

Master of Science (MSc)

Applied Information and Data Science

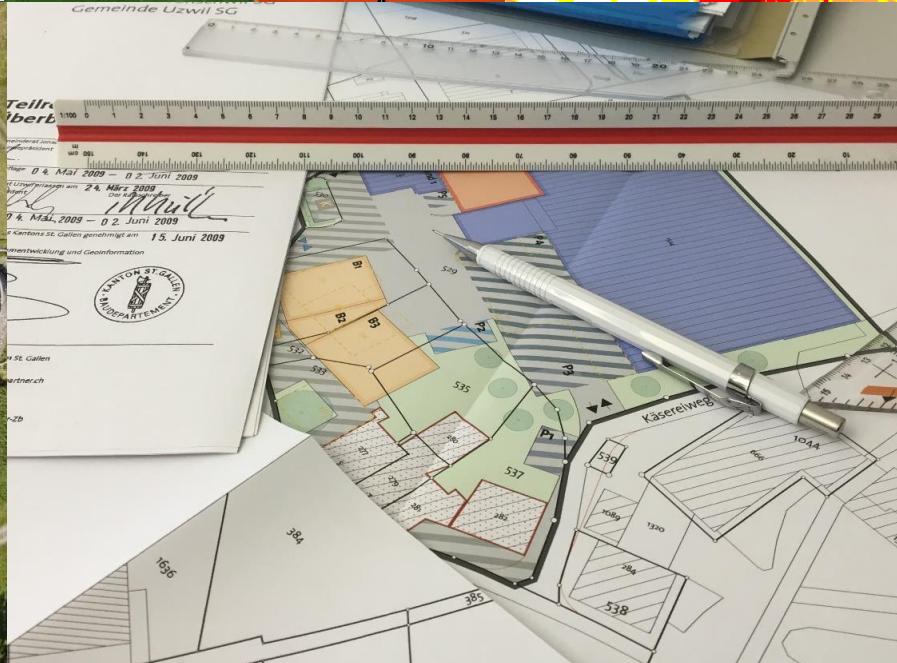
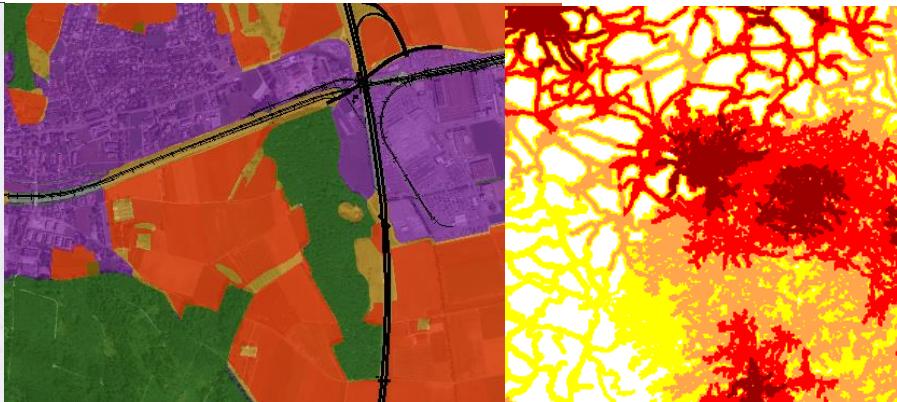
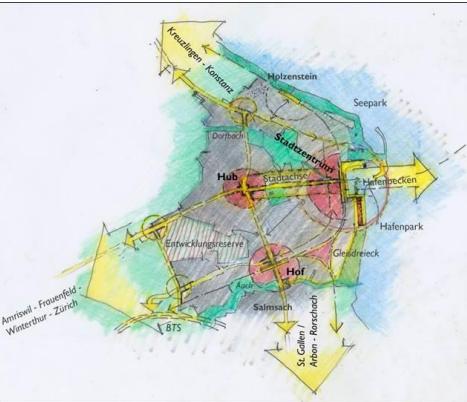
Wälli AG Ingenieure
Balz Bodenmann
Leitung Verkehrsplanung

T +41 58 100 94 21
b.bodenmann@waelli.ch

Lucerne 20.11.2025

Grüezi

Die Infrastrukturplaner



Topics and objectives

- **Topics**
 - Residents, employed persons
 - Land use types (work, residential, mixed areas etc.)
 - Applied examples of a land-use model for Switzerland (FaLC)
- **Objectives**
 - Overview of available data
 - Pitfalls | Fallstricke
 - How do I look for the "right" data set?
 - Things are not always what they seem to be ...
 - Importance of the source for usability (collection, preparation, rights)

Topics and objectives

100 tabs
CHF 8.95



Topics and objectives

Kägi Fret



Miletto wafers



1. Land-use model for Switzerland (FaLC)

APPLICATION

The objectives of the Facility Location Choice (FaLC) project

Support for

- Planning
- Decisions effecting land-use
- Spatial analyses



Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Raumentwicklung ARE

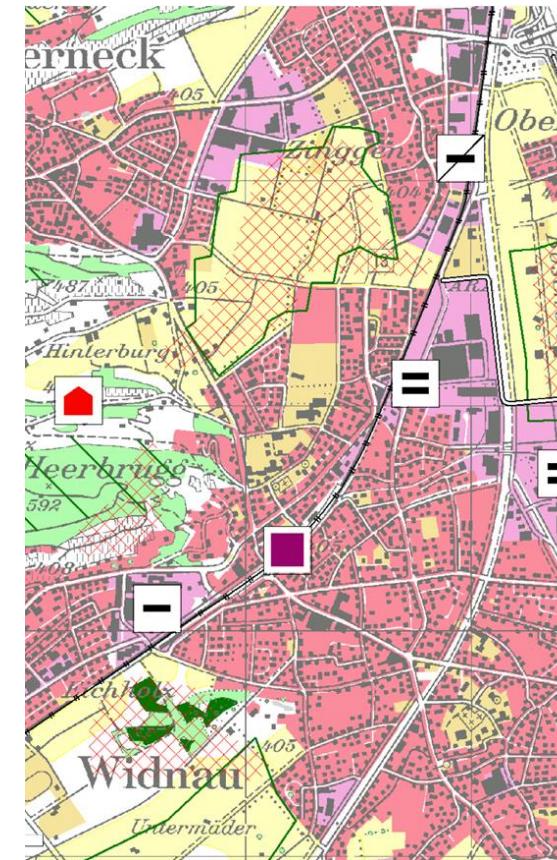


Die Infrastrukturplaner

Imperial College London



clavis:IT
winning solutions for leading companies



Land-use model for Switzerland – FaLC

**Because a known fact is better
than an unknown fact**

– Mark Spitz

Land-use model for Switzerland – FaLC

**Because a known fact is better
than an unknown fact**

– Mark Spitz

Land-use model for Switzerland – FaLC

Where will people work, live or spend their free time in **2020, 2030, 2040** ?

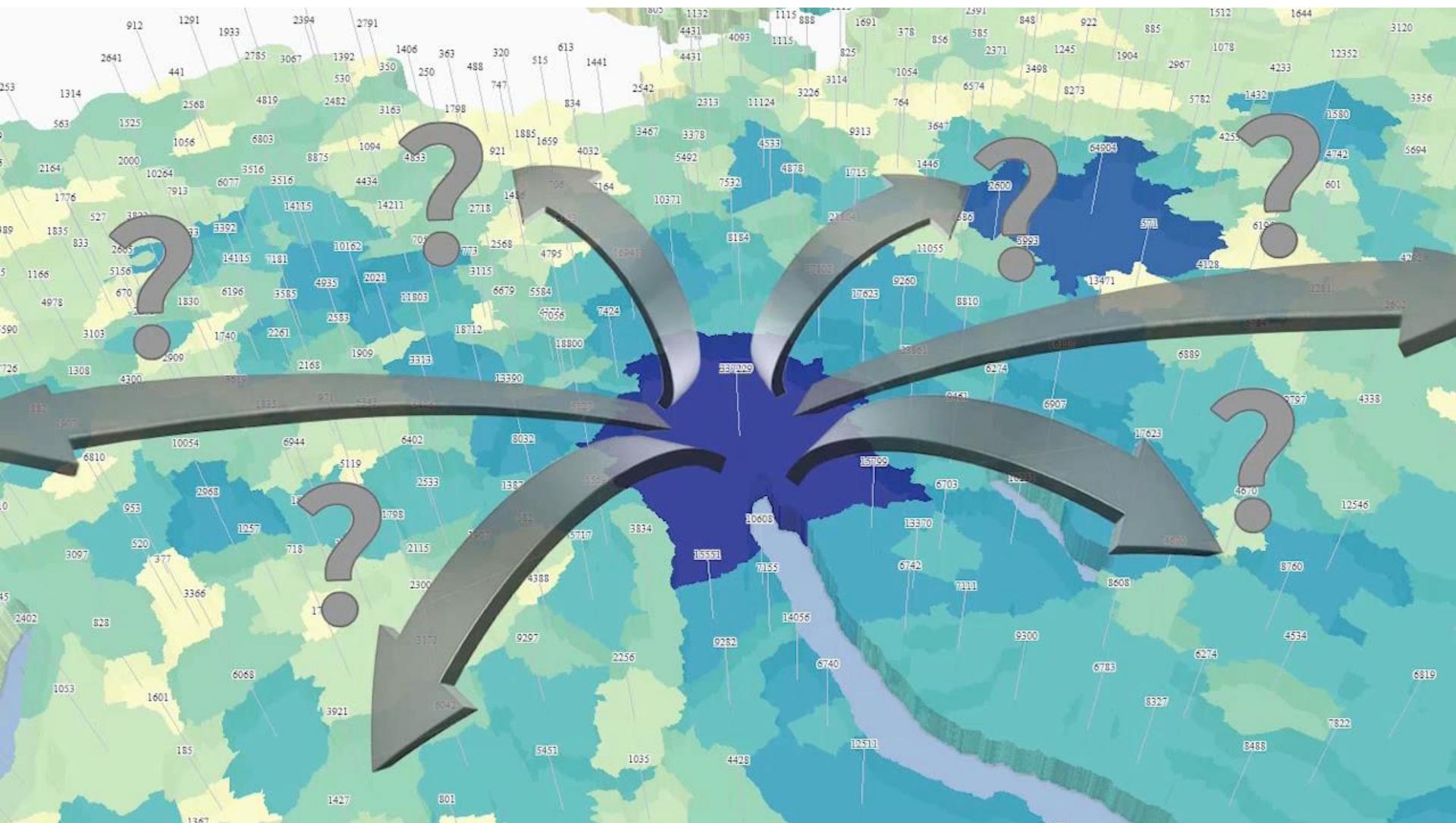
You have two ways to find the answer:

- a) waiting until 2040
- b) simulating the future . . .

