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Integrated Transport LandUse Simulation on the Canton of Zurich

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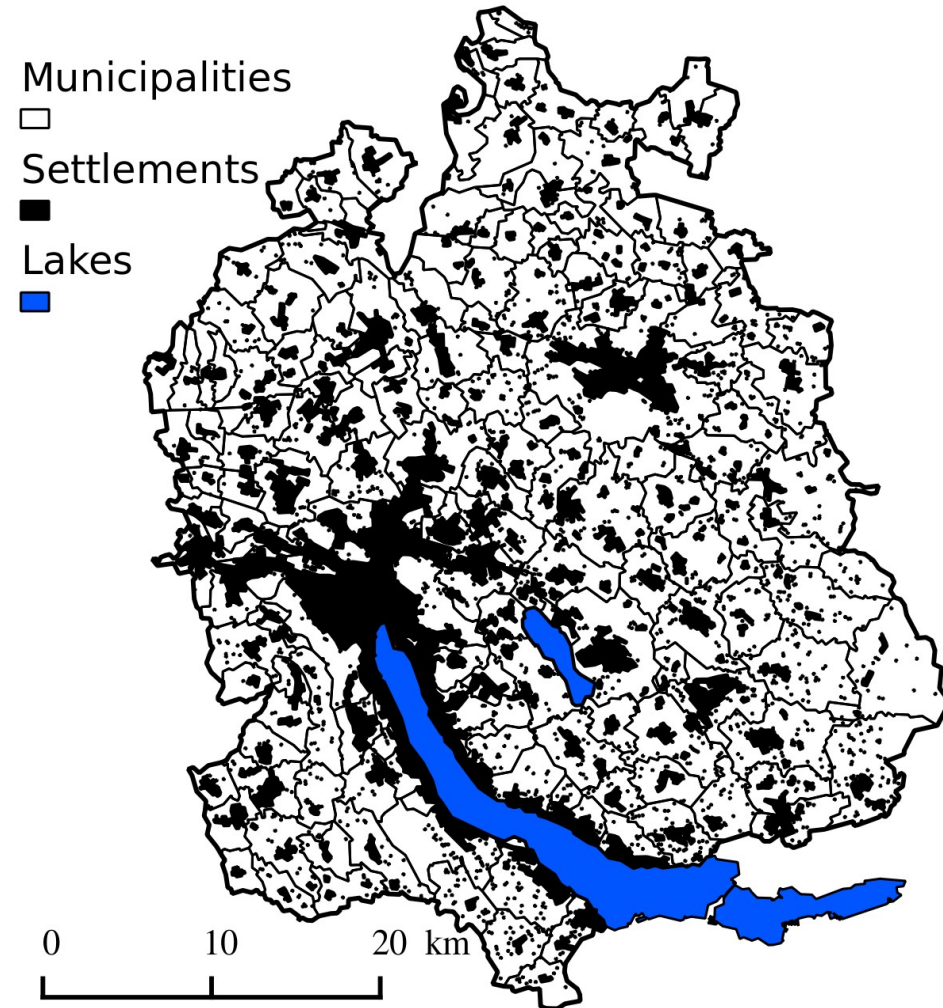
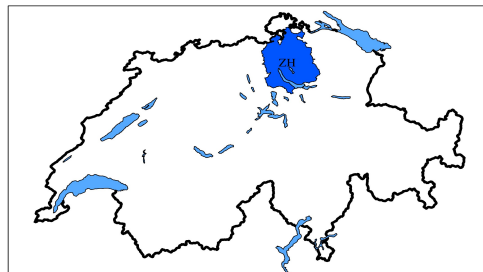
Introduction – Simulation area and time period

Parcel level

Simulation start: 2000

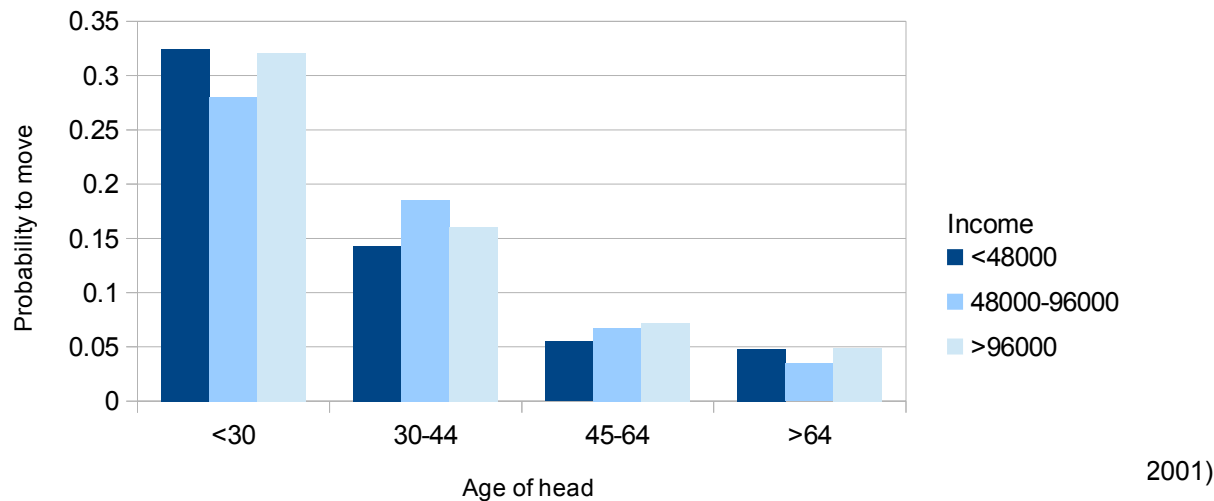
Evaluation period: 2000-2010

(Simulation period: 2010-2030)

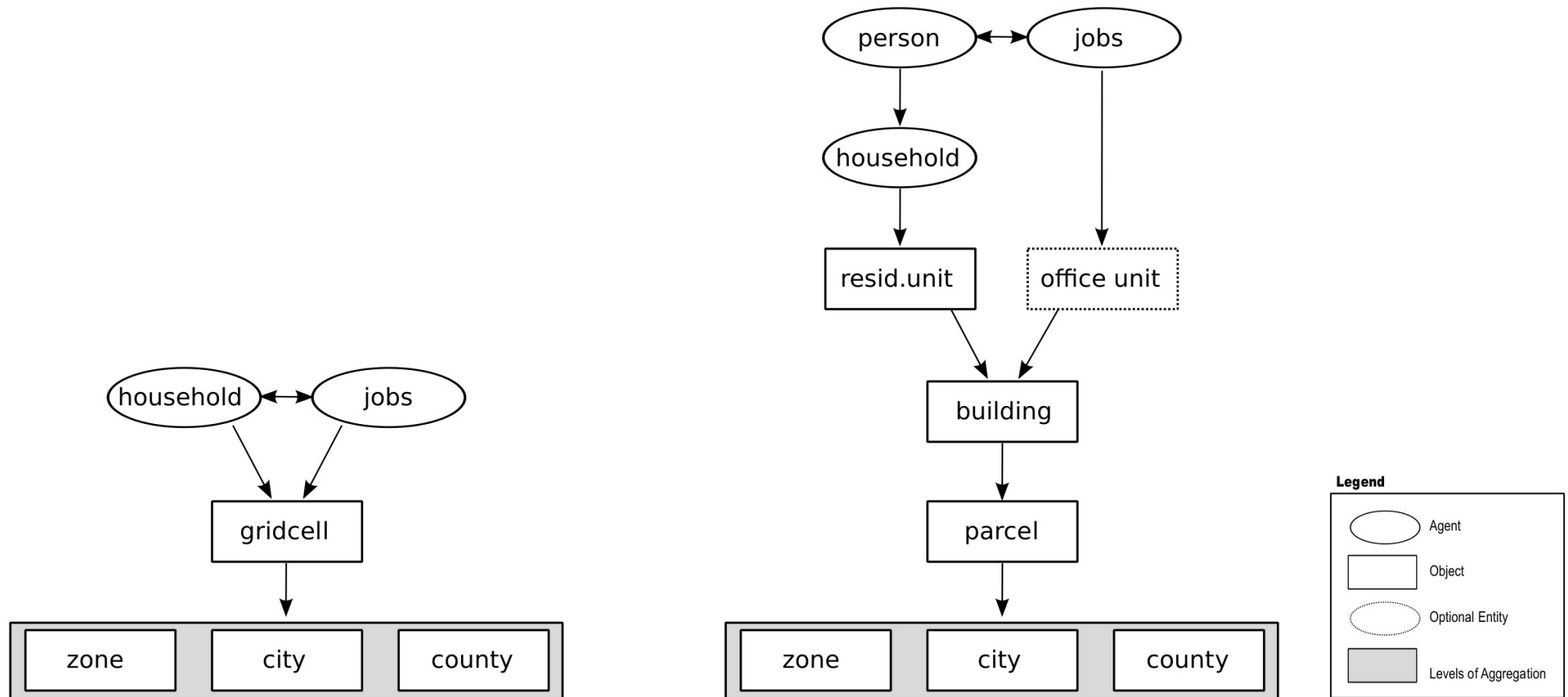


Introduction – City of Zürich

- 370.000 inhabitants in 2007
 - 180 vacant apartments = 0.09% of stock (01.07.2007)
 - 46'551 persons moved into the city
 - 42'108 persons have changed their residence within the city
 - 2'263 new dwellings have been built
 - 40'437 persons moved out of the city, 3'480 persons died
- => almost 1/3 of the population has moved! Source: Thalmann (2010)



