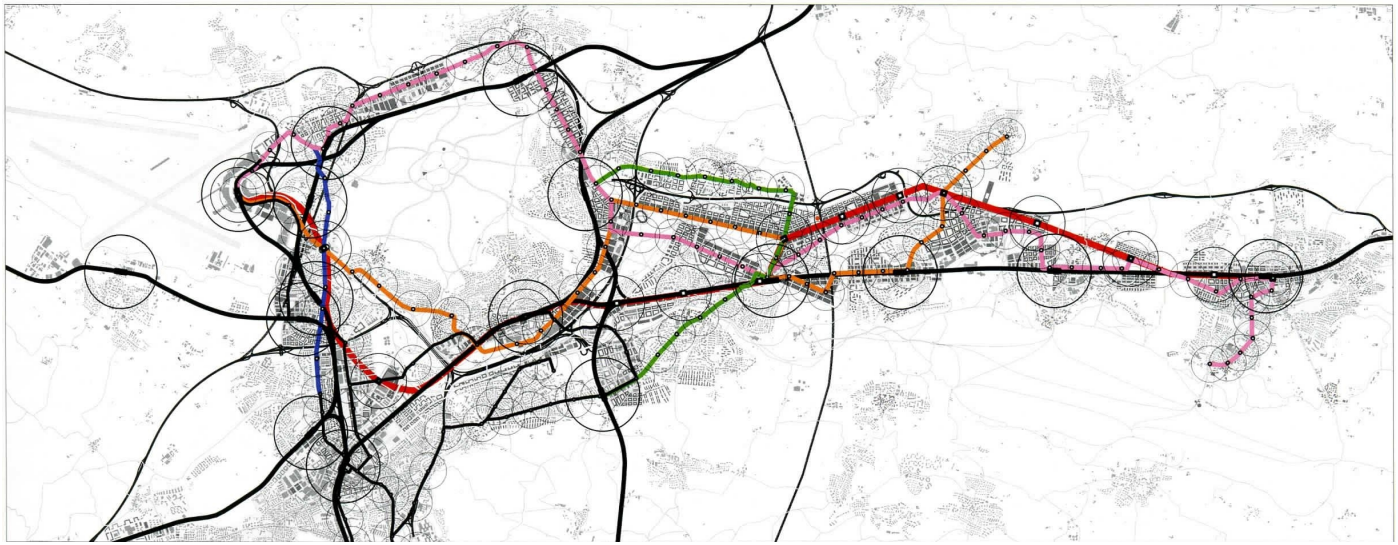


Source: architheses 03.2011

Motivation

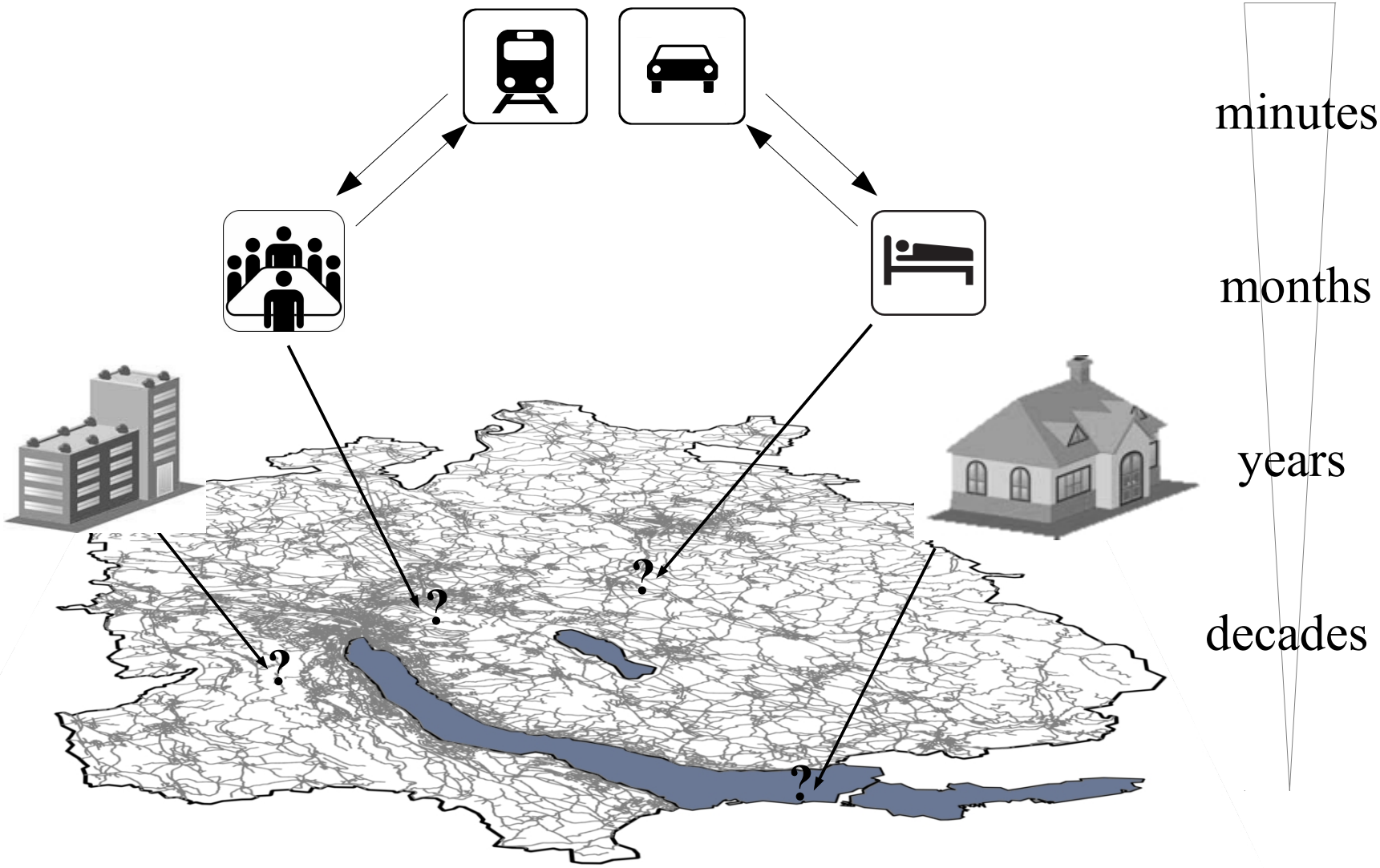
Landscape Design

Transport Design

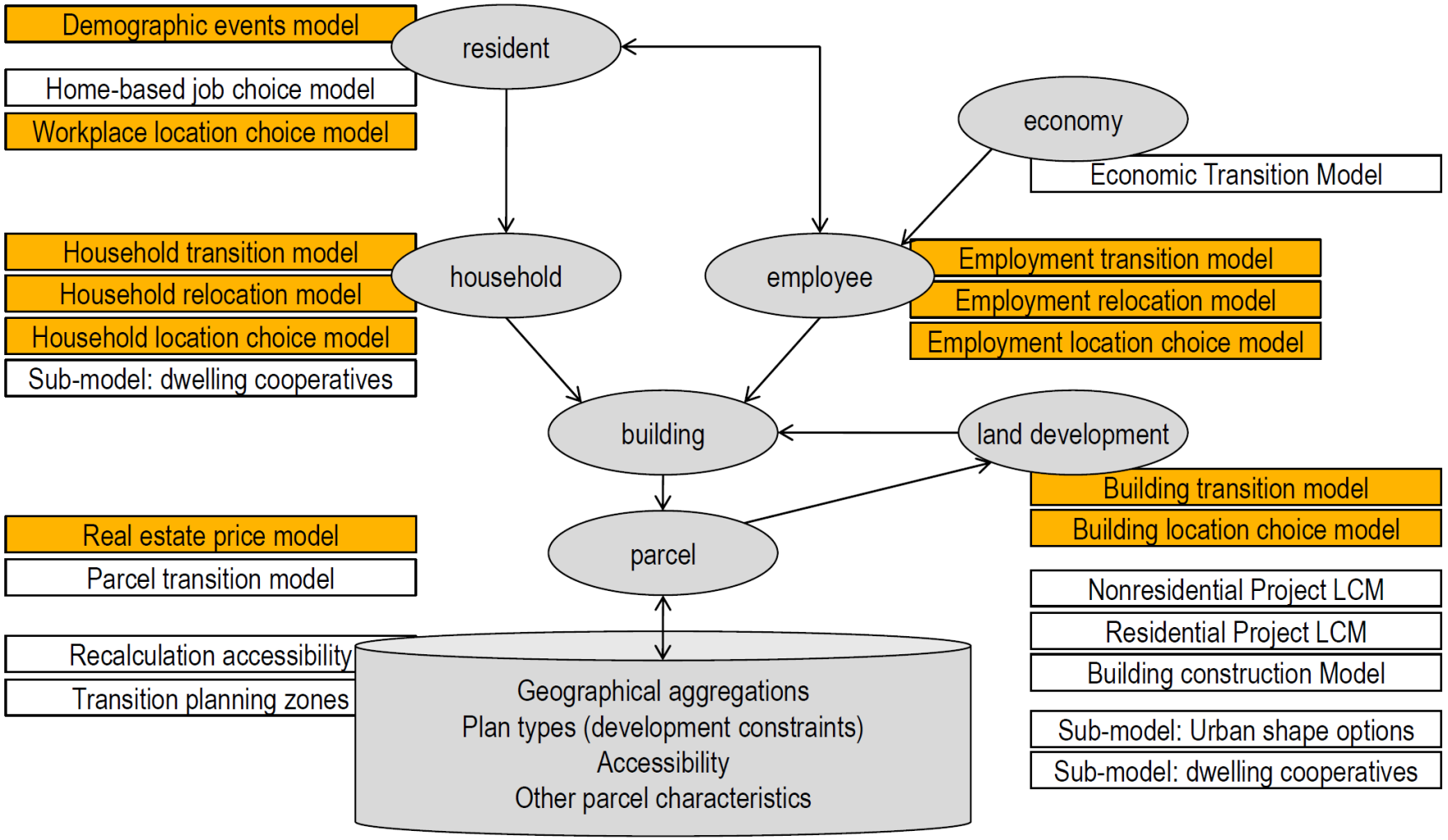


Source: archithese 03.2011

Simulation

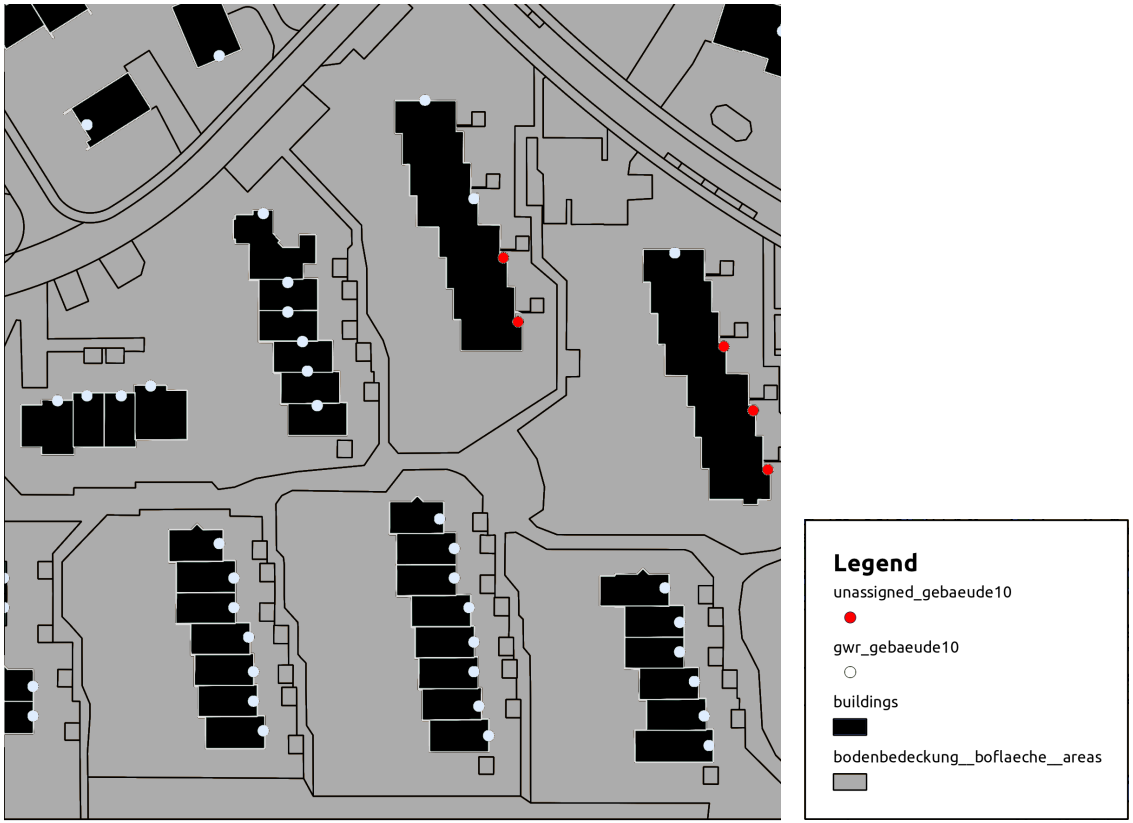


Simulation


Demographic events model
resident
Home-based job choice model
Workplace location choice model
economy
Economic Transition Model
Household transition model
Household relocation model
Household location choice model
Sub-model: dwelling cooperatives
household
employee
Employment transition model
Employment relocation model
Employment location choice model
building
land development
Building transition model
Building location choice model
Real estate price model
Parcel transition model
parcel
Nonresidential Project LCM
Residential Project LCM
Building construction Model
Recalculation accessibility
Transition planning zones
Geographical aggregations
Plan types (development constraints)
Accessibility
Other parcel characteristics
Sub-model: Urban shape options
Sub-model: dwelling cooperatives