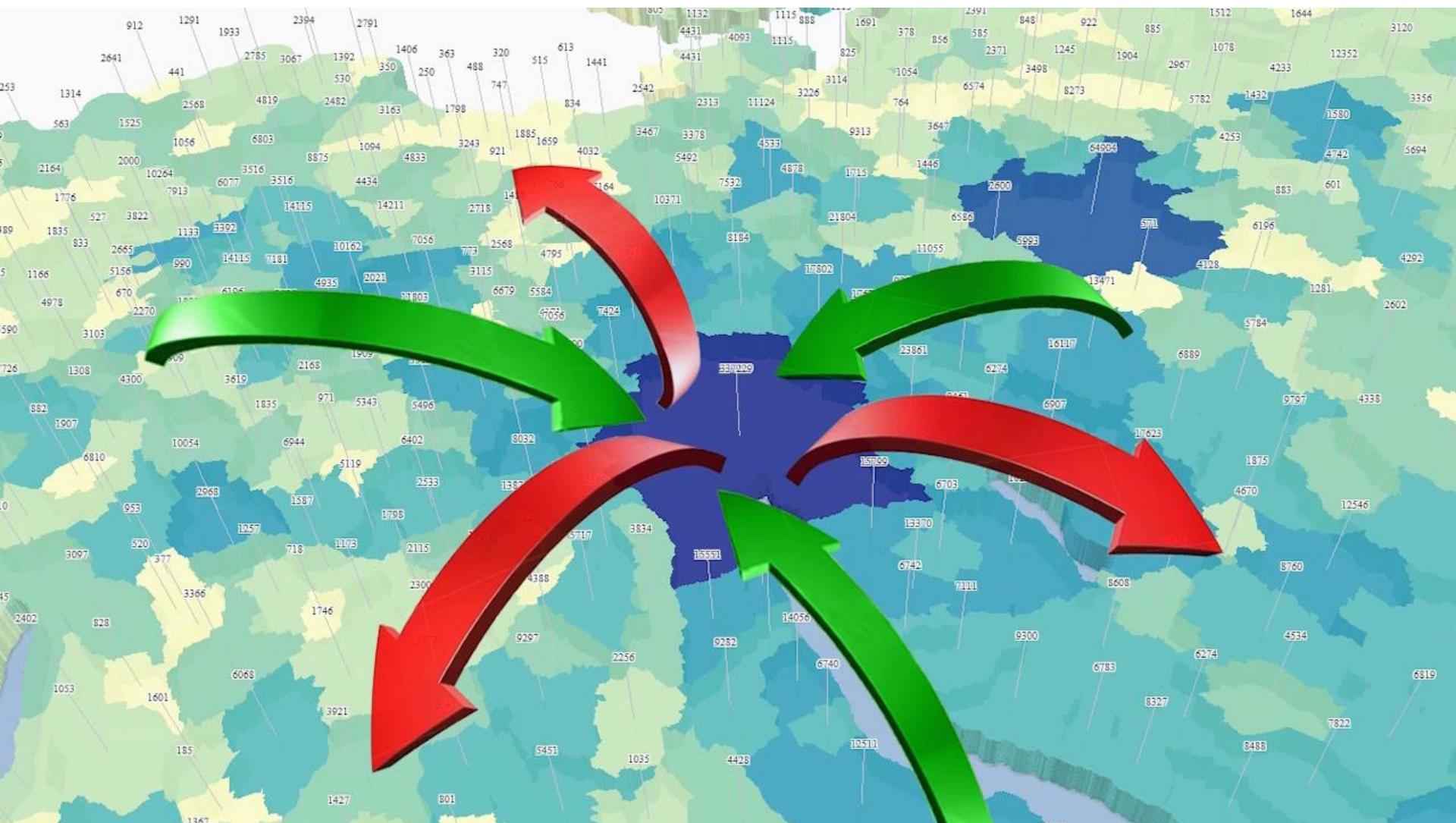
Land-use model for Switzerland – FaLC



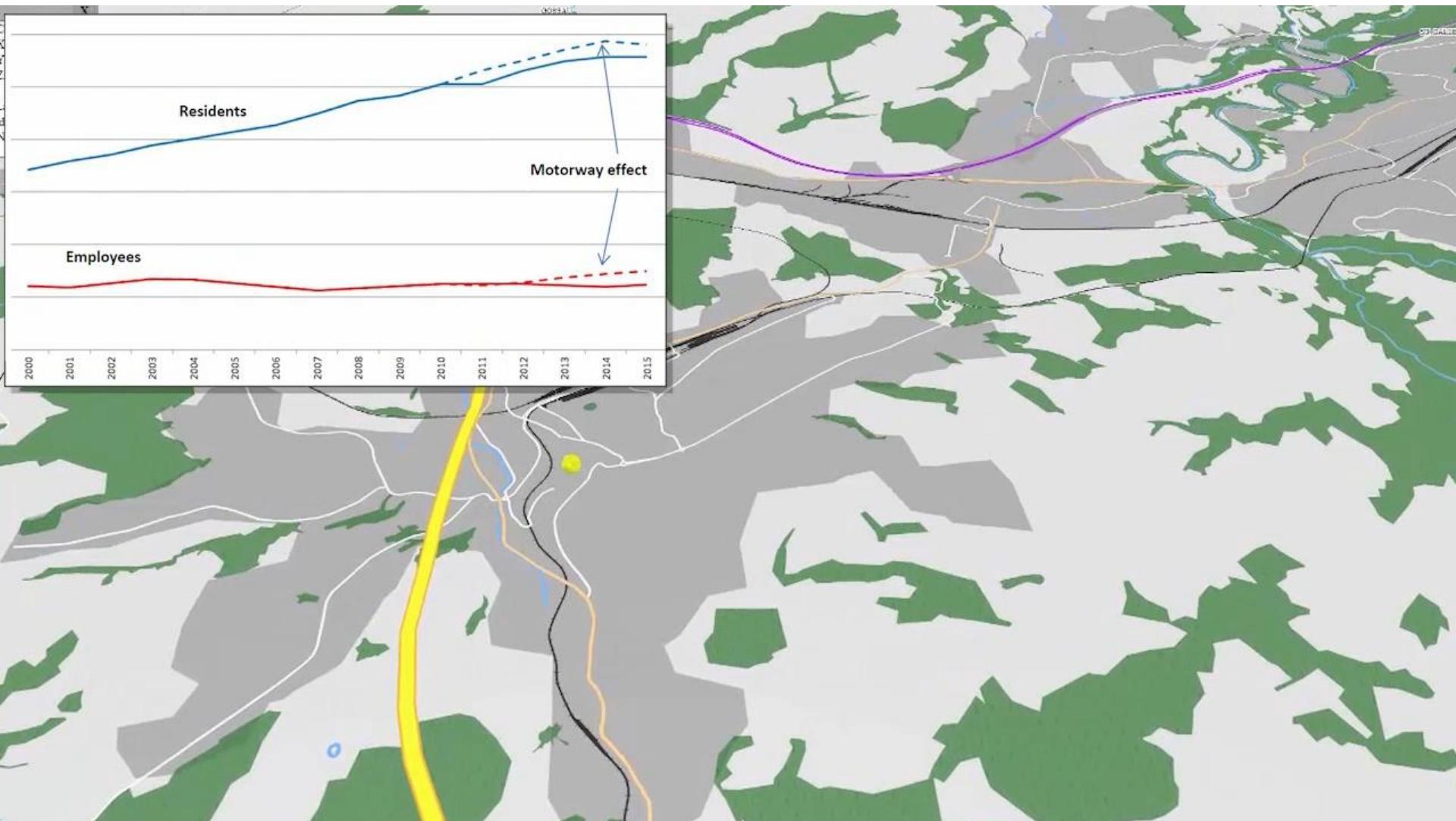
Land-use model for Switzerland – FaLC



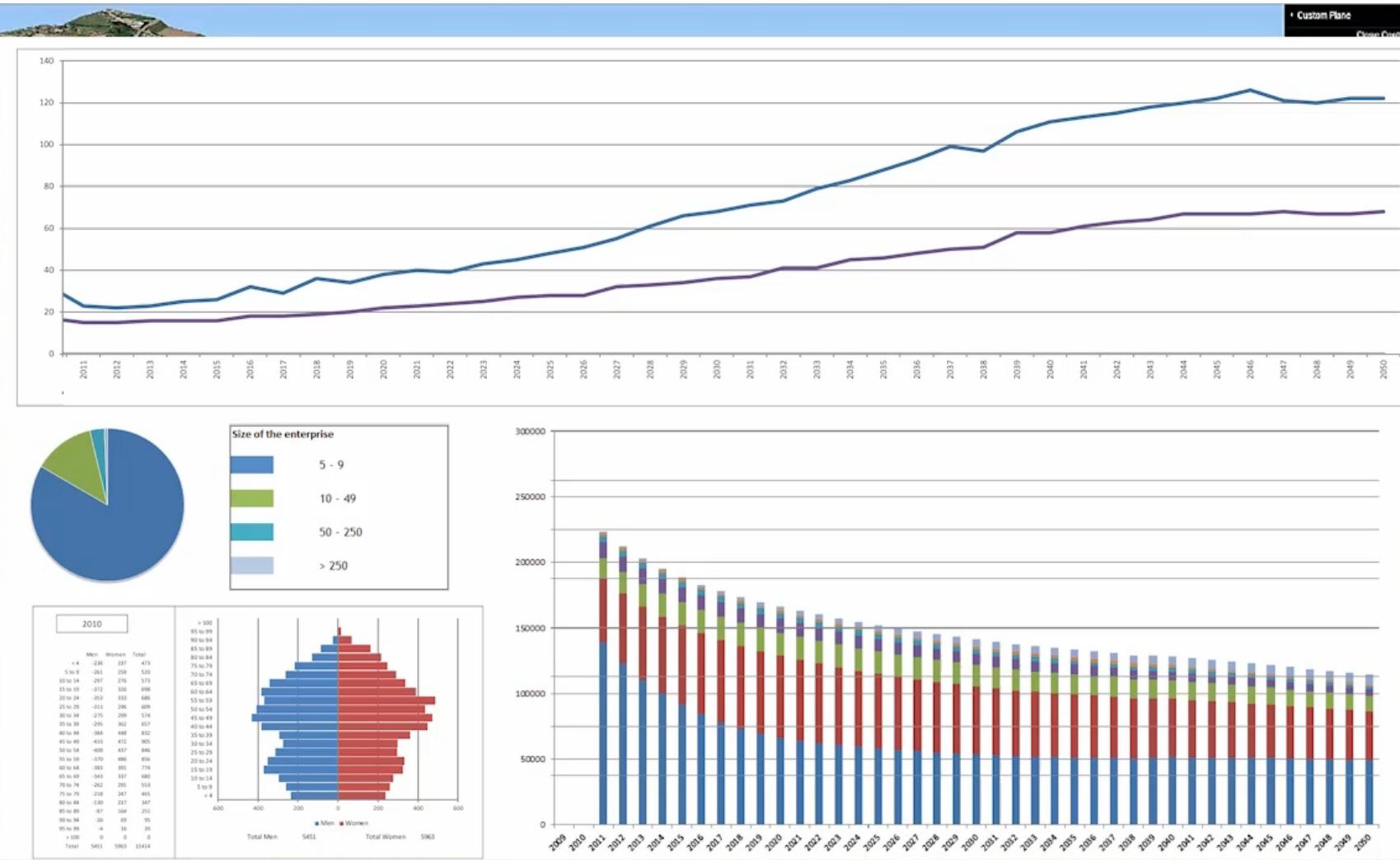
Land-use model for Switzerland – FaLC



Land-use model for Switzerland – FaLC



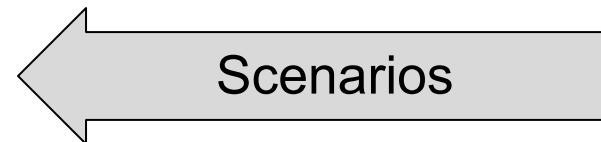
Land-use model for Switzerland – FaLC



Questions: What are the effects of ...

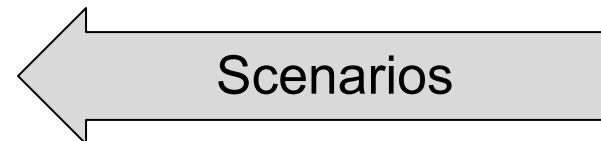
Political decisions

- New infrastructure projects (roads, public transportation)
- Changes in **tax rates / incentives**
- Changes in **laws / regulations** (e.g. development zones)



The economy

- **Economic crises** (e.g. job losses)
- Changes in market mechanisms (especially in real estate)
- Choice of location for (very) **large companies**



Questions: ... effects concerning

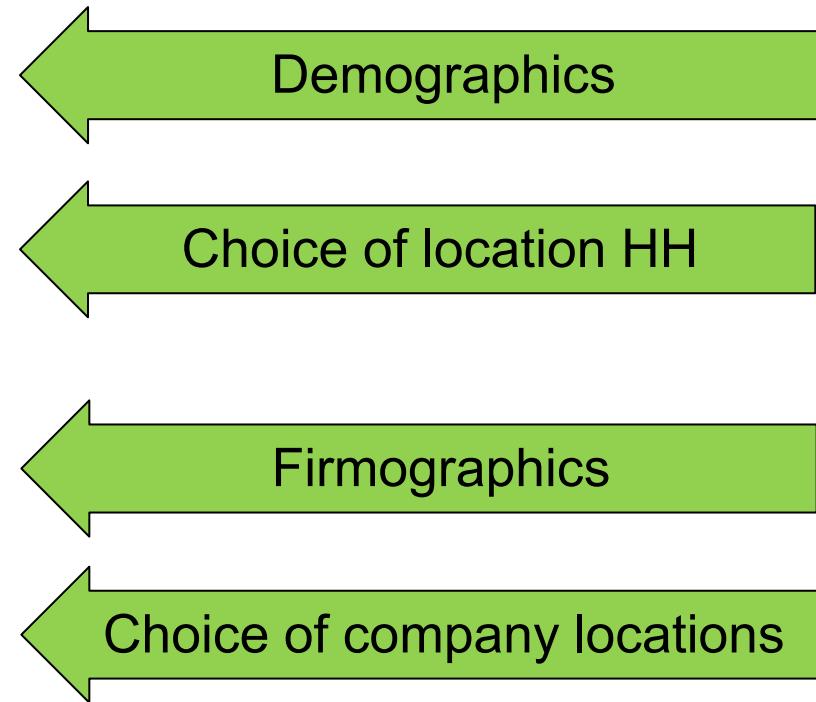
1

Demographics

- **Number / age of inhabitants**
- Status in the life cycle: **In school – working – retired**
- **Income / taxes**
- Spatial **segregation**

Firmographics

- **Sectors and size of companies**
- Generated **jobs**
- Generated **tax income**

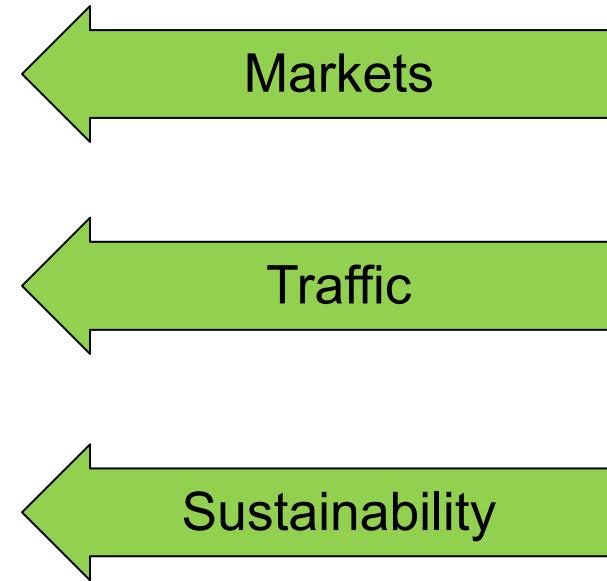


Questions: ... effects concerning

2

Social and political objectives

- Affordability of land and living space
- Reliability of the real-estate market
- Demand for housing/workspace
- Use of public transportation
- Congestion
- Driving distances (in particular commuter traffic, leisure time)
- CO₂ immissions (etc.)
- Prevention of urban sprawl