Introduction – Data model SustainCity

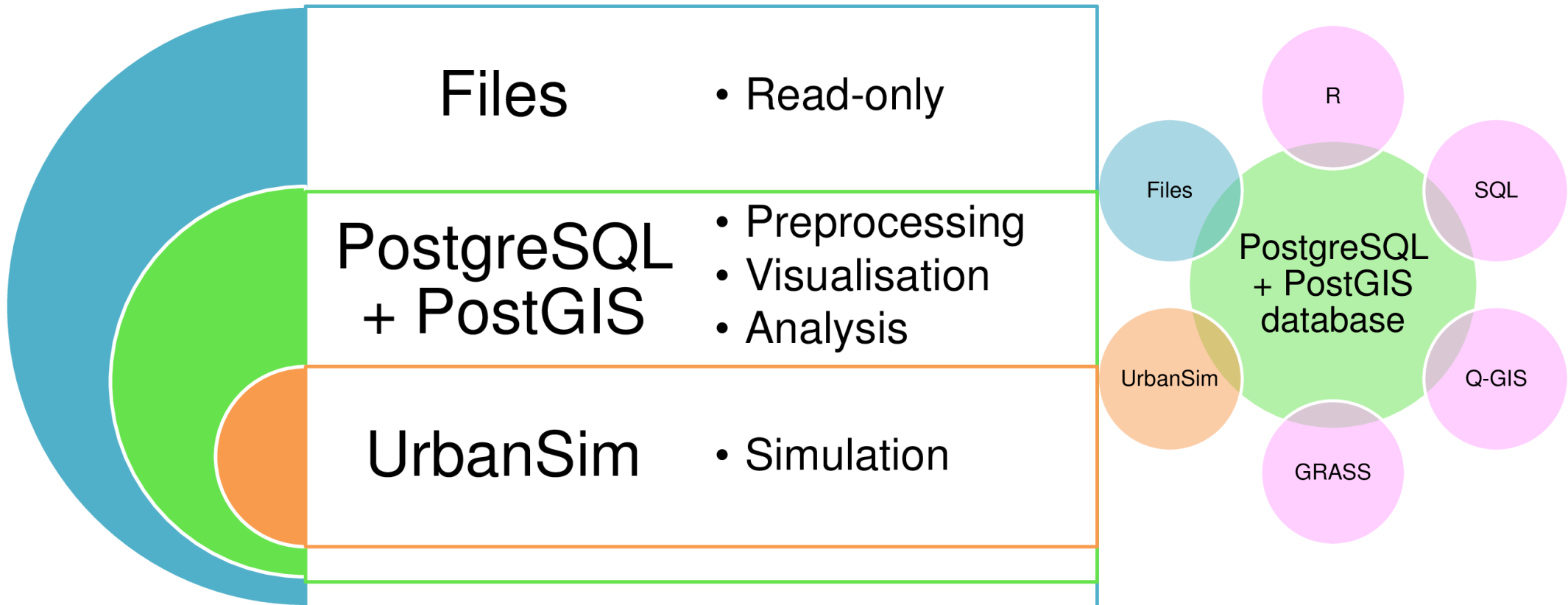


Data processing – spatial matching

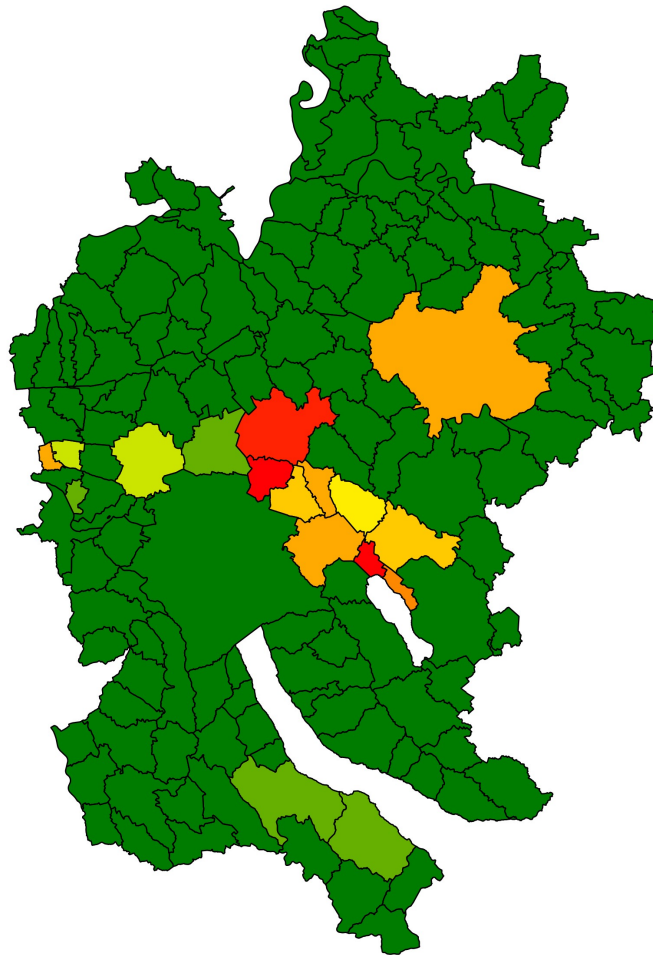
- **GWR/GVZ**
Housing units
Construction year
Value
.....
- **Soil coverage zones (AV)**
surface information
buildings footprints
.....
- **Parcel**
size
FAR covered
.....
- **Land use zone**
planning constraints



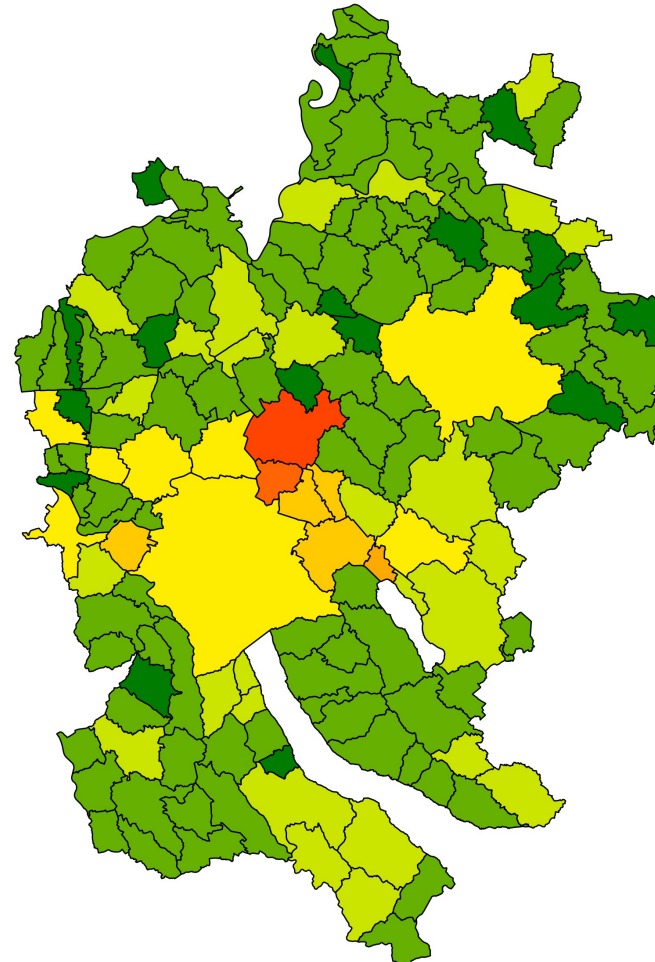
Data storage



Data processing – import quality



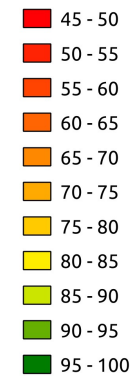
Quality of matching jobs to buildings (%)



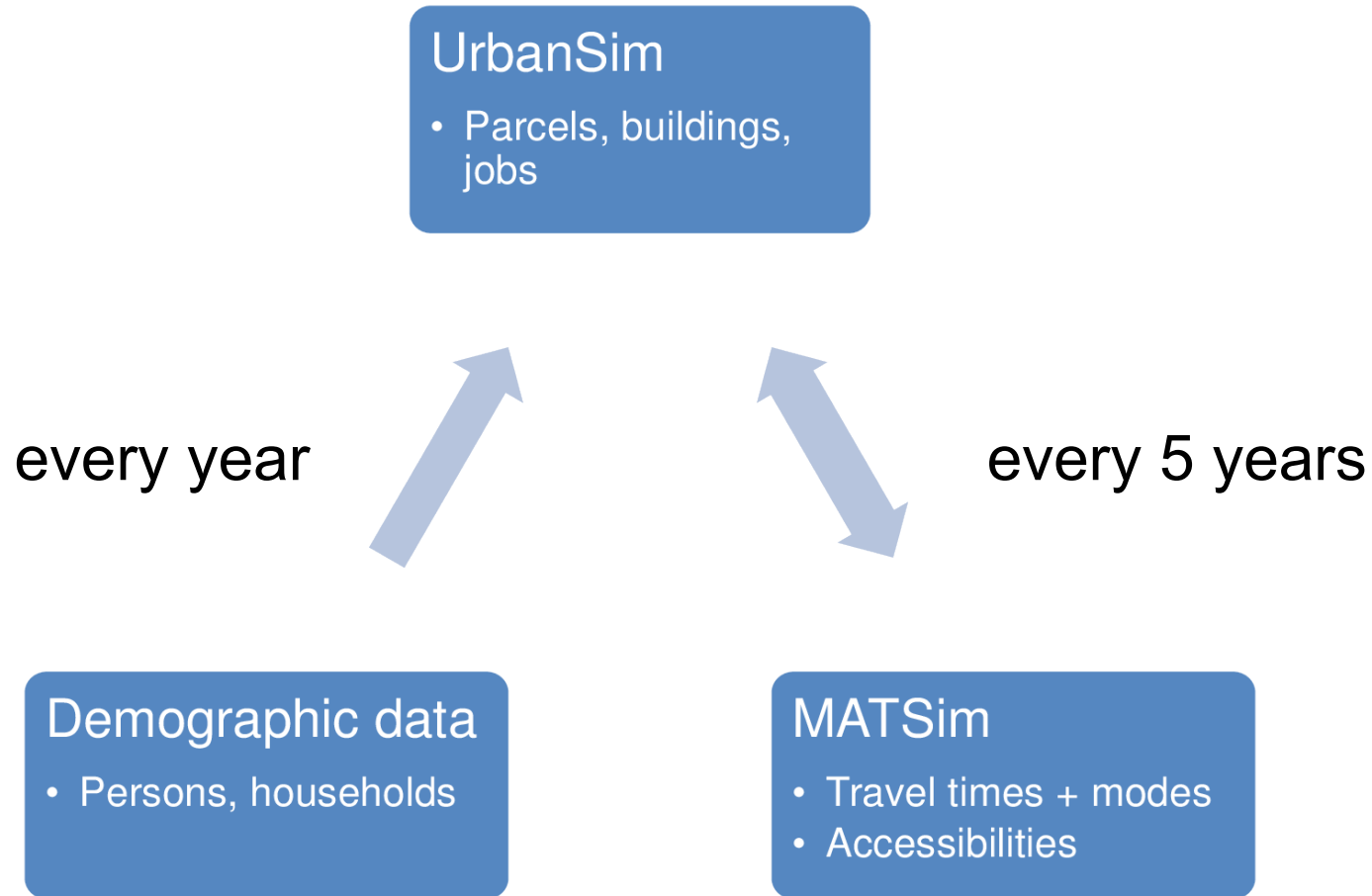
Quality of all data-processings (%)

