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Simulating the evolution of urban systems for sustainability assessment

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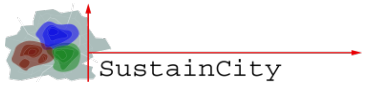
Simulating the evolution of urban systems for sustainability assessment

C. Zöllig Renner

Collaborators: P. Schirmer, E. Renner, K. Müller, B.R. Bodenmann, K.W. Axhausen



Overview

Introduction

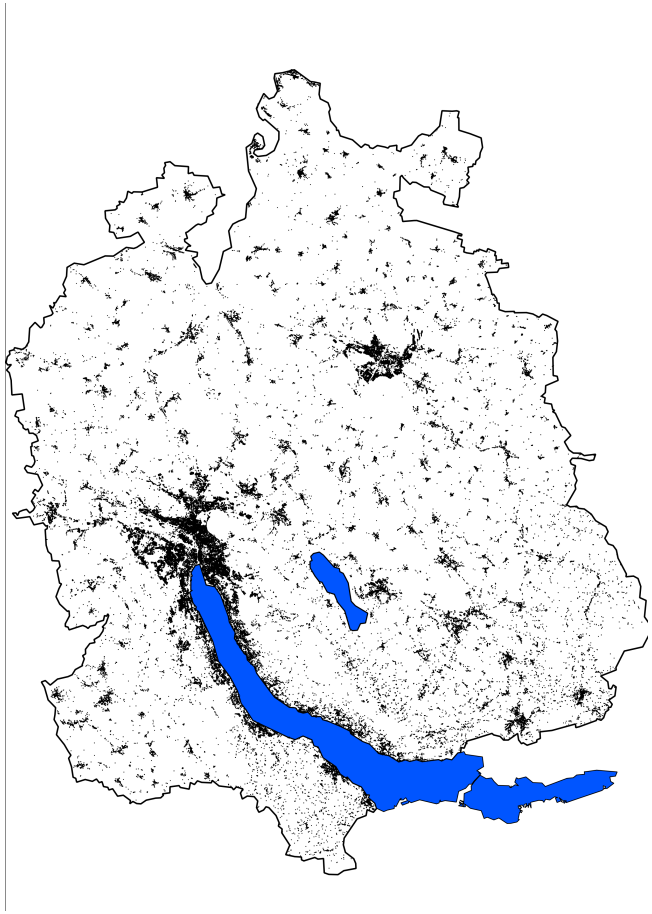
Model

Case study results

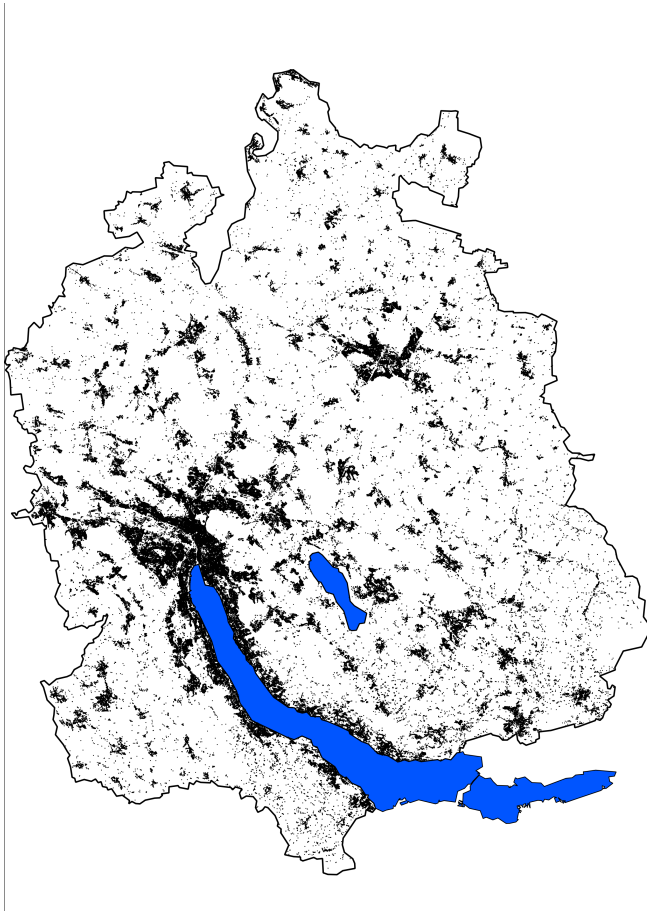
Experiences and challenges

Source backgroundimage: GoogleEarth

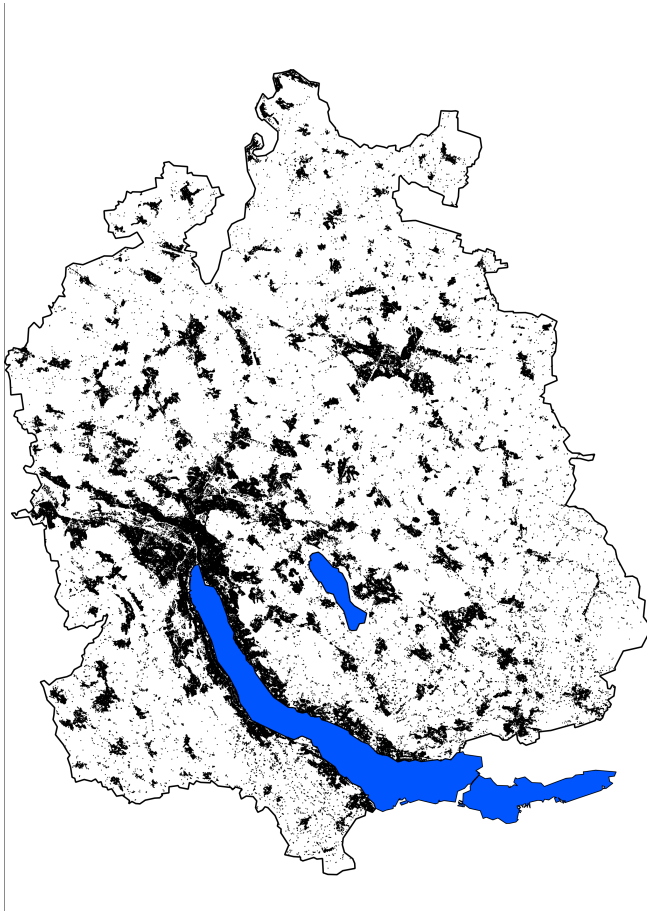
Urban systems' evolution



1950



1980



2010

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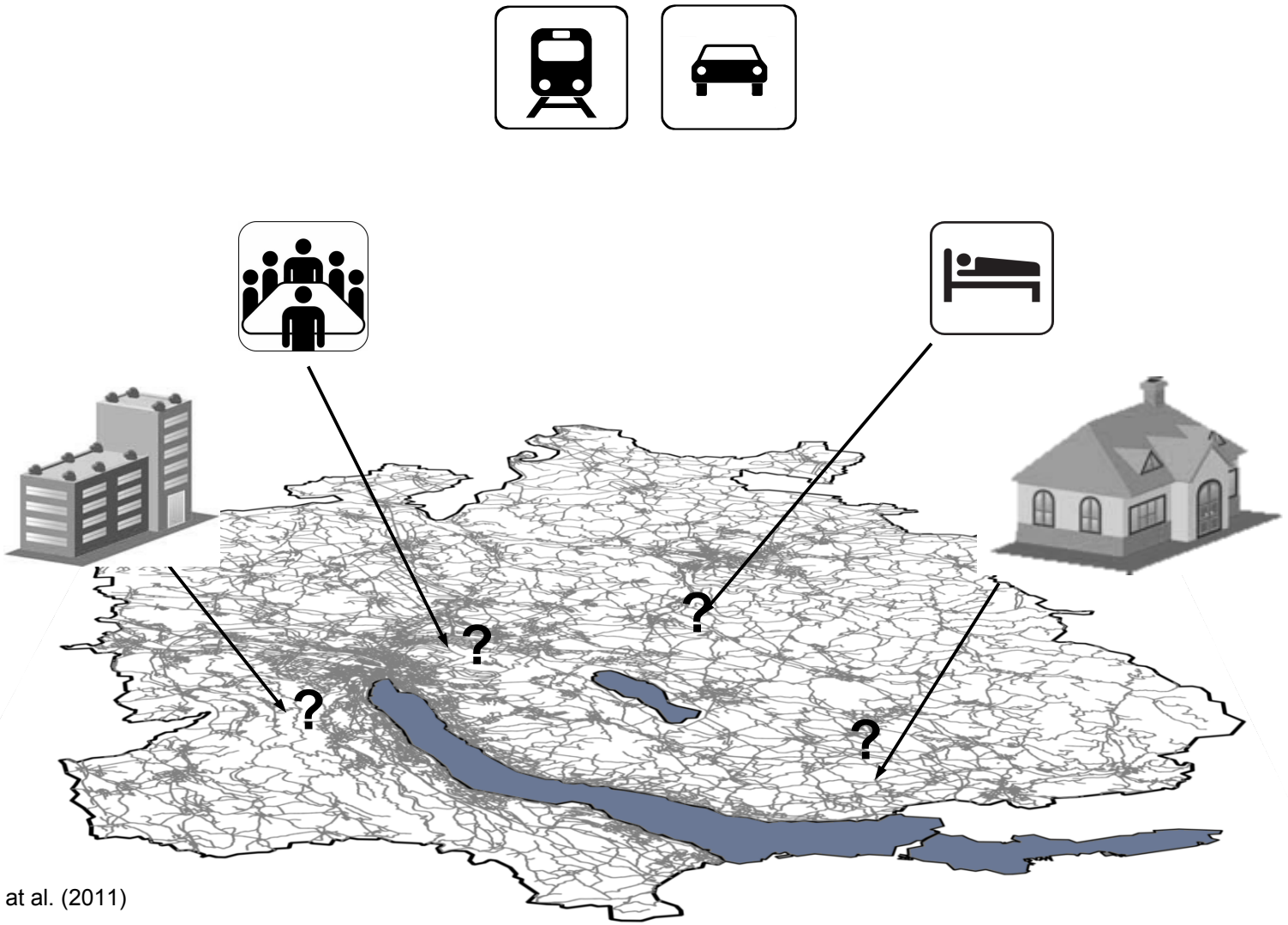
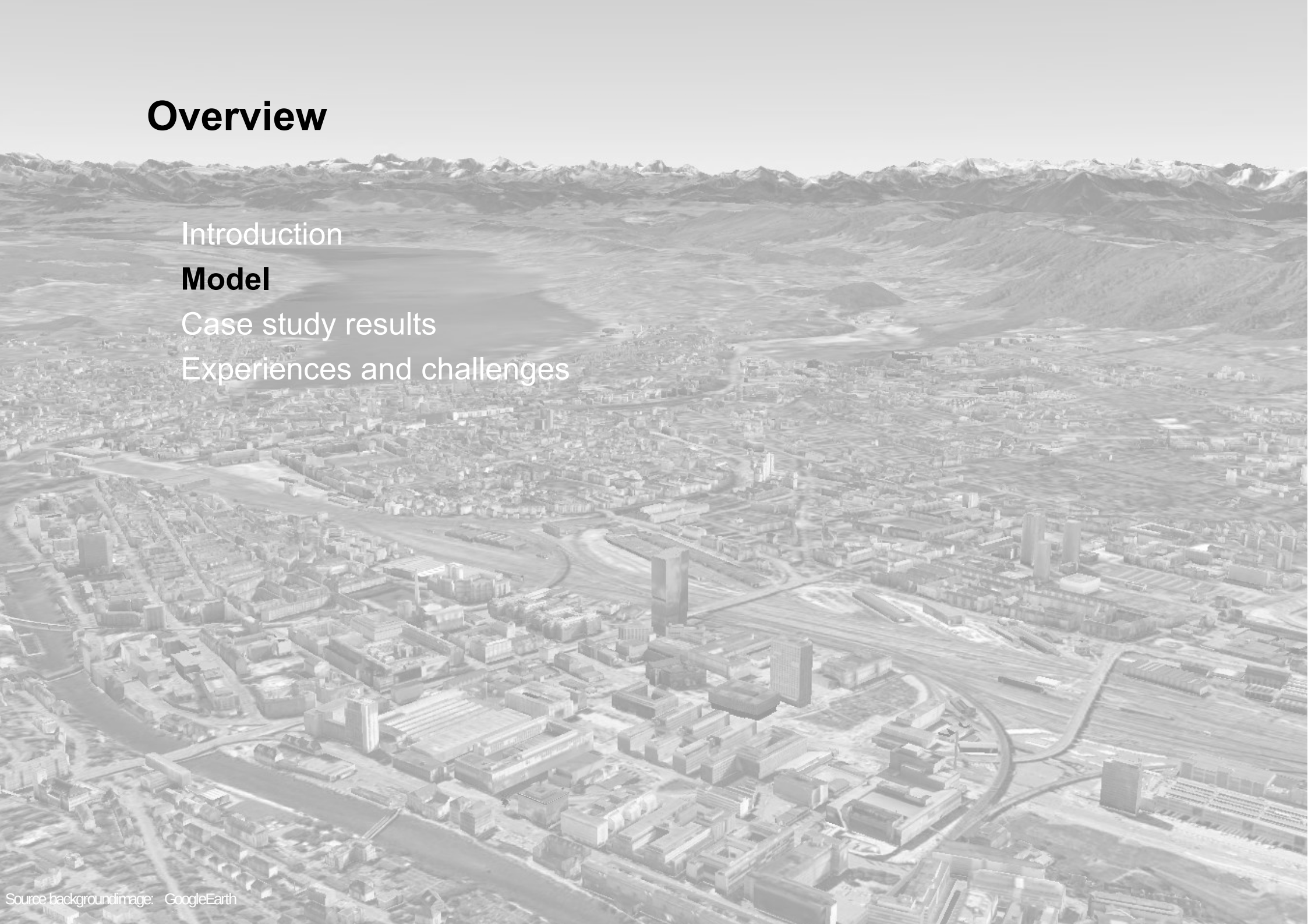
Consequence of decisions



Source: Zöllig at al. (2011)