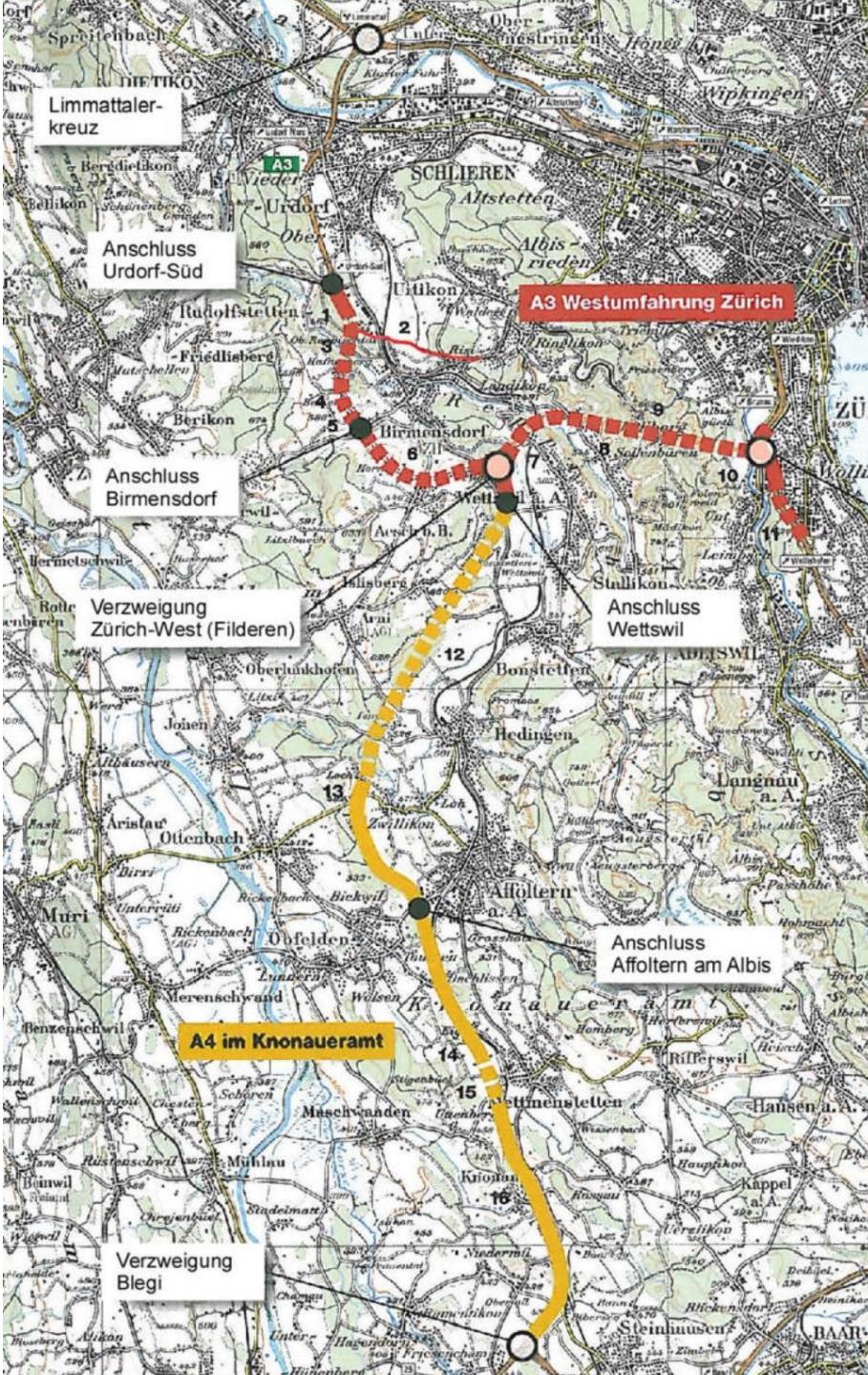


1. Land-use model for Switzerland (FaLC)

RESULTS

Western bypass of Zurich

- **26.3 km** of newly-built highway
- of which
- **14 km** are tunnels/covered
- **3** new highway connections
- Opening **2009**

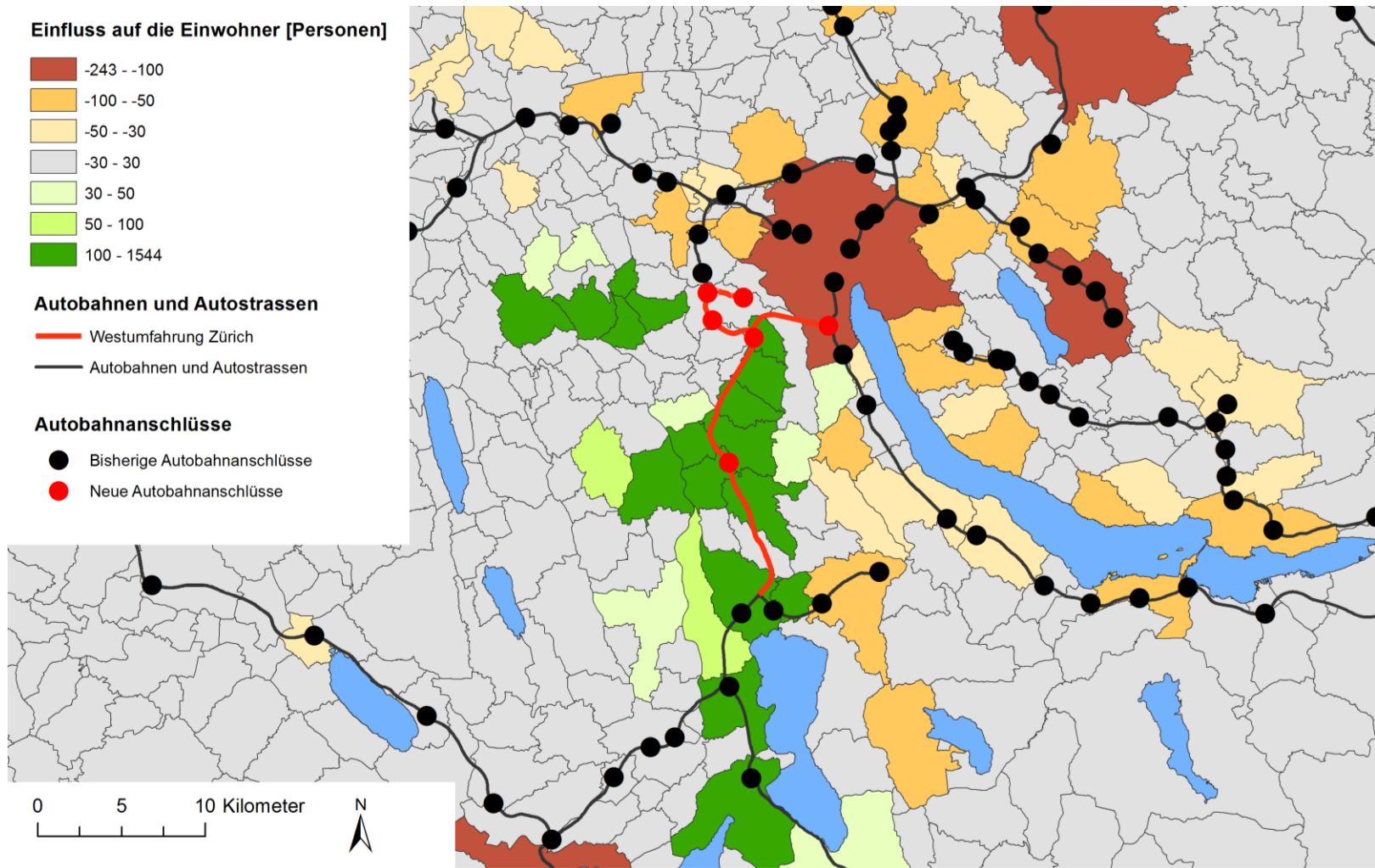


Effects

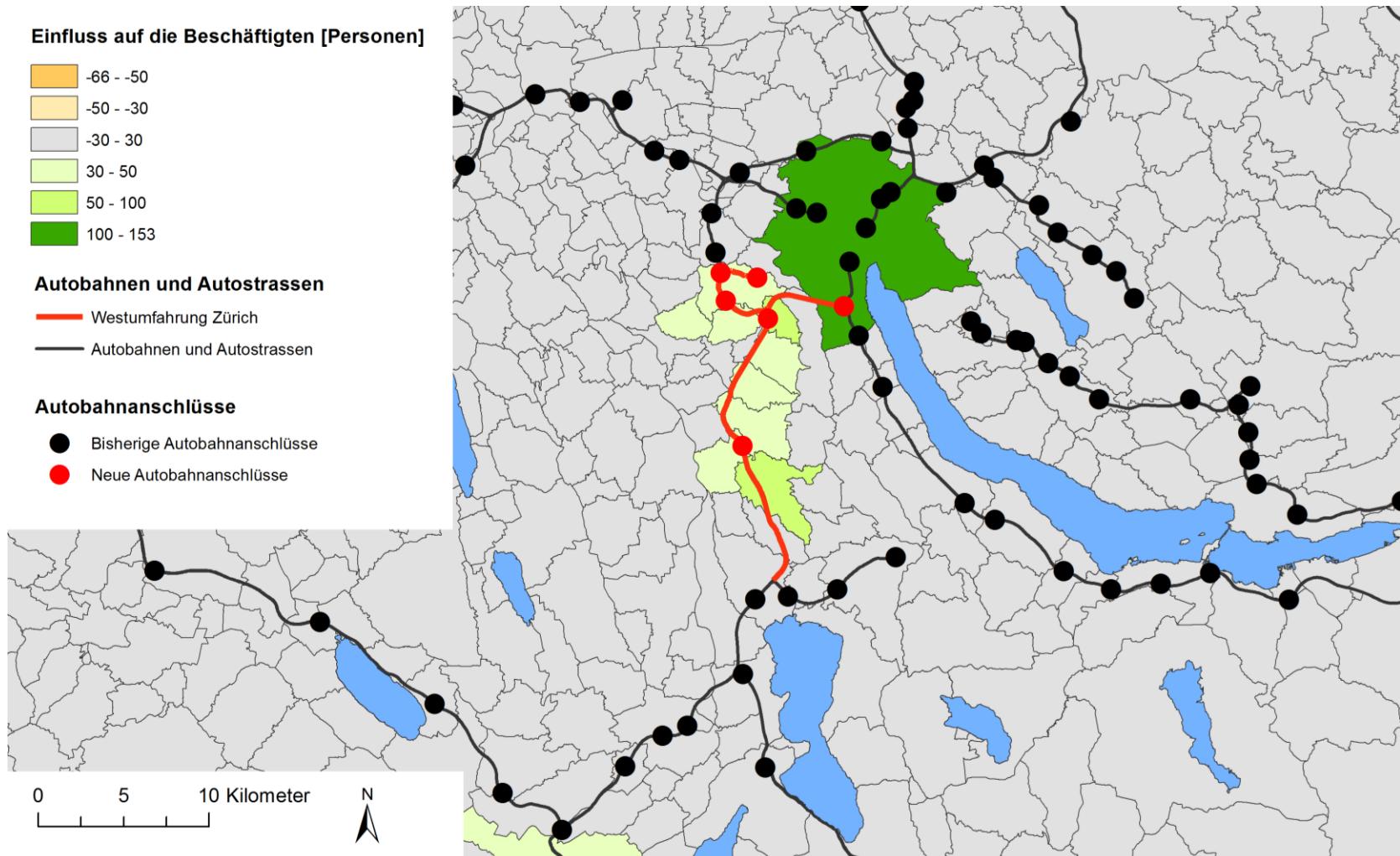
- 5 years later
- 40-70% reduction of traffic on roads running parallel to the highway
- 2/3 reduction of heavy vehicles on cantonal roads
- 2%-3% more traffic
- Increased quality of life
 - Structure of inhabitants
 - More local traffic, especially in the city of Zurich