Legend

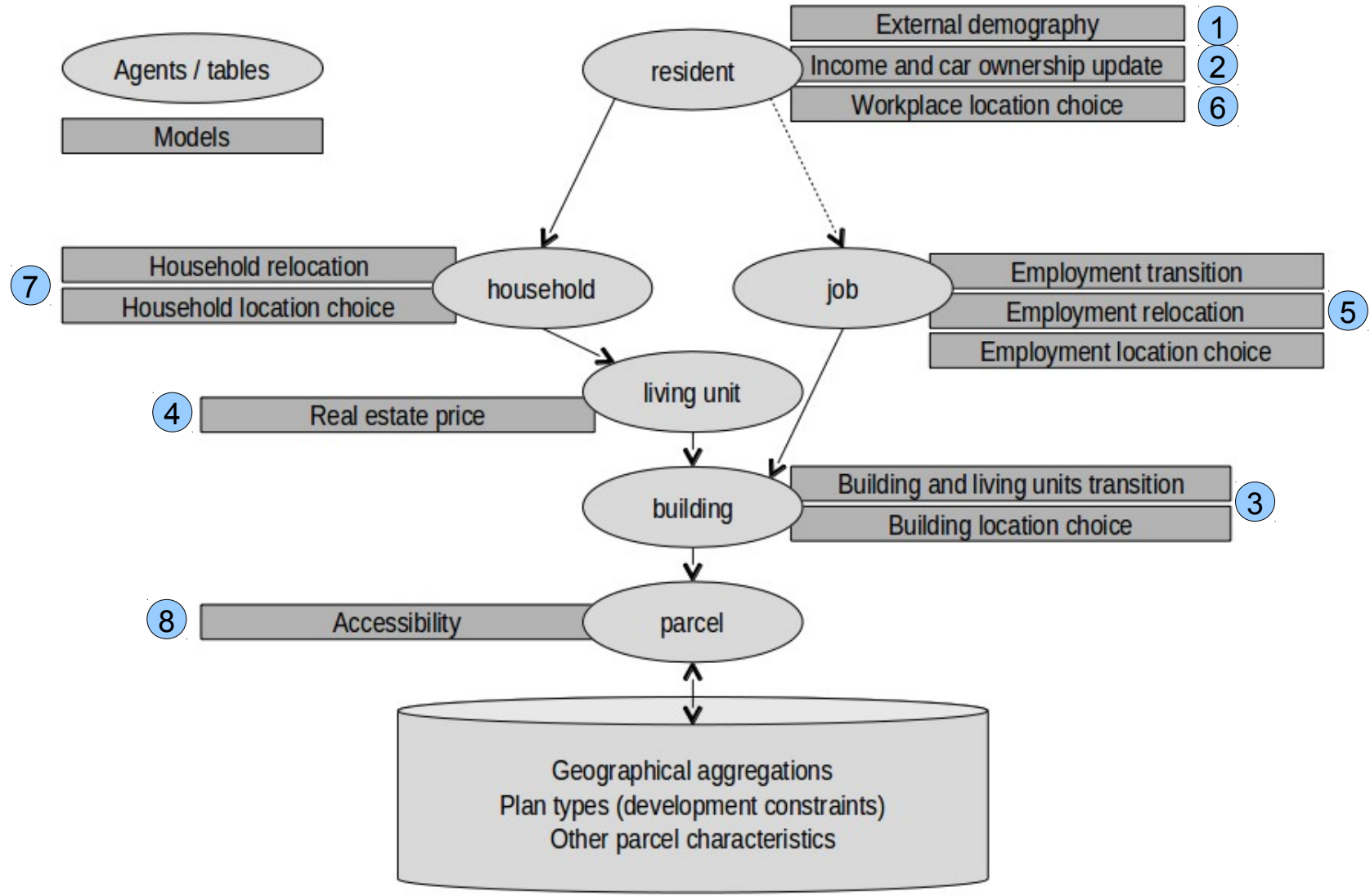
quality



General structure of the model system

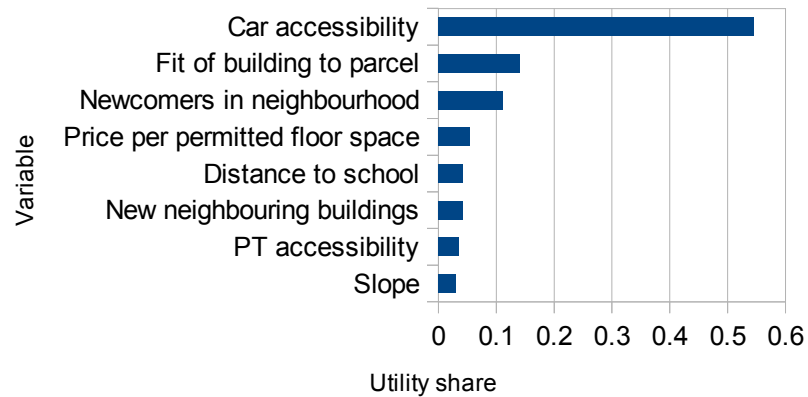


Run order of simulated models

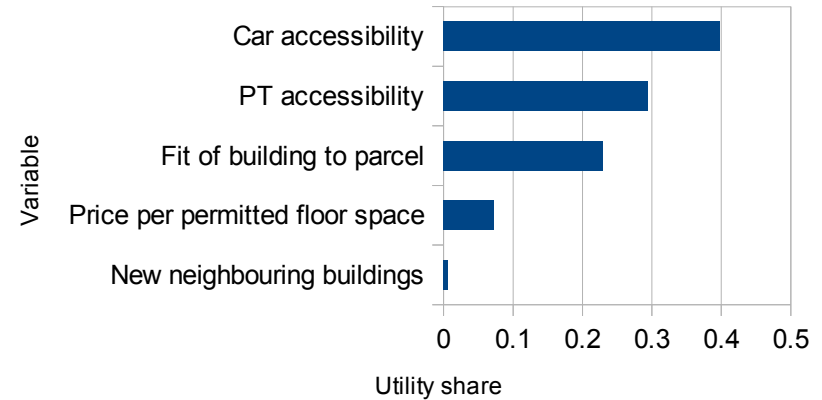


Models- Building Location

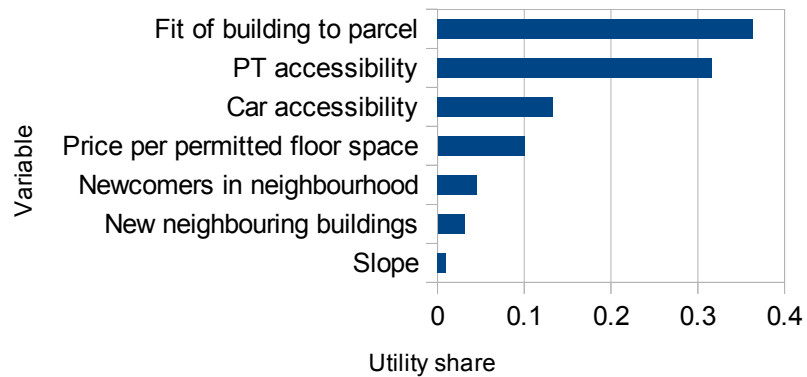
Single Family Housing



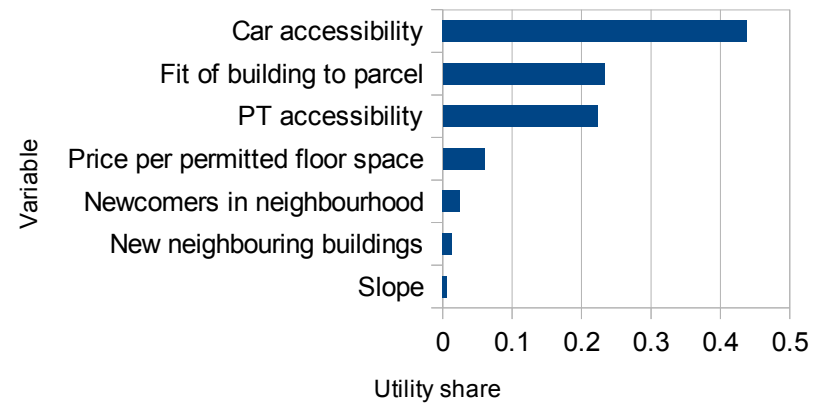
Mixed Use



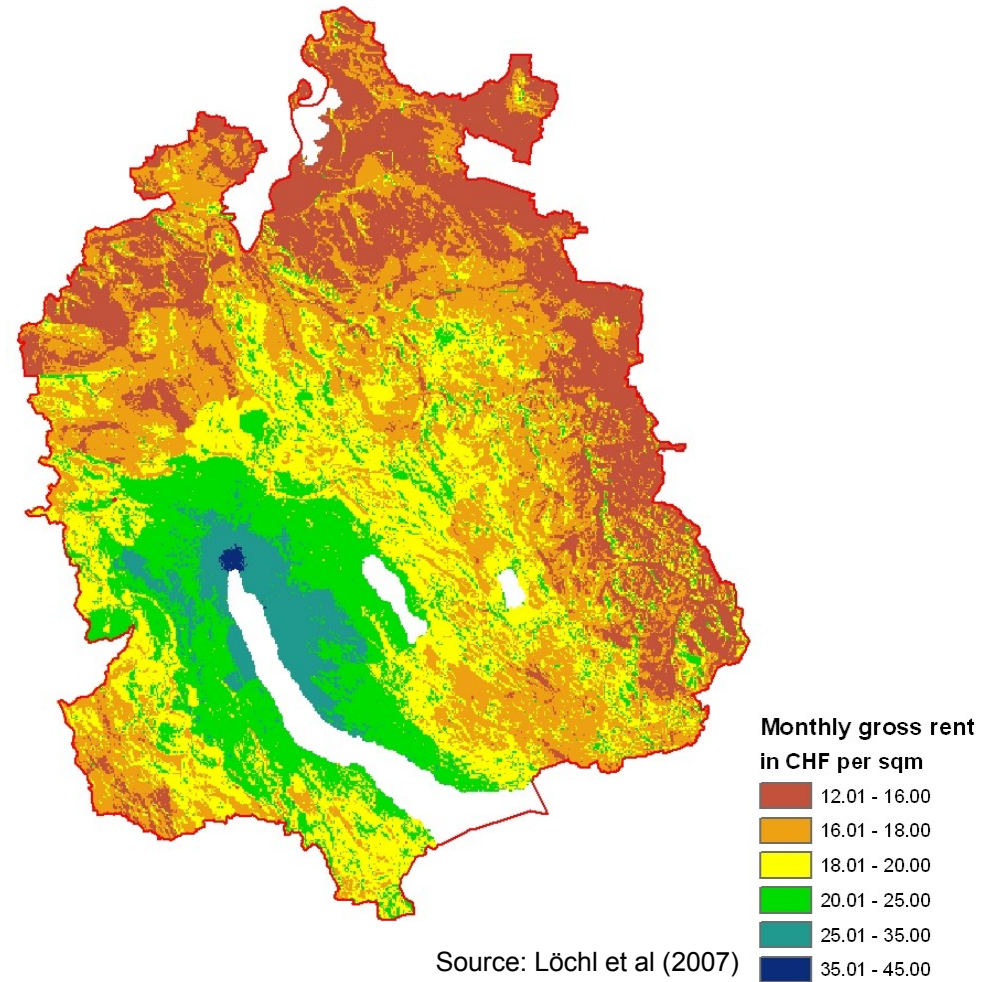
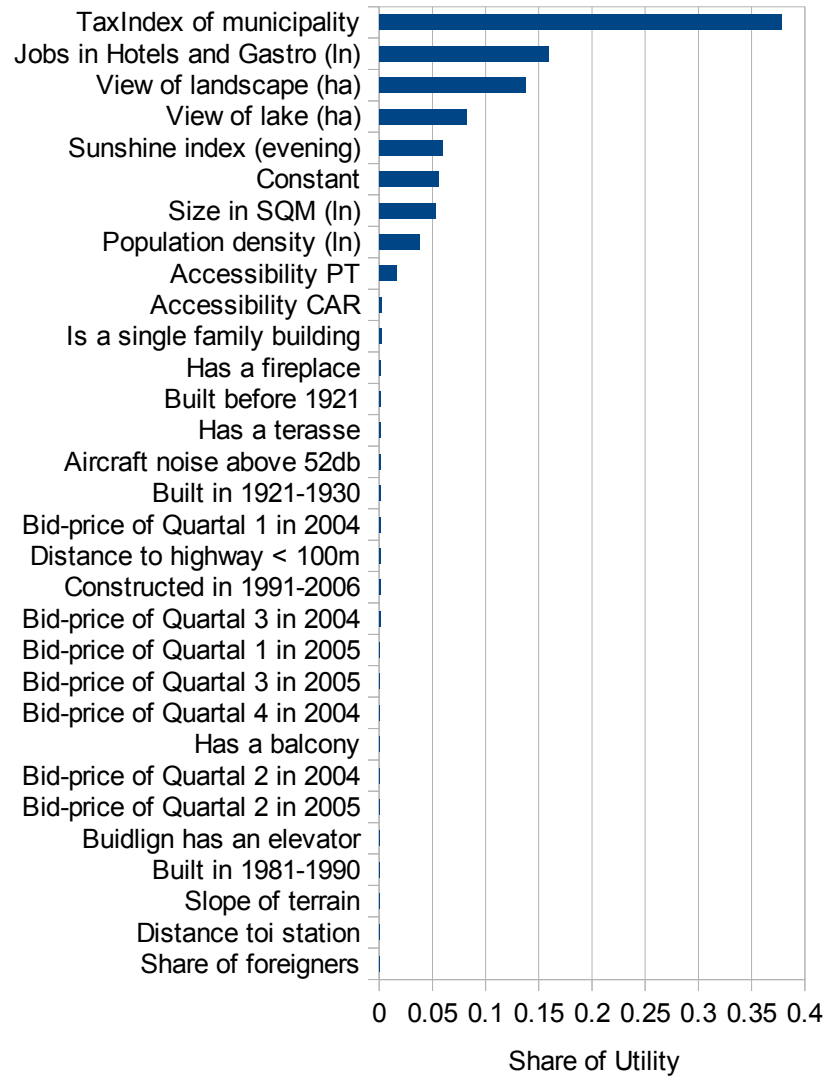
Multiple Family Housing