Data preparation – data quality

Example: No geometry data available



Example: Missing building seperation

Data preparation – processing framework

Data processing

Spatial Joins

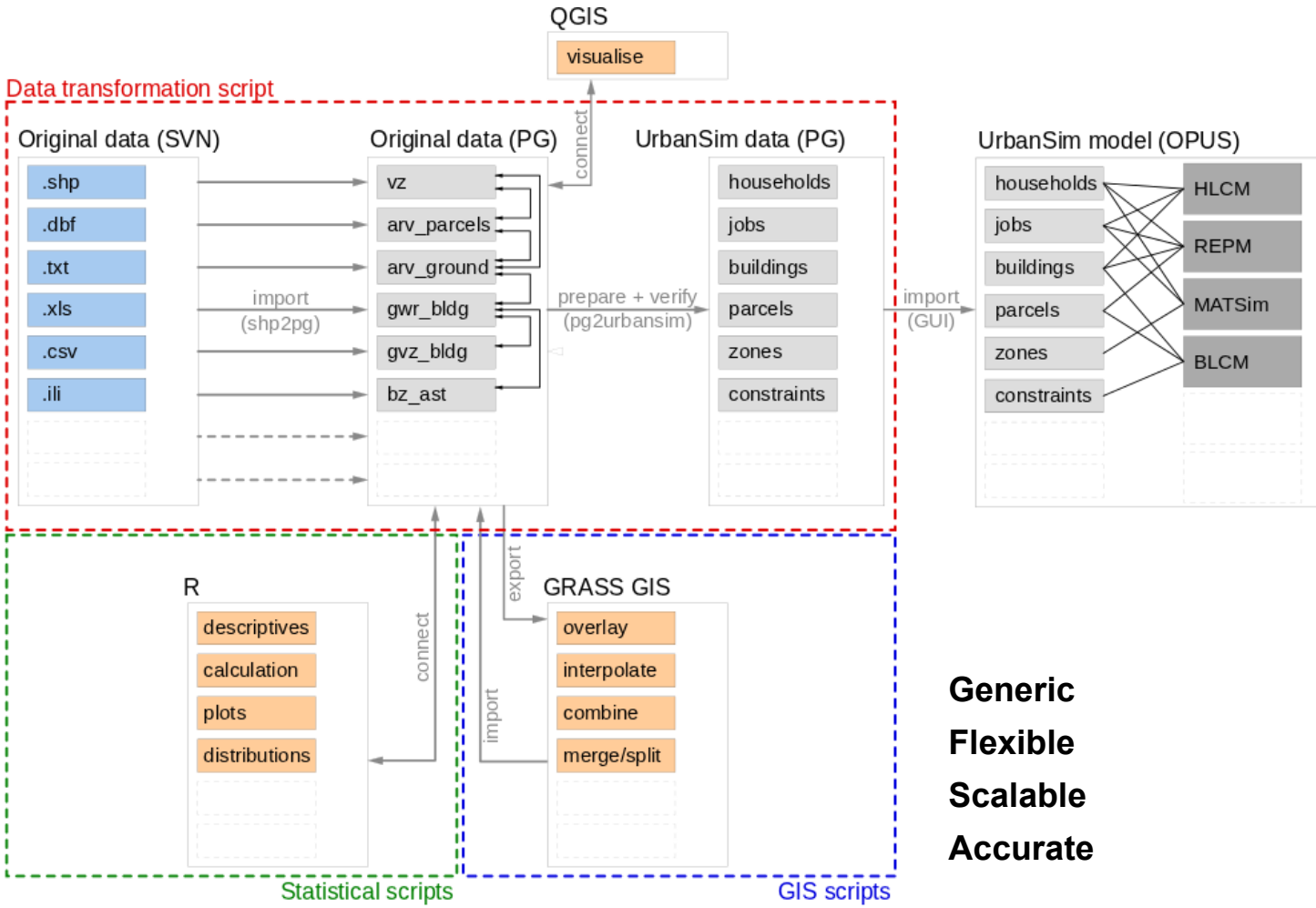
Attribute Joins

Imputations

Populations Synthesis

Approximations

Classification



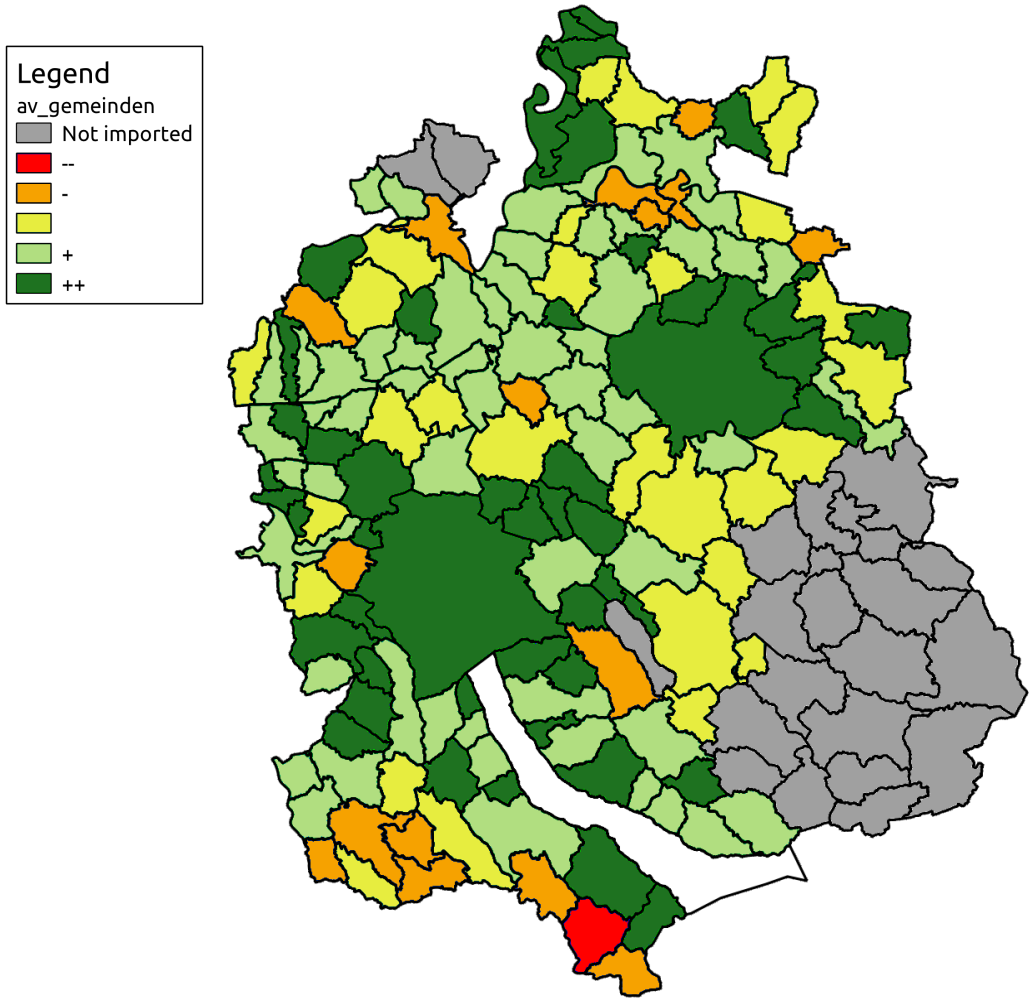
Generic

Flexible

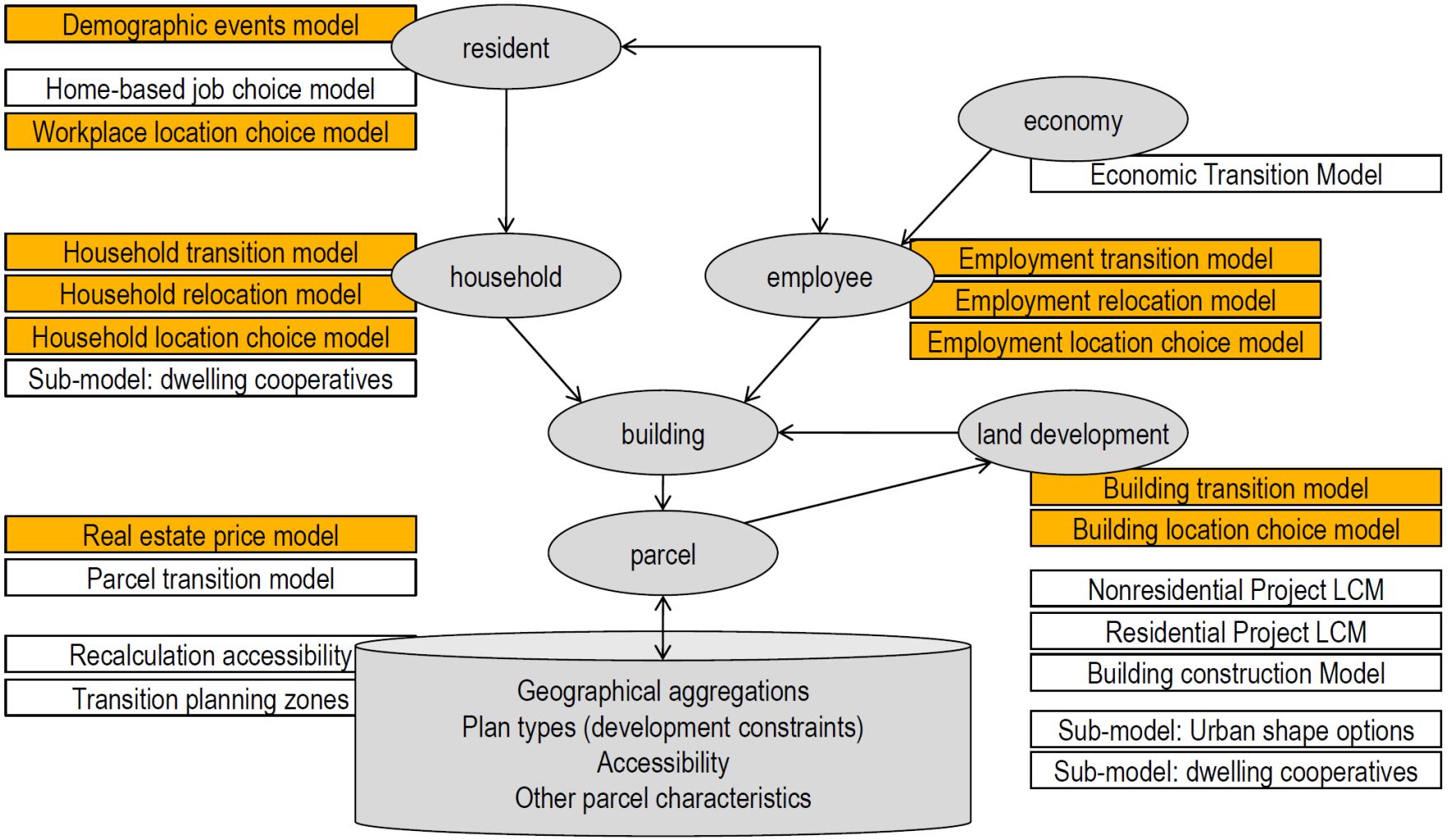
Scalable

Accurate

Data preparation- Import quality (assert error rate)



Simulation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Plan types (development constraints)
Accessibility
Other parcel characteristics
Sub-model: Urban shape options
Sub-model: dwelling cooperatives

Models – Household Transition (HTM) and Relocation (HRM)

Household control totals:

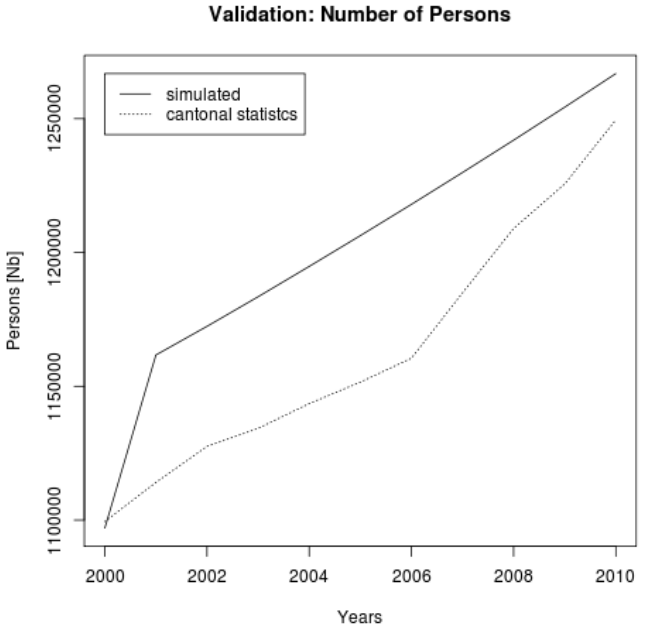
Scenario: assumption 1%growth

(observed data)