Zurich: Effect on population 10 years later



Zurich: Effect on employees 10 years later



Projects in St.Gallen / Appenzell region

Connections of the Appenzellerland to the A1

Rheintal – St. Gallen – Zürich

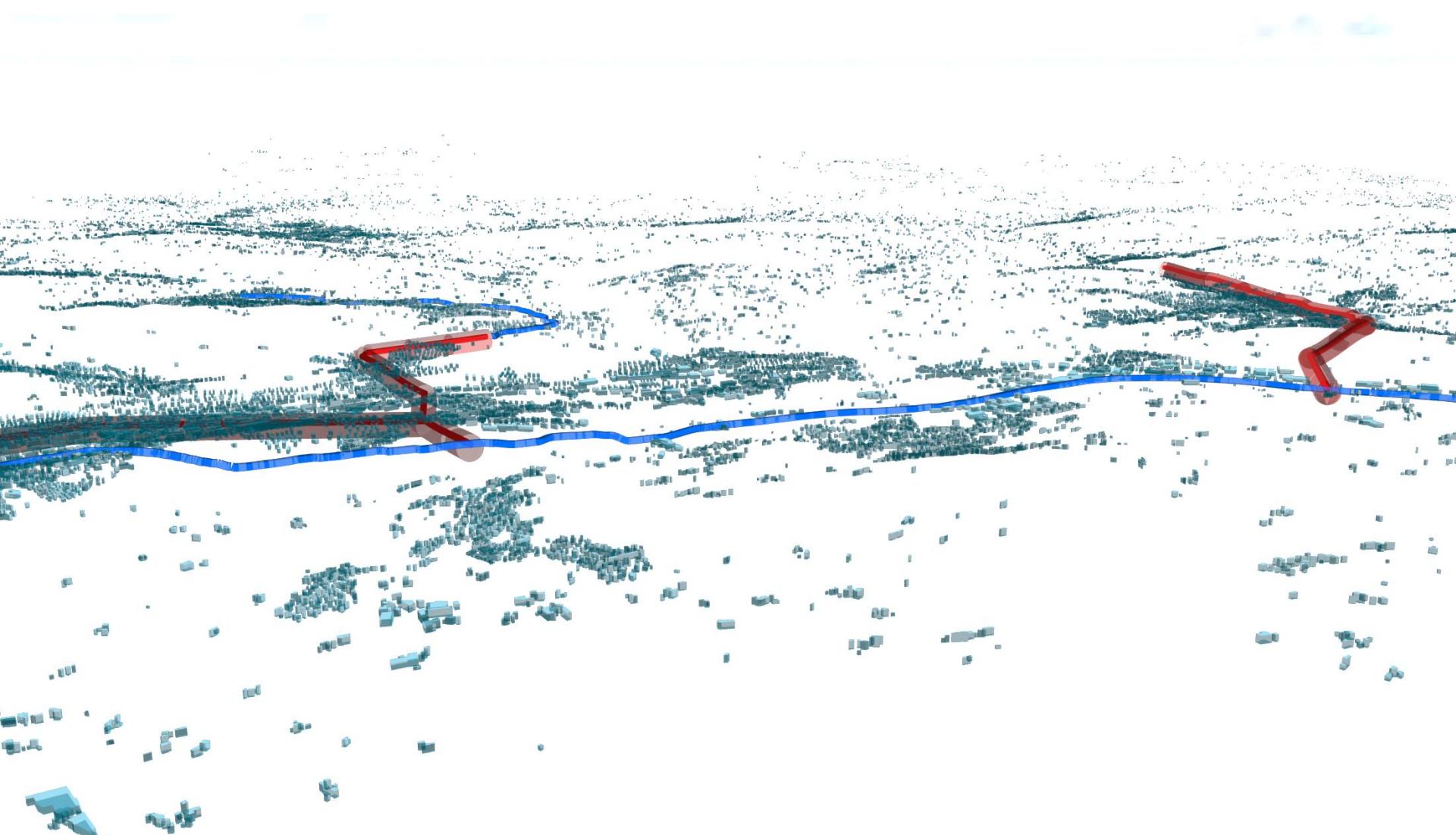
- Appenzell Hinterland / Inner Rhodes - Herisau - A1
- Appenzeller Mittelland / Inner Rhodes - Teufen - A1

Political issue

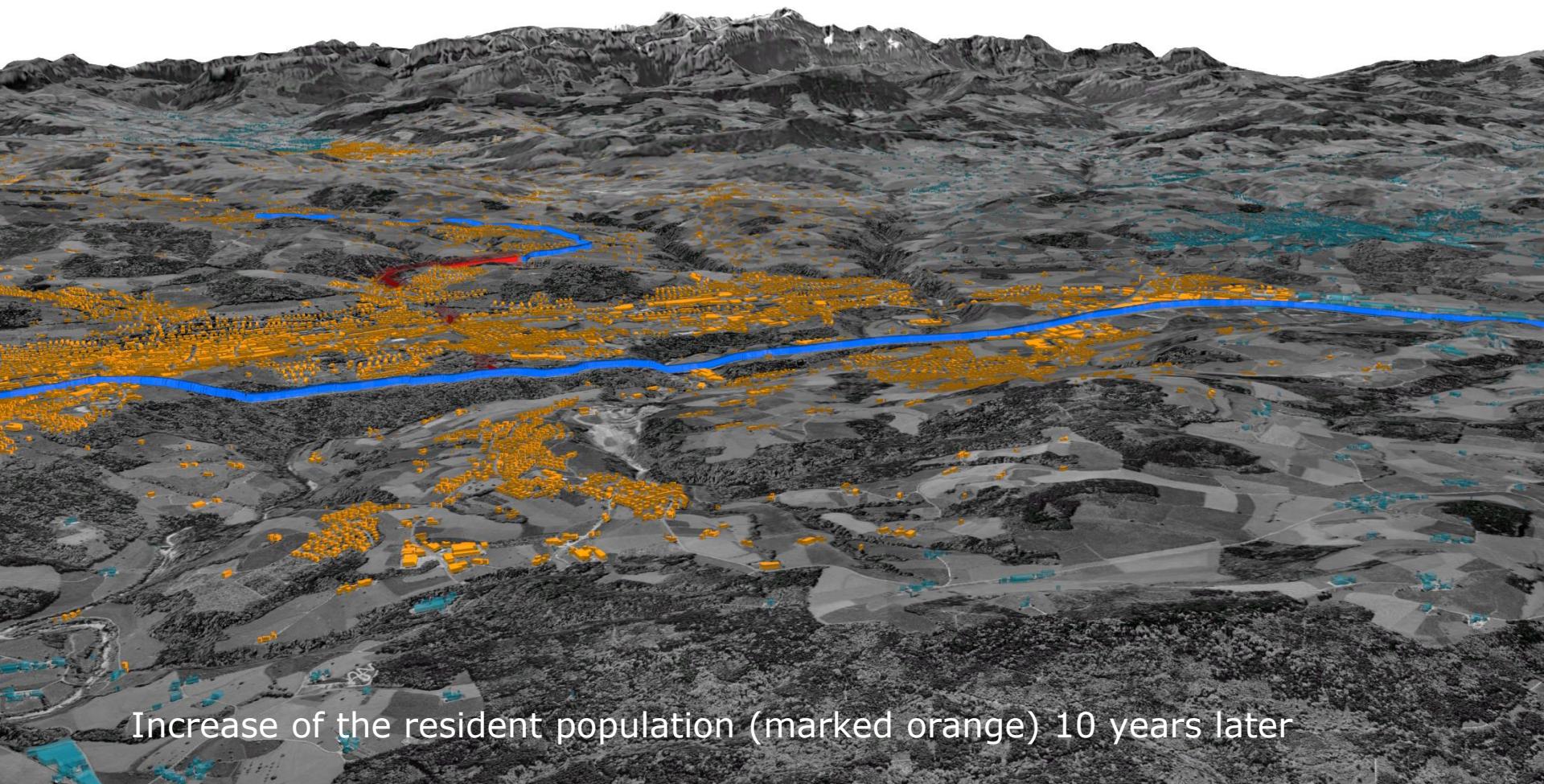
- How significant is this for population development in Appenzell?

- Construction activity
- Land prices
- Traffic

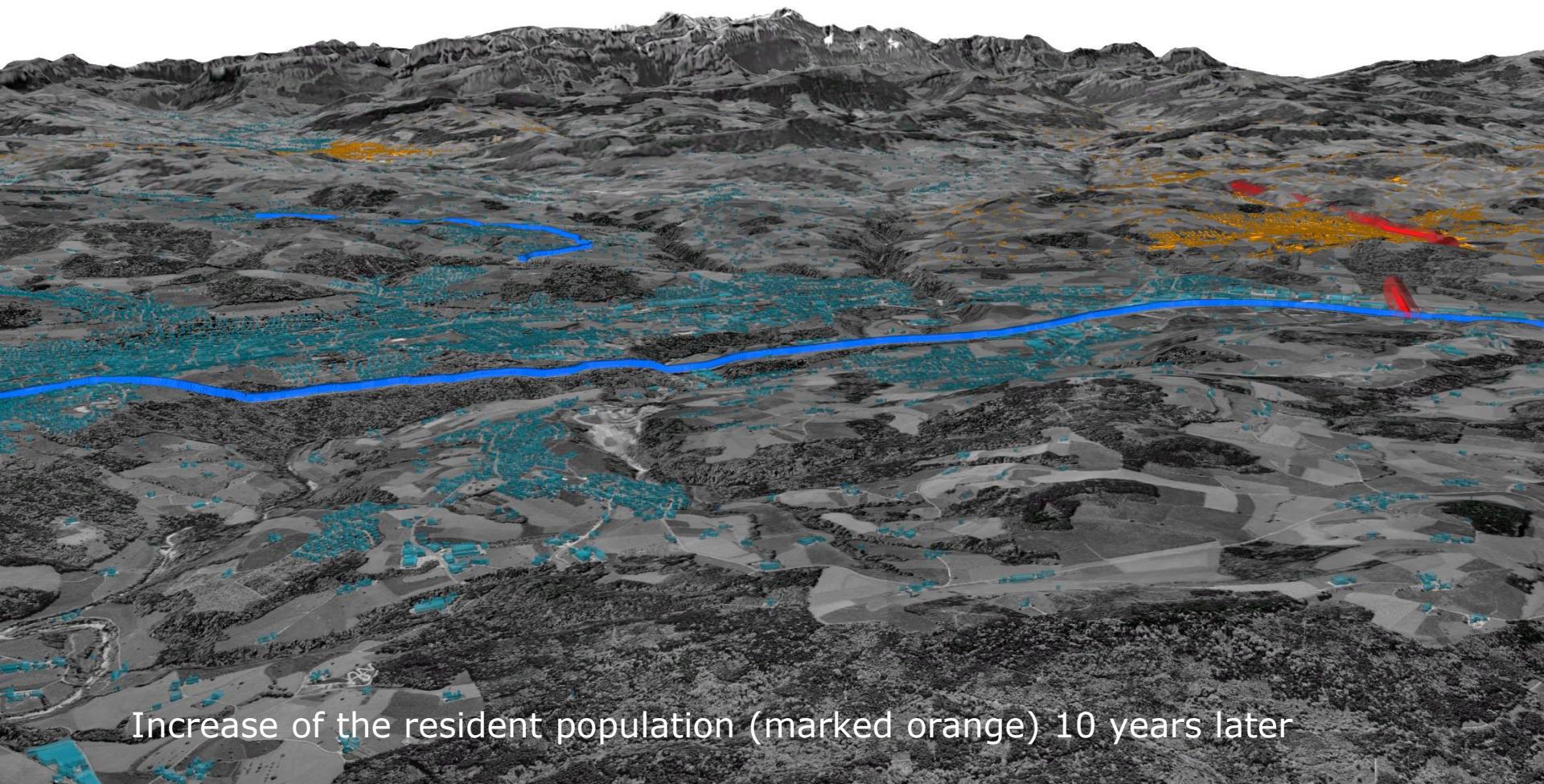
Projects in St.Gallen / Appenzell region