Overview



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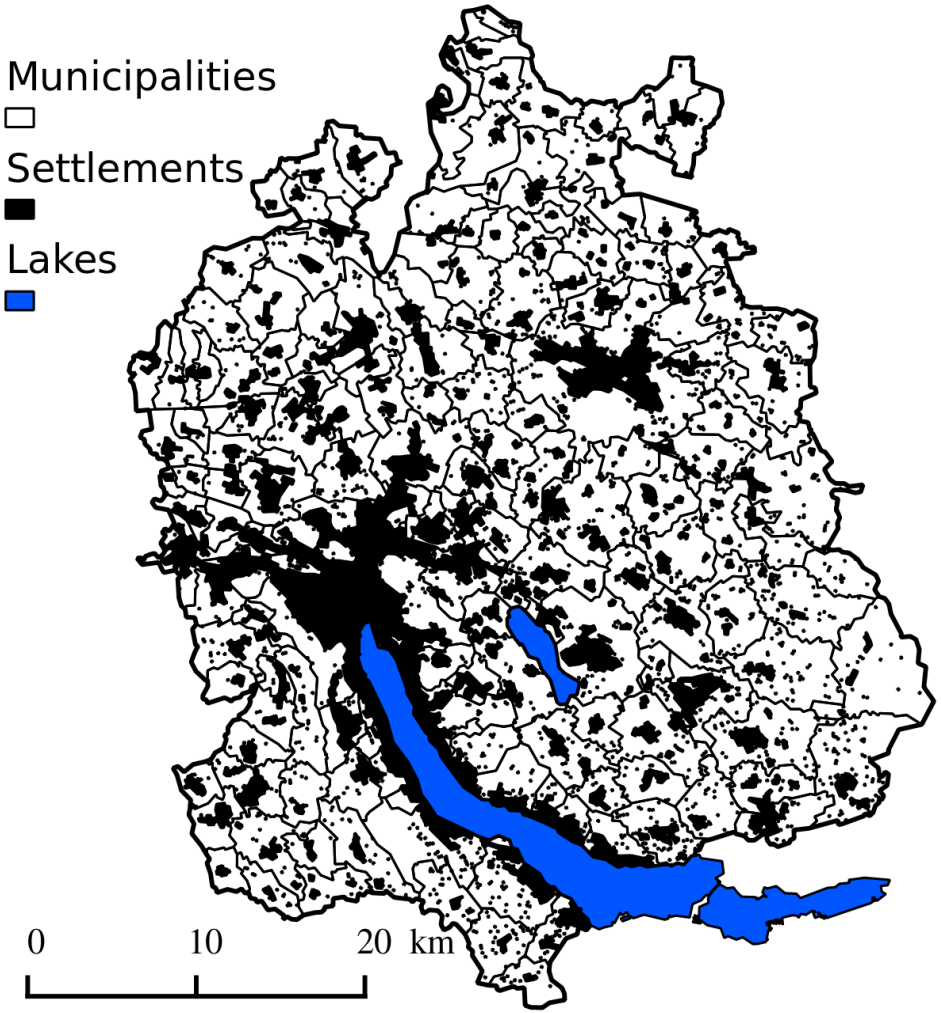
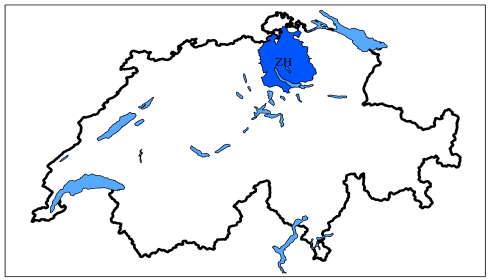
Simulation area and time period