Non-Residential



Models – Real estate price



Models – Real estate price

	UrbanSim		Löchl (2007)	
	Effect	Sign.	Effect	Sign.
Constant	+	**	+	**
Car accessibility	+	**	n.a.	n.a.
PT accessibility	+	**	+	**
Built in 1921 to 1930	+	**	+	**
Built in 1981 to 1990	+		+	**
Built after 1991	+	**	+	**
Built before 1921	+	**	+	**
Distance to station	-	**	-	**
Proximity to highway (< 100 m)	-	**	-	**
Is a single family house	+	**	+	**
Jobs in hotels and gastronomy	+	**	+	**
View of lake (ha)	+	**	+	**
Population density (ln)	-	**	-	**
Size in m ² (ln)	+	**	+	**
Slope of terrain	+	**	+	**
Sunshine index (evening)	+	**	+	**
Foreigners within 300 m	+	**	(-)	(**)
Adj. Likelihood ratio index:	0.78173		0.85	
Number of observations:	6497		8592	

Models – Employment location choice

Type	1	2	3	4	5	6	7	8
Average zonal income	- **	- **	- **	- **	- **	- **	- **	- **
Car accessibility	+ **	+ **	+ **	+ **	+ **	+ **	+ **	+ **
PT accessibility	+ **	+ **	+ **	+ **	+	+	+ **	+
Distance to motorway access	- **	- **	- **	- *	+	- **	+ **	+ **
Distance to station	- **	- **	- **	- **	- **	- **	- **	- **
Distance to Zürich CBD	+ **	+	+ **	+ **	+	+ **	-	- **
Household density (km ²)	- **	- **	- **	- **	- **	- **	- **	- **
Job density (km ²)	+ **	+ **	+ **	+ **	+ **	+ **	+ **	+ **
Share of same jobs (zone)	+ **	+ **	+ **	+ **	+ **	+ **	+ **	+ **
Adj. likelihood ratio index:	0.17	0.11	0.23	0.18	0.13	0.26	0.21	0.17
Number of observations:	15714	9187	11895	10143	7038	14390	33170	12382

Type 1 = Manufacturing (NOGA-code C - E)

Type 2 = Construction (NOGA-code F)

Type 3 = Wholesale Trade (NOGA-code G 45, G46)

Type 4 = Retail Trade (NOGA G47)

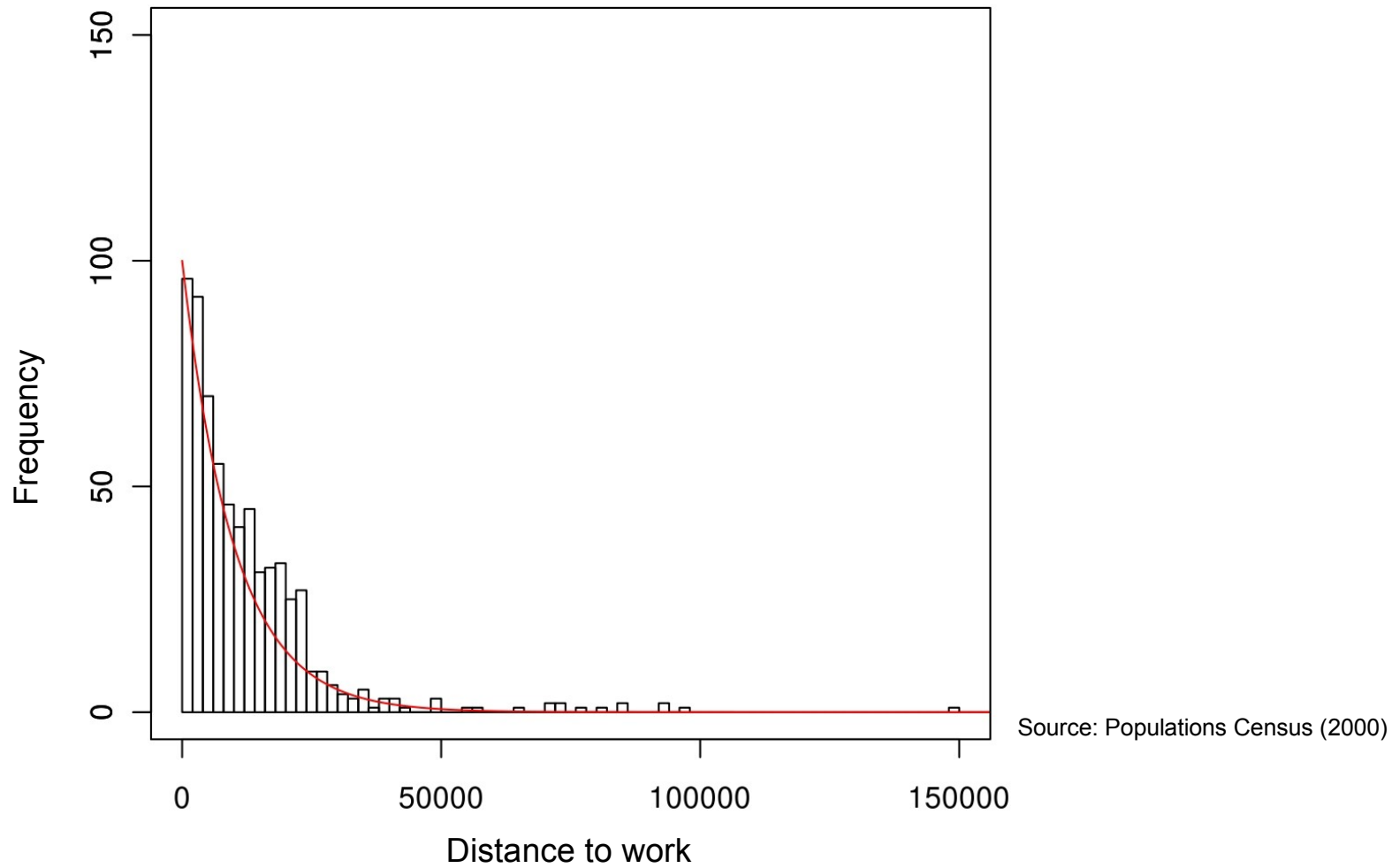
Type 5 = Hotel & Gastronomie (NOGA-code I)

Type 6 = Transport & Communication (NOGA-code J)

Type 7 = Service & Finance (NOGA-code K - N)

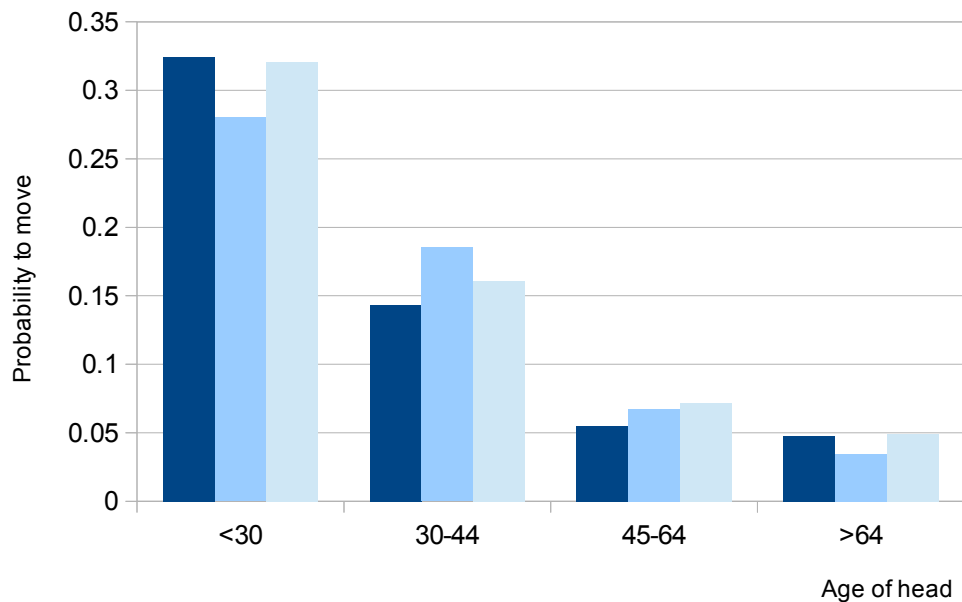
Type 8 = Health (NOGA-code Q)