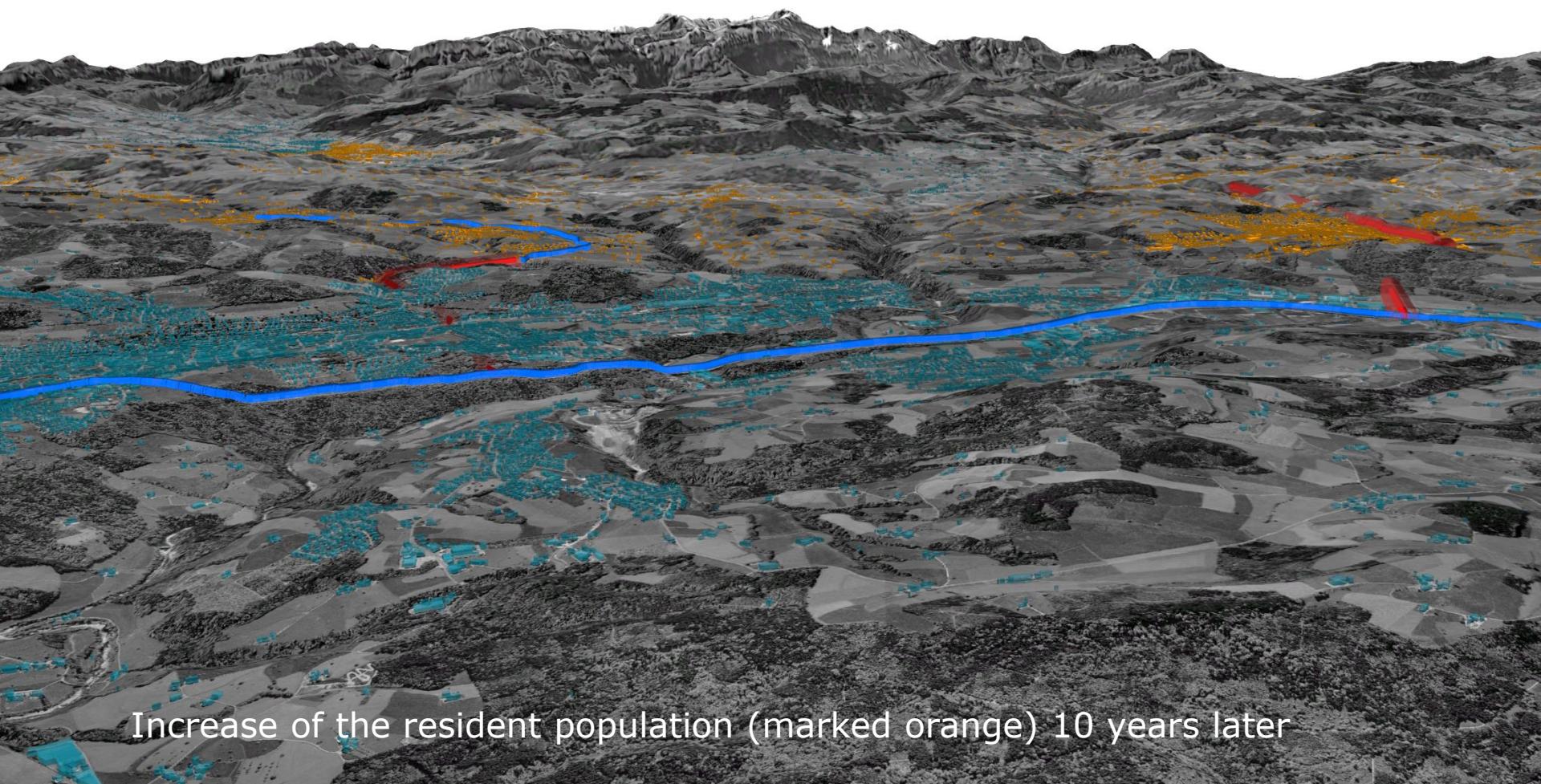
Effects of the Teufen connection



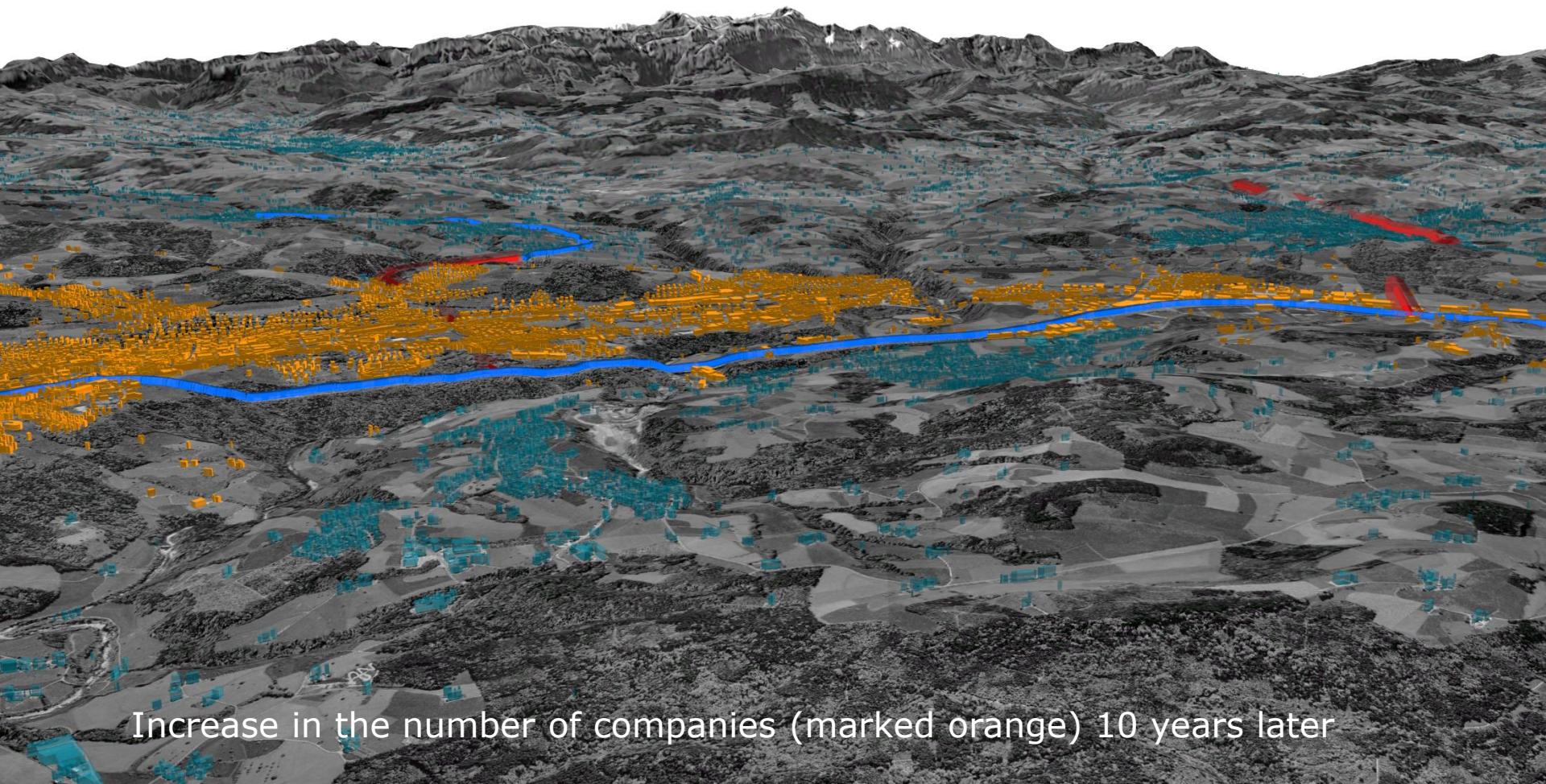
Impact of the Herisau connection



Impact of the Teufen and Herisau connection



Impact of the Teufen and Herisau connection



Conclusion

Based on the first model calculations and the experiences of Zurich, we can deduce:

- New highways have a major impact on traffic flows and settlement trends.
- These can be verified physically as well as in the model.
- Much less traffic on roads that were used heavily in the past
- Total additional traffic MIV about 1%-2%
- Population increase along main roads
- More jobs in central locations (city of Zurich/St.Gallen)
- Structural change along roads in cities that were used heavily in the past
- More construction projects throughout the region

2. Residents, employed persons

BASIC PRINCIPLES

Looking for the "right" data

Where can we find data?

Who are the most exciting data owners?

What are the differences?

Note

Today we have data about everything in society – it's simply a question of whether we can/may find it and use it!

Looking for the "right" data

Paradigms for data searches

- Know what question you want to answer with your analysis!
→ It may take two tries ...
- Prioritize the requirements:
 - Large spatial coverage
 - Time series
 - Reusability of data
 - Conduct follow-up analyses regularly
 - Accuracy and reliability of data
- Understand the data set you use and the source(s) and purpose for which the data was collected!
→ Sources of error / pitfalls
- Focus on what's essential!

2. Residents, employed persons

RESIDENTS

Wanted!

Looking for a population data set for a traffic model of Lucerne

- Objective: Study various infrastructure projects in the city of Lucerne to see if they have the desired effect on traffic flows.
- Perimeter
- Aggregation level
- Reliability
- Time/time series
- Reusability of data/results
- Updates

What data on population distribution did you find?

- Data content
- Data source / data owner

Google einwohner schweiz

Alle Bilder Maps News Videos Mehr Einstellungen

Ungefähr 21'300'000 Ergebnisse (0.36 Sekunden)

Schweiz / Bevölkerung

8.42 Millionen (2017)

10.000.000
8.000.000
6.000.000
4.000.000
2.000.000
0

1960 1970 1980 1990 2000 2010

Mehr entdecken

Andere suchten auch nach

Land	Einwohnerzahl
Österreich	8.773 Mill...
Deutschland	82.52 Mill...
Schweden	9.995 Mill...

Quellen: Eurostat

Schweiz – Wikipedia

<https://de.wikipedia.org/wiki/Schweiz> ▾

Die Schweiz (französisch Suisse [sy̷z(e)], italienisch Svizzera ['zvit:sera], rätoromanisch) ist ein Land in Europa. Die grösste Stadt der Schweiz ist Zürich mit 409'241 Einwohnern (31. Dezember 2017), die grösste Gemeinde ist Corippo mit 12 Einwohnern (31.

[Liste der Städte in der Schweiz](#) · [Bundespräsident \(Schweiz\)](#) · [Gemeinde \(Schweiz\)](#)

Schweiz hat 8,5 Millionen Einwohner - Schweizer Bauer

<https://www.schweizerbauer.ch/.../schweiz-hat-85-millionen-einwohner-41481.htm>

06.04.2018 - Die Bevölkerung der Schweiz ist 2017 um lediglich 0,7 Prozent gewachsen

Time's up ...

How did you search?
How effective were your queries?

Where did you find informations?

- Google
- Wikipedia
- Federal Statistical Office
- Newspapers
- Private providers of statistics
- ...

Main data source: Federal Statistical Office | BFS

Census

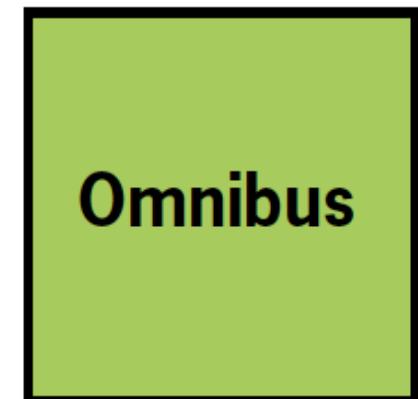
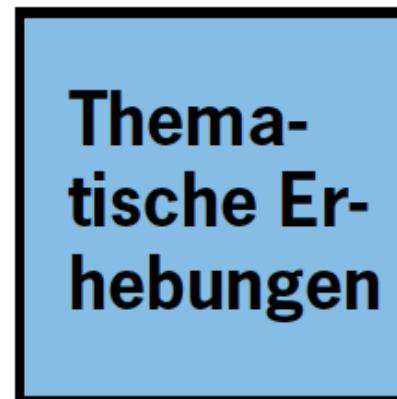
- 1850-2000
- Every 10 years (about 5 years later)
- Survey with questionnaire: Entire population, building owners and property management companies
- Population
- Households
- Buildings
- Apartments

Register survey STATPOP

- Starting in 2010
- Annually (approx. Sept. in the following year)
- Registers of residents
- Federal register of persons
- Building and housing registers
- Plus sample survey
- Population
- Households
- Buildings
- Apartments

"New census": STATPOP

- Register survey
 - Less costly
 - Quickly available
 - Higher data quality
- But some content is missing, e.g.
 - Income
 - Commuter relations
 - ...
- Register survey
- Structural survey
- Thematic surveys
- Omnibus



Typical access

- **Predefined MS Excel tables**
at www.bfs.admin.ch
→ Municipalities, cantons, Switzerland
- **STAT-TAB – interactive tables**
at www.bfs.admin.ch
→ finer query possibility (time series)
- **GEOSTAT – geodata**
at www.bfs.admin.ch / www.geocat.ch
→ Hectare raster (csv) and GIS data (shp)
- **Data orders**
on request/request by e-mail
→ Data contract depending degree of detail
→ To individual data

Weiterführende Informationen

Tabellen

Grafiken

Karten

Daten

22.08.2024

Ständige und nichtständige Wohnbevölkerung nach institutionellen Gliederungen, Staatsangehörigkeit (Kategorie), Geschlecht und Alter, 2010-2023



Bundesamt für Statistik | Dargestellter Zeitraum: 2010-2023

22.08.2024

Demografische Bilanz nach institutionellen Gliederungen



Bundesamt für Statistik | Dargestellter Zeitraum: 1981-2023

[Alle Daten zum Thema](#)

Publikationen

Typical aggregation levels

Data at municipal, regional and cantonal level

- Some data already prepared (incl. maps)
- Usually freely accessible
- Limited offer
- Pitfall: Municipal status

Hectare raster data

- Mostly freely accessible
- Grid depends on coordinate system (reference frame LV03 to LV95)
- Pitfall: Contingencies for assignment via address
- Pitfall: Calculation of inhabitants per zone based on hectare raster

Individual data

- Data with exact addresses (meter-coordinates)
- Generally not accessible, otherwise with use restrictions
- Price and offer are contingent on use and client
- Pitfall: Procurement costs

Typical aggregation levels

Data at municipal, regional and cantonal level

- Some data already prepared (incl. maps)
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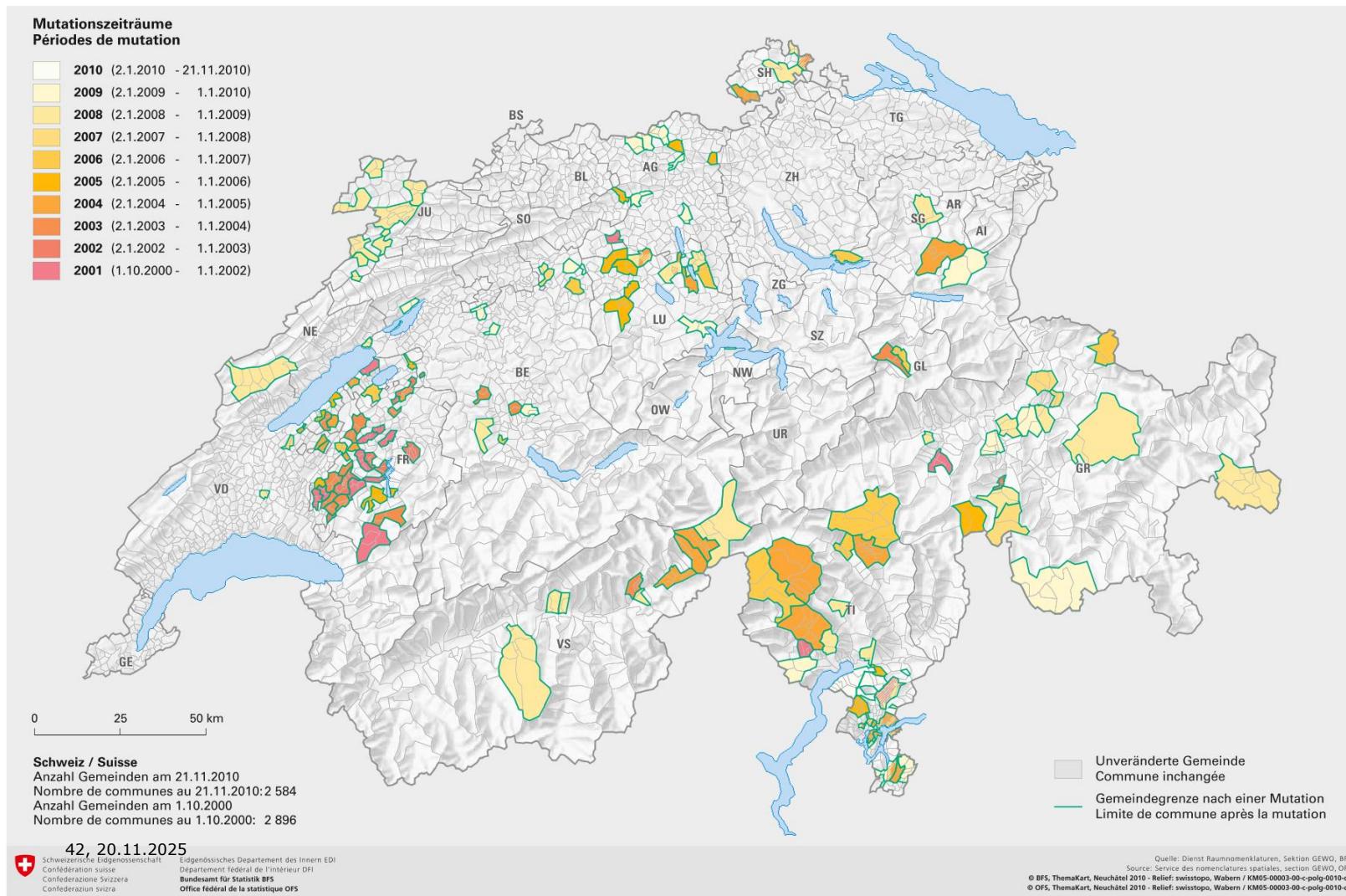
Hectare raster data

