



# LESSON OBJECTIVES

**Understand what a GIS is**

**Understand how spatial data is represented in a GIS**

**Look at some GIS applications**

# DATA VS INFORMATION

Pure data is without context.

Data is of little use unless it is transformed into information.

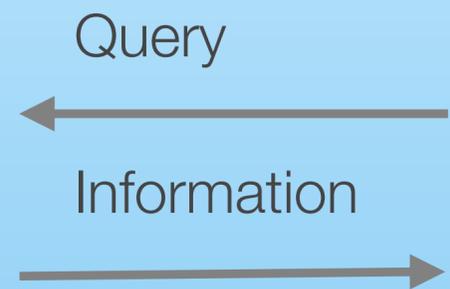
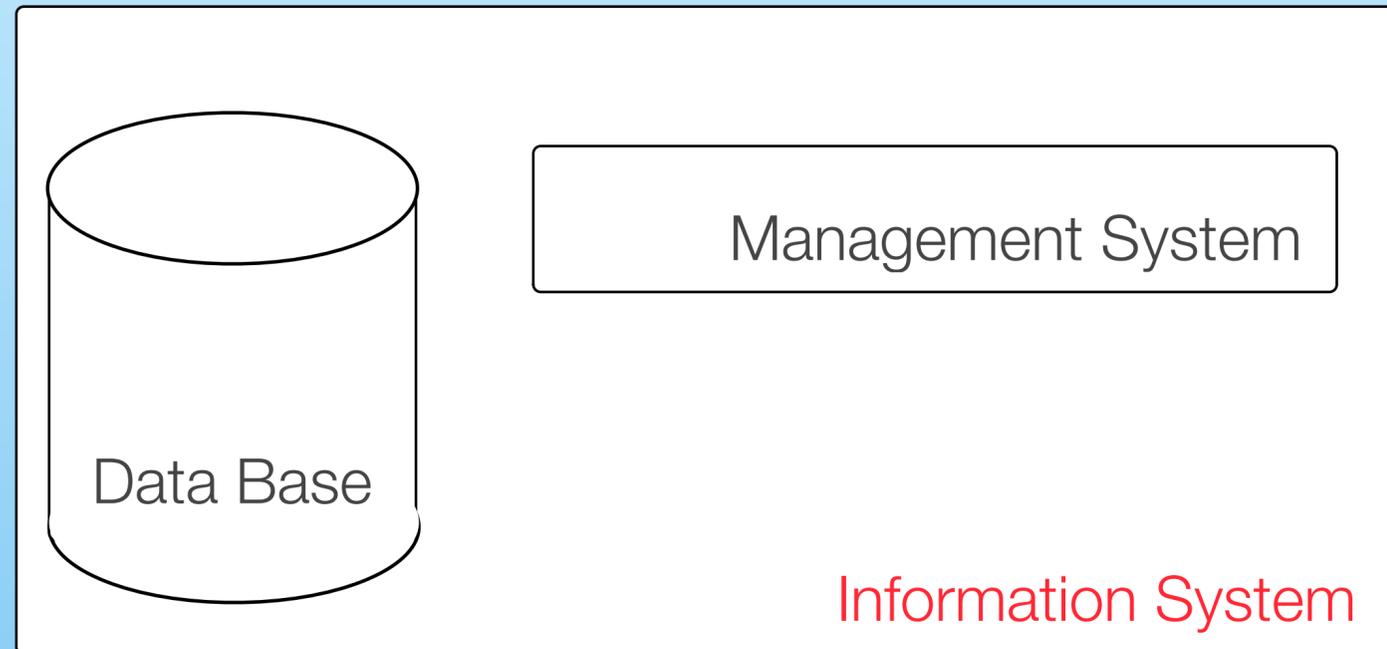
Information is an answer to a question based on raw data.

We transform data into information through the use of an Information System.

Data, by itself, generally differs from information.



# WHAT IS AN INFORMATION SYSTEM?



# Request

# WHAT IS AN INFORMATION SYSTEM?

In the digital environment we use software to create complex information systems.

The screenshot shows the Amazon.de website interface. The search bar contains 'architektur eth' and the results page displays three book listings:

- Jahrbuch Architektur: Lehre und Forschung** von ETH Zürich Departement Architektur von Gta Verlag (31. Juli 2011)
 

Formate	Neu kaufen	Neu ab	Gebraucht ab
<b>Taschenbuch</b>	EUR 30,00	EUR 24,00	EUR 24,00
- Architekturdialoge** von Departement für Architektur der ETH Zürich, Marc Angéllil und Jørg Himmelreich von Niggli (November 2011)
 

Formate	Neu kaufen	Neu ab	Gebraucht ab
<b>Broschiert</b>	EUR 62,00		
- Jahrbuch Architektur: Lehre und Forschung** von ETH Zürich Departement Architektur von Gta Verlag (September 2011)
 

Formate	Neu kaufen	Neu ab	Gebraucht ab
<b>Taschenbuch</b>	EUR 30,00	EUR 30,00	EUR 30,00

Query from Amazon.de as an example of an information system  
Source: <http://www.amazon.de>