Models – Workplace location choice



Models – Household transition and relocation

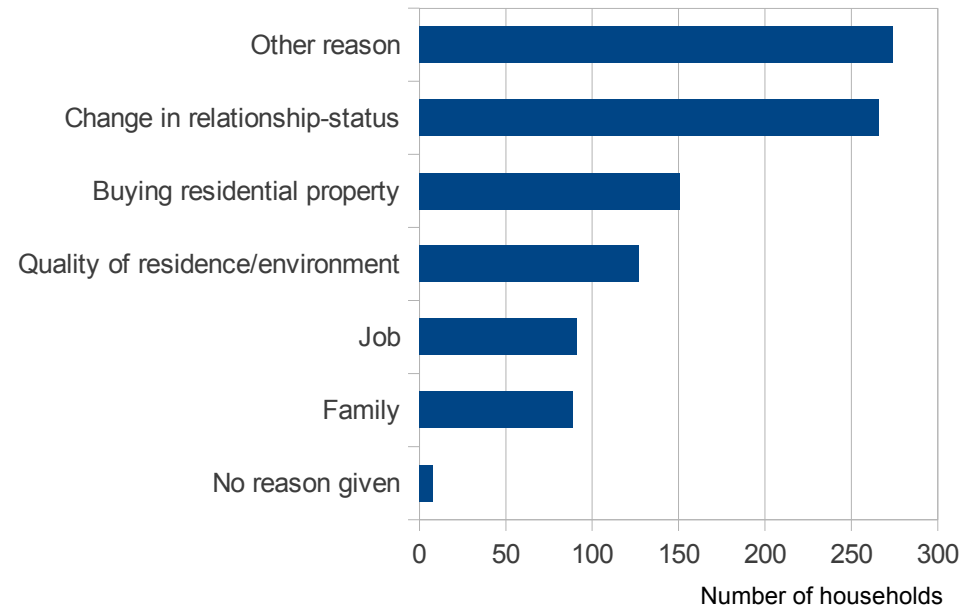
Relocation probability



Income
 ■ <48000
 ■ 48000-96000
 ■ >96000

Source: Beige (2005)

Reason to move



Survey: Belart (2010)



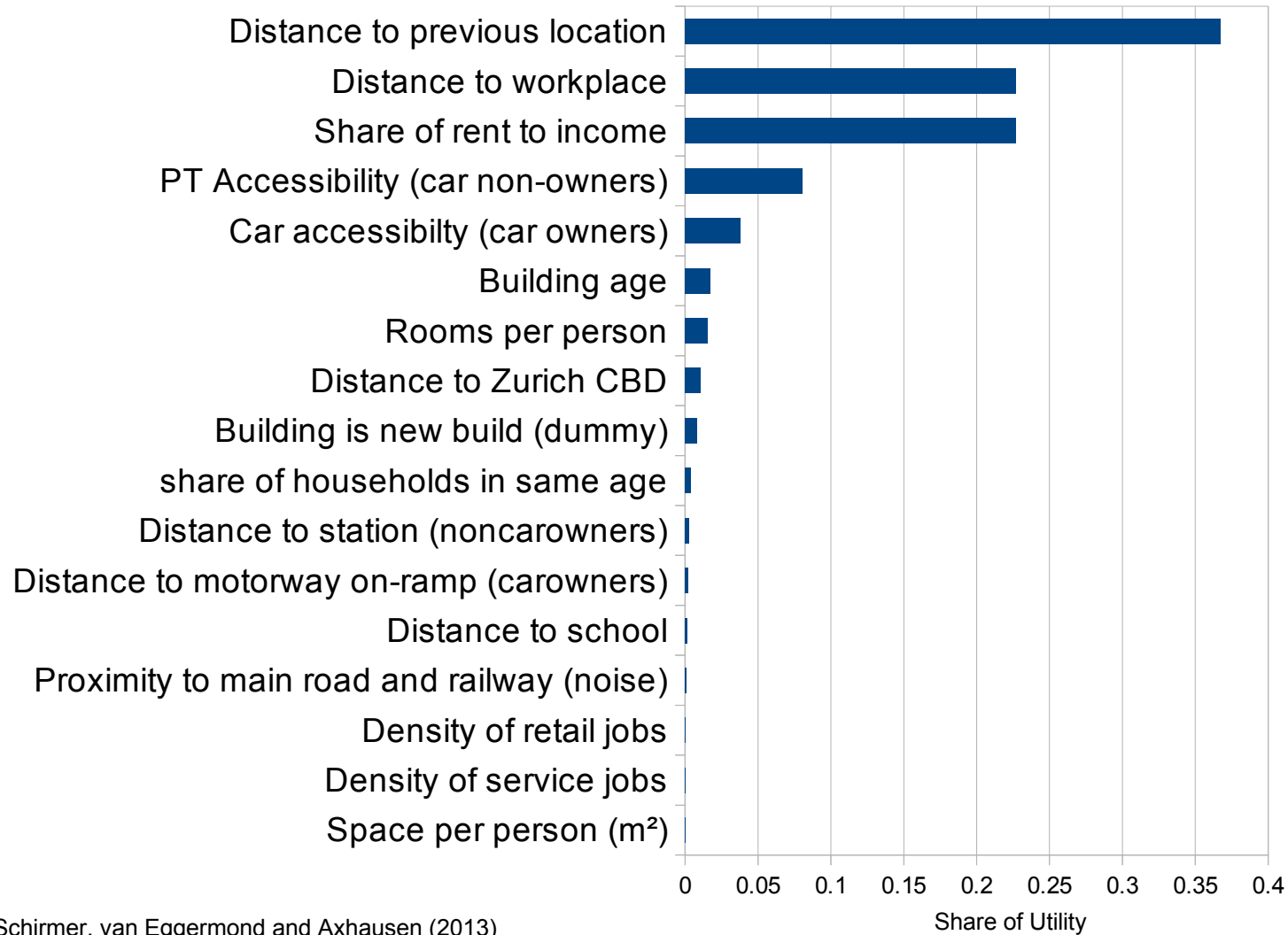
Models – Household location choice

	Effect	Sign.		Effect	Sign.
Building age	+	**	Proximity to main road	-	*
Building is new build (dummy)	+	**	and railway (noise)		
Share of rent to income	-	**			
Rooms per person	-	**	Distance to Zurich CBD	+	**
Space per room (m ²)	+	**	Distance to motorway	-	*
			on-ramp (car owners)		
Distance to previous location (beta *dist ^eta)	-	**	Distance to station (car non-owners)	-	
Distance to workplace (beta *dist ^eta)	-	**	Density of retail jobs	-	**
			Distance to school	+	**
			Density of service jobs	-	**
Car accessibility	-	**	Share of households	+	**
PT accessibility	+	**	in same age		

Adj. likelihood ratio index 0.522
 Number of observations 1065

Schirmer, van Eggermond and Axhausen (2013)

Models – Household location choice



Source: Schirmer, van Eggermond and Axhausen (2013)



Choice sets – Household location choice

	UrbanSim (mean)	Survey (mean)	Diff (%)	
Car accessibility (car owner)	9.89	9.07	9.03	
PT accessibility (car non-owner)	11.97	11.16	7.33	
Building is new build (dummy for)	0.10	0.24	-55.96	(1)
Building age (log)	3.46	3.03	14.25	
Distance to motorway on-ramp (c	2147.81	2333.57	-7.96	
Distance to school	420.50	446.98	-5.93	
Distance to station (car non-owne	800.86	723.72	10.66	
Distance to Zurich CBD	10299.55	12104.99	-14.91	
Proximity to main road and railwa	0.02	0.08	-76.38	(2)
Density of retail jobs	83.82	16.46	409.24	(3)
Density of service jobs	255.84	61.10	318.75	(3)
Share of rent to income	0.00	0.24	-98.92	(4)
Rooms per person	1.93	1.89	1.90	
Share of households with age (<4	0.38	0.37	1.30	
Share of households with age (40	0.37	0.46	-20.91	
Share of households with age >60	0.21	0.20	7.07	
Space per person (m ²)	26.48	28.32	-6.52	

(1) recent movers of survey are located in new buildings

(2) recent buildings are at peripheral areas and closer to highway

(3) recent buildings are at peripheral areas and have a low density of other uses

(4) corrected error: income categories and log(rent_price)

Models - Summary

Achievements

Combining 6 main datasets (census data, cadastral data and register data)

Interaction of:

- 5 discrete-choice-models (12 submodels)
- 2 regression models
- 5 rate based models

Current limitations

all: estimation on distribution, vs. estimation on RP/SP

BLCM: templates can include mixed use (no link to job type)