- Mostly freely accessible
- Grid depends on coordinate system (reference frame LV03 to LV05)
- Pitfall: Coincidences if assessed via the address
- Pitfall: Calculation of inhabitants per zone based on hectare raster

Individual data

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- Price and offer are contingent on use and client
- Pitfall: Procurement costs

Municipal data: Pitfall of municipal status



Municipal data: Pitfall of municipal status

E.g. impact of railways on population trends 1850-1910

Rang	Stadt	Bevölkerung	1850	1870	1880	1888	1900	1910
1850	1910		41 585	65 668	86 890	103 862	168 021	215 488
1	1	Zürich	27 844	44 868	61 737	71 131	109 161	132 276
2	3	Genf	37 724	60 004	70 355	75 709	97 359	115 243
3	4	Bern	29 670	37 548	45 743	48 605	67 550	90 937
5	5	St. Gallen	17 858	26 398	35 265	43 296	53 796	75 482
6	6	Lausanne	17 108	25 845	29 356	33 340	46 732	64 446
7	7	Winterthur	13 651	19 496	25 924	29 508	40 961	46 384
9	8	Luzern	10 068	14 400	17 758	20 314	29 255	39 339
8	9	La Chaux-de-Fonds	12 638	20 847	23 617	26 933	35 968	37 751
17	10	Biel	5 609	11 666	16 579	21 181	29 557	32 136
14	11	Neuenburg	7 901	12 934	15 675	16 565	21 195	24 171
10	12	Fribourg	9 065	10 581	11 410	12 195	15 794	20 293
12	13	Schaffhausen	8 477	11 049	12 557	13 099	16 320	19 267

Source: FSO (censuses 1850-1910, municipal status 2000)

Municipal data: Pitfall of municipal status

E.g. impact of railways on population trends 1850-1910

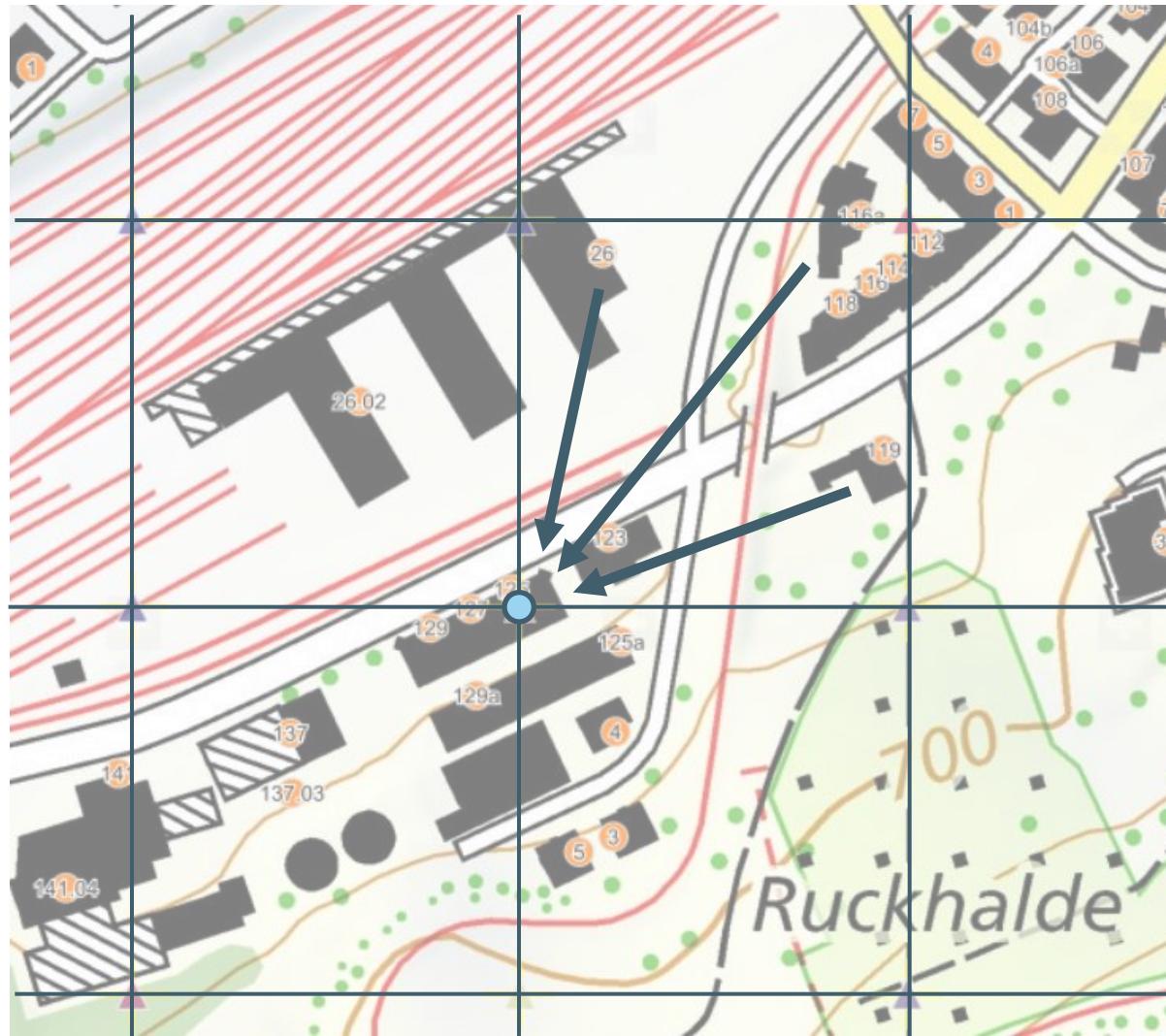
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			1850	1870	1880	1890	1900	1910
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12	13	Schaffhausen	8 477	11 049	12 557	13 099	16 320	19 267

Source: FSO (censuses 1850-1910, municipal status 2000)

Municipal status
Adapt: Swiss official
commune register
<https://www.bfs.admin.ch/bfs/de/home/grundlagen/agvch.html>

Hectare raster data: Pitfall: Contingencies for assignment via address

- Address is assigned to the **lower left-hand hectare corner**
- A **point data set (csv)** is delivered with the corresponding coordinates

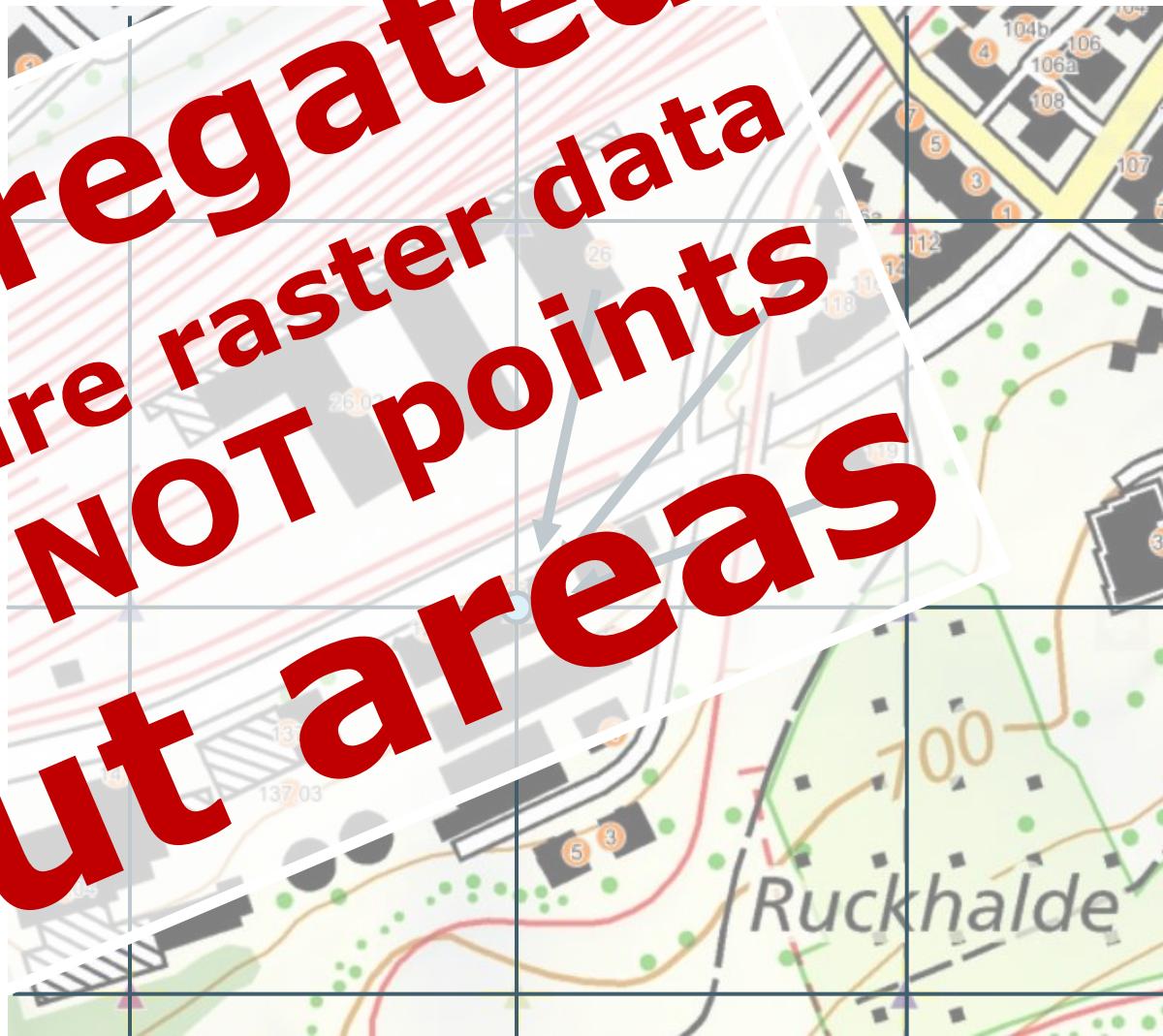


Hectare raster data:

Pitfall: Contingencies for assignment via address

- Address is assigned to the **lower left-hand hectare corner**
- A point feature (`cs`) is delivered with the corresponding coordinates

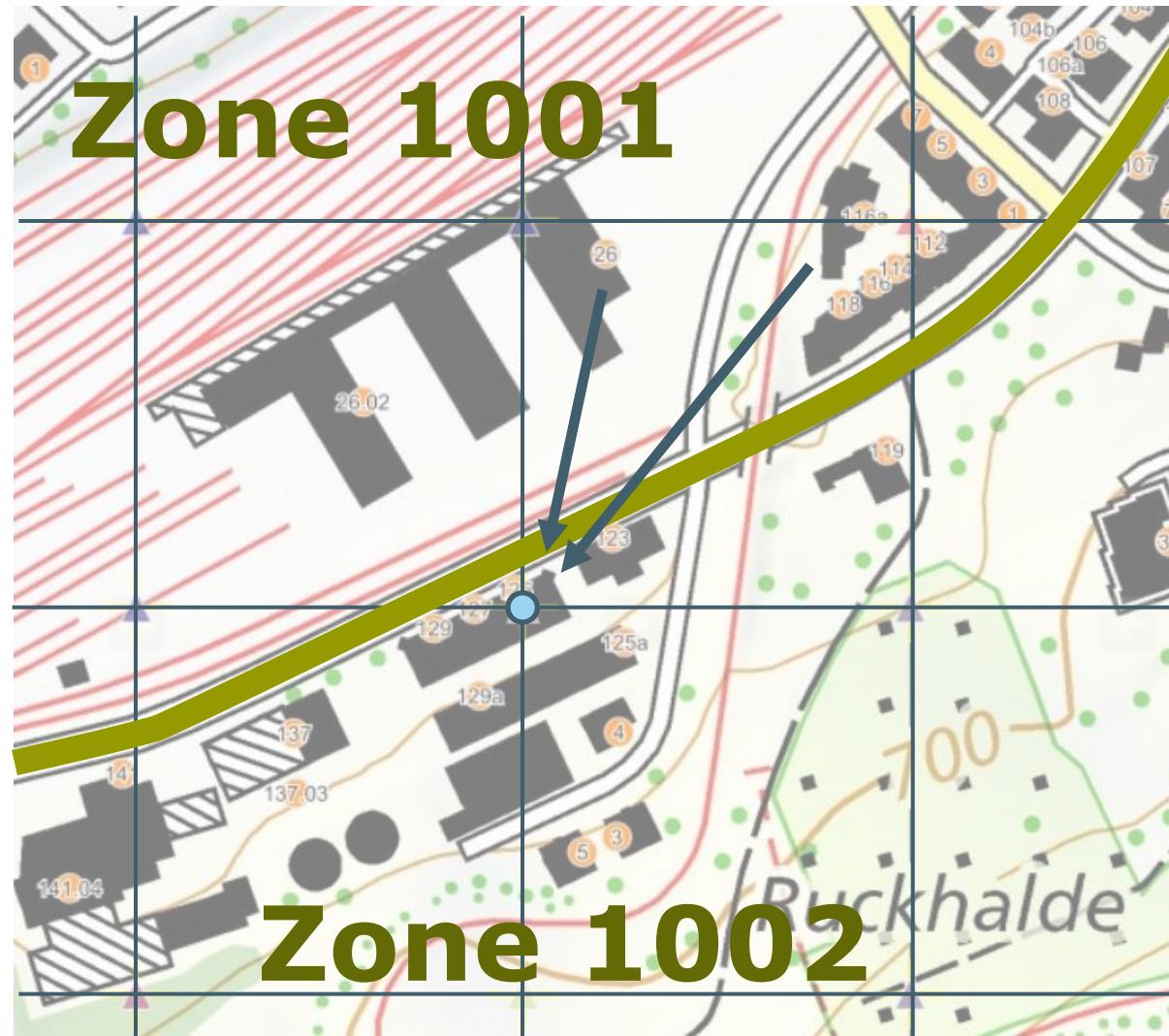
**Aggregated
Hectare raster data
are NOT points
but areas**