Information System



+

Geographic Position

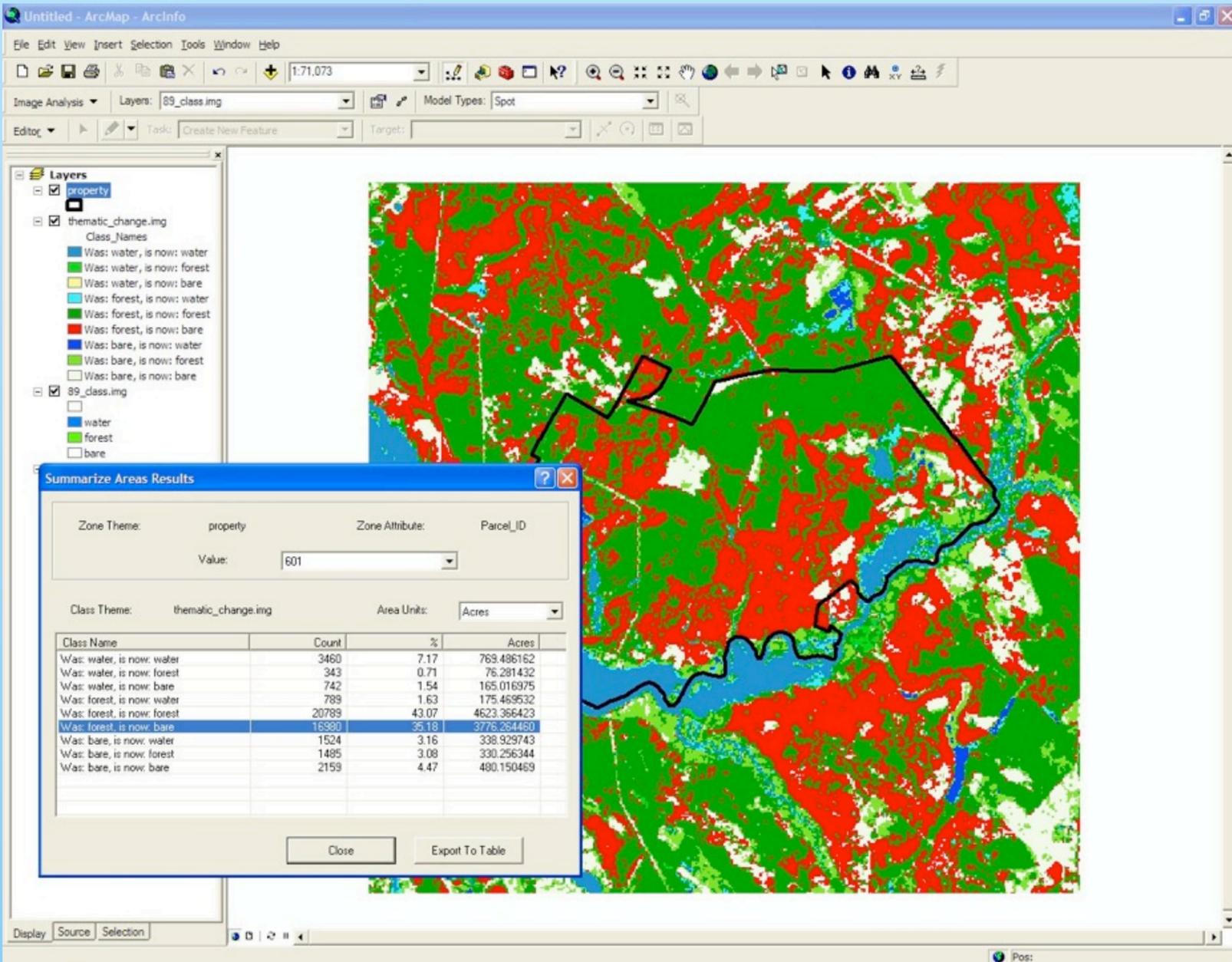


## WHAT IS A GIS?

A means of storing, retrieving, sorting, and comparing **spatial data** to support analytic process.

# WHAT IS A GIS?

GIS links graphical features (**entities**) to tabular data (**attributes**)



Example of a GIS frontend

Source: [http://www.erdas.com/Libraries/Screenshots/Facilitates\\_the\\_Extraction\\_of\\_Quantitative\\_Information.sflb.ashx?width=440&proportional=true&decreaseOnly=false%22%3Eas](http://www.erdas.com/Libraries/Screenshots/Facilitates_the_Extraction_of_Quantitative_Information.sflb.ashx?width=440&proportional=true&decreaseOnly=false%22%3Eas) of 11/06/2011

# GIS DEFINITION

A GIS is a system (hardware + database engine) that is designed to efficiently, assemble, store, update, analyze, manipulate, and display **geographically referenced information** (data identified by their locations).

A GIS also includes the **people** operating the system and the **data** that go into the system.



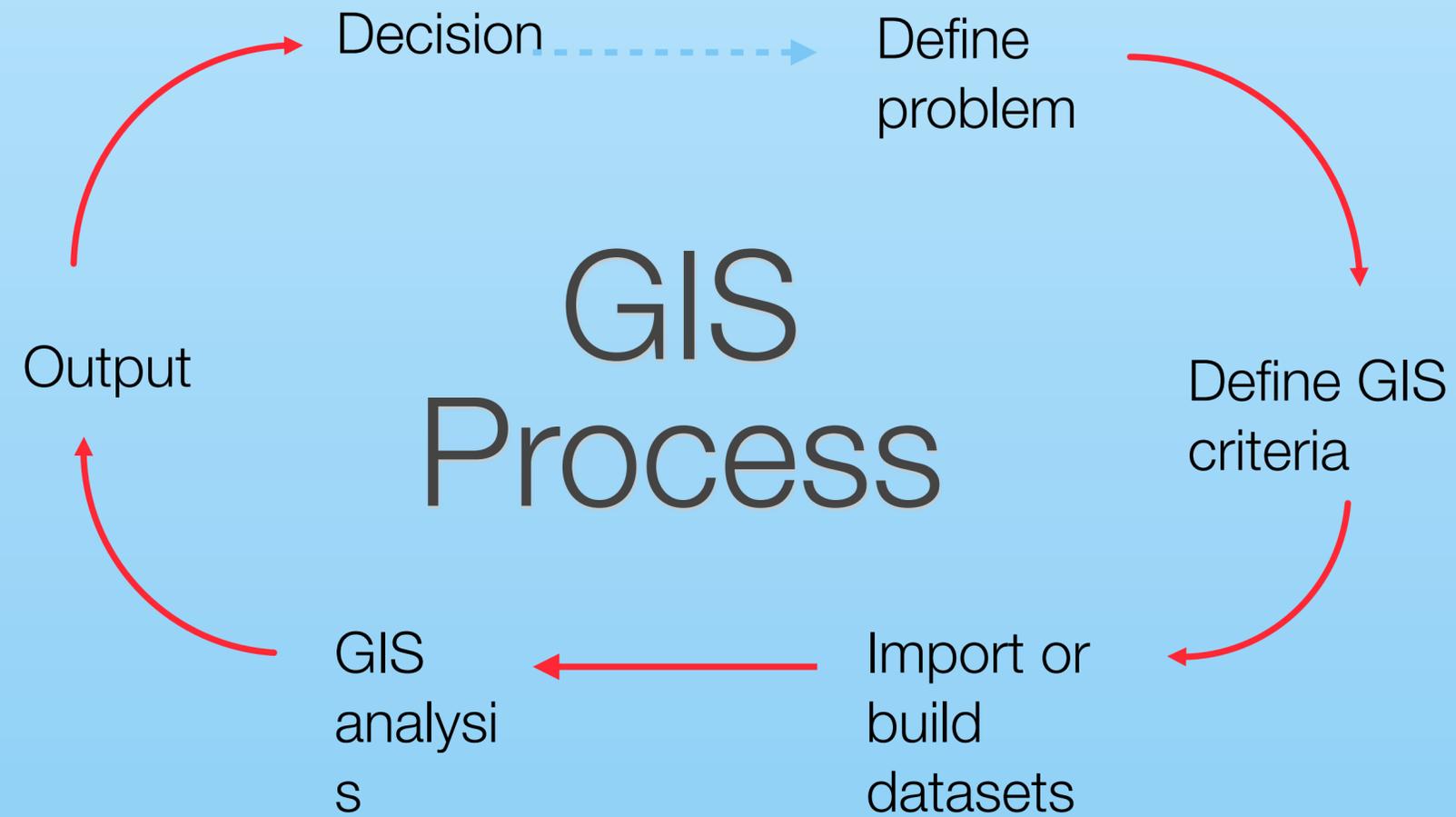
Example of a Network Analyses

Source: MIT GIS Library

[http://libraries.mit.edu/sites/news/files/2011/10/BA\\_libblog.png](http://libraries.mit.edu/sites/news/files/2011/10/BA_libblog.png)