Annual relocation rates of households:

Survey and census data: S.Beige (2005)

Grouped into 12 categories based on age of head and income



Models – Household Location Choice Model HLCM

Structure

Dependancies: HRM, HTM (scenario 1% growth)

Model: Discrete Choice (Multi Nomial Logit)

Locations: building, capacitiy vacant_residential_units

Agents: household

Estimation: *external estimation*

Configuration: Variables on residential unit and POIs not included

Running the simulation (2001)

Number of agents: 90458 movers (total: 524264 households)

Number of calculations loops: 2 chunks + 2 loops for unplaced

Total time for run: 37min (previously 18h)

Models – Household Location Choice Model HLCM

Coeff_names	estimate	std err	t-values
Age_of_House	0.01	0.00	10.38
Job Density in 1km²	-0.69	0.04	-16.63
Pop_density	0.03	0.00	14.31
Distance_to_station	-0.23	0.07	-3.45
historical building	1.32	0.14	9.75
Accessibility of PT* no_car_ownership	0.15	0.05	3.21
Rent Vacancy in municipality	-0.11	0.05	-2.24
Traveltime to Zürich CBD by car	0.00	0.00	5.21
Distance to last residence	3.76	0.19	19.82
Distance to workplace	1.57	0.29	5.41
ETA_last residence	-0.15	0.01	-14.60
ETA_distance to workplace	-0.09	0.02	-5.65

Not integrated in UrbanSim

Log-likelihood is	*-1749.81*
Null Log-likelihood is	*-2679.74*
Likelihood ratio index	*0.35*
Adj. likelihood ratio index	*0.34*
Number of observations	*685.00*
Number of alternatives	*50.00*

Models – Household Location Choice Model HLCM

Current Works:

Spatial Variables and their impact (IATBR 2012, Schirmer et al.)

=>*Relevance of Points of Interests and Residential Units*

Location

LB Build Space

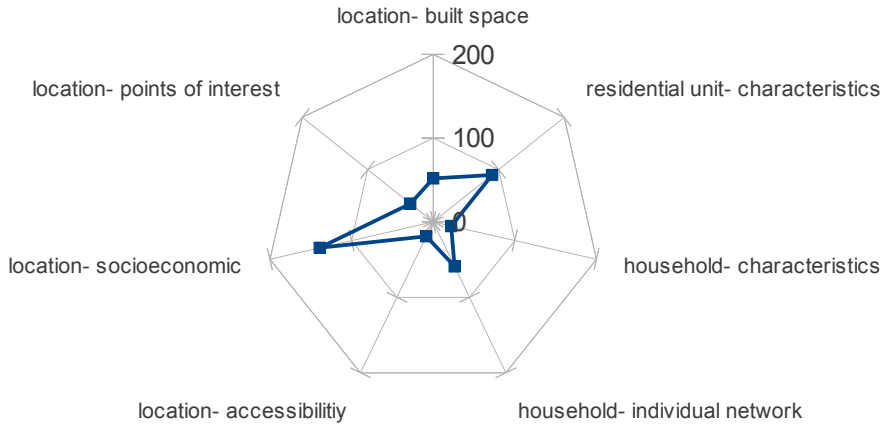
LP POIs

LS Social/Economic

LA Accessibility

HH Household

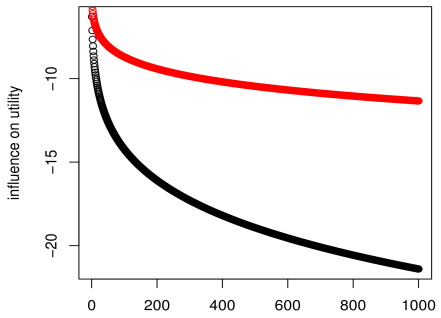
RU Residential Unit



Models – Household Location Choice Model HLCM

Initial Models

	MOD_BASIC					
measurements	dat2		dat3		dat4	
HH_DIST_PREVLOC	-	-5.060 **	-	-6.300 **	-	-7.180 **
HH_DIST_WORK	-	-3.440 **	-	-4.630	-	-5.420
HH_ETA_PREVLOC	+	0.202 **	+	0.177 **	+	0.159 **
HH_ETA_WORK	+	0.139 **	+	0.128 *	+	0.108 *
LA_MIVACC_CAR	-	-0.453 **	-	-0.536 **	-	-0.457 **
LA_PTACC_NOCAR	+	0.187 *	+	0.231 **	+	0.196 *
RU_LOG_BUILDING_AGE	+	0.287 **	+	0.319 **	+	0.315 **
RU_RENT_INCOME_RATIO	-	-3.330 **	-	-3.730 **	-	-3.950 **
RU_ROOMS_PERSON_x_NONSINGLE	-	-0.608 **	-	-0.572 **	-	-0.501 **
RU_ROOMS_PERSON_x_SINGLE	-	-0.549 **	-	-0.591 **	-	-0.549 **
RU_SQM_ROOM	+	0.000 **	+	0.000 **	+	0.000 **
log_init		-2679.736		-2679.736		-2679.736
log_final		-1367.874		-1307.153		-1317.754
R^2		0.490		0.512		0.508
adj R^2		0.485		0.508		0.504
final gradient norm		0.066		1.944		2.290
iterations		44		47		62



Value of distance to work (black) and distance to previous location (red)

Models – Household Location Choice Model HLCM

Final Model

	MOD_ALL					
measurements		dat2		dat3		dat4
HH_DIST_PREVLOC	-	-5.150 **	-	-7.070 **	-	-8.740 **
HH_DIST_WORK	+	6.380 **	-	-3.220 *	-	-3.880 *
HH_ETA_PREVLOC	+	0.205 **	+	0.163 **	+	0.135 **
HH_ETA_WORK	-	-0.060 **	+	0.203 **	+	0.166 **
LA_MIVACC_CAR	-	-0.165	-	-0.302 **	-	-0.187
LA_PTACC_NOCAR	+	0.590 **	+	0.541 **	+	0.547 **
LB_NETWORK_BUF	-	-0.090	-	-0.304 *	-	-0.247
LP_CBD_ZH_DIST	+	0.000 **	+	0.000 **	+	0.000 **
LP_HIGHWAY_ACCESS_DIST_x_CAR	-	0.000 **	-	0.000 *	-	0.000 *
LP_RAILSTATION_DIST_x_NOCAR	-	0.000 *	-	0.000	-	0.000
LP_RETAIL_DENS	-	-0.003 **	-	-0.003 **	-	-0.002 **
LP_SCHOOL_DIST	+	0.000	+	0.000 **	+	0.000 **
LP_SERVICE_DENS	-	0.000	-	-0.001 **	-	-0.001 *
LS_SAME_HH_AGE_SHARE	+	0.792 **	+	0.684 **	+	0.634 *
RU_LOG_BUILDING_AGE	+	0.324 **	+	0.360 **	+	0.350 **
RU_NEW_BUILDING	+	0.614 **	+	0.578 **	+	0.634 **
RU_RENT_INCOME_RATIO	-	-3.070 **	-	-3.400 **	-	-3.580 **
RU_ROOMS_PERSON	-	-0.638 **	-	-0.677 **	-	-0.637 **
RU_SQM_ROOM	+	0.000 **	+	0.000 **	+	0.000 **
log_init		-2679.736		-2679.736		-2679.736
log_final		-1343.573		-1261.079		-1276.291
R^2		0.499		0.529		0.524
adj R^2		0.492		0.522		0.517
final gradient norm		3.221		5.193		0.811
iterations		45		49		75

Models – Real Estate Price Model REPM

Structure

Model: OLS regression (estimation of rent prices)

Dataset: Building

Estimation: *PhD-Thesis of M.Löchl (2010)*

Configuration: V*ariables on residential unit not included*

Running the simulation (2001)

Total time for run: 6min

Current work

R. Fuhrer (2012), GWR with environmental services

R. Haase (2011), OLS regression model for commercial rent price

Models – Building Location Choice Model (BLCM)

Structure

Locations: parcels with capacity of undeveloped land

Agents: buildings

Estimation: *inside UrbanSim; based on baseyear data*

Configuration: submodels for residential and nonresidential

Running the simulation (2001)

