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The Zürich experience (UrbanSim 4.0; 3. Jan. 2007)

M Löchl
KW Axhausen

IVT
ETH
Zürich

March 2008

IVT Institut für Verkehrsplanung und Transportsysteme
Institute for Transport Planning and Systems

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Team, project duration and sponsor

Team:

- Prof. K.W. Axhausen
- Prof. W. Schmid (IRL)

- Michaela Bürgle
- Michael Löchl
- Urs Waldner (until 12/2005)

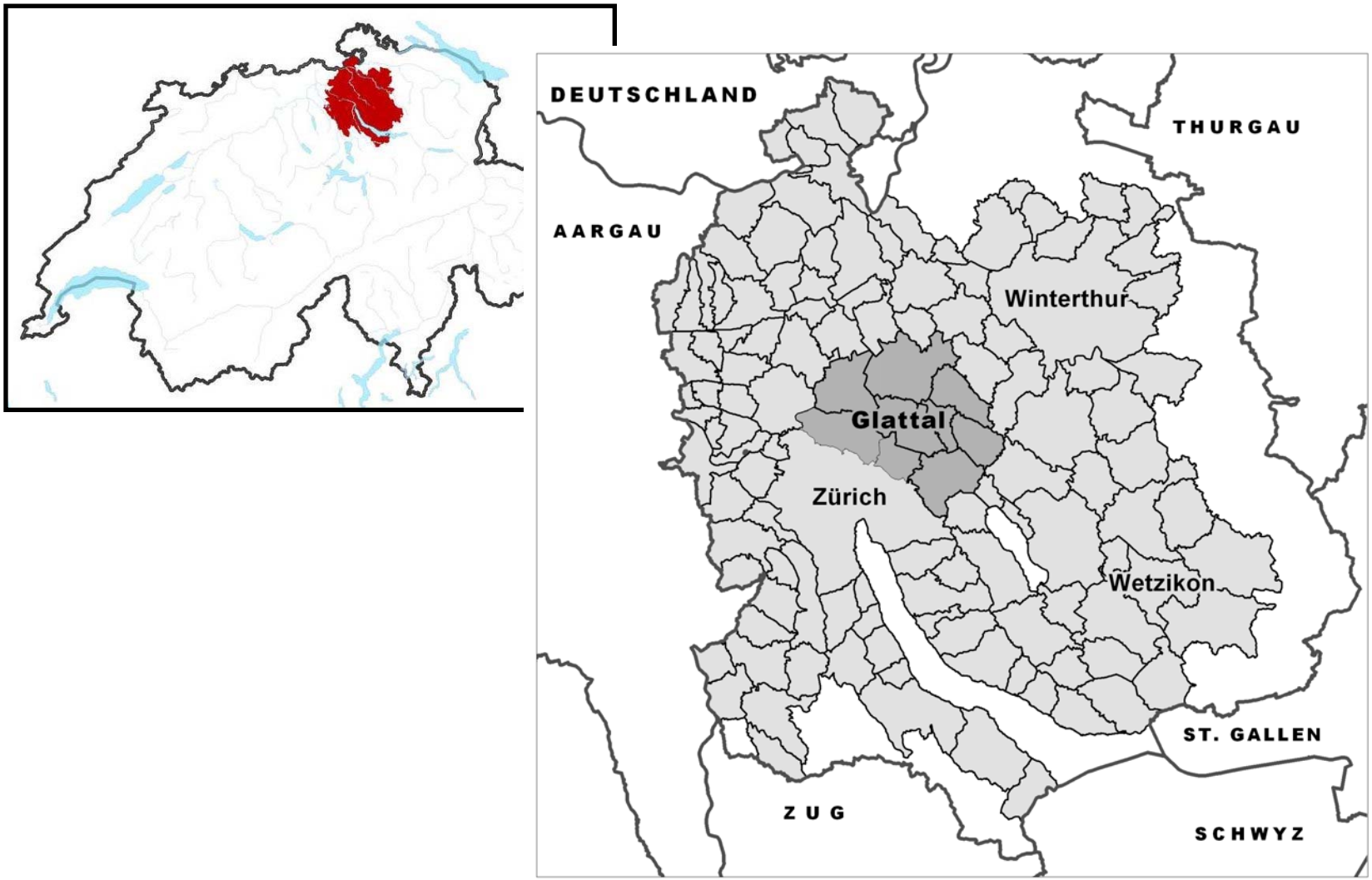
Project duration:

- 02/2004 until 01/2007

Sponsor:

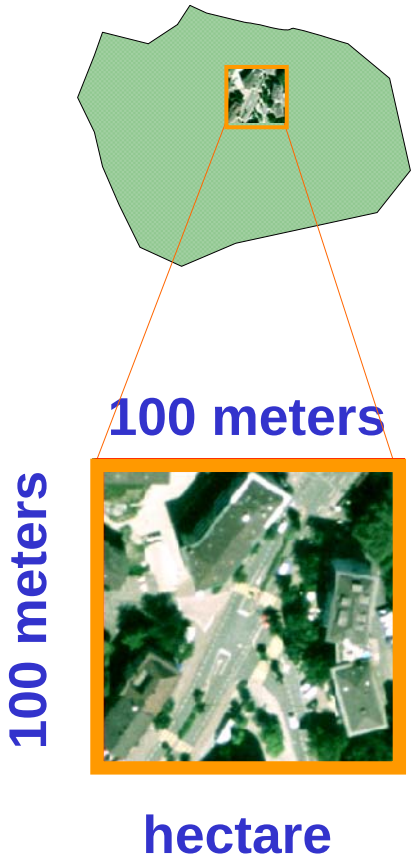
- ETH Zürich Research Fund

Study area


DEUTSCHLAND
THURGAU
AARGAU
Winterthur
Glattal
Zürich
Wetzikon
ST. GALLEN
ZUG
SCHWYZ

Geographies

Traffic analysis zone



Accessibility (road, public transport)

Number of households
Workplaces by sector
Floor area
Flats
rent price
Maximum use & use regulations

Input data

Input data

Item	Provider
Topographical maps	Swisstopo
Vector maps 1:25000	Swisstopo
Digitial terrain model	Swisstopo
Census data by ha (2000)	Federal Statistical Office
Census of work places by ha (2001)	Federal Statistical Office
Official business register (1991-2006)	Canton St. Gallen/AG
Building vol., floor area (1995-2004)	Cantonal fire insurance
Land use regulation (1996-2002)	Canton Zürich

Input data

Issue	Provider
Public transport stops (2004)	Public transport provider
Aircraft noise (2005)	Unique Airport
Road accessibilities (2003)	IVT (Cantonal model)
Public transport accessibilities (2003)	IVT (Cantonal model)
Household survey (2005)	IVT
Online database of real estate offers	Comparis

Models

Model	Data used	Publication
Mobility model of households	Household survey by IVT	Beige and Axhausen (2005); Beige (2006)
Mobility model of jobs (businesses)	Business data from Canton St. Gallen, Appenzell Ausserrhofen/Innerrhoden	Bodenmann (2006)
Household location choice model	Household survey, spatial data, synthetic household generation	Bürgle (2006a) Bürgle (2006b)
Employment (business) location choice model	Employment data from Swiss Federal Statistical Office, spatial data, synthetic household generation	Bürgle (2006c)
Developer Model	Building data from Canton Zurich	Weis (2006)
Hedonic rent price model	Comparis	Löchl (2006)