# GEOGRAPHIC INFORMATION SYSTEM

## SYSTEM



GIS Process  
Source: Reference is stated here

### Define Problem

Double-click here to edit

### Define GIS criteria

Double-click here to edit

### Import or build dataset

Double-click here to edit

### GIS analysis

Double-click here to edit

### Output

Double-click here to edit

### Decision

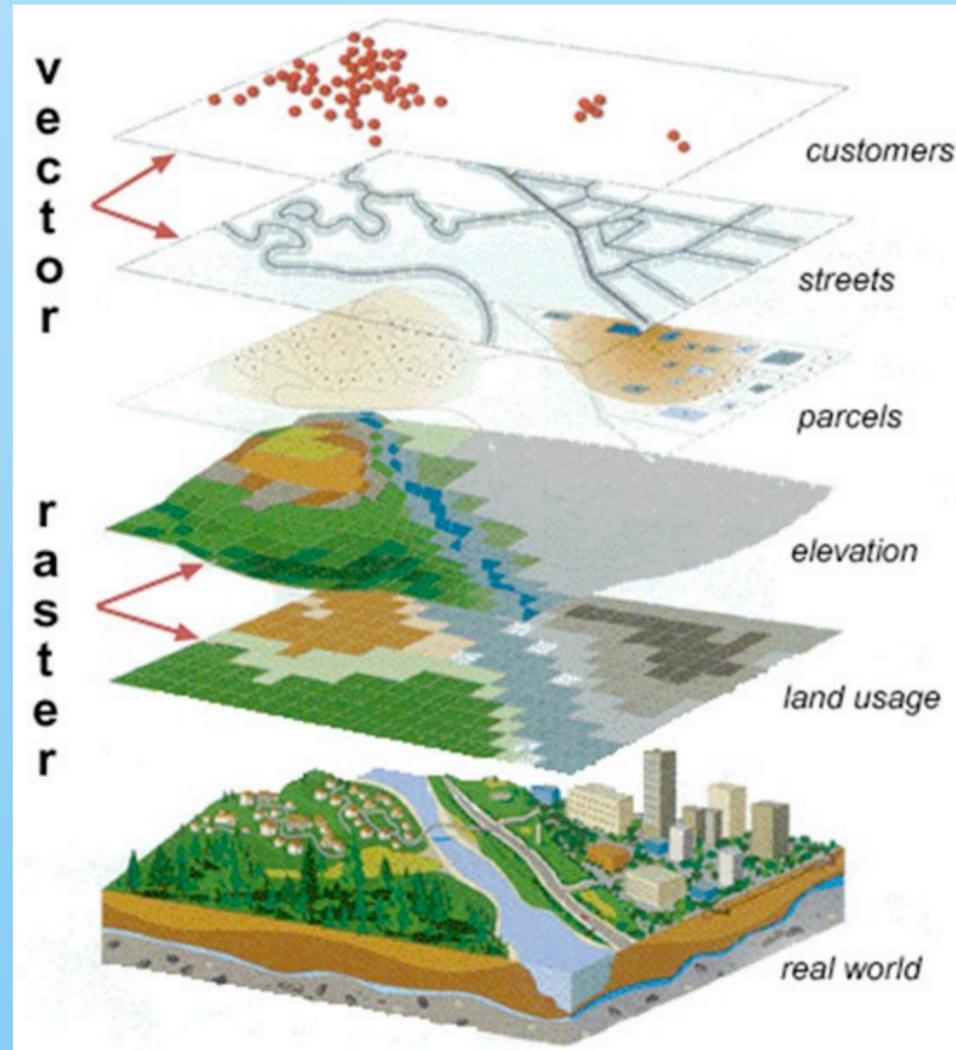
Double-click here to edit

# REPRESENTING SPATIAL ELEMENTS

Raster

Vector

Real World



Monitoring Wells

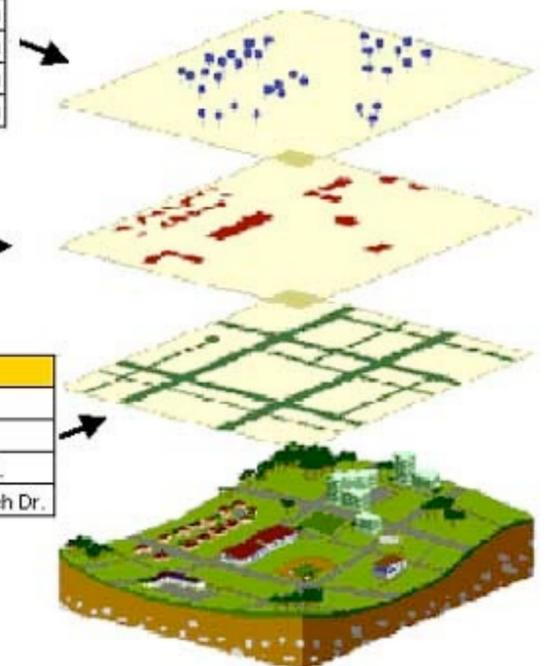
Well ID	Date Sampled	Concentration
C-6A	5/8/94	300
C-8A	5/8/94	20
C-13A	5/8/94	120
C-17A	5/8/94	560

Industries

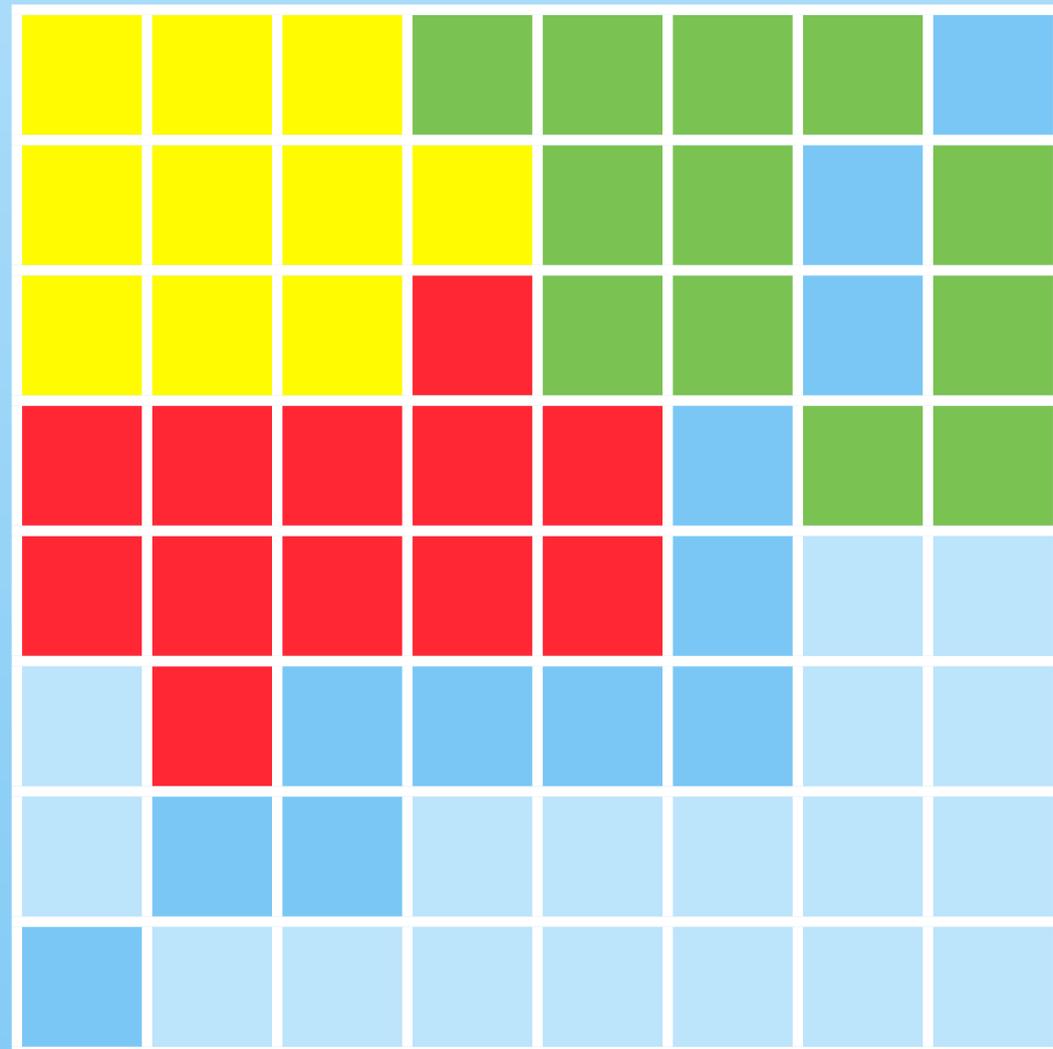
Facility	Address
Acme	3029 Convington Dr.
Fox	742 West Lake St.
TPC	90 Aspen Dr.