Hectare raster data:

Pitfall: Calculation of inhabitants per zone based on hectare raster

- Address is assigned to the **lower left-hand hectare corner**
- A **point data set (csv)** is delivered with the corresponding coordinates

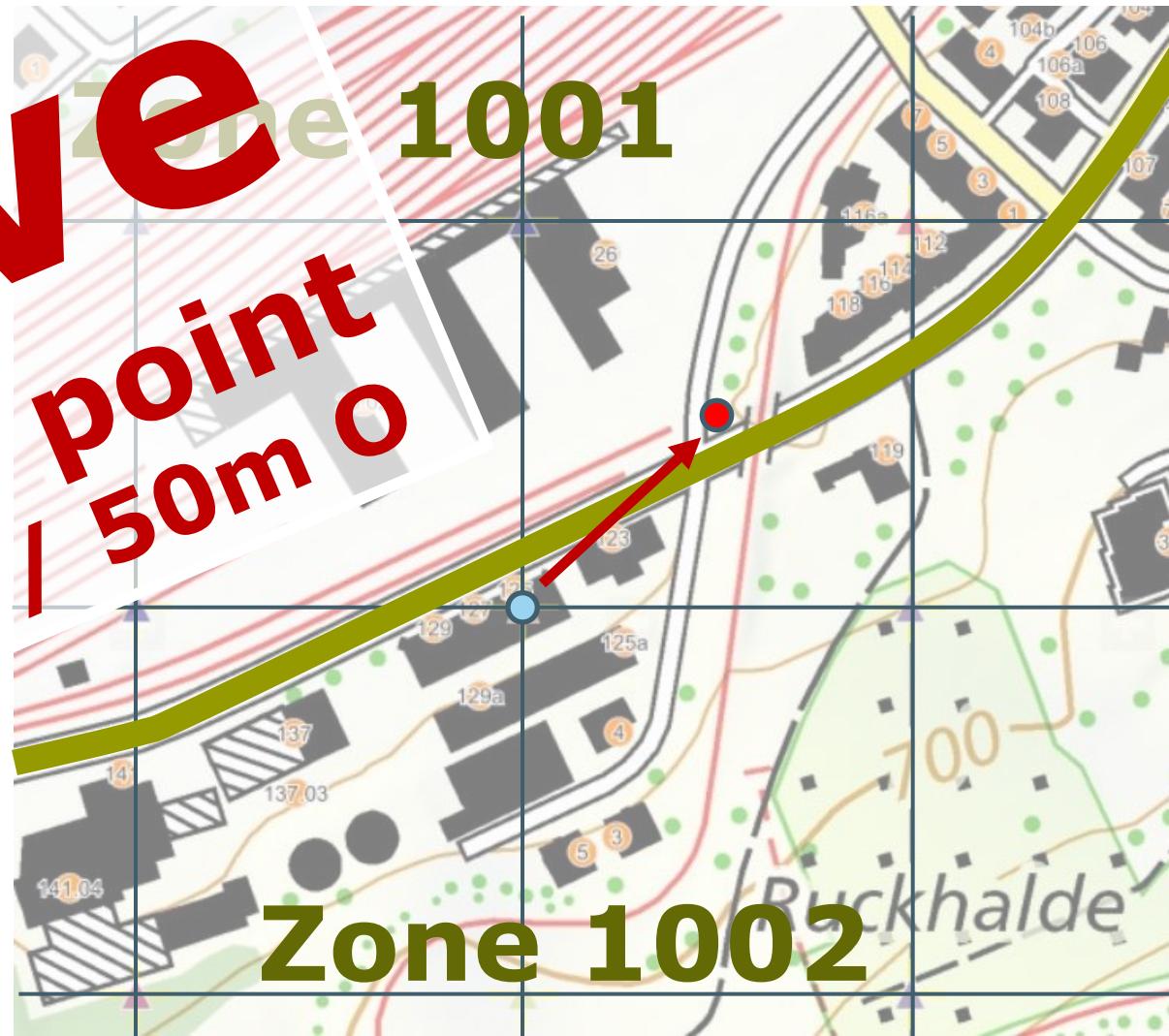


Hectare raster data:

Pitfall: Calculation of inhabitants per zone based on hectare raster

- Address is assigned to the lower left-hand hectare corner

**MOVE
raster point
50m N | 50m O**



Hectare raster data:

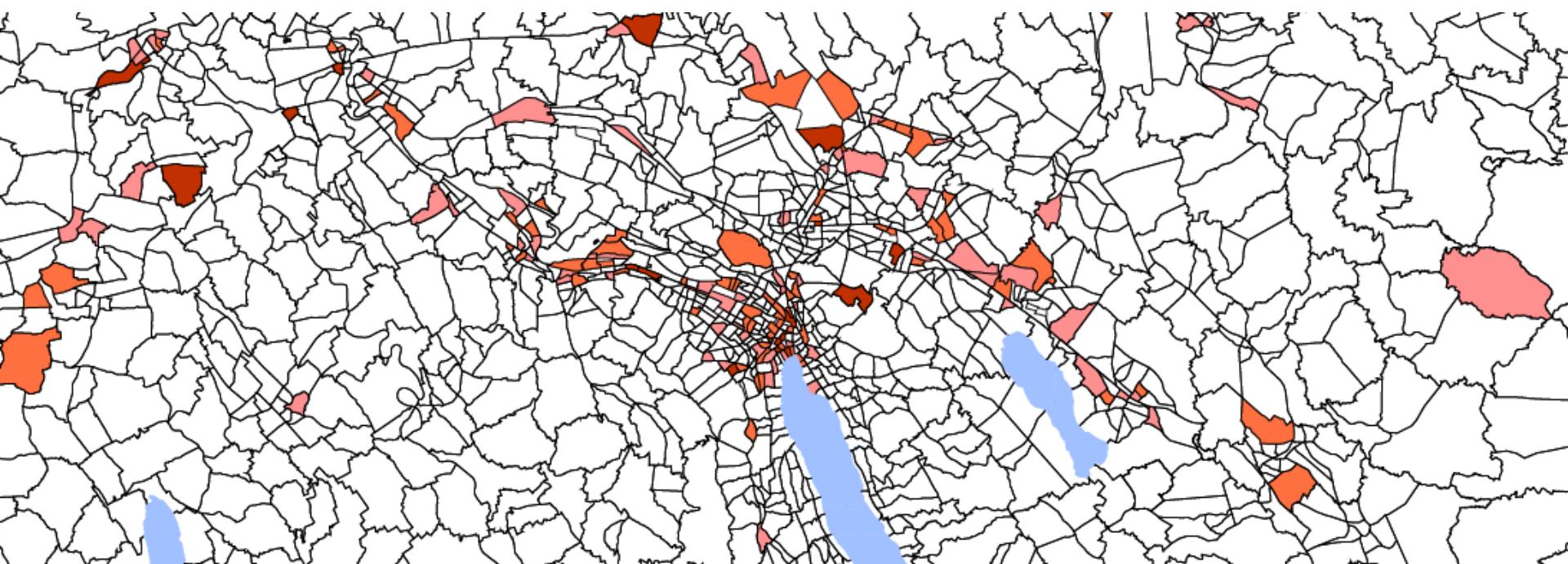
Pitfall: Calculation of inhabitants per zone based on hectare raster

Comparison

- a) Zone data based on address data that is accurate to the meter
- b) Zone data based on hectare raster data

→ Error should ideally be close to zero, as the data source is the same

→ However, error is up to 6,000 inhabitants per zone (20 times)



Individual data: Pitfall of procurement costs

- Access to anonymized individual data is (legally) regulated
→ contact BFS
- In general:
 - Available for statistics, research and planning
 - Perimeter and contents strictly limited (matched to task)
 - Private/business use not possible
 - Contract
 - Limited in time, data must be destroyed after project completion
 - Ensure data protection
 - Application with details of project and analyses

Individual data: Pitfall of procurement costs

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→ contact BFS
- In general:
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 - Limited in time, data must be destroyed upon project completion
 - Ensure data protection
 - Application with details of project and analysis

**Schedule
enough
time**

2. Residents, employed persons

EMPLOYEES

Main data source: Federal Statistical Office

Business census

- 1905-2008
Every 3/4 years
(about 5 years later)
- Survey with questionnaire:
Company 2nd/3rd Sector
- Companies
- Workplaces
- Employees
- Full-time equivalents
- To be completed with data from:
Business census in the primary
sector or in agriculture

Register survey STATENT

- Starting in 2010
- Annually
(approx. Aug. in the year after next)
- AHV compensation funds
- Companies
- Workplaces
- Employees
- Full-time equivalents
- Note:
Always one year older than STATPOP

Typical aggregation levels

Data at municipal, regional and cantonal level

- Some data already prepared (incl. maps)
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Hectare raster data

- Mostly freely accessible
- Grid depends on coordinate system (reference frame LV03 to LV95)
- **Pitfall: Contingencies for assignment via address**
- Pitfall: Calculation of inhabitants per zone based on hectare raster

Individual data

- Data with exact addresses (meter-coordinates)
- Generally not accessible, otherwise with use restrictions
- Price and offer are contingent on use and client
- **Pitfall: Procurement costs**

3. Land-Use types

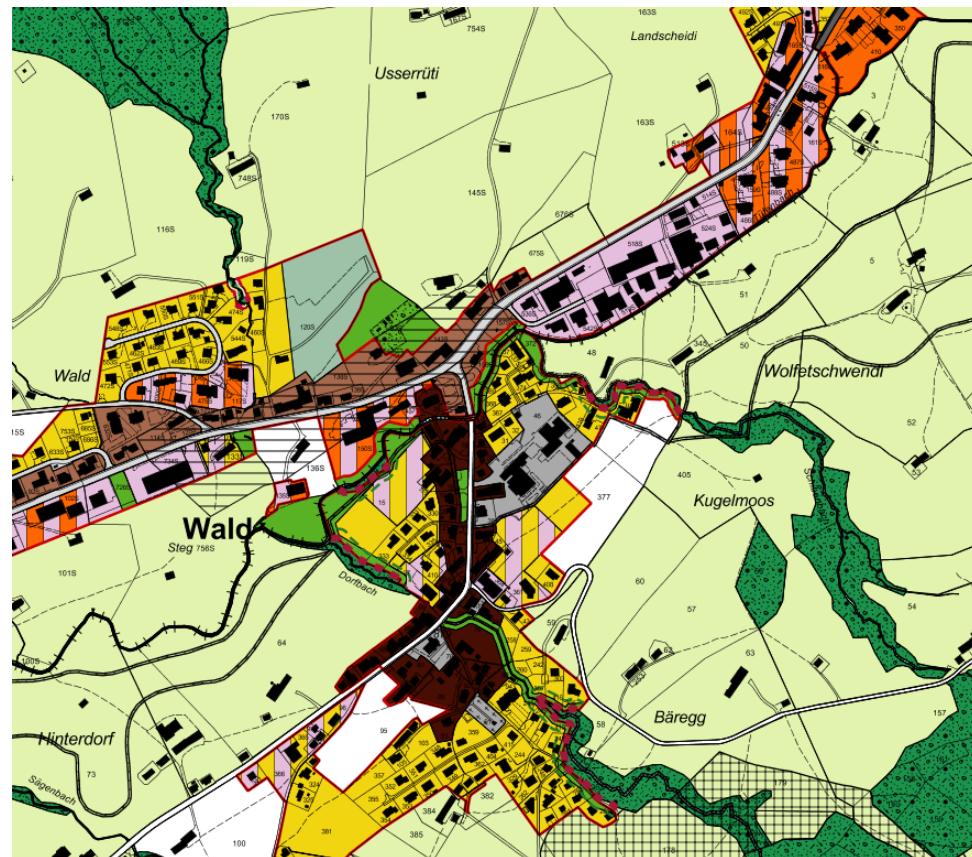
BUILDING ZONE STATISTICS, SITE STATISTICS

Where do certain land-uses take place?