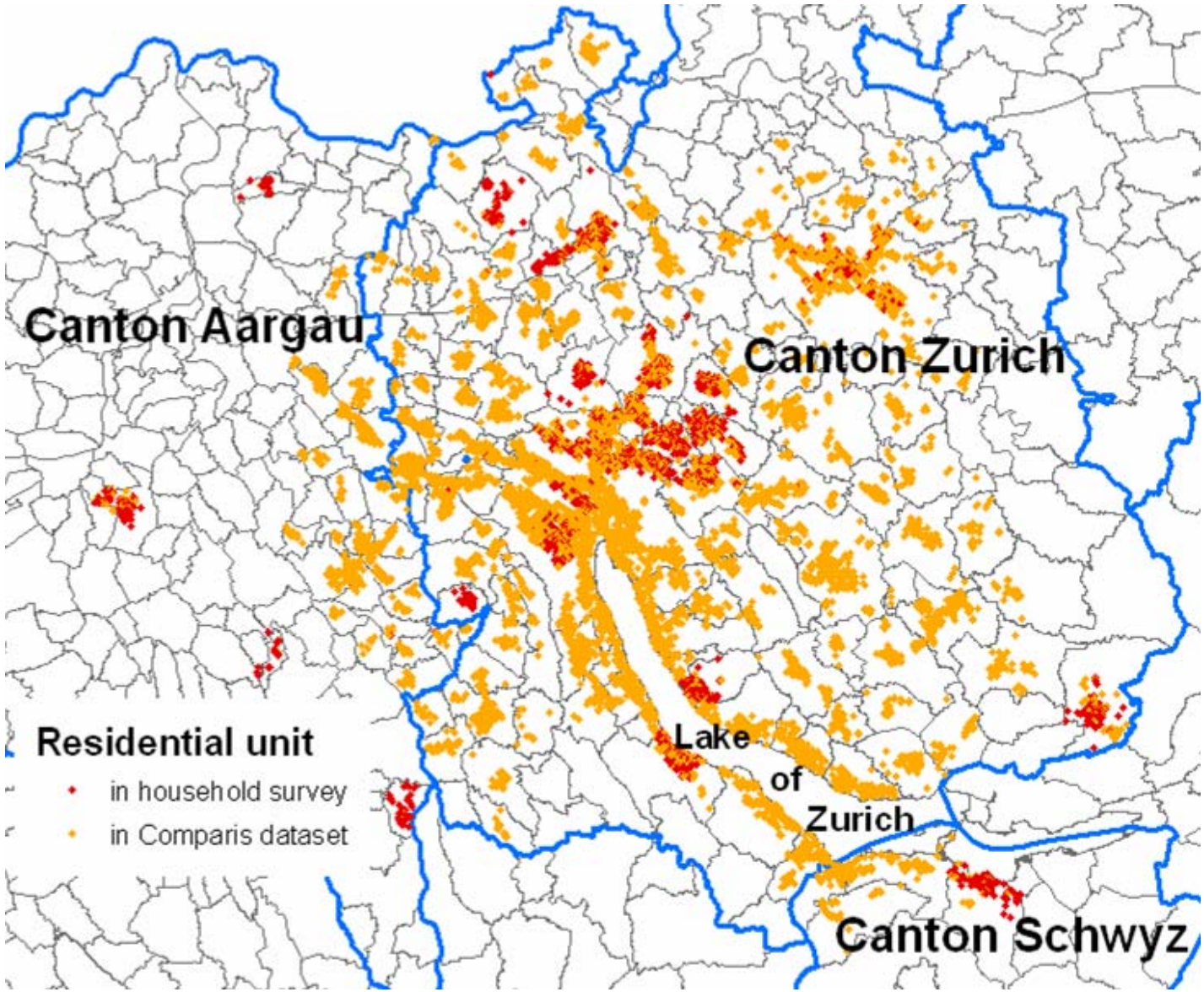
GIS data generation and models

Household probability to move

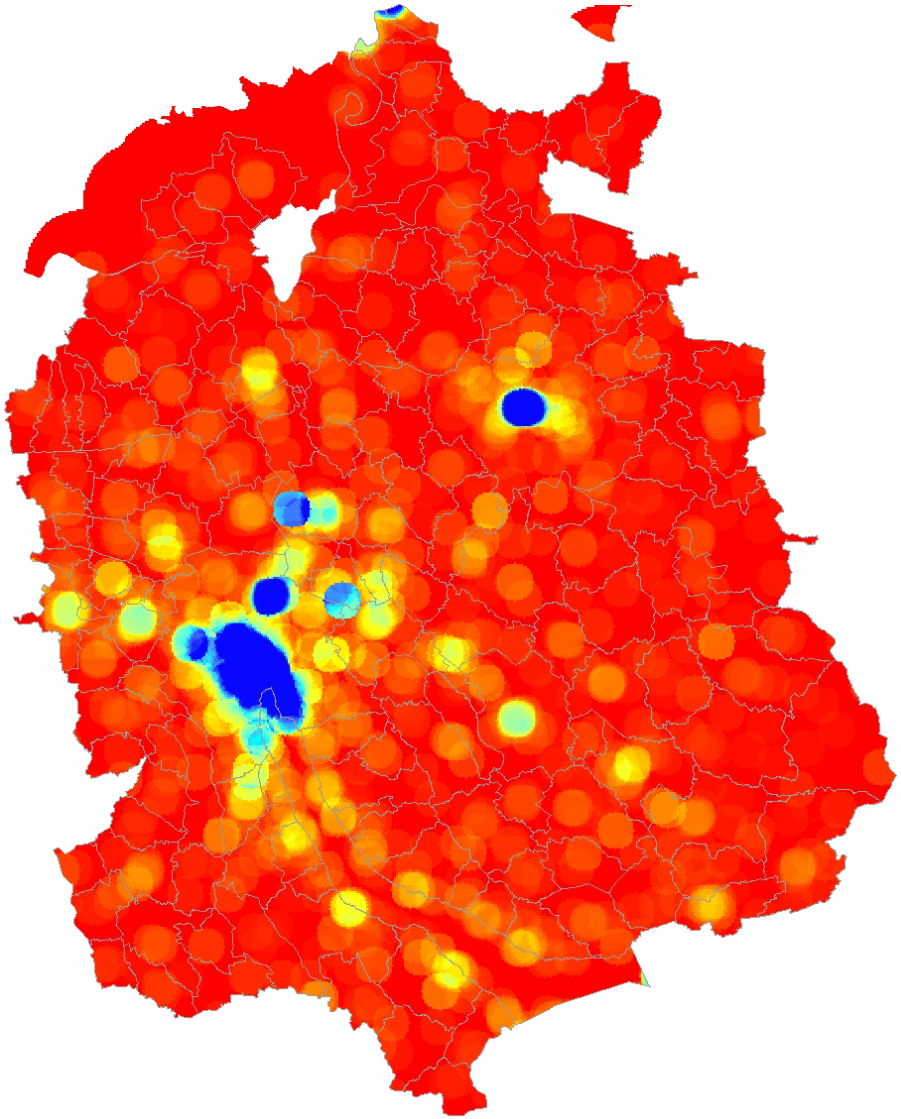
Age of head of household	Low income	Average income	High income
<30 year	0,3243	0,2802	0,3208
30 to 44 years	0,1430	0,1853	0,1606
45 to 64 years	0,0548	0,0673	0,0719
>65 years	0,0478	0,0346	0,0492

Beige, 2005

Data sources



GIS enrichment of the geocoded objects (1)