Population

Family Name	Occupants	Address
Blake	6	79 Circuit St
Hernandez	2	148 Plain St.
Joy	4	18 Webster St.
Smith	5	4321 Tecumseh Dr.



# REPRESENTING SPATIAL ELEMENTS

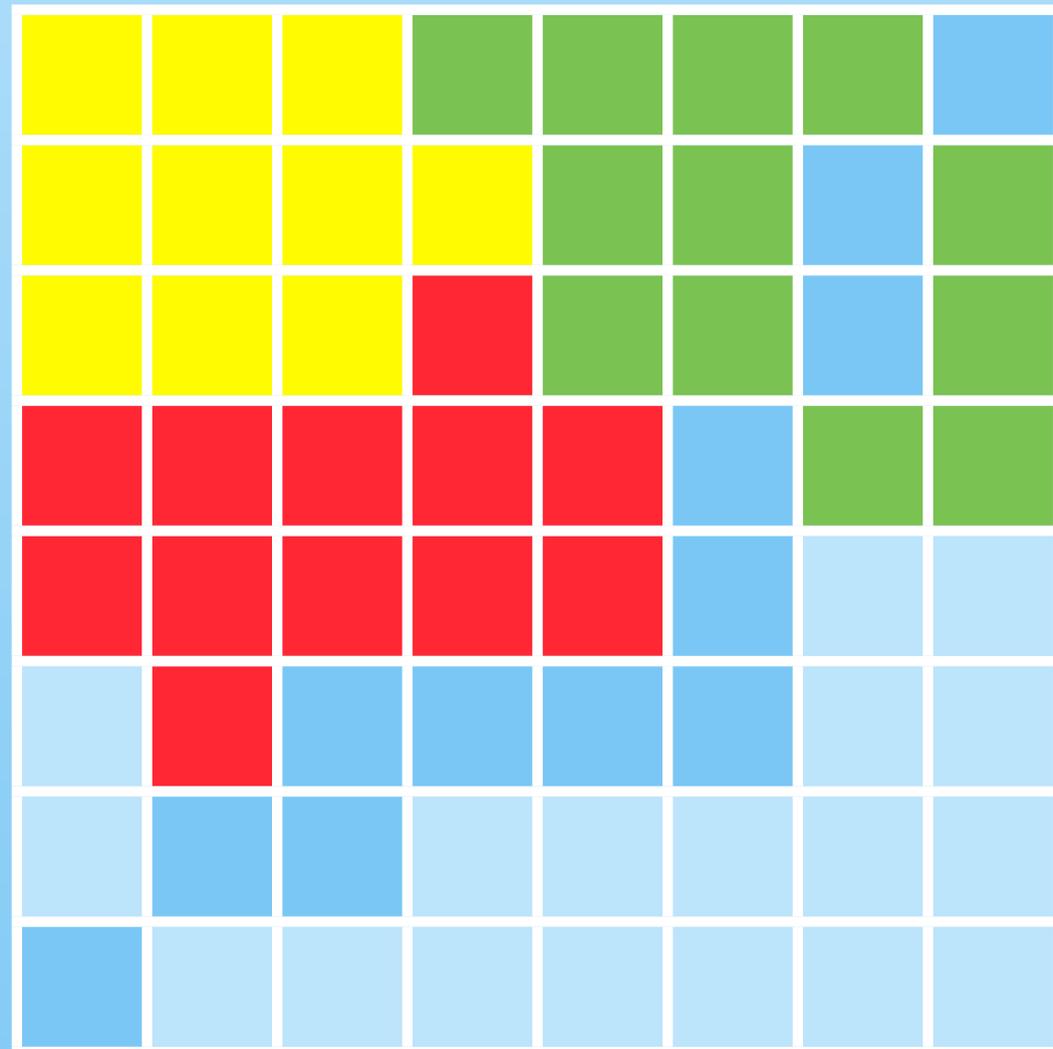


## Raster - 1

- Stores images as rows and columns of numbers with a Digital Value/Number (DN) for each cell.
- Units are usually represented as square grid cells that are uniform in size.
- Data is classified as “continuous” (such as in an image), or “thematic” (where each cell denotes a feature type).
- Numerous data formats (TIFF, GIF, JPG, PNG etc.)