Simulation start: 2000

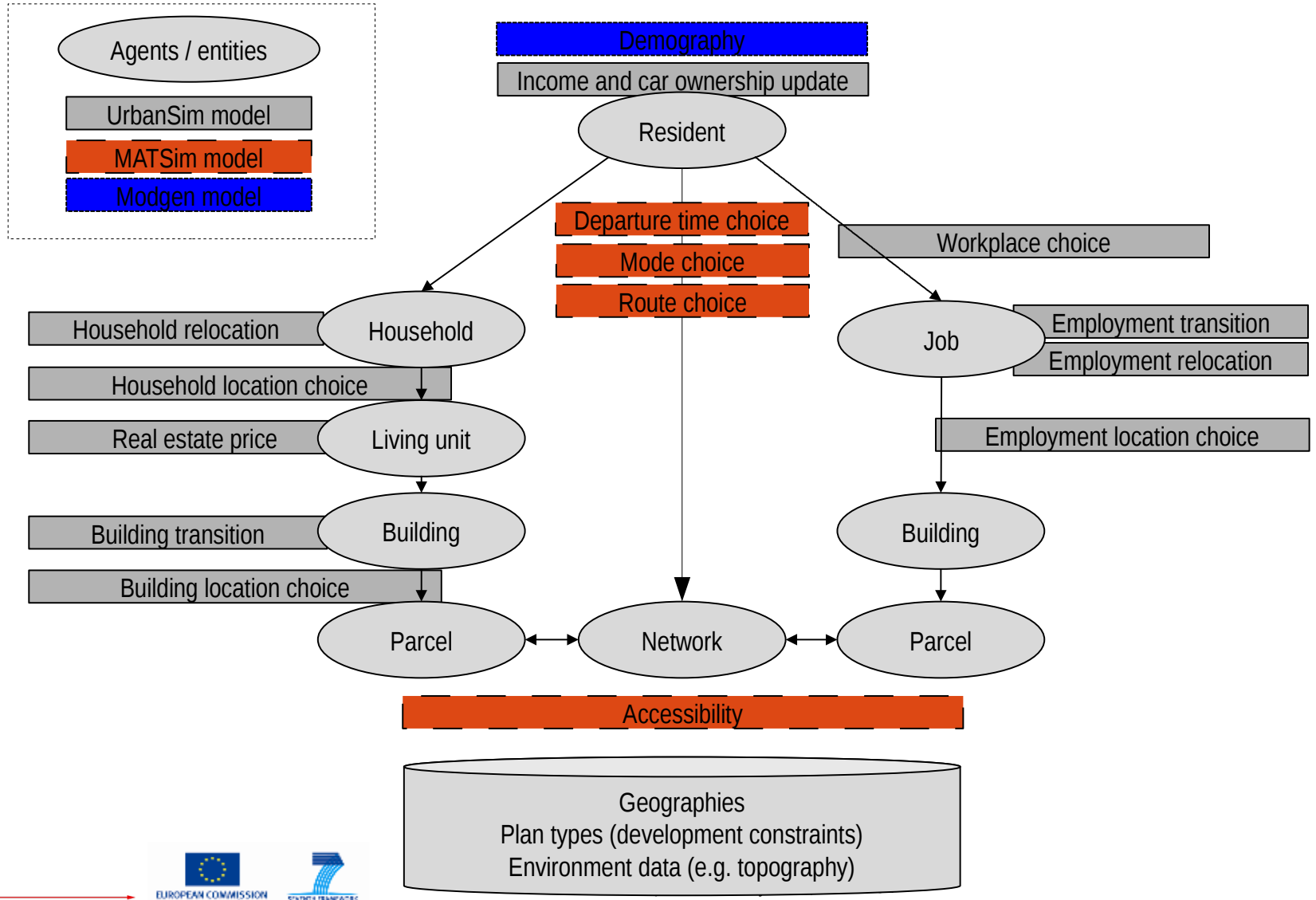
Evaluation period: 2000-2010

Simulation period: 2010-2030

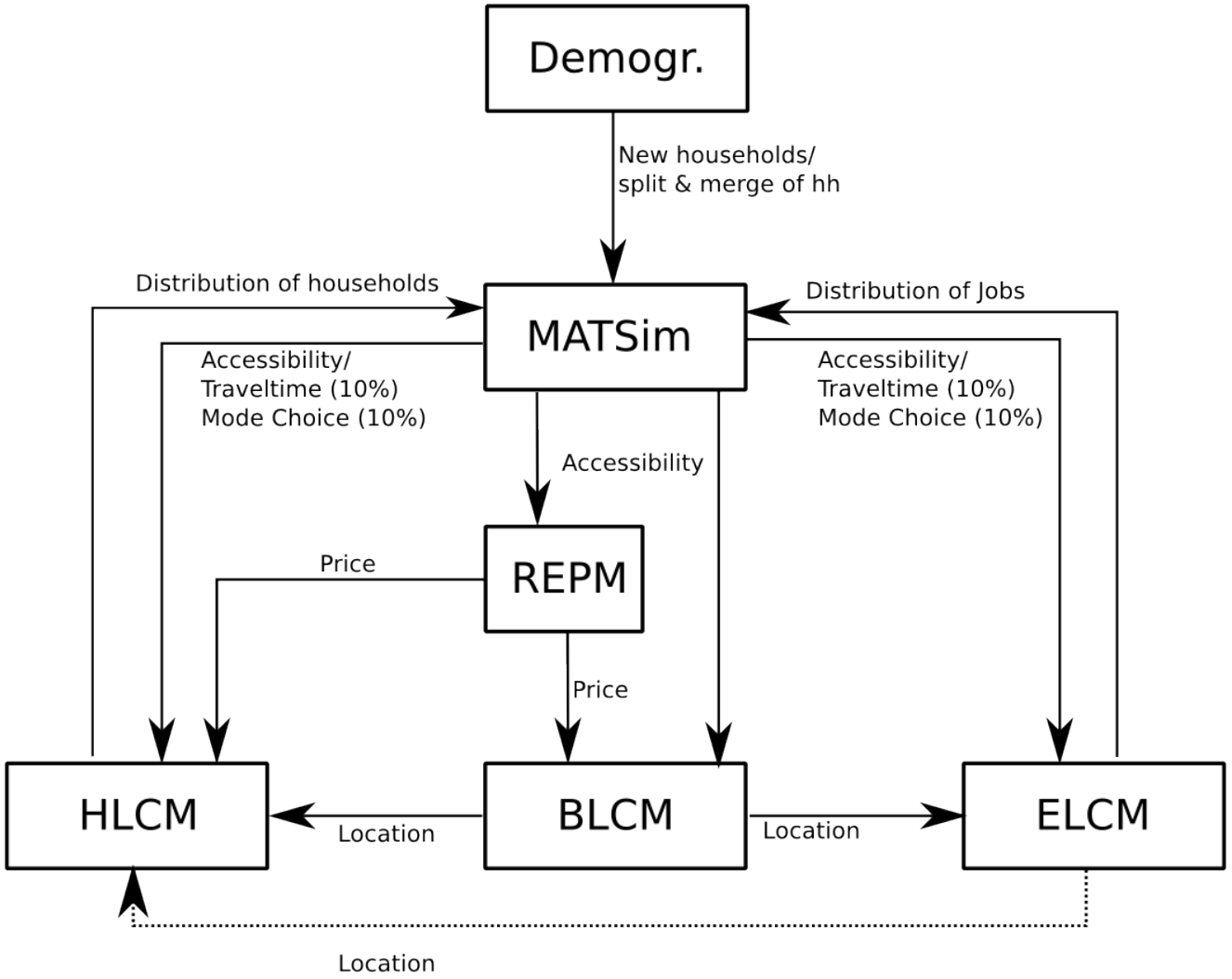




Structure of the model system



Interaction of sub-models



Real estate price model

	UrbanSim		Comparis 2005 (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 m² (ln)	+	**	+	**
Slope of terrain	+	**	+	**
Sunshine index (evening)	+	**	+	**
Foreigners within 300 m	+	**	(-)	(**)