Number of agents: 730 resi/ 24.963 nonresi

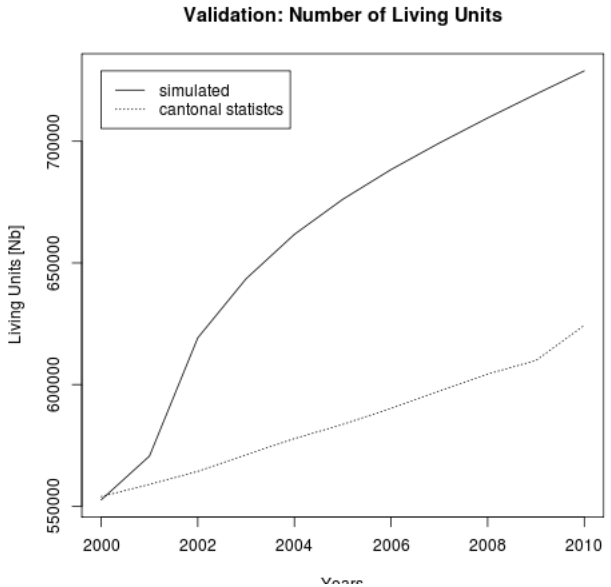
Number of calculations loops: 1

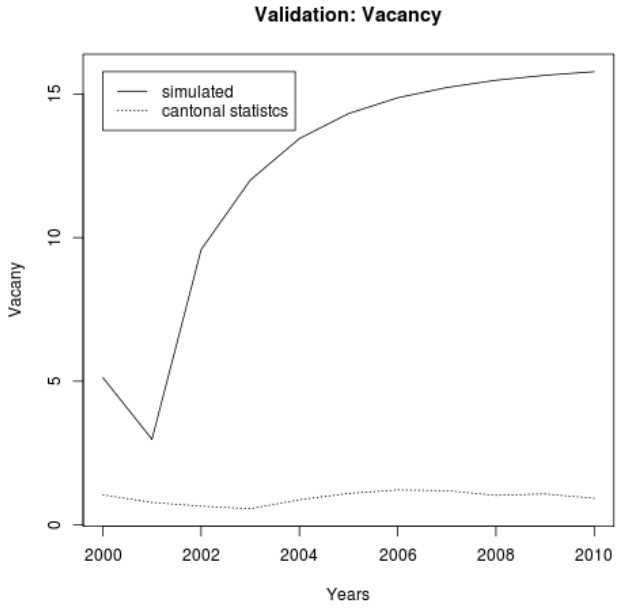
Total time for run: 4 sec

Current works

Building Location vs. Developer Project

Zoellig, 2012





Models – Employment Location Choice Model (ELCM)

Structure (Model created by EPFL)

Dependancies: ERM, ETM (5%growth scenario)

Locations: building with non_residential_sqft

Agents: job; assumptions on jobspace per job-type

Estimation: *estimation inside UrbanSim based on baseyear data*

Submodels: *categories for jobs as used in relocation rates*

Configuration: mainly clustering of jobs;

Running the simulation (2001):

First year rate: - 58137 !

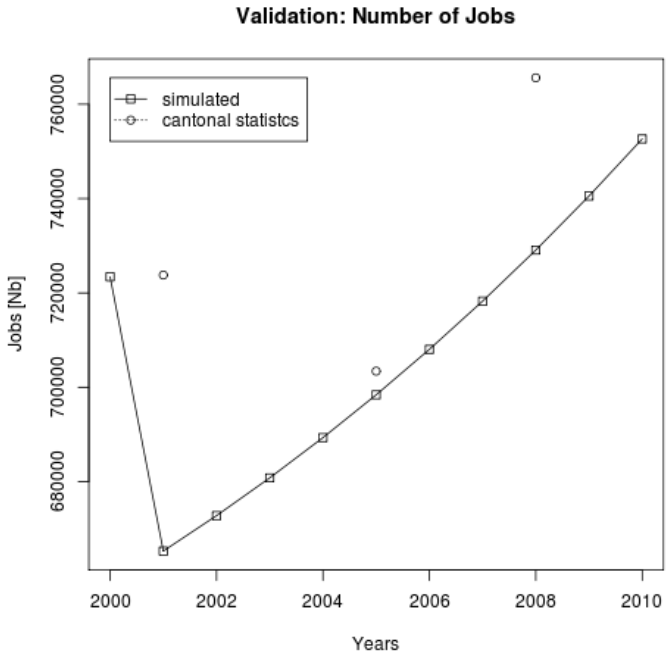
37362 movers

Current works

Bodenmann, 2011

Haase, 2011

(Update models EPFL)



Models – Workplace Location Choice Model WLCM

Structure

Dependancies: *ELCM, HLCM (implicit)*

Locations: job

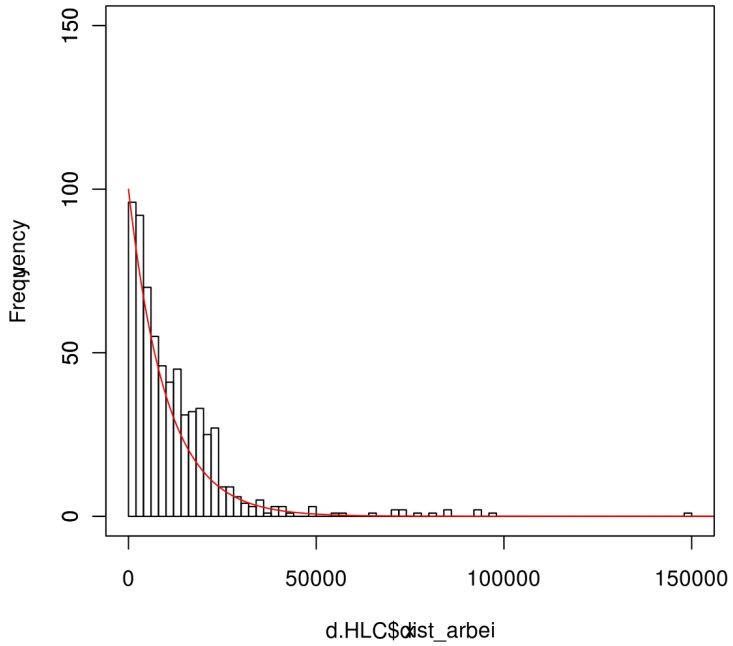
Agents: person

Estimation: *definition based on observed distribution*

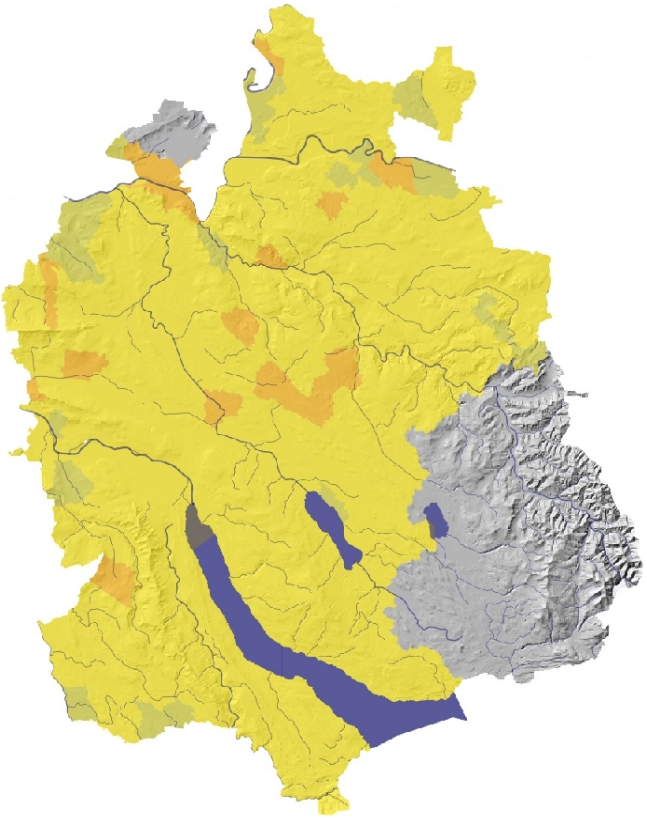
Configuration: *based on distance to residence*

Current works

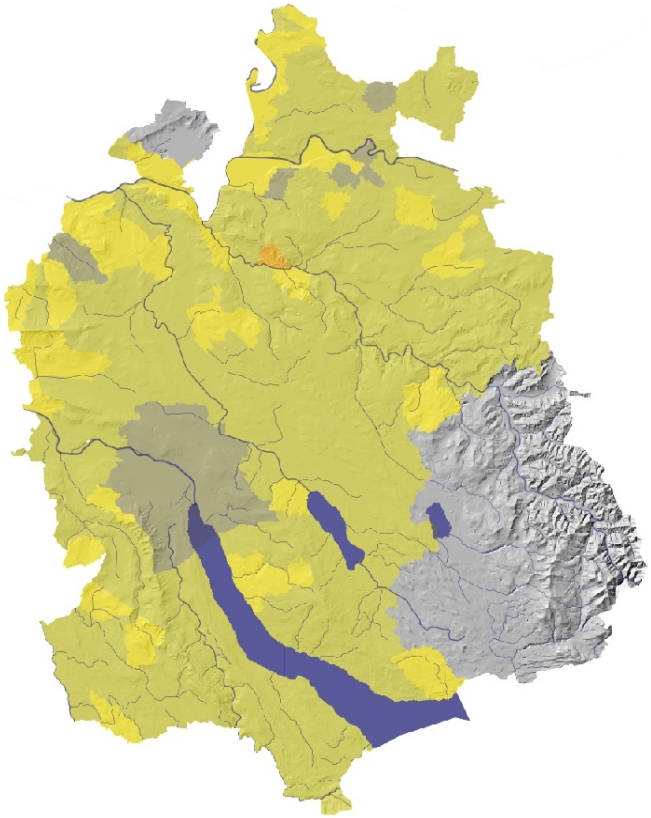
Khivasara, 2012 (in work)