- Distribution of land-uses
- Development of the landscape
- Legally possible uses

Data sets

- Building zone statistics of Federal Office for Spatial Development ARE | Bauzonenstatistik ARE
- Land-use statistics | Arealstatistik

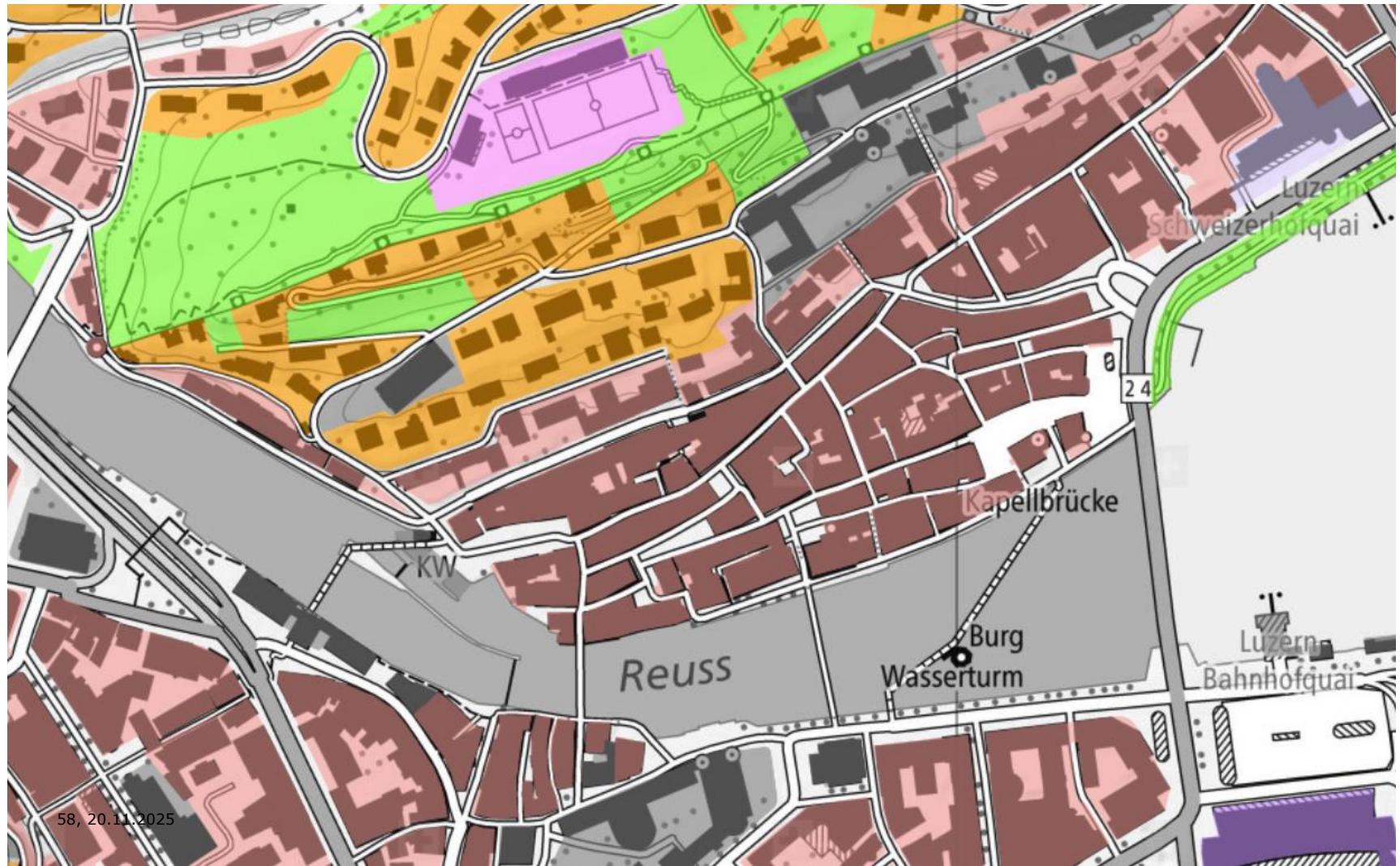


Building zone statistics for Switzerland (ARE)

The building zone statistics for Switzerland show the size and spatial distribution of building zones in Switzerland.

- Building zones of the cantons
- Survey by ARE 2012/2017/2022 (1.1.2022)
- Geodata set
- Harmonized zones
 - 11 residential zones
 - 12 commercial zones
 - 13 mixed zones
 - 14 center zones
 - 15 zones for public use
 - etc.
- Status of development (developed / not developed) | Überbauungsstand
- Access by public transport | Erschliessung mit dem ÖV

Building zone statistics for Switzerland (ARE)



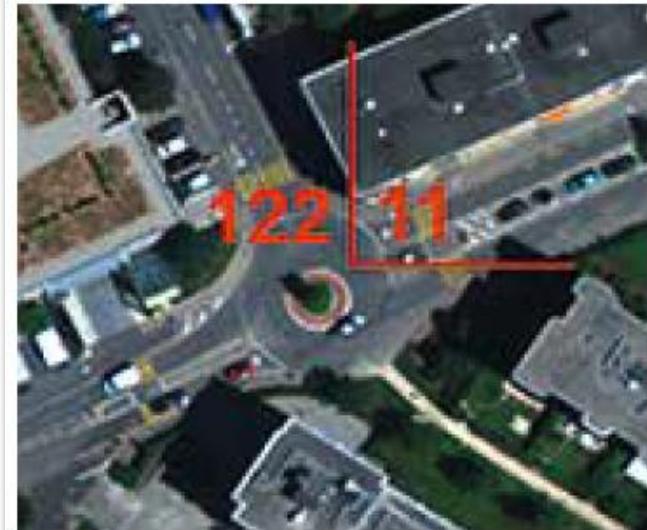
Land-use statistics

Land-Use statistics provide up-to-date, thematically and spatially differentiated information on the state and changes in land use in Switzerland.

- Manual survey based on aerial photographs
- 1979/85, 1992/97, 2004/09, 13/18, 20/25
(in future every 6 years)
- Point data set, mesh size 100 m
- 72 categories
 - Settlement
 - Agriculture
 - Developed areas
 - Unproductive areas

Stichprobenpunkt

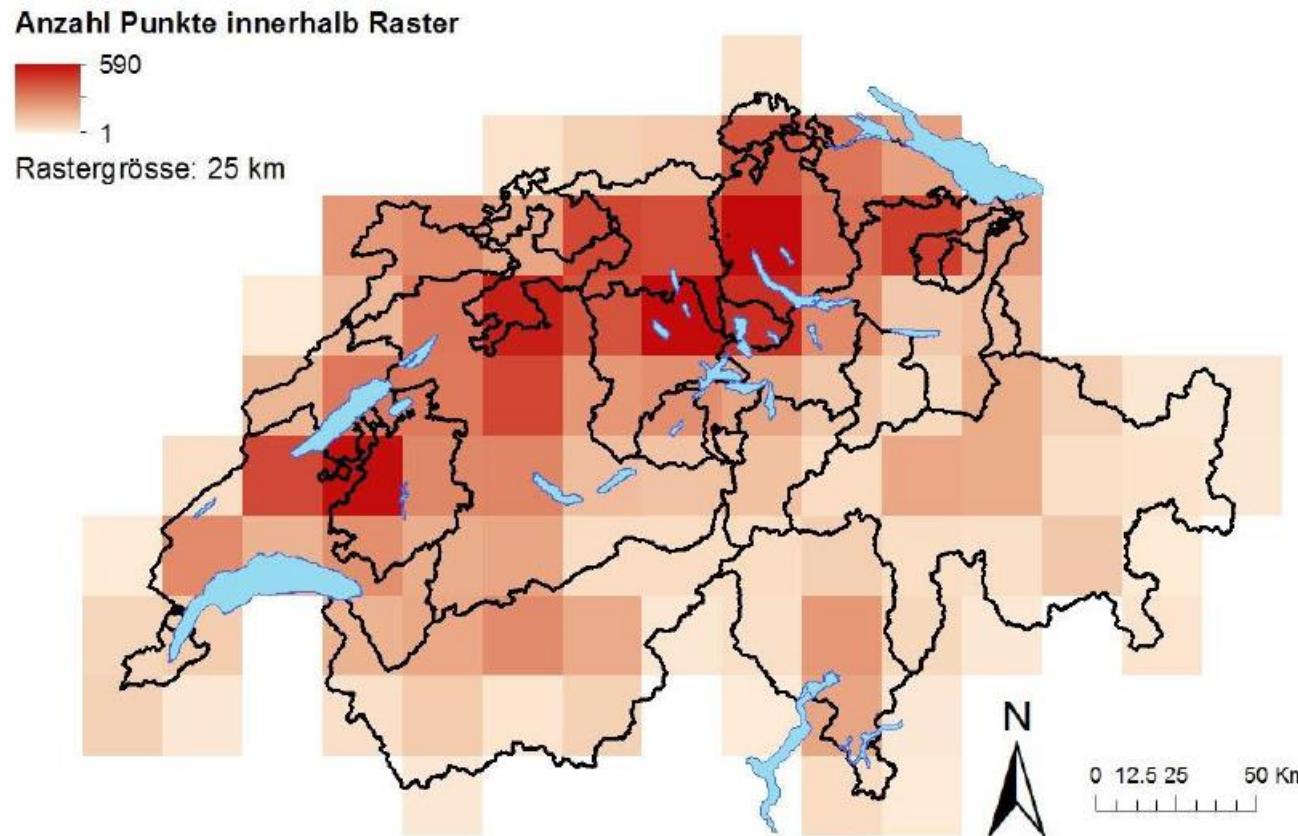
Nutzung (122 = Strassenareal) und
Bedeckung (11 = befestigte Flächen)



Quelle: BFS – Arealstatistik

Analyses of land use statistics

Distribution of construction activity outside development zones



Eschler, 2014

Analyses of land-use statistics

Problem of randomness and reliability

Stichprobenfehler für ein Vertrauensintervall p = 95%

Anhang 2

Häufigkeit der Nutzungsart	Fehler		Häufigkeit der Nutzungsart	Fehler		Häufigkeit der Nutzungsart	Fehler	
	absolut	relativ		absolut	relativ		absolut	relativ
n	ha	%	n	ha	%	n	ha	%
1	± 2,0	± 196	120	± 21	± 18	12 000	± 215	± 1,8
2	± 2,8	± 139	140	± 23	± 17	14 000	± 232	± 1,7
3	± 3,4	± 113	160	± 25	± 15	16 000	± 248	± 1,5
4	± 3,9	± 98	180	± 26	± 15	18 000	± 263	± 1,5
5	± 4,4	± 88	200	± 28	± 14	20 000	± 277	± 1,4
6	± 4,8	± 80	300	± 34	± 11	30 000	± 339	± 1,1
7	± 5,2	± 74	400	± 39	± 10	40 000	± 392	± 1,0
8	± 5,5	± 69	500	± 44	± 8,8	50 000	± 438	± 0,9
9	± 5,9	± 65	600	± 48	± 8,0	60 000	± 480	± 0,8
10	± 6,2	± 62	700	± 52	± 7,4	70 000	± 519	± 0,7
12	± 6,8	± 57	800	± 55	± 6,9	80 000	± 554	± 0,7
14	± 7,3	± 52	900	± 59	± 6,5	90 000	± 588	± 0,7
16	± 7,8	± 49	1 000	± 62	± 6,2	FSO, site statistics, Neuchâtel 2005		
18	± 8,3	± 46	1 200	± 68	± 5,7	120 000	± 679	± 0,6

Analyses of site statistics

Problem of randomness and reliability

Stichprobenfehler für eine Extraktionsrate von p = 95%						Anhang 2			
Häufigkeit der Nutzungsart	Fehlerabschätzung			Häufigkeit der Nutzungsart			Fehlerabschätzung		
	absolut	relativ	n	absolut	relativ	n	absolut	relativ	n
1	± 2,0	± 19	100	± 21	± 17	12 000	± 240	± 1,8	100
2	± 2,8	± 13	140	± 25	± 17	14 000	± 248	± 1,7	140
3	± 3,4	± 113	160	± 26	± 15	16 000	± 263	± 1,5	160
4	± 3,1	± 98	200	± 28	± 15	20 000	± 277	± 1,4	200
5	± 4,4	± 88	200	± 28	± 14	20 000	± 300	± 1,1	200
6	± 4,8	± 80	300	± 32	± 11	30 000	± 335	± 1,0	300
7	± 5,2	± 74	400	± 39	± 10	40 000	± 300	± 1,0	400
8	± 5,5	± 69	500	± 44	± 8,8	50 000	± 438	± 0,9	500
9	± 5,9	± 62	600	± 48	± 8,0	60 000	± 480	± 0,8	600
10	± 6,2	± 59	700	± 52	± 7,4	70 000	± 519	± 0,7	700
12	± 6,8	± 57	800	± 55	± 6,9	80 000	± 554	± 0,7	800
14	± 7,3	± 52	900	± 59	± 6,5	90 000	± 588	± 0,7	900
16	± 7,8	± 49	1 000	± 62	± 6,2	120 000	± 679	± 0,6	1 000
18	± 8,3	± 46	1 200	± 68	± 5,7				1 200

FSO, site statistics, Neuchâtel 2005

Analyses
at a high
aggregation level
min. 100-400
Observations

4. Conclusion

CONCLUSION

Today

Data sets

- Applied examples of the land-use model (FaLC) for Switzerland
- Residents, employed persons
- Land-use patterns

Topics

- Overview of available data
- Pitfalls

My request at the end

- Check regularly whether your data and evaluations match your questions!
- Check whether any data combination/linking you made are reasonable!
- Question your approach and the results!

I would be happy to help with any questions you may have.

THANKS AND HAVE FUN!