Adj. Likelihood ratio index:	0.78173		0.85	

Household location choice model

	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 (m²)	+	**	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)	-	**	Denisty 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)

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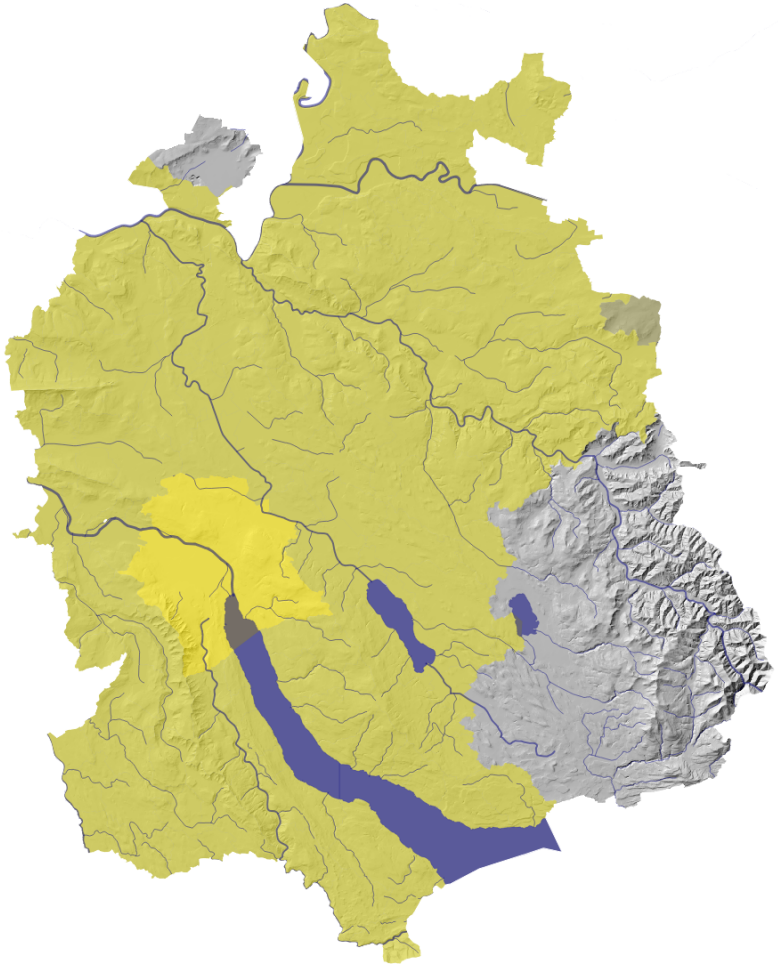
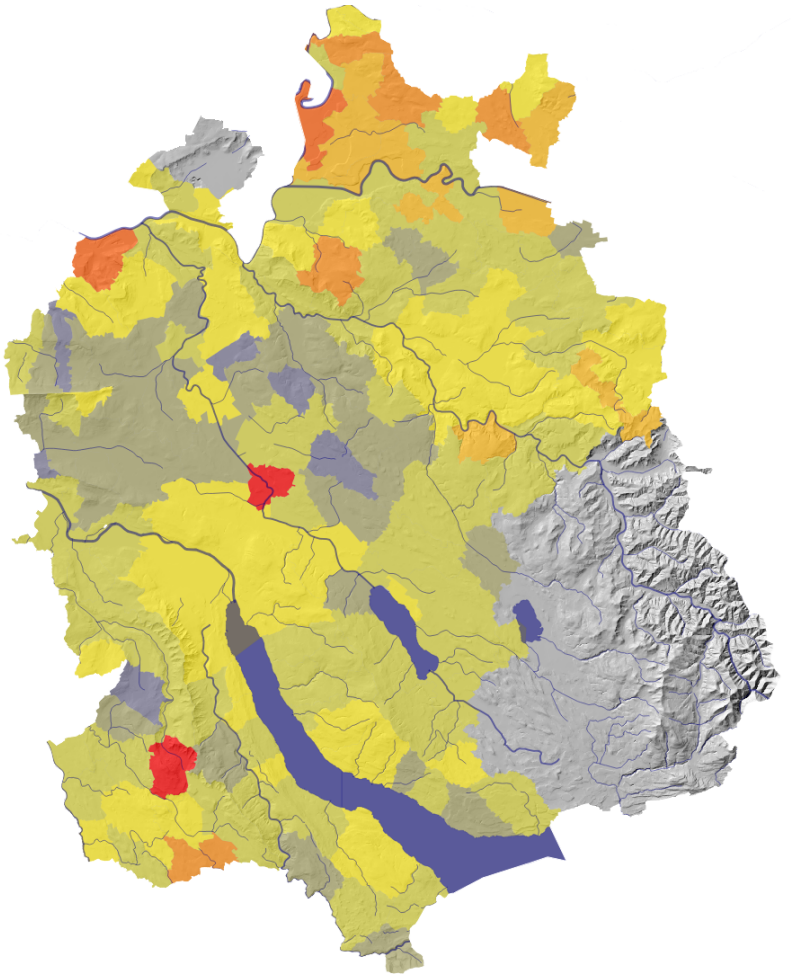
Valuation – Persons