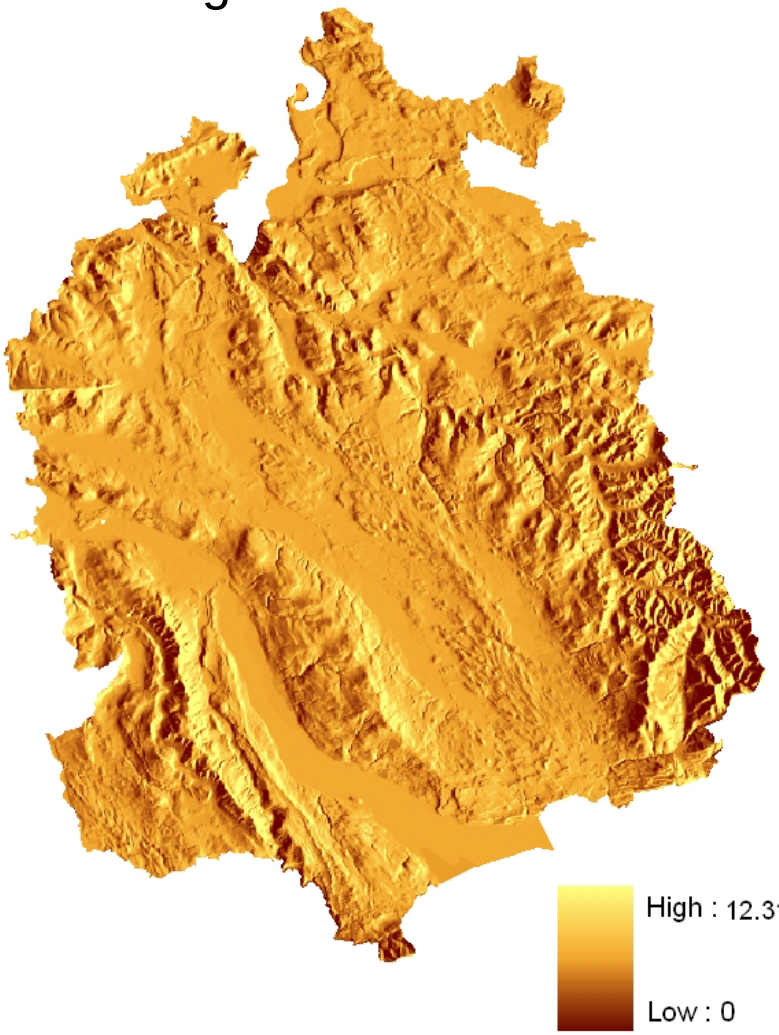
Density of employment in restaurants, bars and cafes (1 km radius)

High : 15.413706

Low : 0.000000

GIS enrichment of the geocoded objects (3)

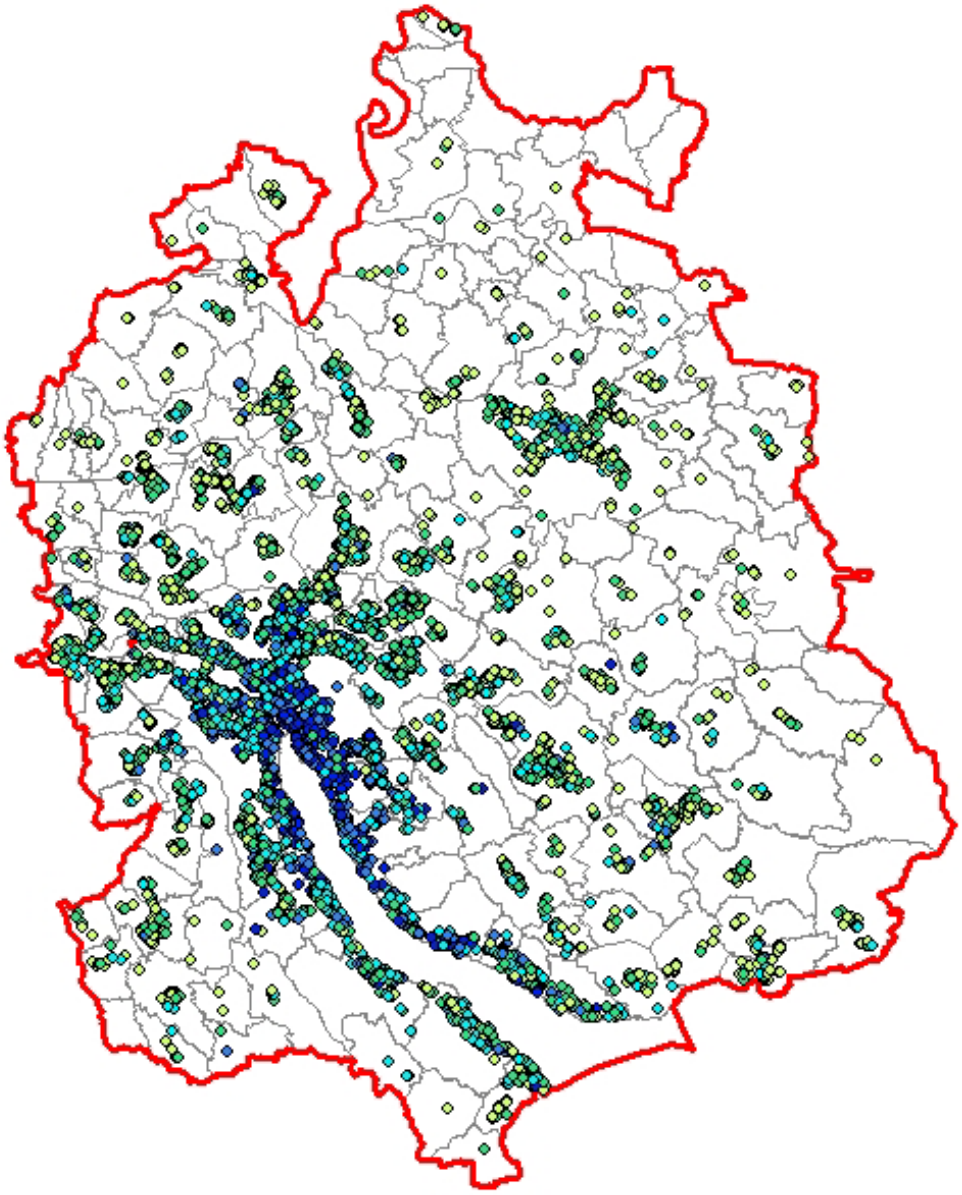
Morning



Evening

Sunshine Index: Shade and shadow situation for 9 typical sun positions (summer, spring, winter; morning, midday, evening)