Simulation - Persons



Observed Development 2001 - 2008:
Persons per km² (Municipality)



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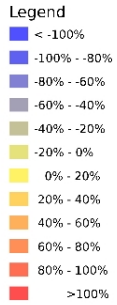
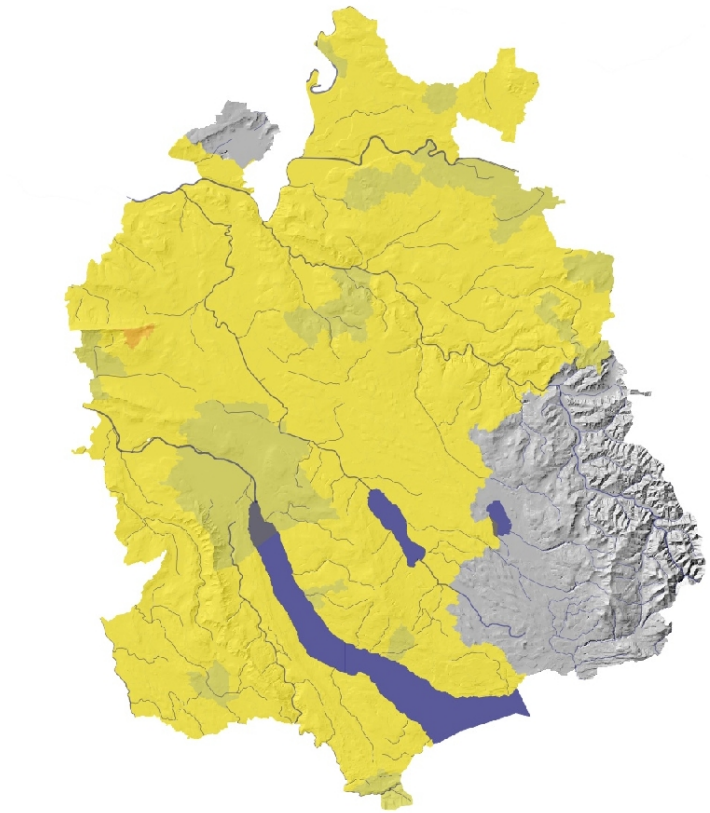
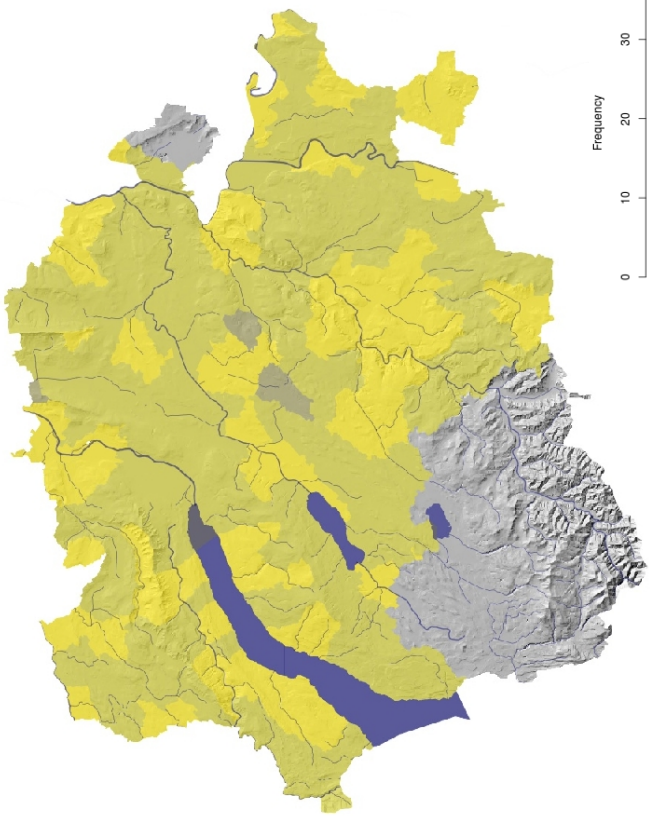
Persons per km² (Municipality)



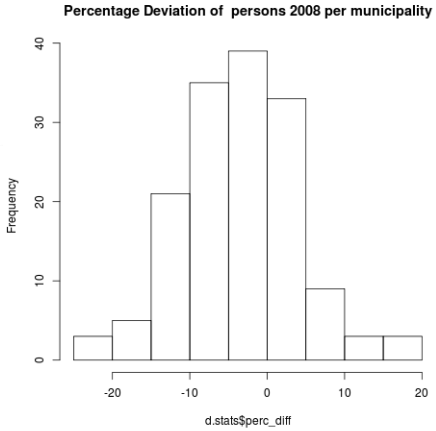
Simulation - Persons

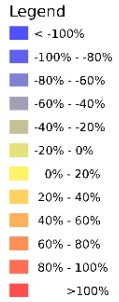


Difference of Simulation to Validation 2001:
Persons per km² (Municipality)

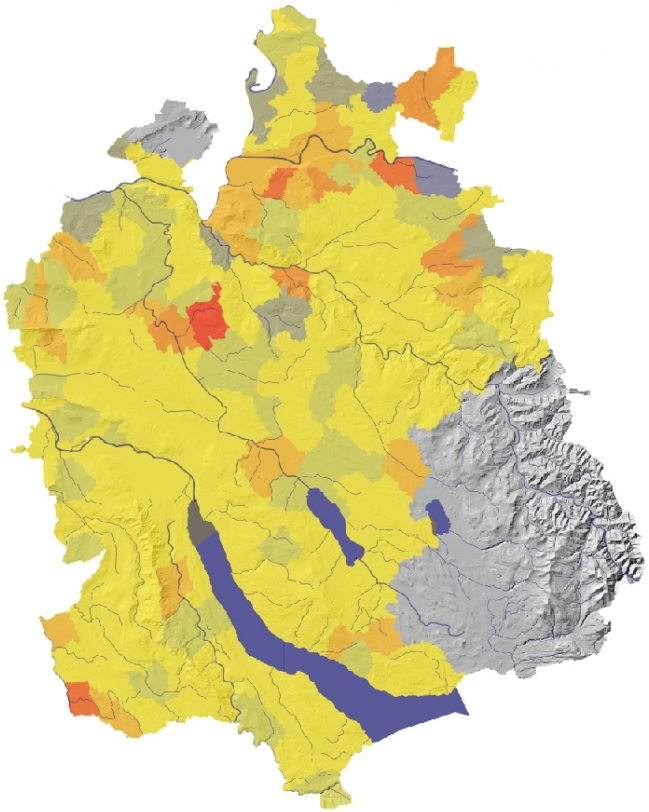


Difference of Simulation to Validation 2008:
Persons per km² (Municipality)