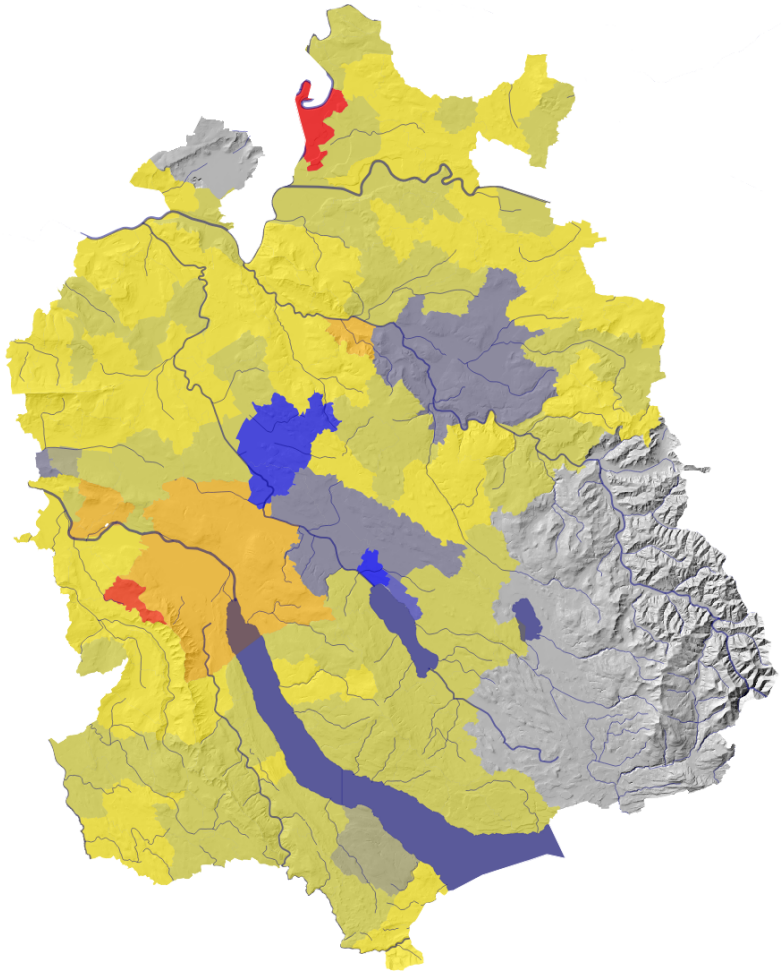


Difference of simulation to validation 2000:
Persons per km^2 of municipality

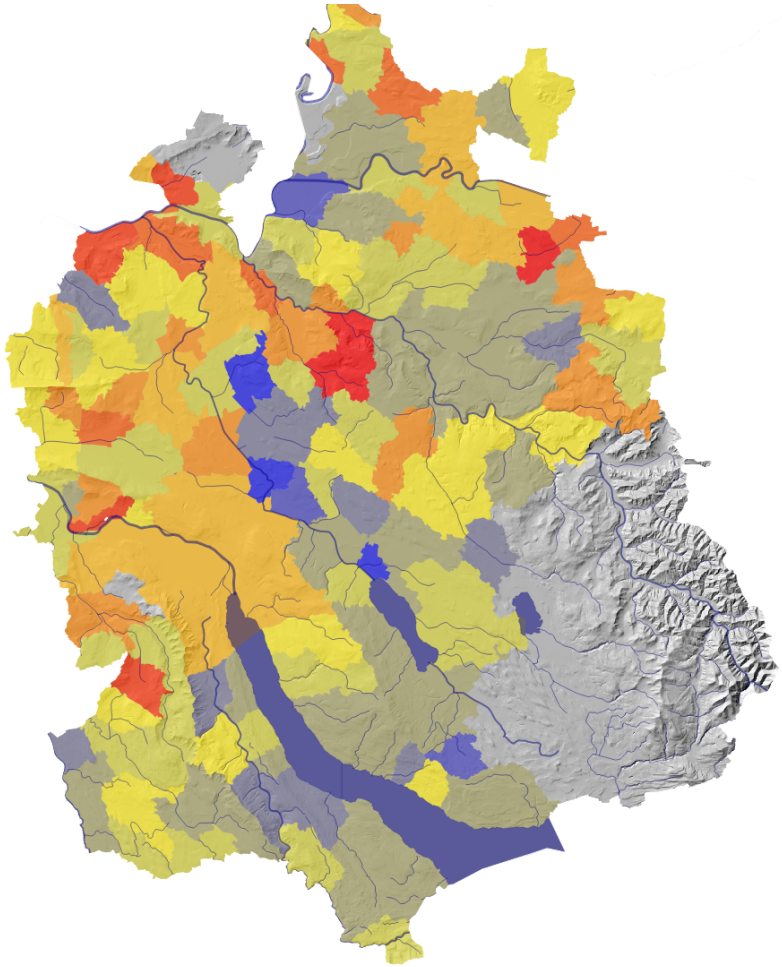


Difference of simulation to validation 2008:
Persons per km^2 of municipality

Valuation – Jobs



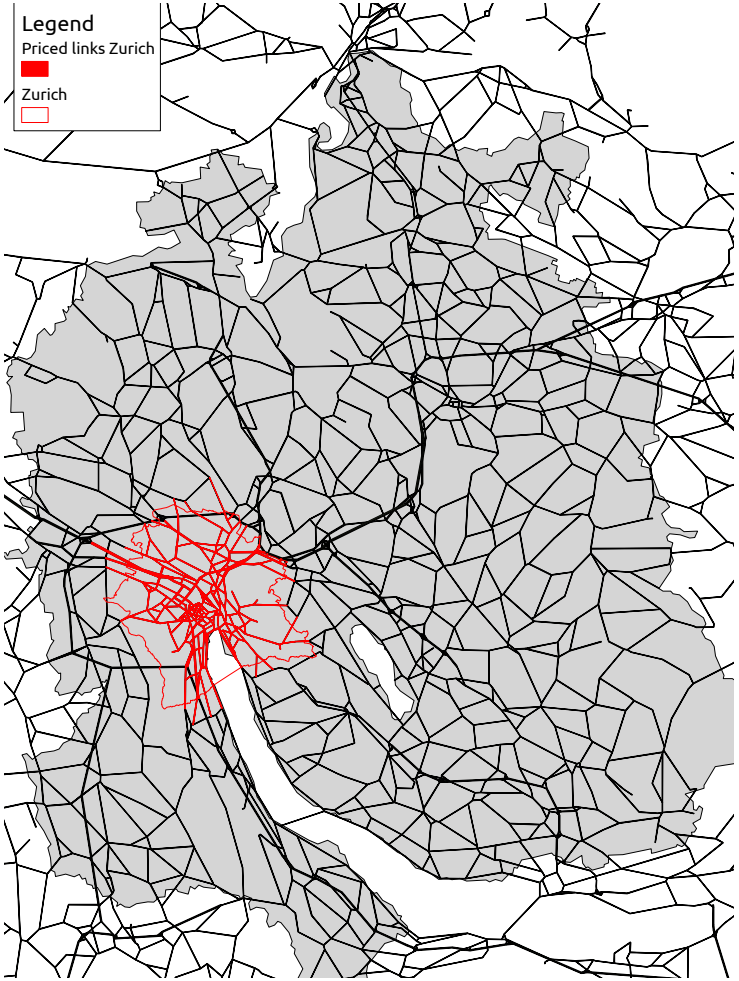
Difference of simulation to validation 2001:
Jobs per km^2 of municipality



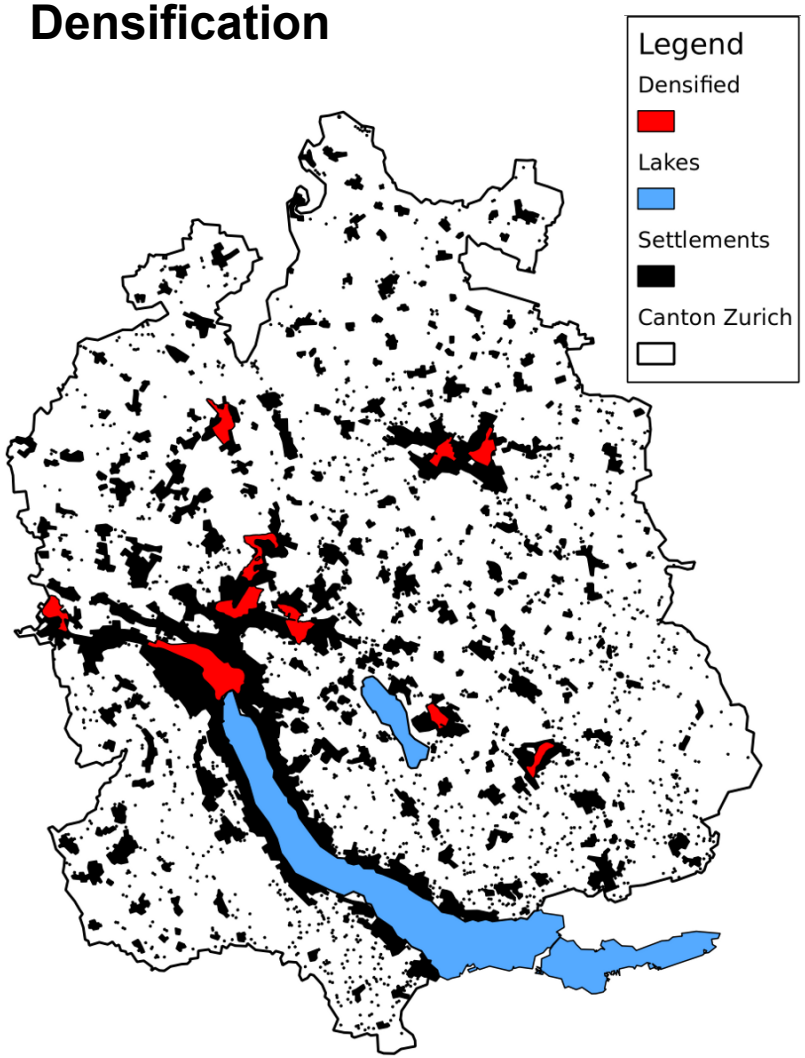
Difference of simulation to validation 2008:
Jobs per km^2 of municipality

Scenario: Definition policies

Roadpricing (cordon toll)