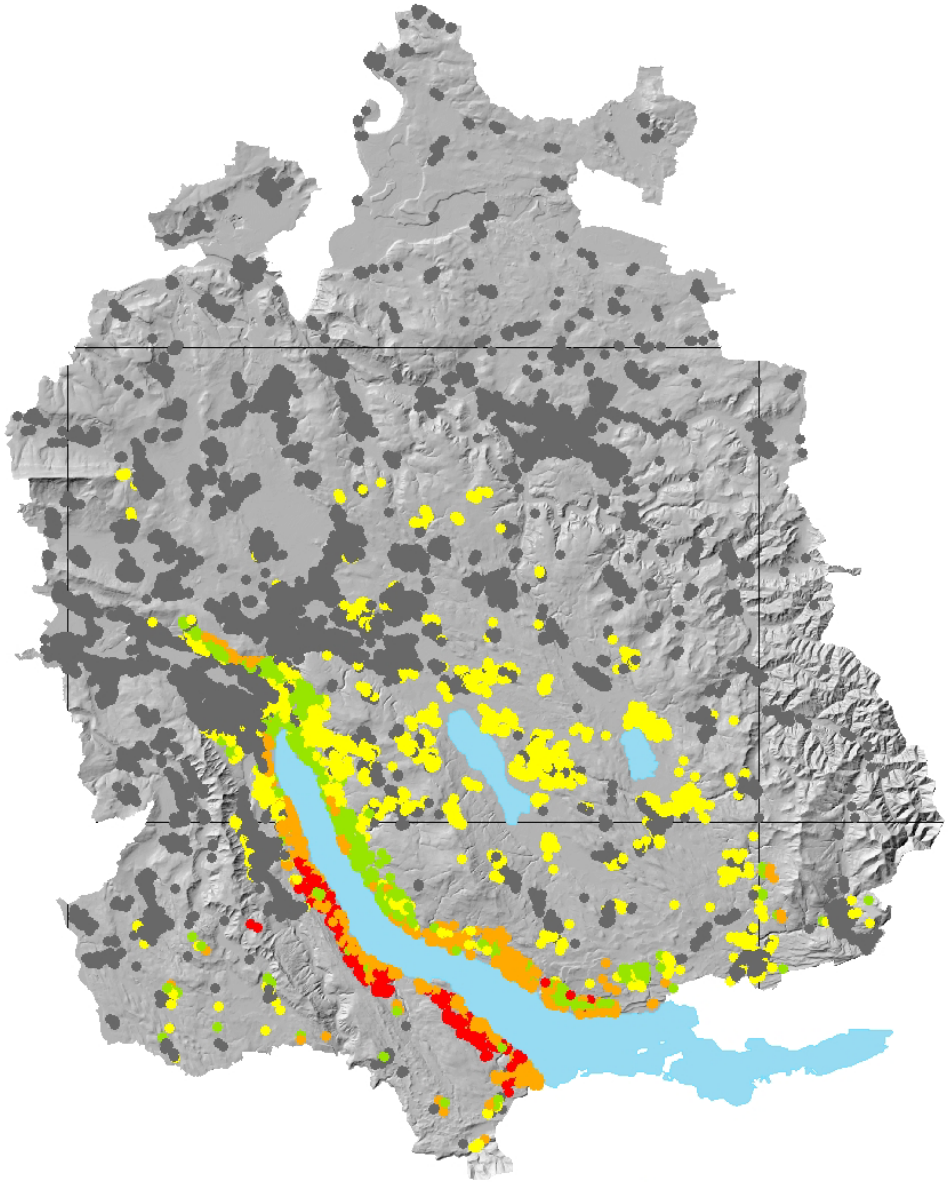
Hedonic rent price estimation (Comparis dataset, N = 9218)



Net bid rent
in CHF per month

- up to 17.0
- 17.1 - 20.0
- 20.1 - 25.0
- 25.1 - 30.0
- beyond 30.1

GIS enrichment of the geocoded objects (2)



Total lake surface visibility in sqkm

- 0
- 1 - 100
- 101 - 200
- 201 - 400
- 401 - 1000
- Lake

Hedonic estimation difficulties

- Travel time to Zürich CBD is most predominant factor
- Restrictions to include other regional accessibility measures due to multicorrelinearity
- Insensitivity of public transport and certain street improvements

- Only rent prices based on spatial variables applicable in UrbanSim
- Only significant variables have been selected
- Vacancy proved not to be significant

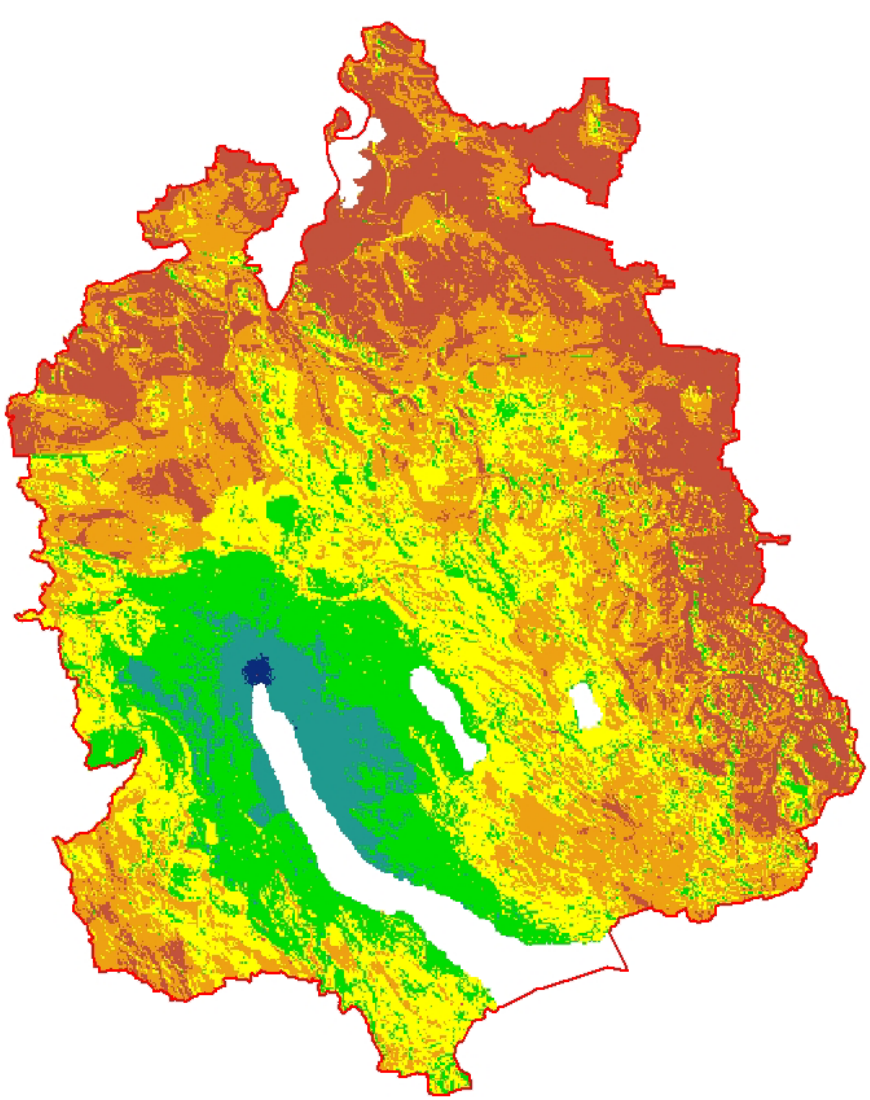
Results *(OLS: R^2 = 0.511; SEM: R^2 = 0.536; SAR: R^2 = 0.538)*

	OLS coeff.	SEM coeff.	SAR coeff.
Constant	1.716	1.740	1.298
(rooms)^0.5	-0.181	-0.180	-0.180
Lift	0.025	0.018	0.020
Fireplace	0.104	0.091	0.094
Balcony	0.021	0.022	0.019
Garden terrace	0.079	0.072	0.073
Ln(Travel time to Zurich City)	-0.263	-0.264	-0.180
Ln(Next rail station)	-0.013	-0.014	-0.010
Rail tracks within 50m	-0.030	-0.030	-0.026
Autobahn within 100m	-0.048	-0.047	-0.038
Autobahn exit within 2km	-0.035	-0.035	-0.024
Air noise beyond 52dB	-0.039	-0.039	0.025