-

# REPRESENTING SPATIAL ELEMENTS



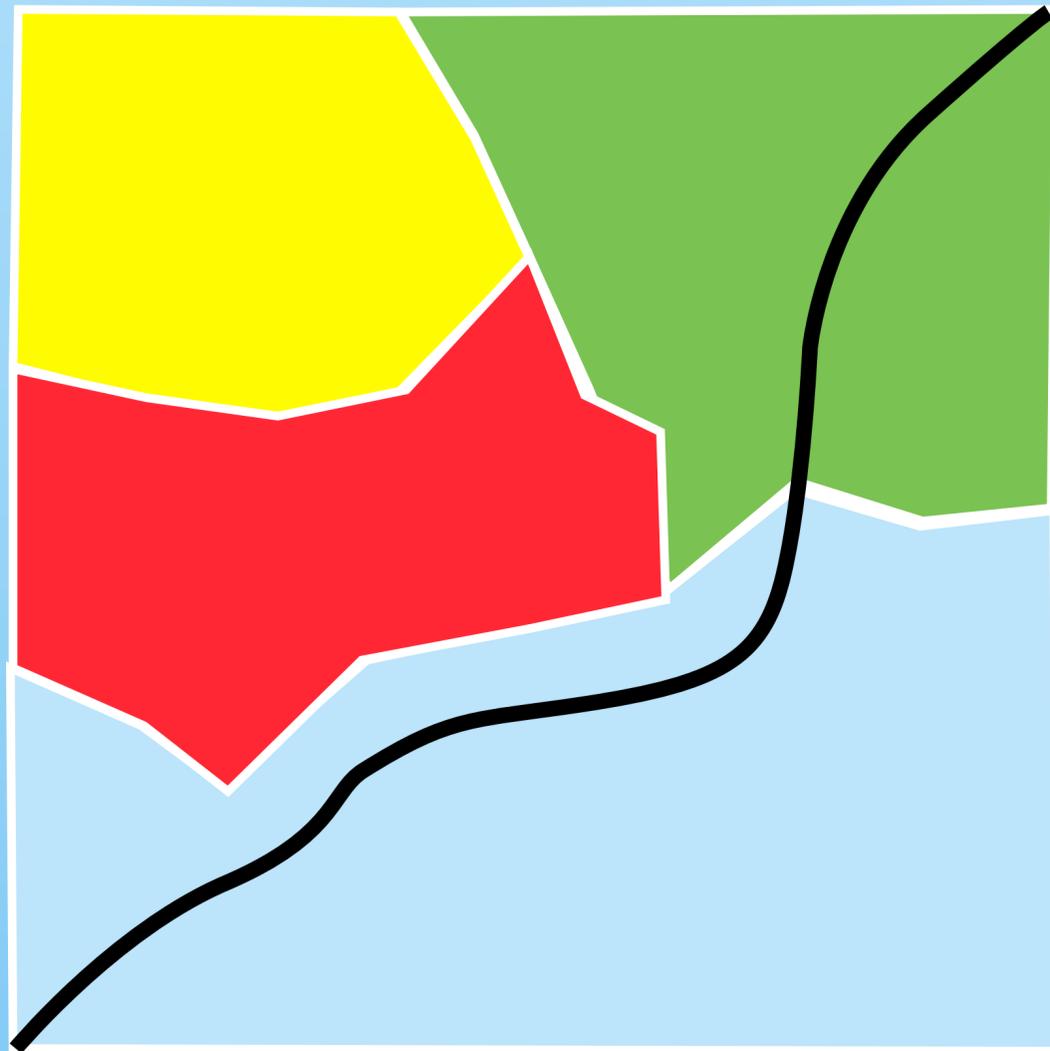
## Raster - 2

- smaller grid cells = higher resolution
- descriptive problems between discrete and continuous values (e.g., borders)
- perfect for discrete representations (thematic maps, satellite data, elevation models)
- local, focal, zonal, global functions
- macro-functions (blow-shrink, flooding,...)
- high- and low-pass filtering

# REPRESENTING SPATIAL ELEMENTS

## Vector

- Allows user to specify specific spatial locations and assumes that geographic space is continuous, not broken up into discrete grid squares
- We store features as sets of X,Y coordinate pairs.



# ENTITY REPRESENTATIONS

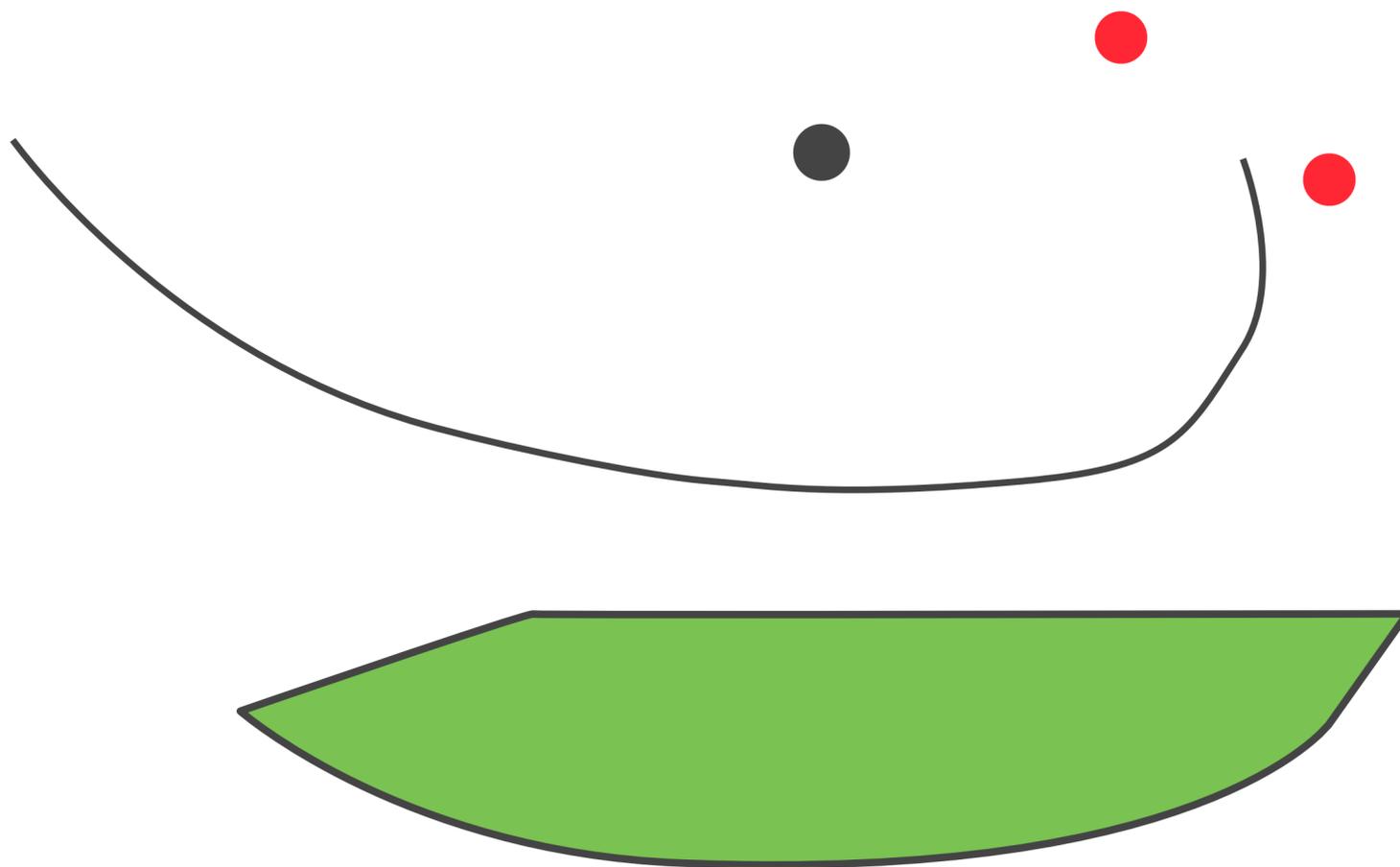
We typically represent objects in space as three distinct spatial elements:

**Points** - simplest element

**Lines** (arcs) - set of connected points

**Polygons** - set of connected lines

We use these three spatial elements to represent real world features and attach locational information to them.



# ATTRIBUTES

In the **raster** data model, the cell value (Digital Number) is the attribute. Examples: brightness, land cover code, SST, etc.