Densification

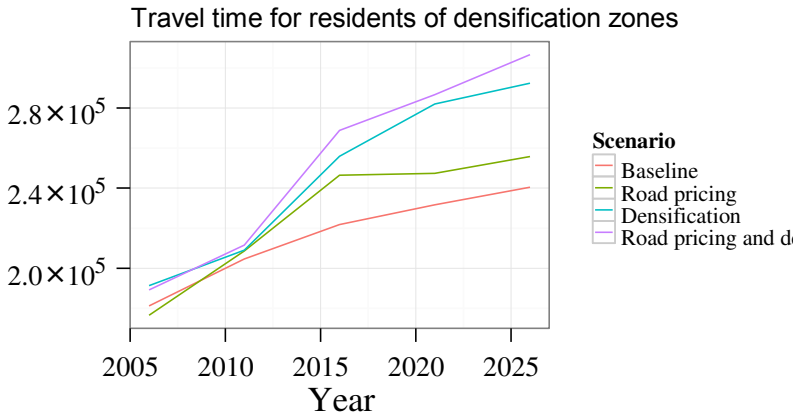


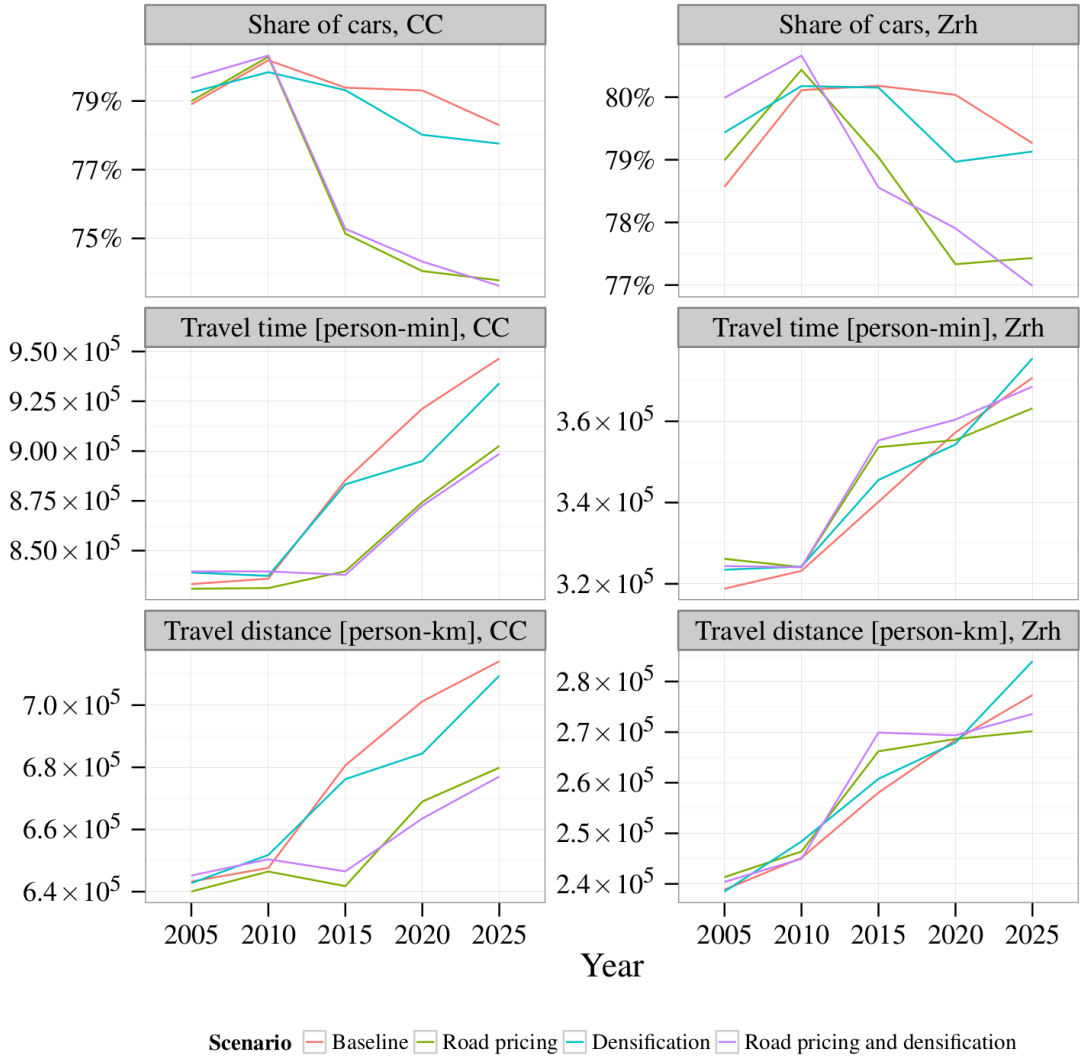
Scenario: Evaluation over time

Scale of observation

cordon crossing traffic (CC)

within-cordon residents (Zrh)





Scenario: Cross-sectional evaluation

Percentage deviation from baseline, 2030

Variable	Road pricing	Densification	Road pricing & Densification
Travel indicators			
Travel time in study area	5.1	0.3	4.3
Travel time in cordon crossing traffic	5.3	0.3	4.6
Travel time of inhabitants of densification zones	10.2	24	30.2
Distance travelled by car in study area	-1	-0.7	-1.9
Distance travelled by car in cordon crossing traffic	-3.2	0	-3.5
Distance travelled by car by residents of Zurich	-1.9	3.1	-1.4
Travel time by car in study area	-1.3	-1	-1.9
Travel time by car in cordon crossing traffic	-3.5	-0.2	-3.6
Travel time by car by residents of Zurich	6.9	2.8	-0.6
Car share in study area	-4	-0.6	-4.1
Car share in cordon crossing traffic	-4.5	-0.2	-4.5
Car share of residents of Zurich	-2.4	-0.2	-2.7
Land use indicators			
Number of households in Zurich	-0.7	1	-0.1
Number of jobs in Zurich	4.9	-0.9	4.1
Number of living units in Zurich	-0.6	0.9	-0.1
Number of households in densification zones	-0.6	18.3	16.8
Number of jobs in densification zones	1.1	0.8	2.3

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Experiences

Integrated consideration of land use and transport changes problem perception

Dynamic and detailed modelling allows flexible assessment (scale, aspect)

Extensible to other aspects of sustainability

Packages of measures can be assessed → Coordination

Data preparation is work intensive

Important data is not available

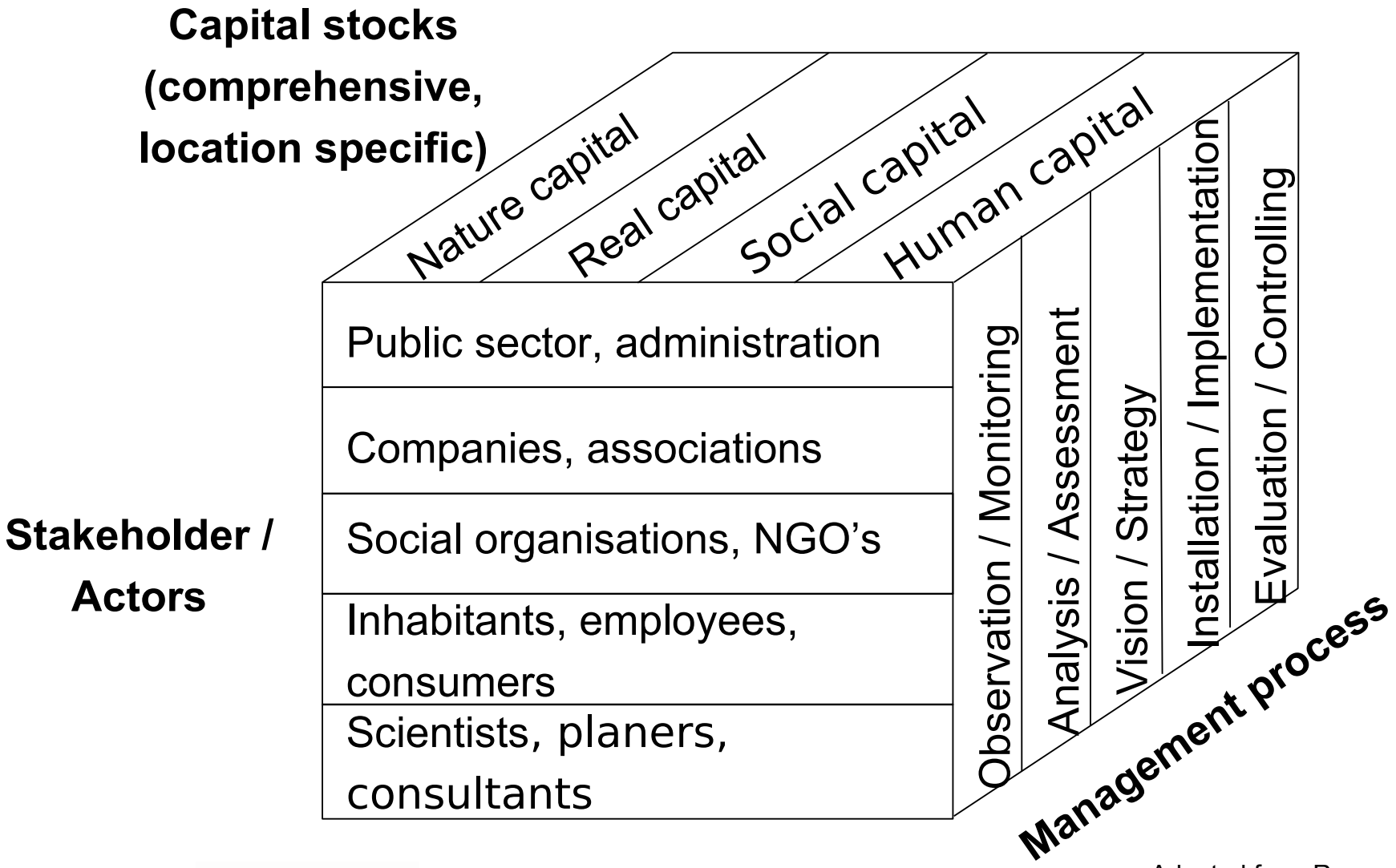
Considerable computation time (2.5 days)

Expertise required

→ Potential to help governing regional sustainability transition.