Results *(OLS: R^2 = 0.511; SEM: R^2 = 0.536; SAR: R^2 = 0.538)*

	OLS coeff.	SEM coeff.	SAR coeff.
Solar exposure index (evening)	0.026	0.024	0.019
Ln(Visibility of terrain in sqkm)	0.005	0.007	0.004
Ln(Visibility of lake (>1sqkm) in sqkm)	0.016	0.016	0.012
Ln(# of inhabitants in ha)	-0.016	-0.018	-0.014
Ln(# of jobs in catering industry within 1km)	0.021	0.021	0.014
Percentage of foreigners in ha	-0.002	-0.002	-0.002
Grocery store (>400sqm) within 500m	0.009	0.008	*0.005*
% of buildings built before 1971 in municipality	0.001	0.001	0.001
Ln(Income per capita in municip. in 1000 CHF)	0.236	0.234	0.163

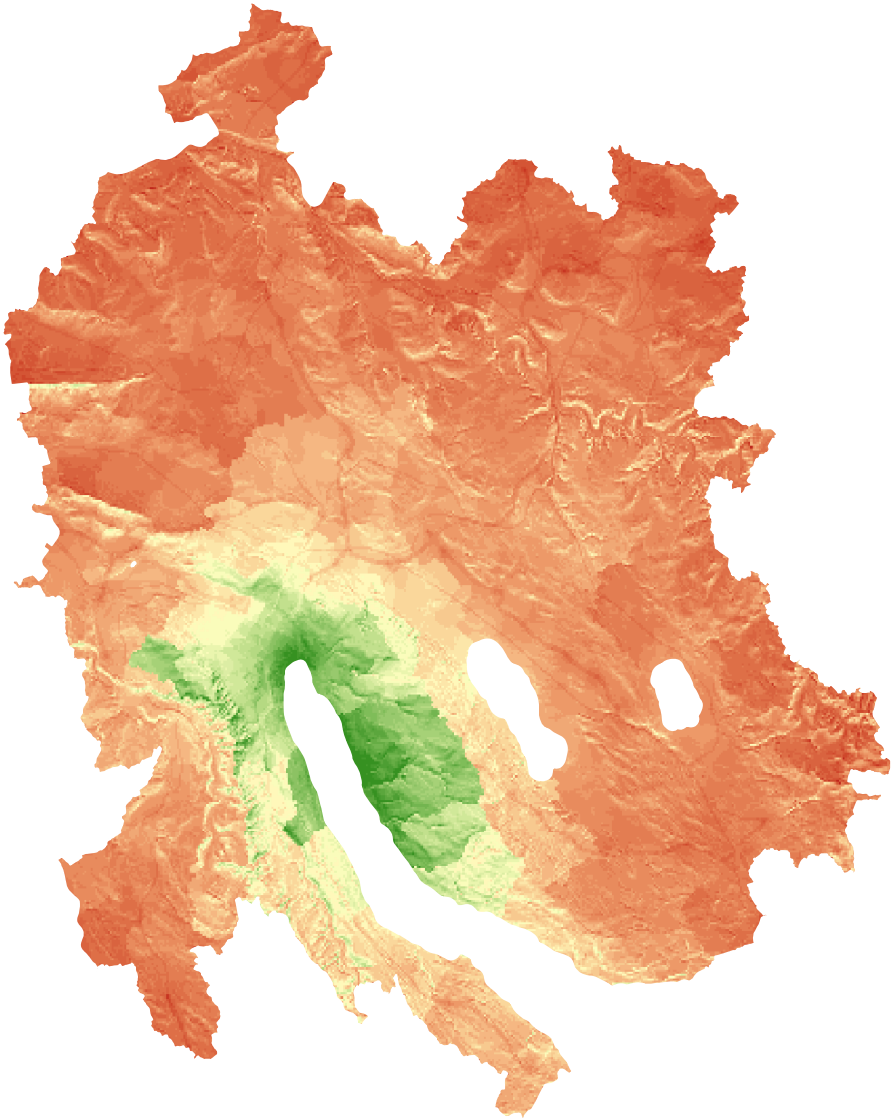
Results (OLS)



Monthly gross rent
in CHF per sqm

- 12.01 - 16.00
- 16.01 - 18.00
- 18.01 - 20.00
- 20.01 - 25.00
- 25.01 - 35.00
- 35.01 - 45.00

Results (UrbanSim)



Monthly gross rent in CHF per sqm

- 0 - 13
- 13.1 - 13.5
- 13.6 - 14
- 19.6 - 20
- 20.1 - 20.5
- 20.6 - 21
- 27.1 - 27.5
- 27.6 - 28
- 28.1 - 35.5

Location choice versus hedonics (1)

	m^2 - rents		Location choice	
Variable	Standard-ized	Non-Standardized	Best model	Urban-Sim
Constant		27,327***		
Accessibility				
Ln (car travel time to Zürich CBD)	-0,349***	-5,580***	0,018***	-3,335***
Ln (transit accessibility) for non-car owners			0,570***	0,600***
Distance to work [km]			-5,459***	
Power of distance to work			0,167***	
Ln (Distance to next motorway ramp [km])	0,080***	0,581***		0,119**
Ln (Distance to next station [km])	-0,033***	-0,242***		-0,115***
Railway line within 50m	-0,027***	-0,878***		-0,933***
Motorway within 100m	-0,017**	-0,702**		-0,400*
Increased noise level			-0,236***	

Location choice versus hedonics (2)

	m^2 - rents		Location choice	
Variable	Standard-ized	Non-Standardized	Best model	Urban-Sim
Local socio-demographics				
Density of young households				0,006***
Household of same size within 1km			0,0004***	0,0001**
Jobs in hotels&restaurants within 1km [10^{-3}]	0,193***	1,289***		
Environment				
Ln (distance to next lake [km])	-0,101***	-0,447***		
Sunshine index	0,090***	0,081***		
Slope (%)	0,064***	0,111***		
Municipal socio-demographics				
Federal income tax take per head [10^{-3} CHF]	0,169***	0,977***	-0,026***	1,037***
Share of buildings built before 1971 (%)	0,146***	0,049***		0,041***
Share of empty units (%)			-0,224***	-0,110***

Location choice versus hedonics (3)

	m^2 - rents		Location choice	
Variable	Standard-ized	Non-Standardized	Best model	Urban-Sim
Share of empty units (%)			-0,224***	-0,110***
Share of college graduates (%)				-3,073***
Household variables				
Ratio of rent to household income			-0,546**	
Rent per m^2 [CHF]				-0,600***
Size (m^2)/ Squareroot of household size			-0,289***	
	n = 9199; adjusted R^2 = 0,454; F = 695,883		n = 877, rho^2=0,26	n = 1356 rho^2=0,08