For **vector** data, attribute records are linked to point, line & polygon features. Can store multiple attributes per feature. Vector features are linked to attributes by a unique feature number.

# RASTER VS VECTOR

## **Raster Advantages**

Easy to perform logical and math operations  
low effort on data acquisition

Satellite information is easily incorporated  
Better represents “continuous”- type data

## **Vector Advantages**

Compact data storage requirements

Can associate unlimited numbers of  
attributes with specific features

Precise geometry and topology of  
individual data

# PROJECTION AND COORDINATE SYSTEMS

## **Ellipsoids**

Earth is no sphere but **geoid**

Geographic coordinate systems use **ellipsoids**

Shape of Earth and position of objects are defined mathematically

Different ellipsoids for different parts of world

## **Geographic coordinate system**

Coordinate system depends from reference ellipsoid

## **Projected coordinate system**

Transforms from 3D to 2D

Results in distorted shapes, areas, distances, direction

Different projections result in different distortions

# PROJECTION AND COORDINATE SYSTEMS

## Conic Projection

Distance correctness along lines

## Cylindric Projection

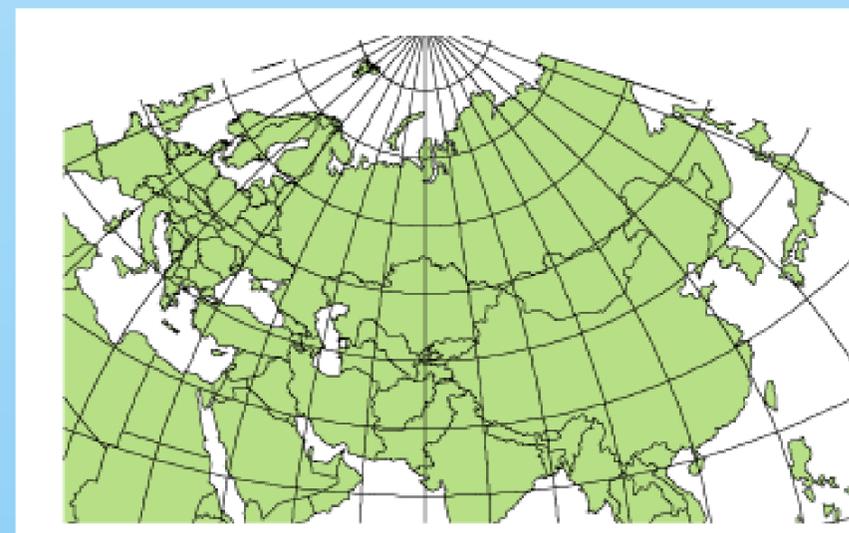
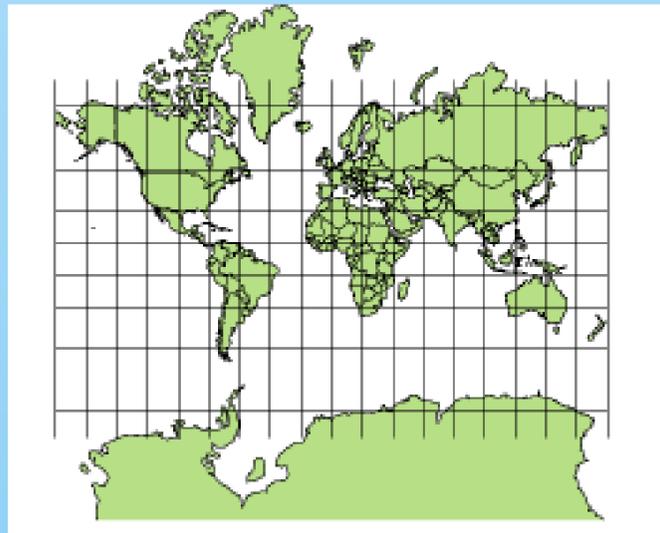
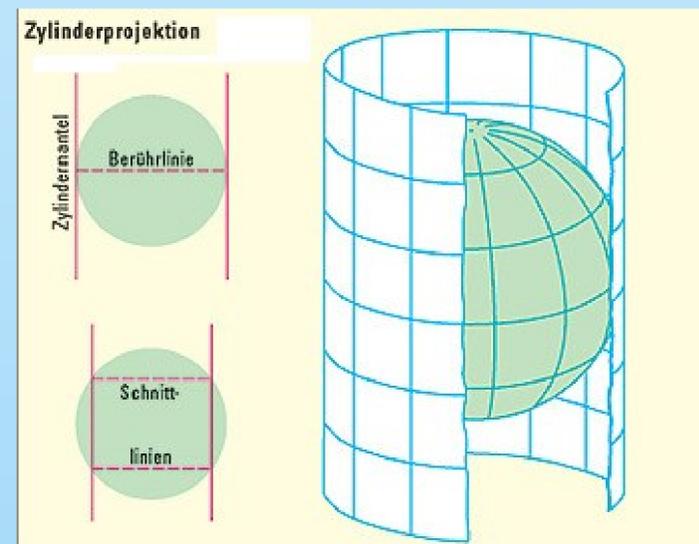
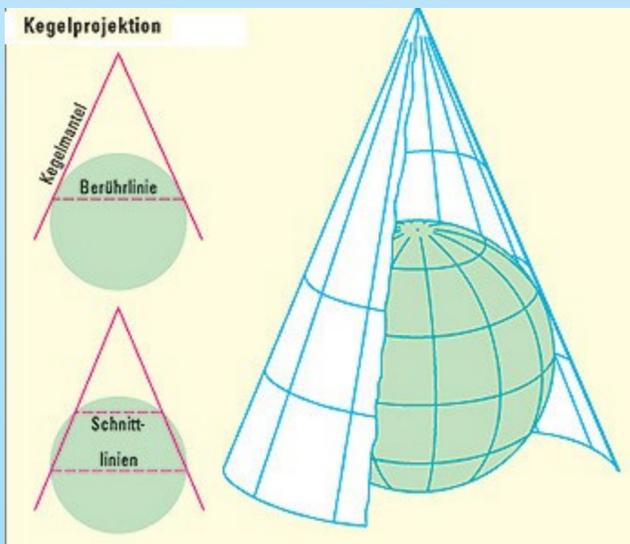
Distance correctness along tangent  
Correct angles

## Mercator

Highly correct angles  
Meridian and latitudes parallel line  
Cylinder tangents equator