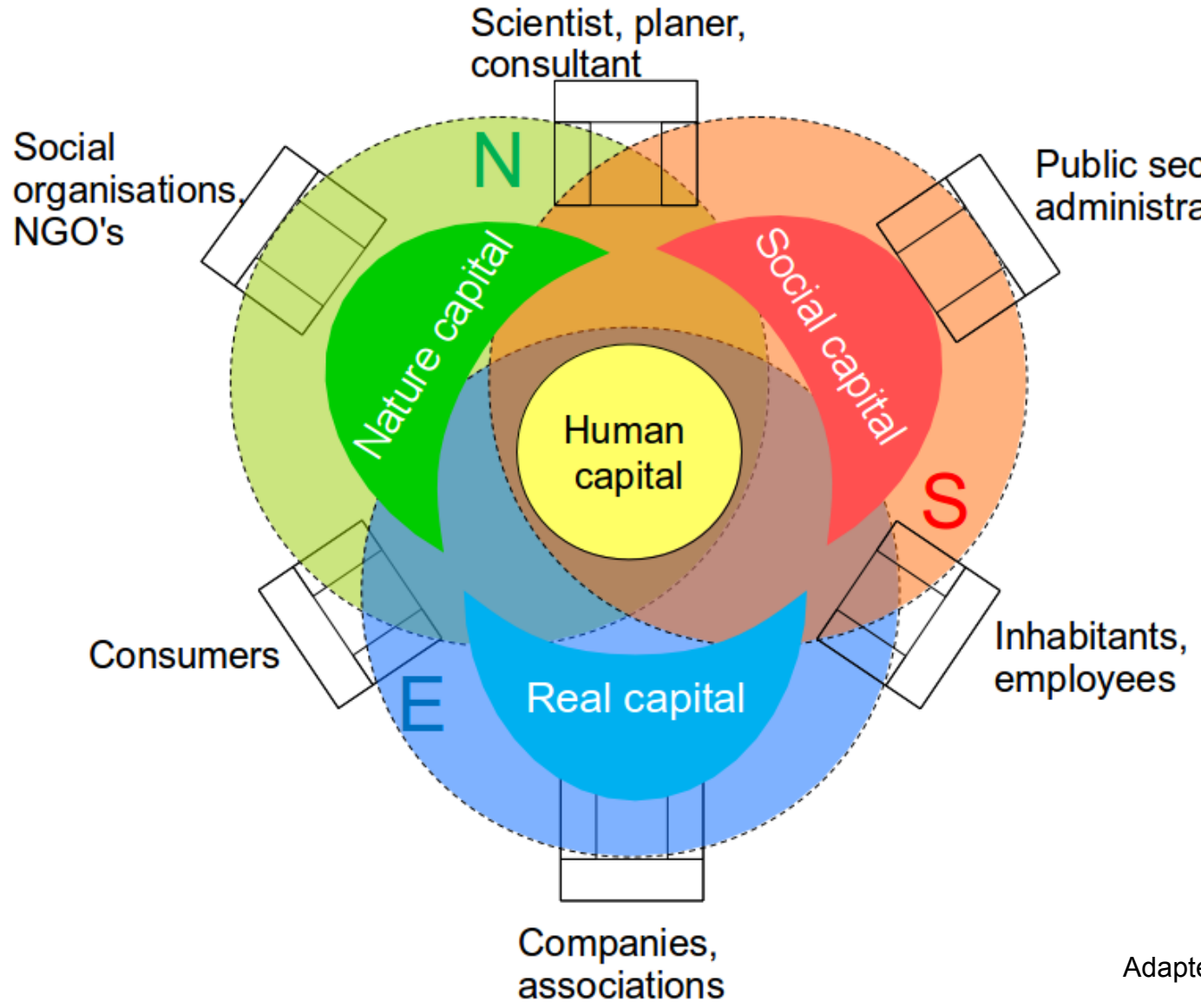
How can such a system be put to practice?

The management model of regional capital stocks



Adapted from Renner (2012)

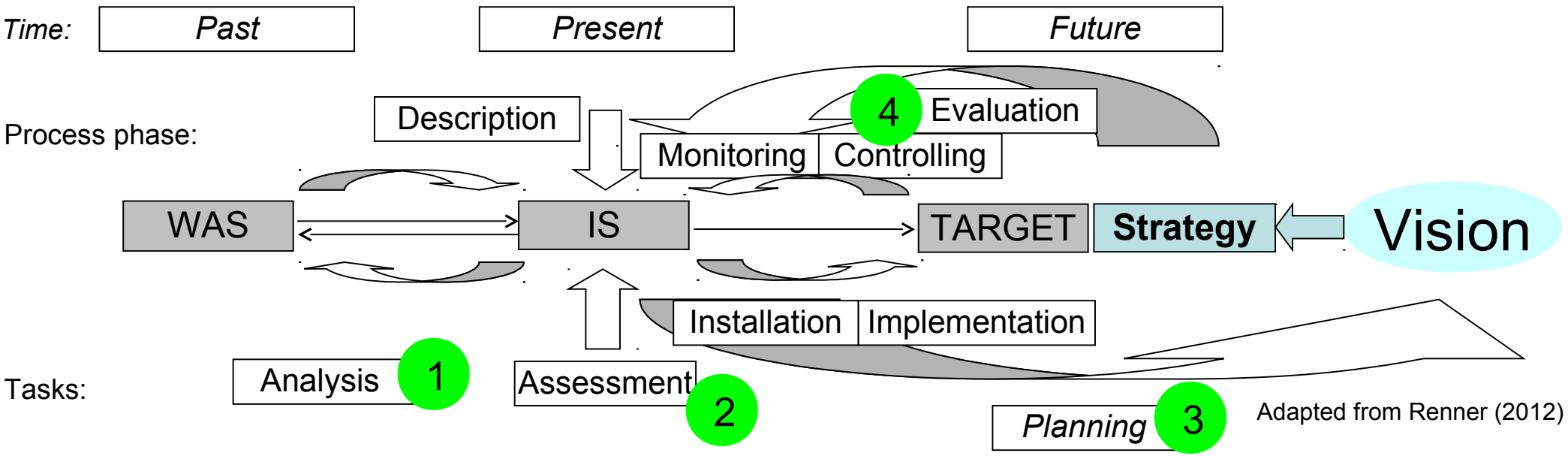
Simulation as crystallisation point on round table about regional capital stocks with stakeholders



Adapted from Renner (2012)

Funded under Socio-economic Sciences & Humanities

Supporting the regional management cycle



1: Find relations in regional data, derive preferences for characteristics
2: Describe current state
3: Stimulate visions, strategies and innovative solutions by contrasting expectations to scenarios
4: Integrate monitoring and controlling to achieve lean processes and continuity

Conclusion

Integrated land use transport simulation offers a distinct approach to governance and can be a helpful tool in various stages of regional management processes aiming for sustainability transition in regions.