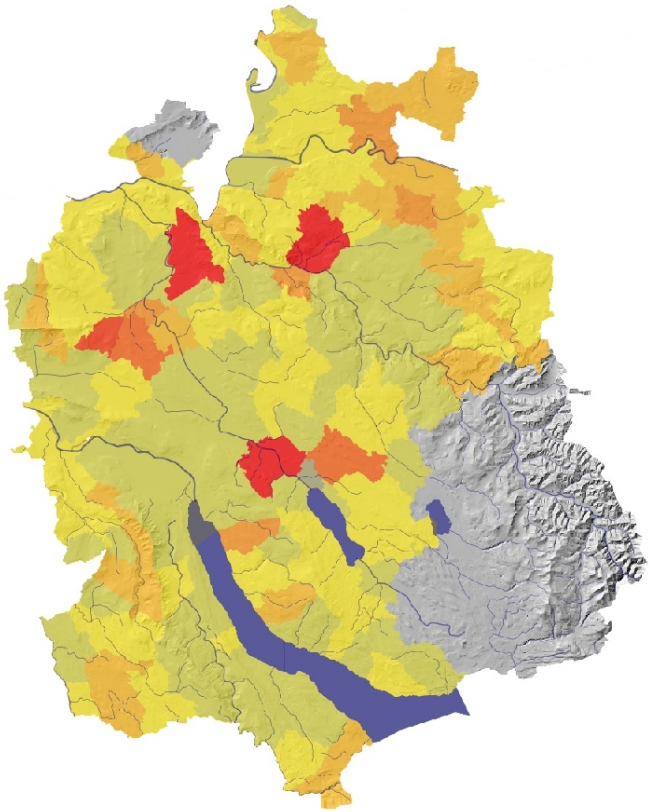




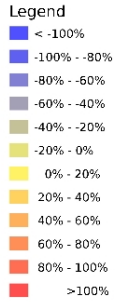
Simulation - Jobs



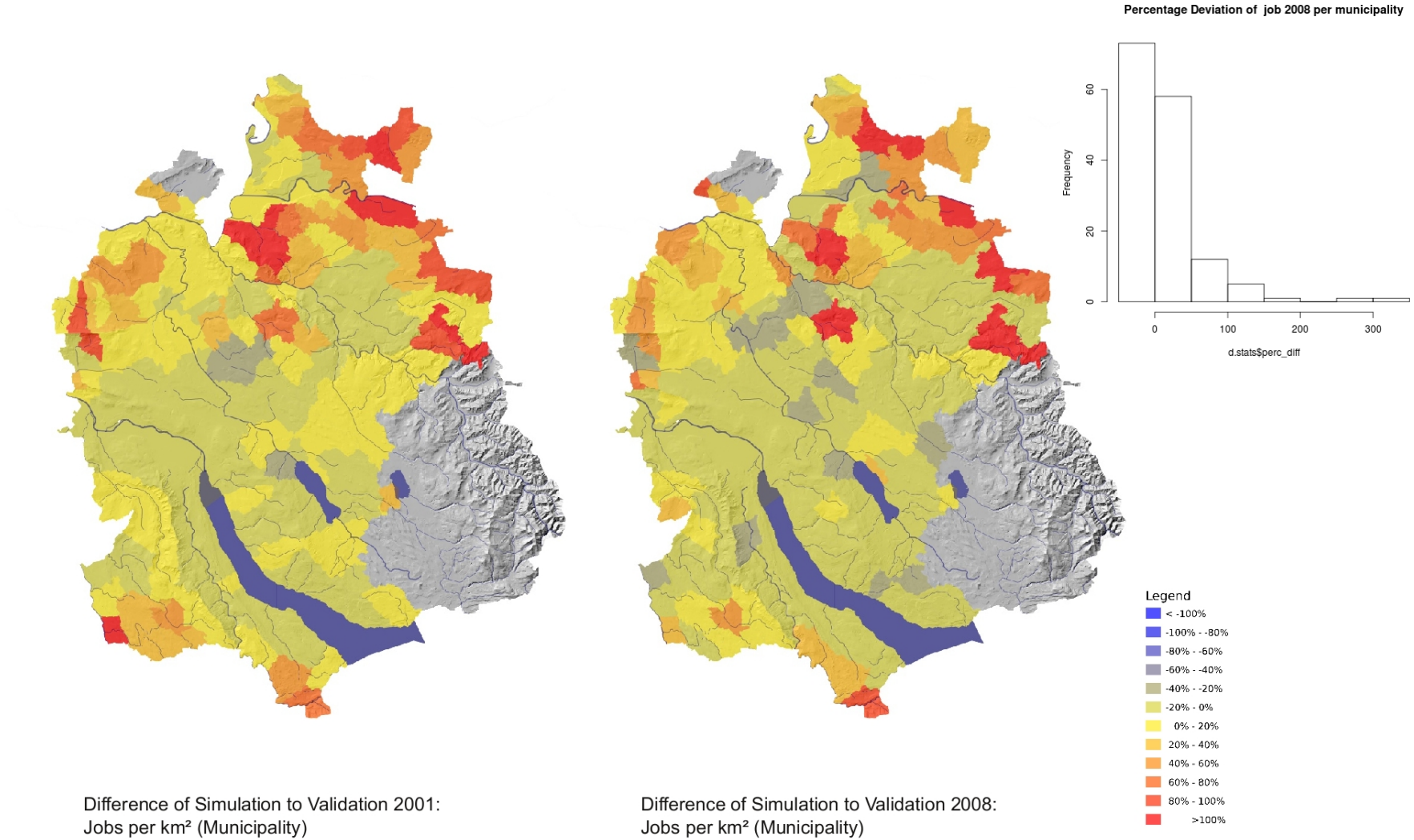
Observed Development 2001 - 2008:
Jobs per km² (Municipality)



Simulated Development 2001 - 2008:
Jobs per km² (Municipality)



Simulation - Jobs



Difference of Simulation to Validation 2001:
Jobs per km² (Municipality)

Difference of Simulation to Validation 2008:
Jobs per km² (Municipality)

Conclusion

Effort for Setup

Data

Modeling

Manpower

FirstRun Results

Runtime

Work with OPUS

Interaction

Ongoing Work

Initial Setup & Planning support

Populations Synthesis: Mueller, 2012

Integration of planning support: Change of networks, zoning constrains, etc.

Extension of datamodel: Residential unit, Points of Interest

Demographics

External model: using modgen

Events: Aging, Birth, Death, Divorce, Union formation/dissolution, Education, Labour market participation

MatSim

www.MATSim.org

Visualisation

Visualize output using shape grammars (ESRI's CityEngine):

Schirmer and Kawagishi (2011); Caduff (2012)

Thank you

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Models – Real Estate Price Model (REPM)

Coeff_names	estimate
Constant	3.638
Ln (sqm per unit)	0.776
Is House	0.125
Built before 1921	0.109
Built between 1921 and 1930	0.094
Built between 1981 and 1990	0.018
Built between 1991 and 2005	0.067
Accessibility by car	0.119
Accessiblity by public transport	0.011
Ln (distance to station)	-0.012
Boolean (highway within in 100m)	-0.067
Ln(jobs in Hotels and Restaurant)	0.032
Ln (population density per ha)	-0.026
Foreigner density per ha (logit)	-0.023
Ln (taxlevel)	-0.223
slope (logit)	0.026

Models – Real Estate Price Model (REPM)

Coeff_names	estimate
Lift	3.638
Fireplace	0.776
Balcony	0.125
GTErrace	0.109
Airnoise	0.094
Ln(View Lake)	0.018
Ln(View All)	0.067
Ln(Solar_eve)	0.119
1Q_04	0.011
2Q_04	-0.012
3Q_04	-0.067
4Q_05	0.032
1Q_05	-0.026
2Q_05	-0.023
3Q_05	-0.223

Not integrated in UrbanSim

(including additional variables of original model!)

Models – building location choice model (BLCM)

Coeff_names	estimate	std err	t-values	
Slope	-0.02	0.01	-2.90	
Logit_foreigners_within_ha_of_parcel	-0.40	0.03	-13.08	?cost
ln_population_density_in_ha	0.45	0.02	20.49	
jobs_within_ha_of_parcel	-0.01	6.00E-04	-11.24	?quality
building_fit_parcel	-7.30E-05	1.50E-06	-48.32	

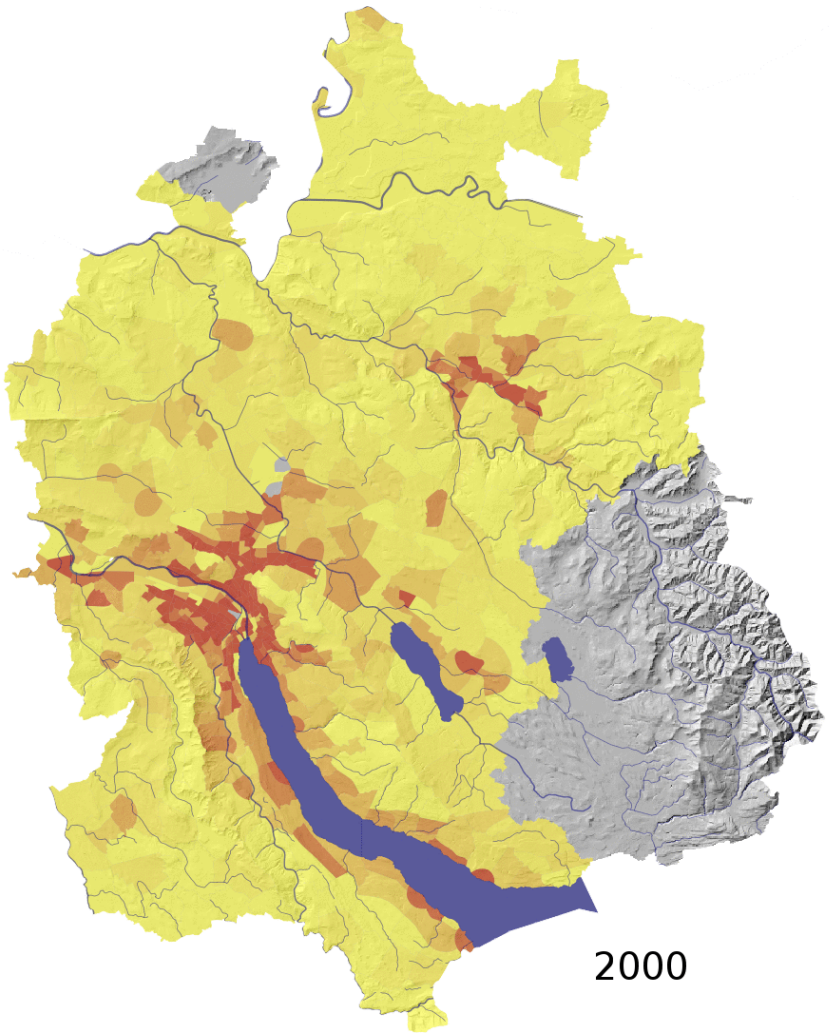
Models – Employment Location Choice Model (ELCM)