## Transverse Mercator

Shifted projection cylinder  
Specific projection: Gaus-Krüger CS



äquatorial



schräg

# GIS FUNCTIONALITY

**Data Assembly / Creation**

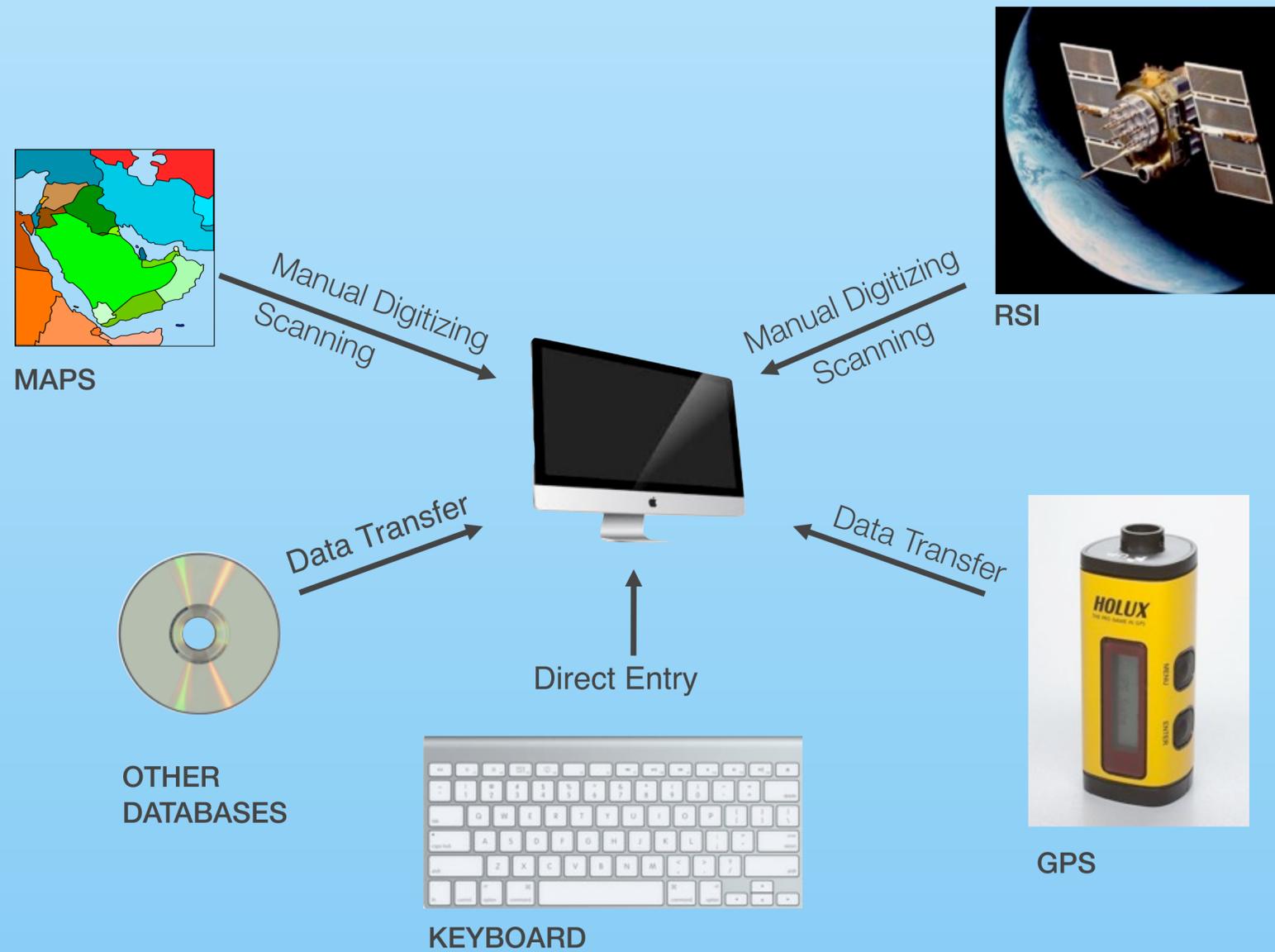
**Data Storage**

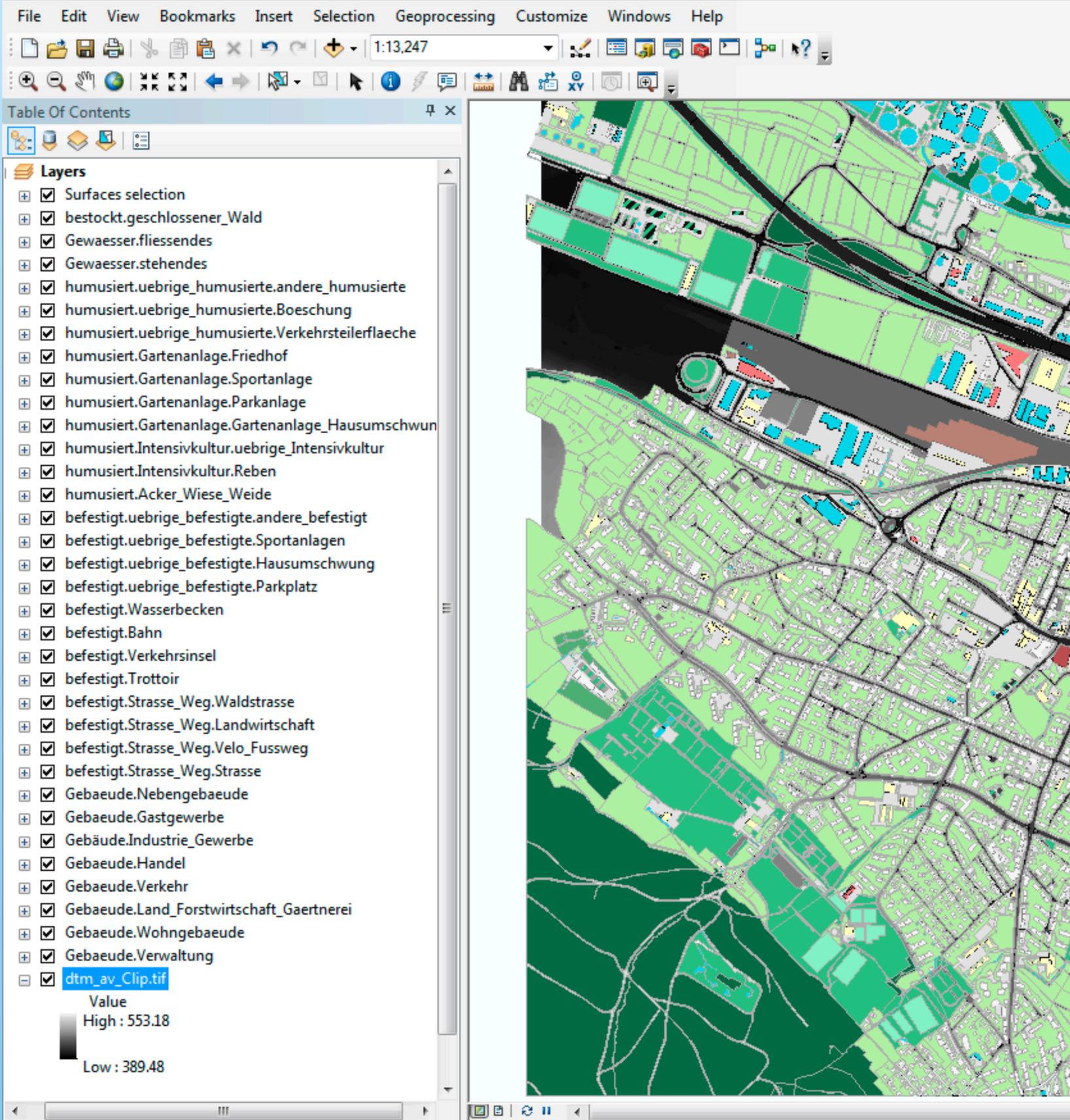
**Spatial Data Analysis and Manipulation**