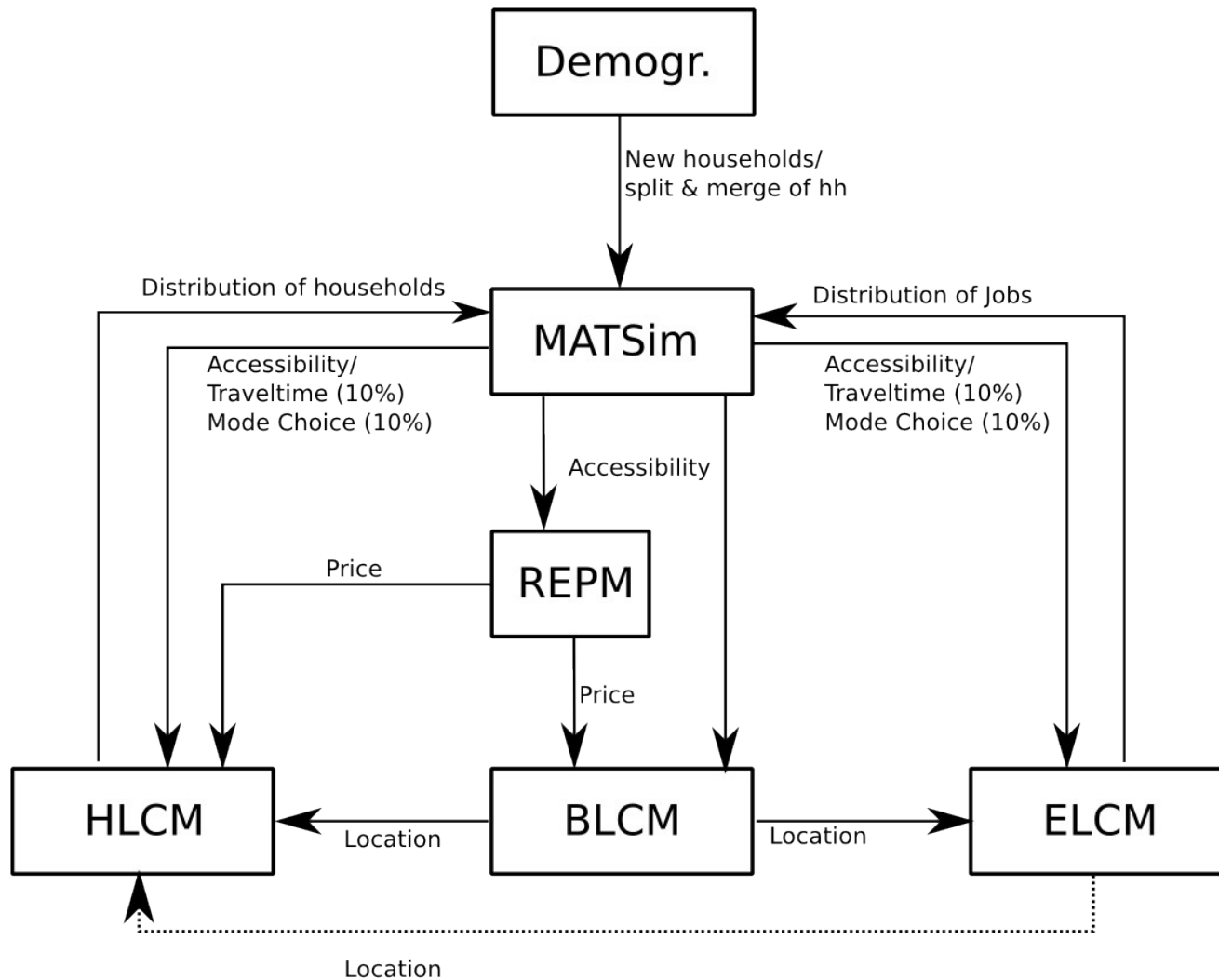
ELCM: needs to include taxes

HLCM: no social groups; no bidprices

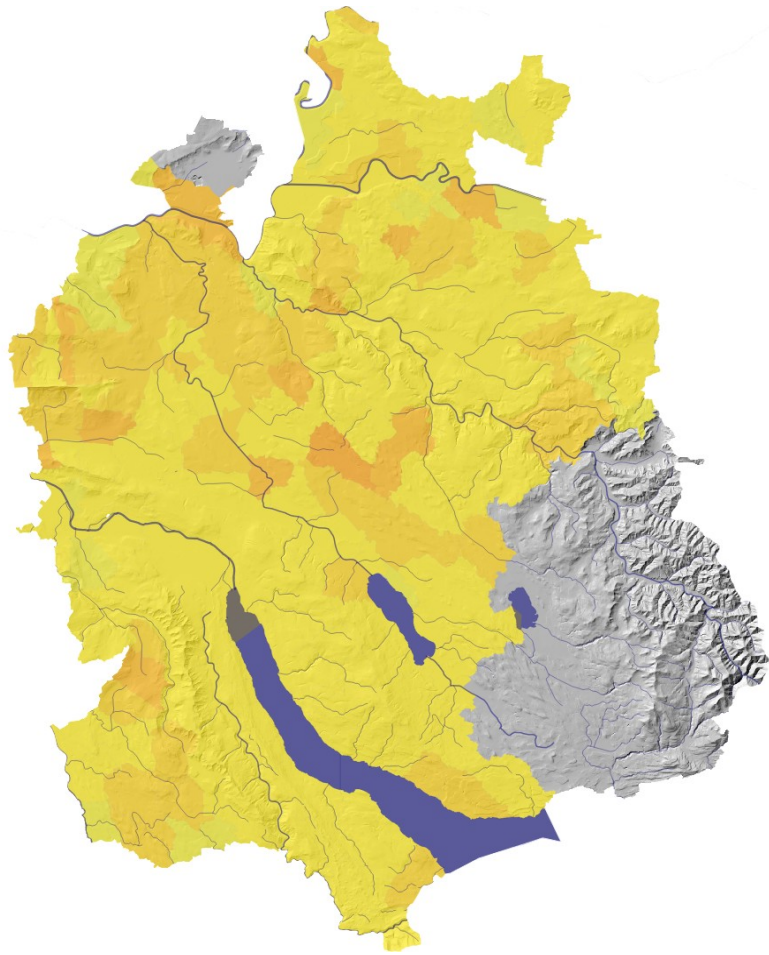
REPM: not including market; not including taxes

WLCM: choice only distance based, due to missing observations

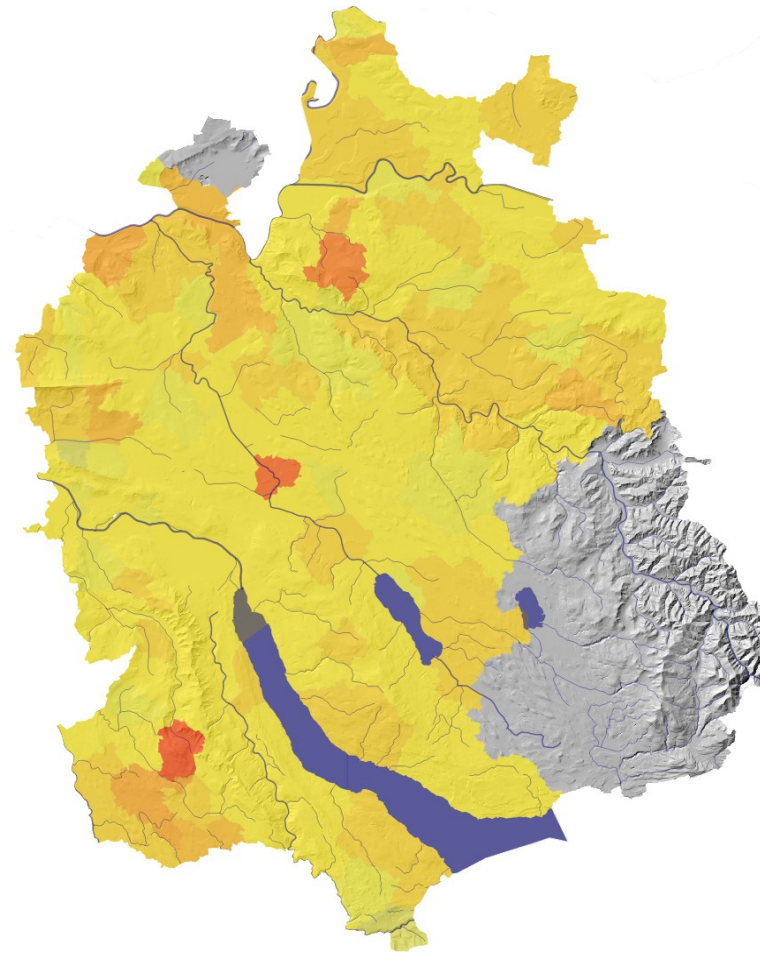
Models – Interaction (influence of transport)