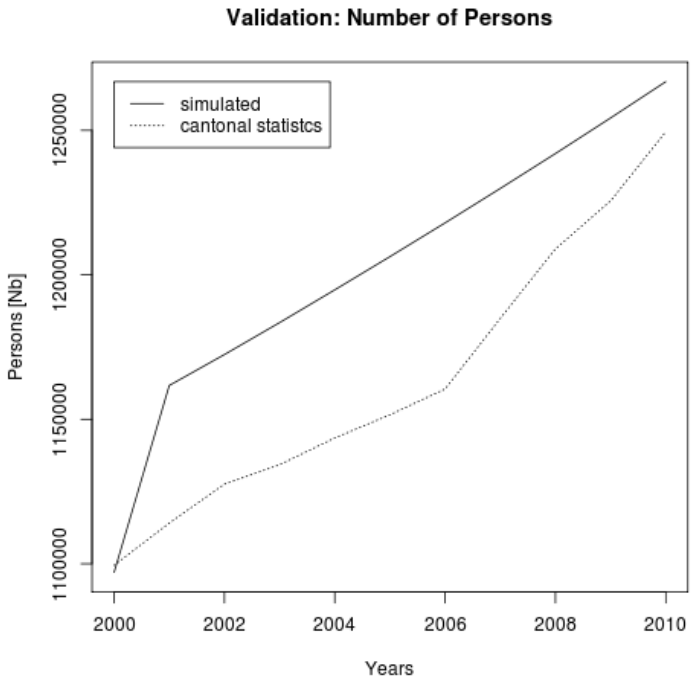
Assumptions on occupied space:

- Manufacturing, Trade, Retail, Hotel & Restaurant: 50
- Construction, Transport: 100
- Services: 15
- Health: 25
- *Other: 100*

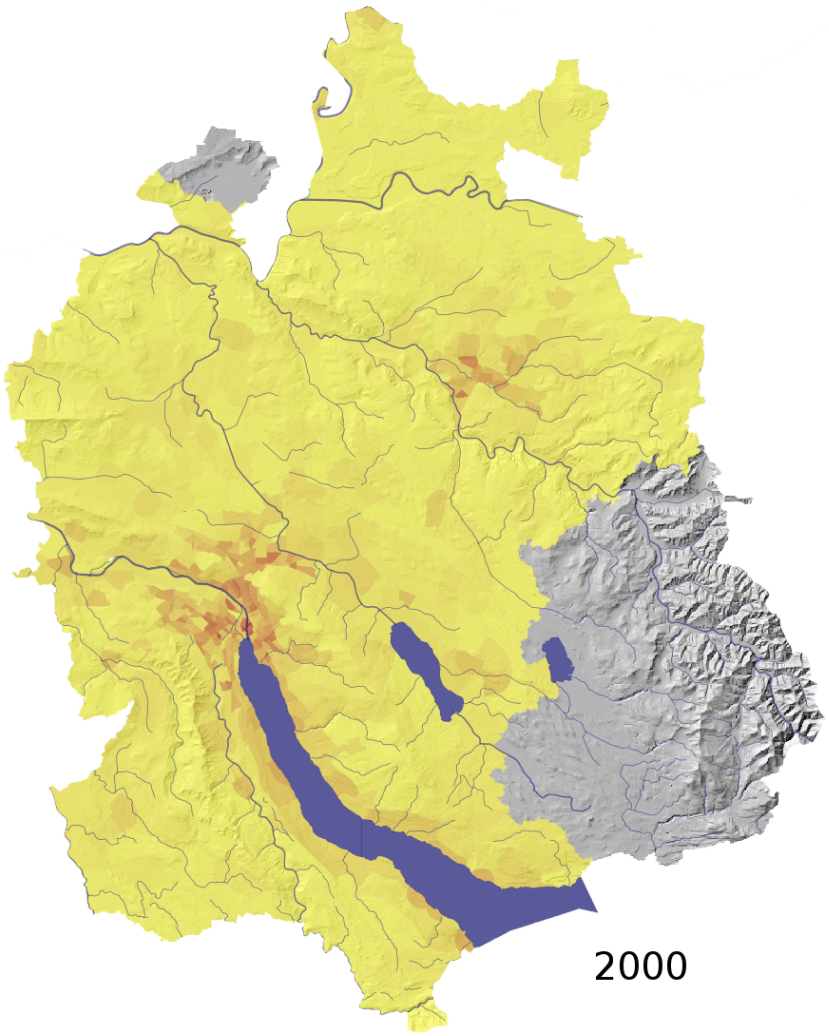
	manufacturing		construction		trade		retail		hotel&gastro		transport		services		health	
Coeff_names	est	t_stat	est	t_stat	est	t_stat	est	t_stat	est	t_stat	est	t_stat	est	t_stat	est	t_stat
ln_(non_residential_sqm in building)	-	-45.13	-	-33.66	-	-38.12	-	-33.21	-	-21.38	-	-38.01	-	-52.29	-	-16.39
avrg_income_in_zone	+	8.12	-	-0.593	+	4.18	+	0.52	-	-0.53	-	-12.33	-	-13.92	-	-8.97
number_of_jobs_in_same_sector	+	44.92	+	25.06	+	38.04	+	20.4	+	28.3	+	39.17	+	67.51	+	47.56
number_of_jobs_sector1	***	***	+	5.45	-	-0.62	-	-2.3	-	5.34	-	-8.42	-	-0.99	+	1.64
number_of_jobs_sector2	+	1.52	***	***	-	-2.7	+	0.72	-	-1.09	-	-9.13	-	-1.79	-	-0.54
number_of_jobs_sector3	+	6.47	+	5.25	***	***	+	3.8	+	1.02	+	14.35	+	3.18	-	-3.38
number_of_jobs_sector4	-	-2.91	-	0.43	-	-1.17	***	***	-	-1.19	+	12.21	+	8.19	+	5.12
number_of_jobs_sector5	-	-4.10	+	4.23	+	1.57	+	8.77	***	***	-	-3.74	+	2.52	-	-1.8
number_of_jobs_sector6	-	-4.35	-	-8.5	+	1.91	-	-3.33	-	-5.53	***	***	+	3.71	-	-1.53
number_of_jobs_sector7	+	-4.38	-	-3.03	+	0.28	+	2.85	+	4.42	-	-1.76	***	***	-	-0.76
number_of_jobs_sector8	-	-2.72	-	-5.48	-	-4.67	-	-5.07	-	-1.07	-	-4.48	-	-9.42	***	***
distance_to_highwayaccess	-	-3.74	-	-5.59	-	-2.95	-	-1.83	-	-2.56	-	-2.12	-	-7.7	+	7.63
distance_to_station	-	-0.99	-	-4.84	-	-7.9	-	-11.5	-	-4.41	-	-14.82	-	-20.94	-	-9.96

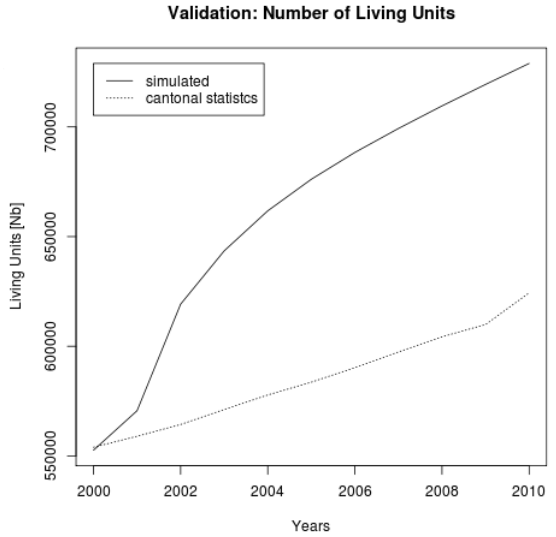
Simulation - Persons

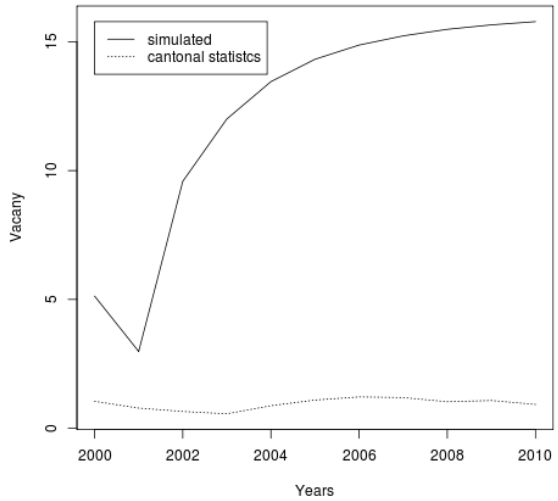




Simulation - Buildings







Simulation – Jobs