Firmographics

Data

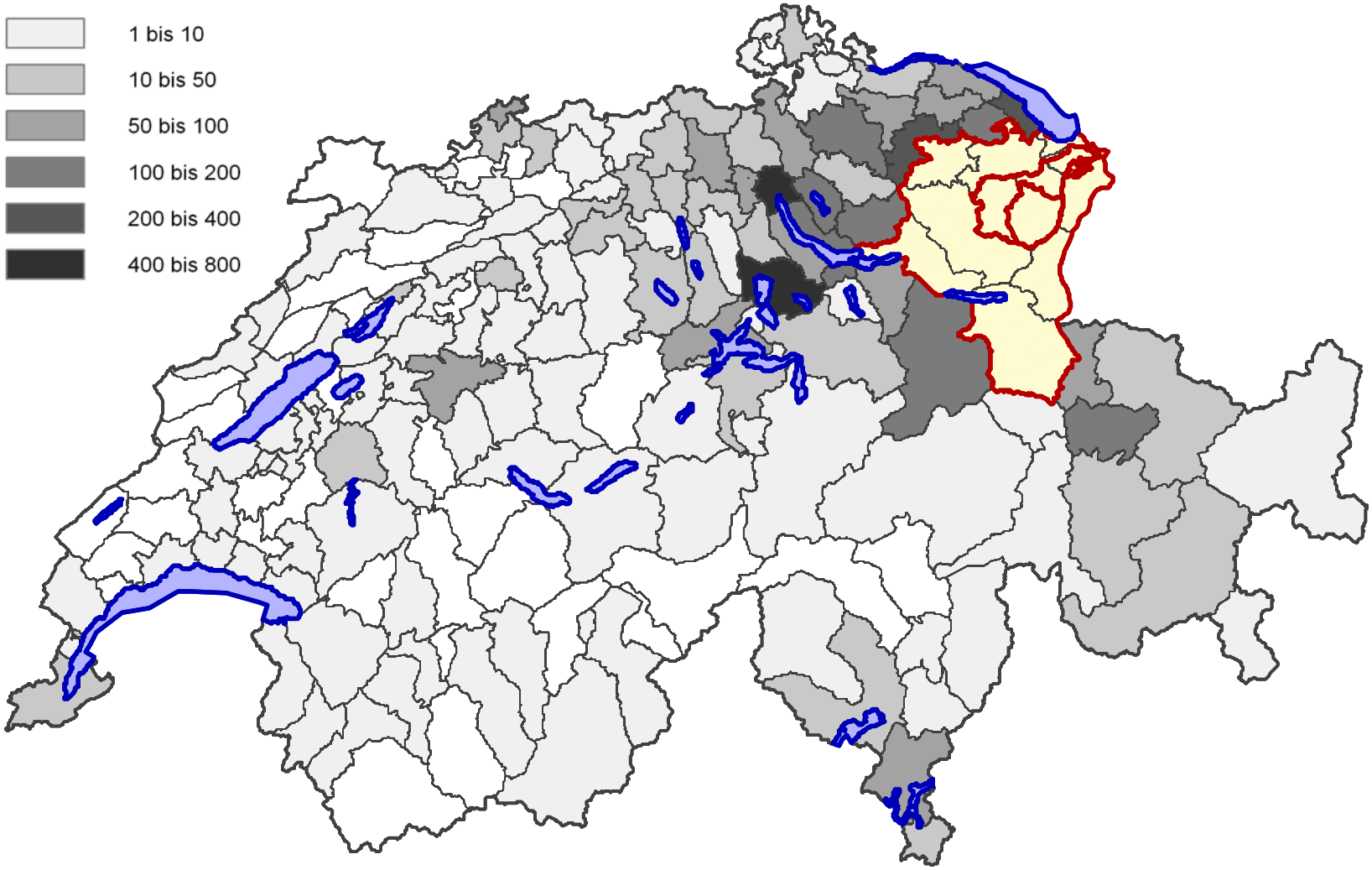
Sources:

- Official business register (1991-2006)
- Census of places of employment (2001)

Area:

- Canton St. Gallen
- Canton of Appenzell

Distribution of the moves

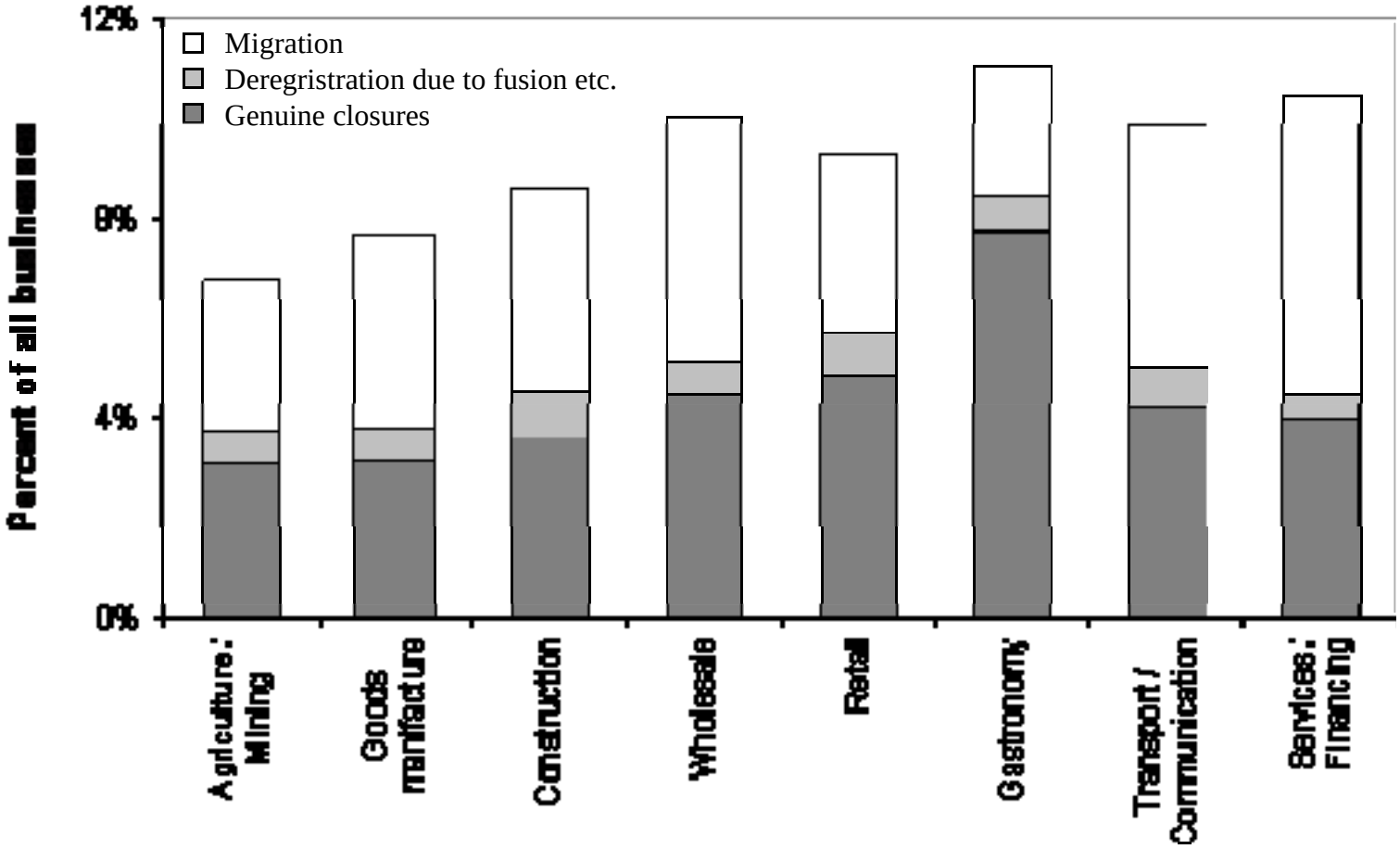


Bodenmann, 2007

Business sector formation

Sector	**NOGA codes**
Goods manufacturing	15 – 41 (D, E)
Construction	45 (F)
Wholesale	50, 51 (***G***)
Retail	52 (***G***)
Hotels and Restaurants	55 (H)
Transport and Communication	60 – 64 (I)
Services and Financing	65 – 67, 70 – 74, 90 – 93 (J, K, O)