Simulation – Persons

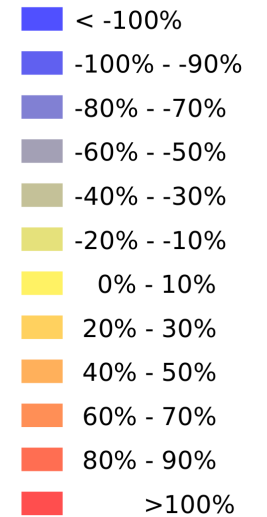


Observed development 2001 - 2008:
Persons per km2 of municipality

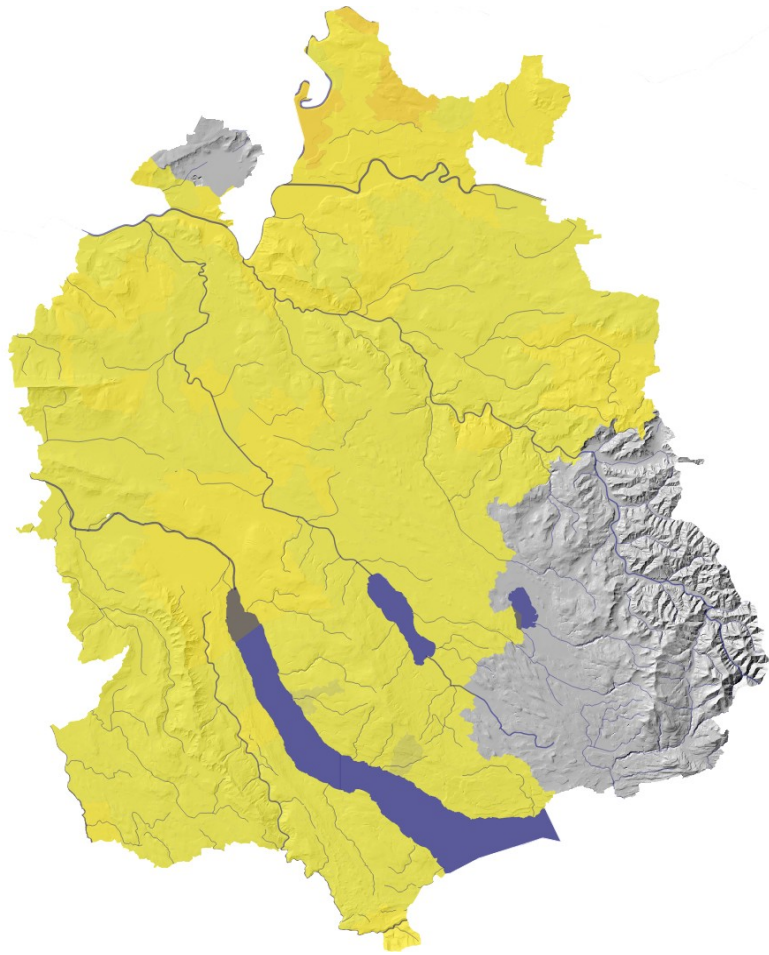


Simulated development 2001 - 2008:
Persons per km2 of municipality

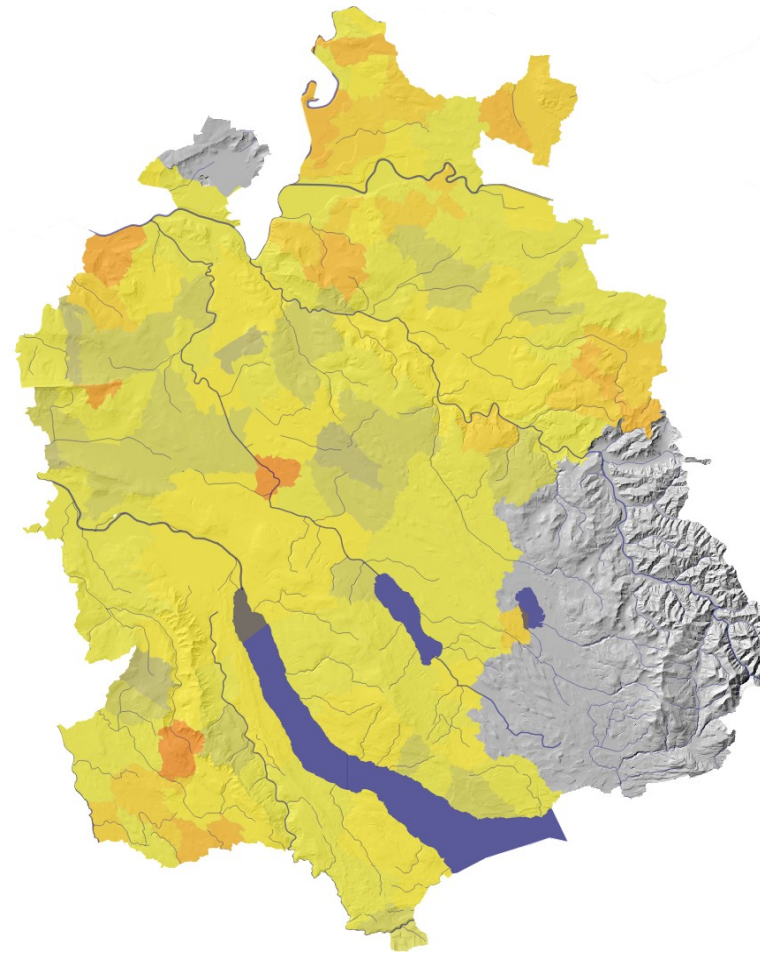
Legend



Simulation – Persons



Difference of simulation to validation 2001:
Persons per km² of municipality

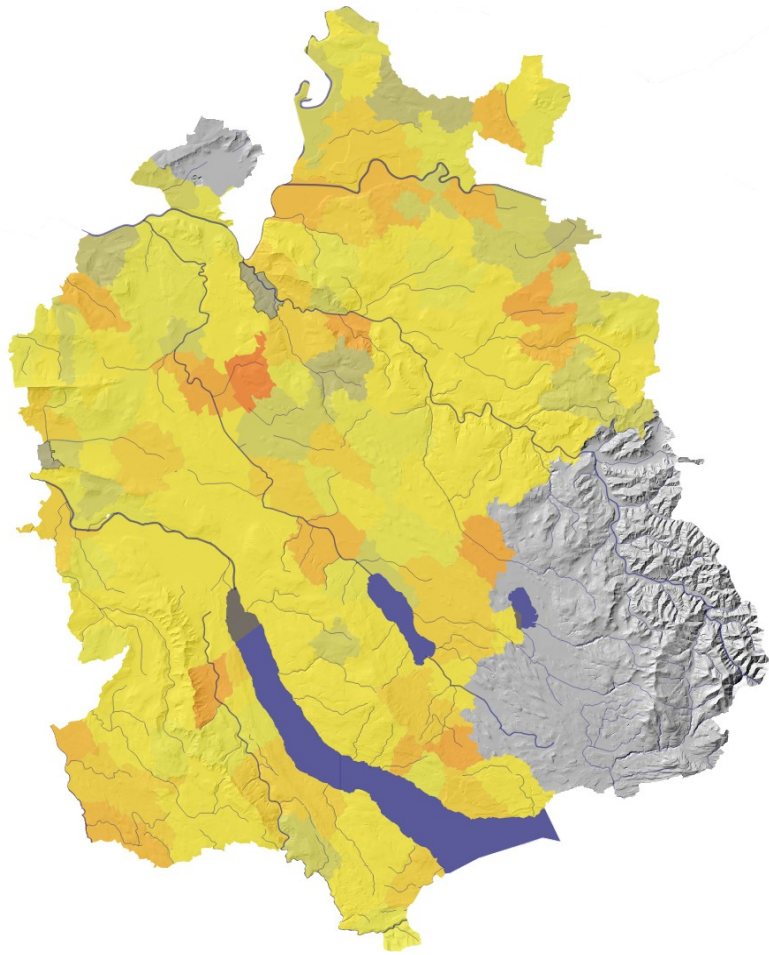


Difference of simulation to validation 2008:
Persons per km² of municipality

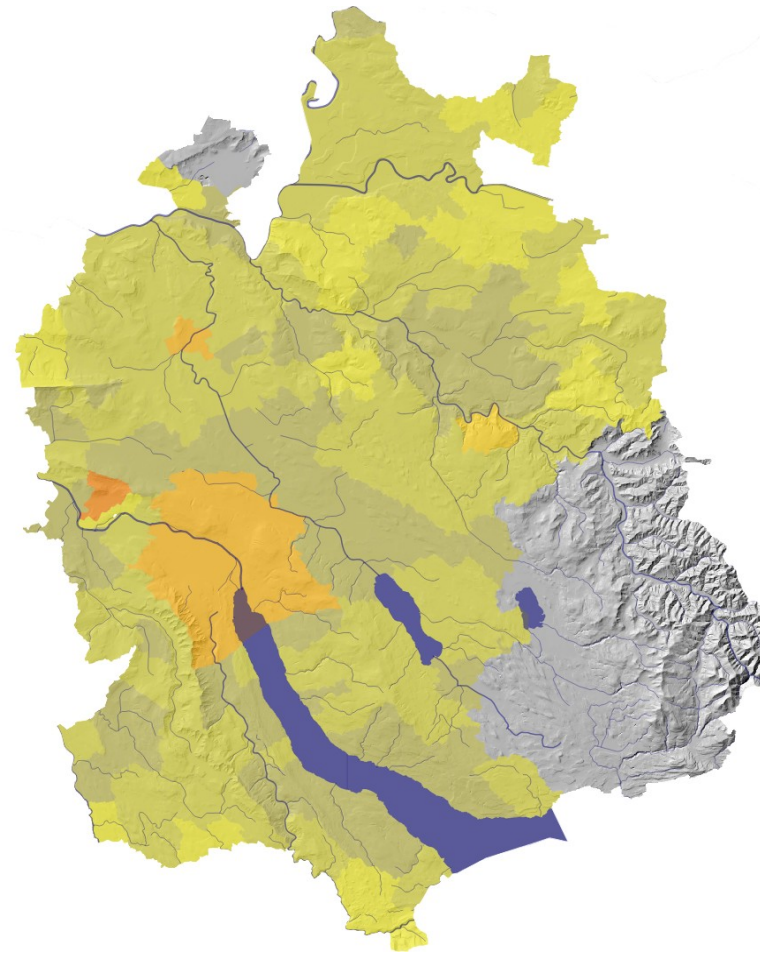
Legend

- < -100%
- -100% - -90%
- -80% - -70%
- -60% - -50%
- -40% - -30%
- -20% - -10%
- 0% - 10%
- 20% - 30%
- 40% - 50%
- 60% - 70%
- 80% - 90%
- >100%

Simulation – Jobs



Observed development 2001 - 2008:
Jobs per km² of municipality

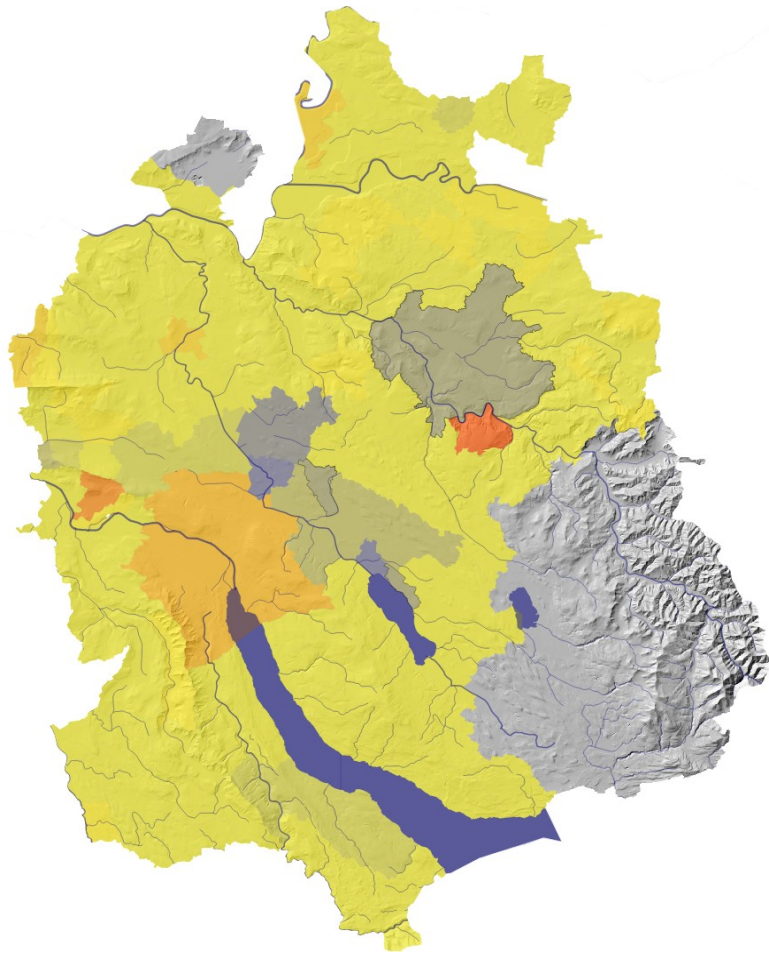


Simulated development 2001 - 2008:
Jobs per km² of municipality

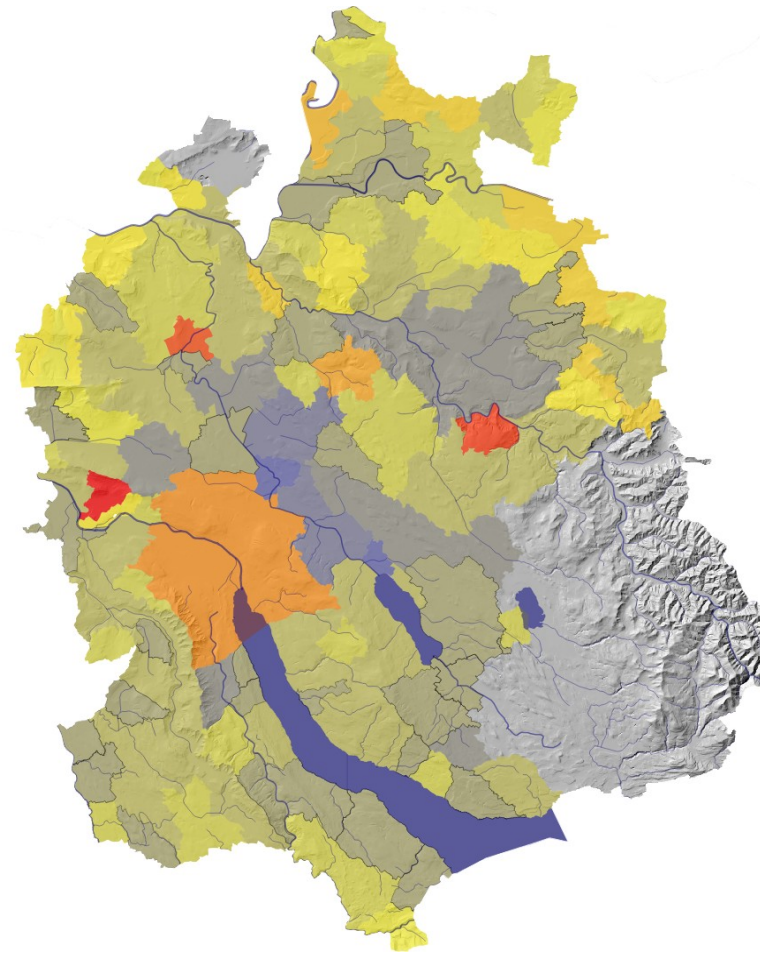
Legend

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- >100%

Simulation – Jobs



Difference of simulation to validation 2001:
Jobs per km² of municipality



Difference of simulation to validation 2008:
Jobs per km² of municipality

Legend

- < -100%
- -100% - -90%
- -80% - -70%
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- -20% - -10%
- 0% - 10%
- 20% - 30%
- 40% - 50%
- 60% - 70%
- 80% - 90%
- >100%

Findings

Methodological

Reproducible research with big data?

Harmonised data / Synthetisation

Estimation of model in UrbanSim (base year)

Estimation of model using surveys (RP and SP)

Simulation of households fits to observation

Simulation of employment reflects limited data quality

Evaluation of scenario effects

Calibration and correlation of models

Simulation – Persons

Movie persons

Scenario: Densification

Topic

Cantonal directive plan (11 densification areas)

Densification of centers

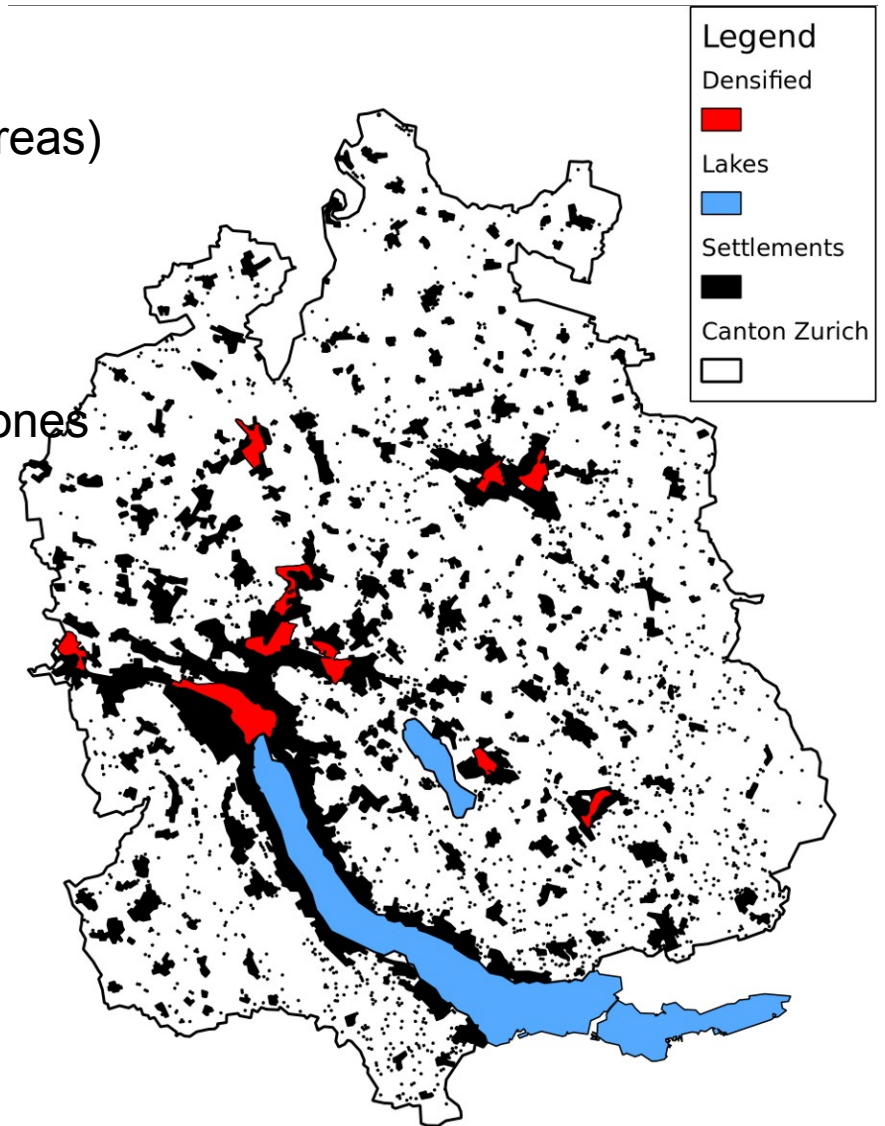
Implementation

Increase FAR of parcels in densification zones

Expected effects

Increased building activity

Less vehicle miles travelled



Scenario: New infrastructure

Topic

New infrastructure facilities from cantonal directive plan

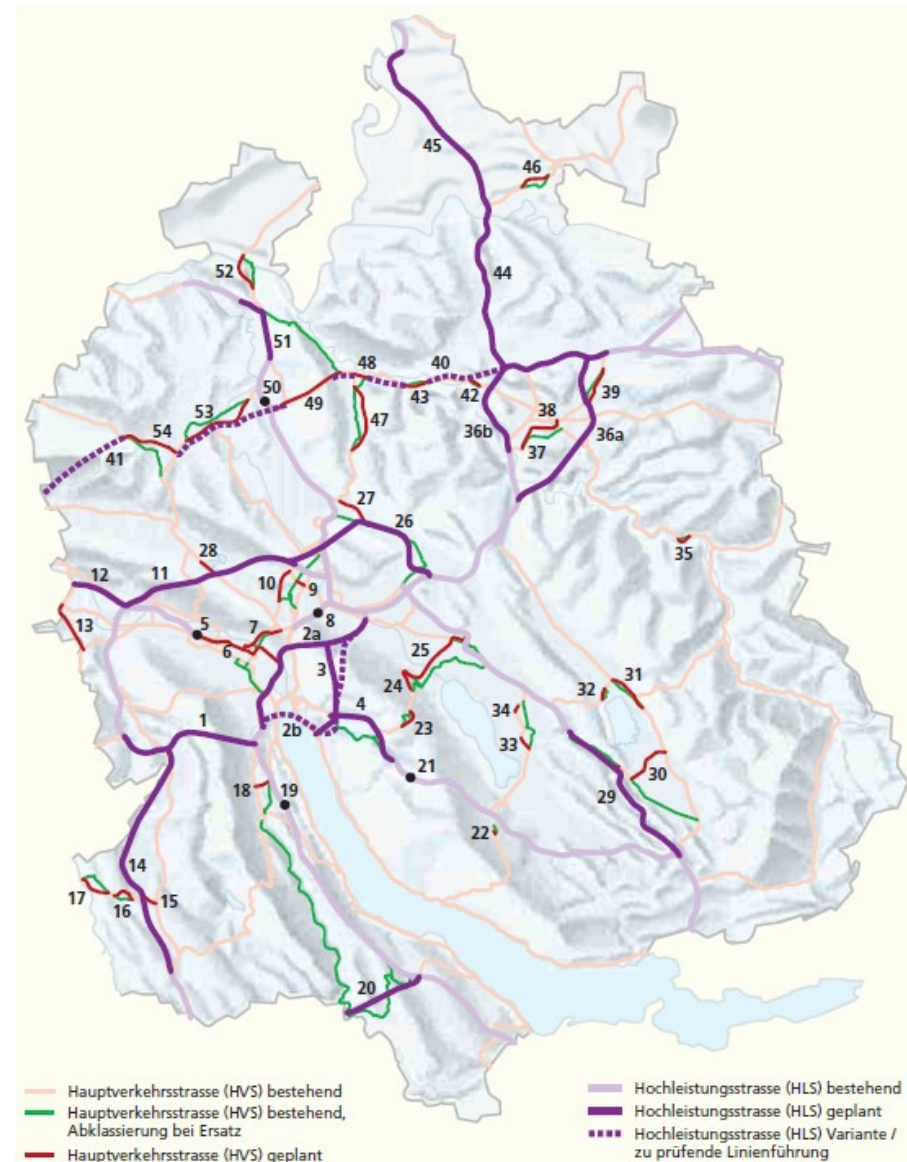
Implementation

Adaptation of MATSim network

Expected effects

Locally increased accessibility

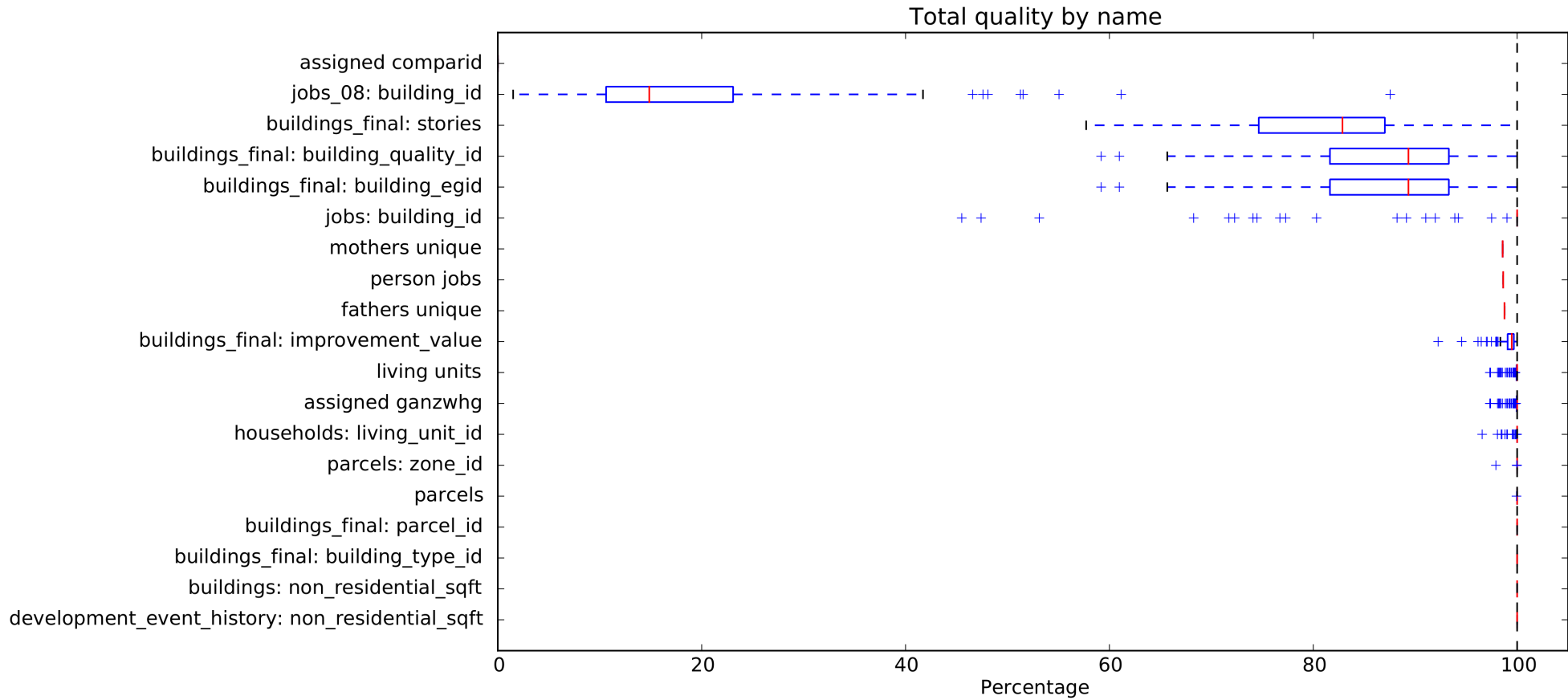
According local growth



Source: Canton Zurich (2007), Cantonal Directive Plan

Attachments

Data processing



An aerial, grayscale view of a city, likely Denver, Colorado, showing a river, mountains in the background, and a dense urban area. A large, solid blue rectangle is overlaid on the right side of the image, partially obscuring the city buildings.

Attachments

Model details