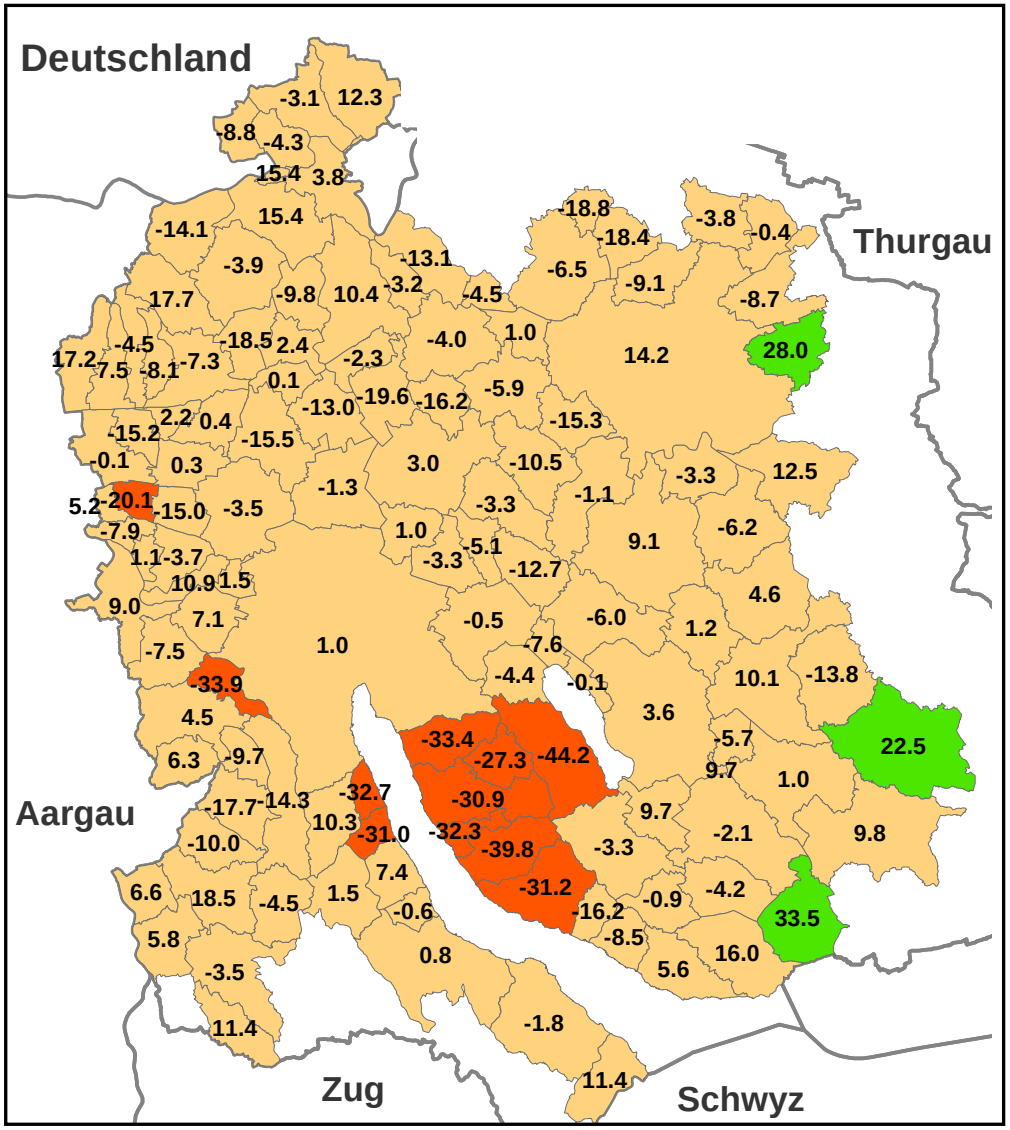
Annual chance of moving (1991-2006)



Bodenmann, 2007

First experiences

Running the model for four years (1996 – 2000)



Deviation of households per municipality: Simulation 1996 to 2000 in comparison to Census 2000

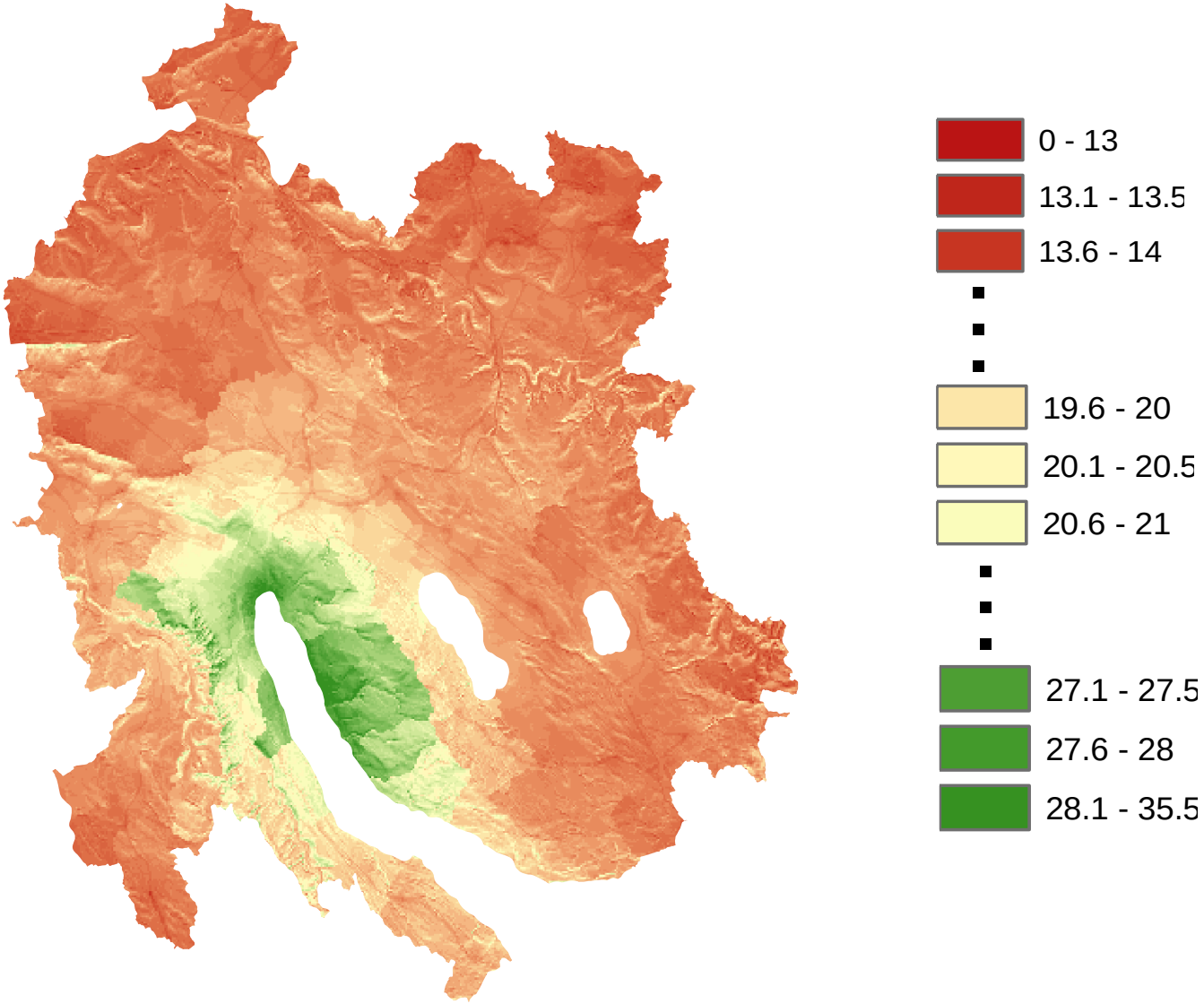
-45.0% - -20%

-19.9% - 20%

20.1% - 35%

Administrative Units:
GG25 © 2007 swisstopo
(DV33492.2)

Results (UrbanSim)



Challenges we had

- Restrictions because of input data, i.e.
    - lack of data concerning job space requirements and commercial vacancy rates
    - commercial floor area and job location incompatibility
- Two transport models with differing zones
- Low explanatory power of residential location choice models
- Submodels of development project location choice have been estimated based on categories not by sizes (as required by new version)
- Simulation without land use restrictions resulted in better new residential development allocation
- Could not penetrate source code completely (due to time restrictions at the end)
    - residential building construction in all land uses
      (plantype_id seemed to be disregarded)
    - irritating assignments of development types of new developments

Lessons we learned

- Start simulating ASAP
- Don’t wait for the perfect data
- Have one senior staff in the core team

Outlook

- Validation in an application setting
- Maintenance

- Development of an “advanced development model”
- (land assembly, platting, regulatory trading, infrastructure provision, construction, sale)

- Interface to MATSIM-T

Sources at

www.ivt.ethz.ch

Development modelling

- Generated development types out of changes in gross floor area by hectare (for every year between 1995 and 2004)
- MNL has been estimated based on changes in development types
- Seperate model for each initial condition (10 categories)
- 0 = no change in development type in consecutive years
- Alternatives generated out of all observed transition of the referring development type
- Often only constant and sum neighbouring hectares with same development have been significant

Model for W2 (>90% residential, 50-90% utilisation)

development to	W1	W3	WG2	WG3	I1	I2	I3	OE	UN
constant	**-3.54**	**-5.28**	**-5.38**	*-6.38*	**-2.38**	**-3.59**	**-2.66**	*-2.51*	**-6.57**
Amount of neighbouring hectares of same development type	**0.04**	*0.07*	*0.22*	**0.48**					*0.09*
parameter significant at:	**95% level**								
	90% level								

$\rho^2 = 0.850$

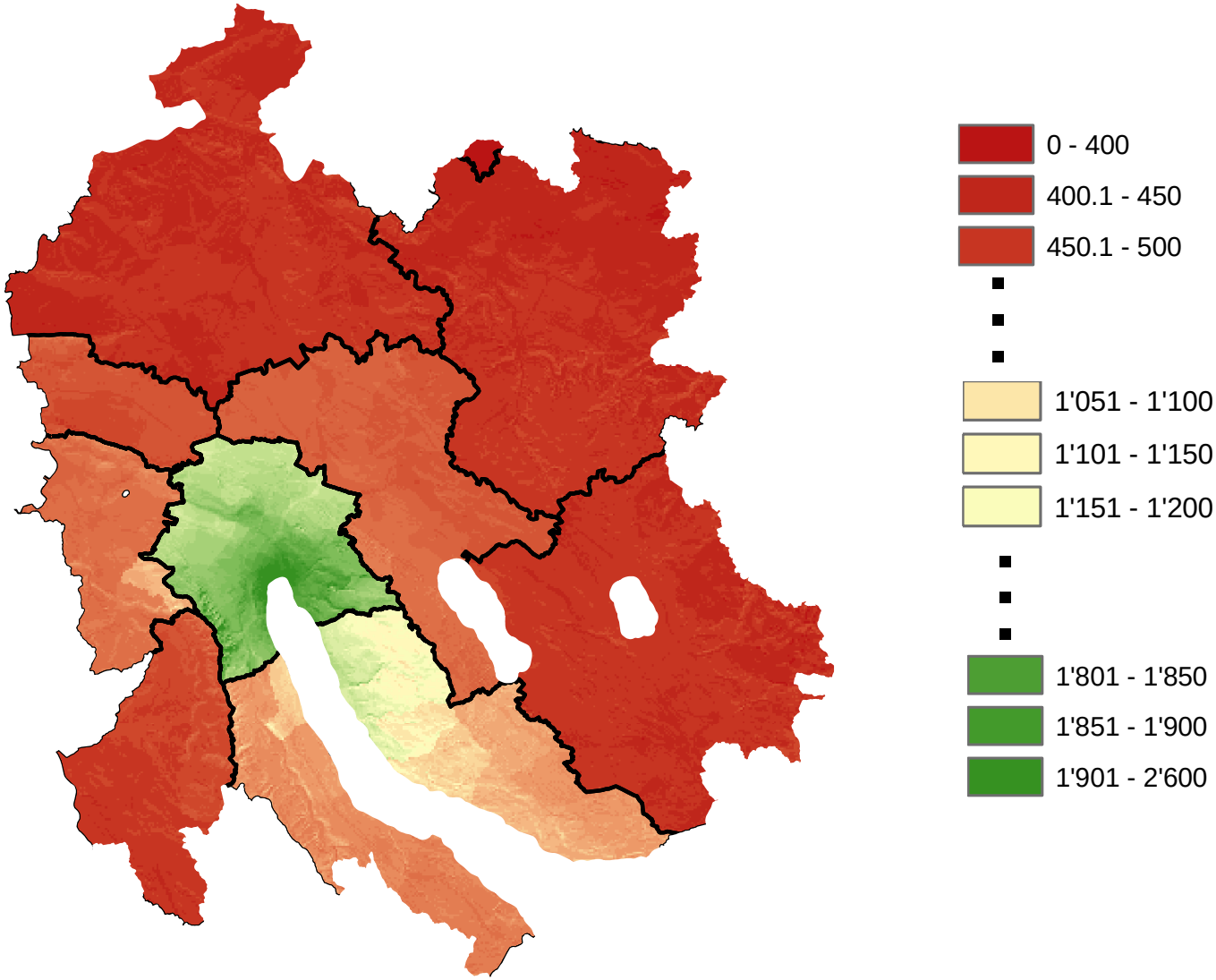
Employment location choice (retail)

	beta	robust t-test
Accessibility of population by car (2003) in municipality	-0,66828*	-4,70
Ln(commercial gross floor area) in ha	0,27899*	14,55
Ln(industrial gross floor area) in ha	0,13514*	5,88
Ln(governmental floor area) in ha	0,07143*	6,02
Ln(residential units) in ha	0,02965*	16,33
Reserved area in municipality	-0,07367	-1,68
Share of inhabitant with college degree in municipality	-0,07052*	-4,26
Income per capita in municipality	0,00003*	6,47
Total jobs in radius of 1km	0,00504*	2,09
Jobs in the same sector in radius of 1km	0,47579*	6,78
Jobs in the services and financing sector in radius of 1km	0,01476	0,35
Share of households with average income in skm	2,52632*	9,11

Rho^2: 0,60; N: 3514

* : significance at 5% level

Land price


0 - 400
400.1 - 450
450.1 - 500
1'051 - 1'100
1'101 - 1'150
1'151 - 1'200
1'801 - 1'850
1'851 - 1'900
1'901 - 2'600