**Spatial Data Output**

# GIS FUNCTIONALITY

## Data Assembly / Creation





The screenshot displays the ArcMap interface with a map of Zurich. The map shows a mix of green areas (parks and forests), grey areas (buildings and roads), and blue areas (water bodies). The Table of Contents on the left lists the following layers:

- Surfaces selection
- bestockt.geschlossener\_Wald
- Gewaesser.fliessendes
- Gewaesser.stehendes
- humusiert.uebrige\_humusiert.andere\_humusiert
- humusiert.uebrige\_humusiert.Boeschung
- humusiert.uebrige\_humusiert.Verkehrsteilerflaeche
- humusiert.Gartenanlage.Friedhof
- humusiert.Gartenanlage.Sportanlage
- humusiert.Gartenanlage.Parkanlage
- humusiert.Gartenanlage.Gartenanlage\_Hausumschwun
- humusiert.Intensivkultur.uebrige\_Intensivkultur
- humusiert.Intensivkultur.Reben
- humusiert.Acker\_Wiese\_Weide
- befestigt.uebrige\_befestigte.andere\_befestigt
- befestigt.uebrige\_befestigte.Sportanlagen
- befestigt.uebrige\_befestigte.Hausumschwung
- befestigt.uebrige\_befestigte.Parkplatz
- befestigt.Wasserbecken
- befestigt.Bahn
- befestigt.Verkehrinsel
- befestigt.Trottoir
- befestigt.Strasse\_Weg.Waldstrasse
- befestigt.Strasse\_Weg.Landwirtschaft
- befestigt.Strasse\_Weg.Velo\_Fussweg
- befestigt.Strasse\_Weg.Strasse
- Gebaeude.Nebengebäude
- Gebaeude.Gastgewerbe
- Gebäude.Industrie\_Gewerbe
- Gebaeude.Handel
- Gebaeude.Verkehr
- Gebaeude.Land\_Forstwirtschaft\_Gaertnerei
- Gebaeude.Wohngebäude
- Gebaeude.Verwaltung
- dtm\_av\_Clip.tif

The 'dtm\_av\_Clip.tif' layer is selected, and its properties are shown below:

- Value
- High : 553.18
- Low : 389.48

# GIS FUNCTIONALITY

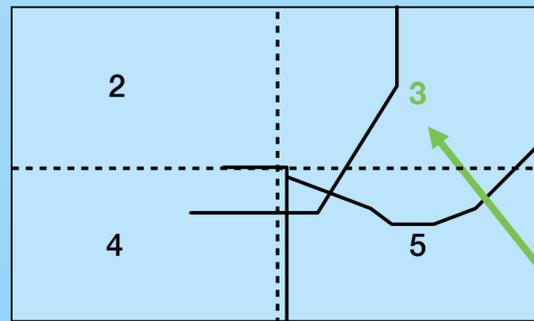
## Data Assembly / Creation

# GIS FUNCTIONALITY

Data Assembly / Creation

Data Storage

Universe polygon



**Spatial data**  
ARC functions

COV#	ZONE	ZIP
1		0
2	C-19	22060
3	A-4	22061
4	C-22	22060
5	A-5	22057

**Attribute data**  
INFO or TABLES functions

# GIS FUNCTIONALITY

Data Assembly / Creation

Data Storage

**Spatial Data Analysis and Manipulation**

## Spatial Data Analysis and Manipulation



### Common Manipulation

Reclassification

Map Projection changes

### Common Analysis

Buffering

Overlay

Network

# GIS FUNCTIONALITY

Data Assembly / Creation

Data Storage

Spatial Data Analysis and Manipulation

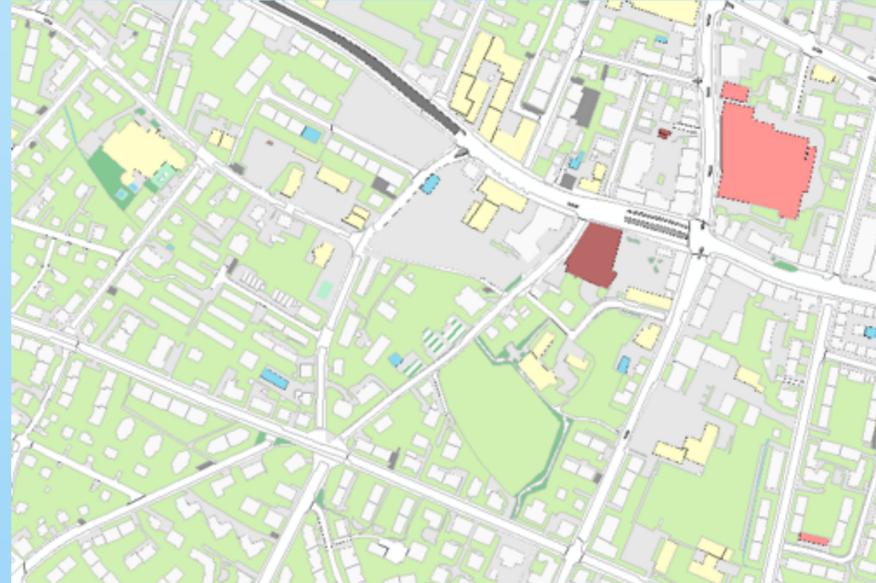
Spatial Data Output

Tables

Maps

Interactive Displays

3-D Perspective View



OBJ	OBJID	ENTSTEHQ	QUALITAA	ART_TXT	R1_OBJID	R1_NBID	R1_IDEN	R1_BESC	R1R1_GUEL
274	42167	BBNachf	AV93	bestockt 844	ZH0200	HG3205	9334,	gueltig	
5		uehrung 0		3. uebrige_	000261		Amt für	1	
		[844]		bestockt			Städteb		
				e			au,		
							Waldgr		
275	44590	BBNachf	AV93	bestockt 844	ZH0200	HG3205	9334,	gueltig	
4		uehrung 0		3. uebrige_	000261		Amt für	1	
		[844]		bestockt			Städteb		
				e			au,		
							Waldgr		
275	29583	BBNachf	AV93	bestockt 2513	ZH0200	22161	Sammel	gueltig	
8		uehrung 0		3. uebrige_	000261		mut/Wa	1	
		[2513]		bestockt			ldrandä		
				e			nd		
294	42414	BBNachf	AV93	bestockt 610	ZH0200	HG3088	AV93	gueltig	
1		uehrung 0		3. uebrige_	000261		Aufarbei	1	
		[610]		bestockt			tung		
				e					
295	42482	BBNachf	AV93	bestockt 610	ZH0200	HG3088	AV93	gueltig	
3		uehrung 0		3. uebrige_	000261		Aufarbei	1	
		[610]		bestockt			tung		



# GIS DATA SOURCES FOR URBAN PLANNING, DESIGN

## GOOGLE MAPS

- Professional routing services
- Location-based advertisement

## BING MAPS

- Isometric views for urban studies

## Open Street Map

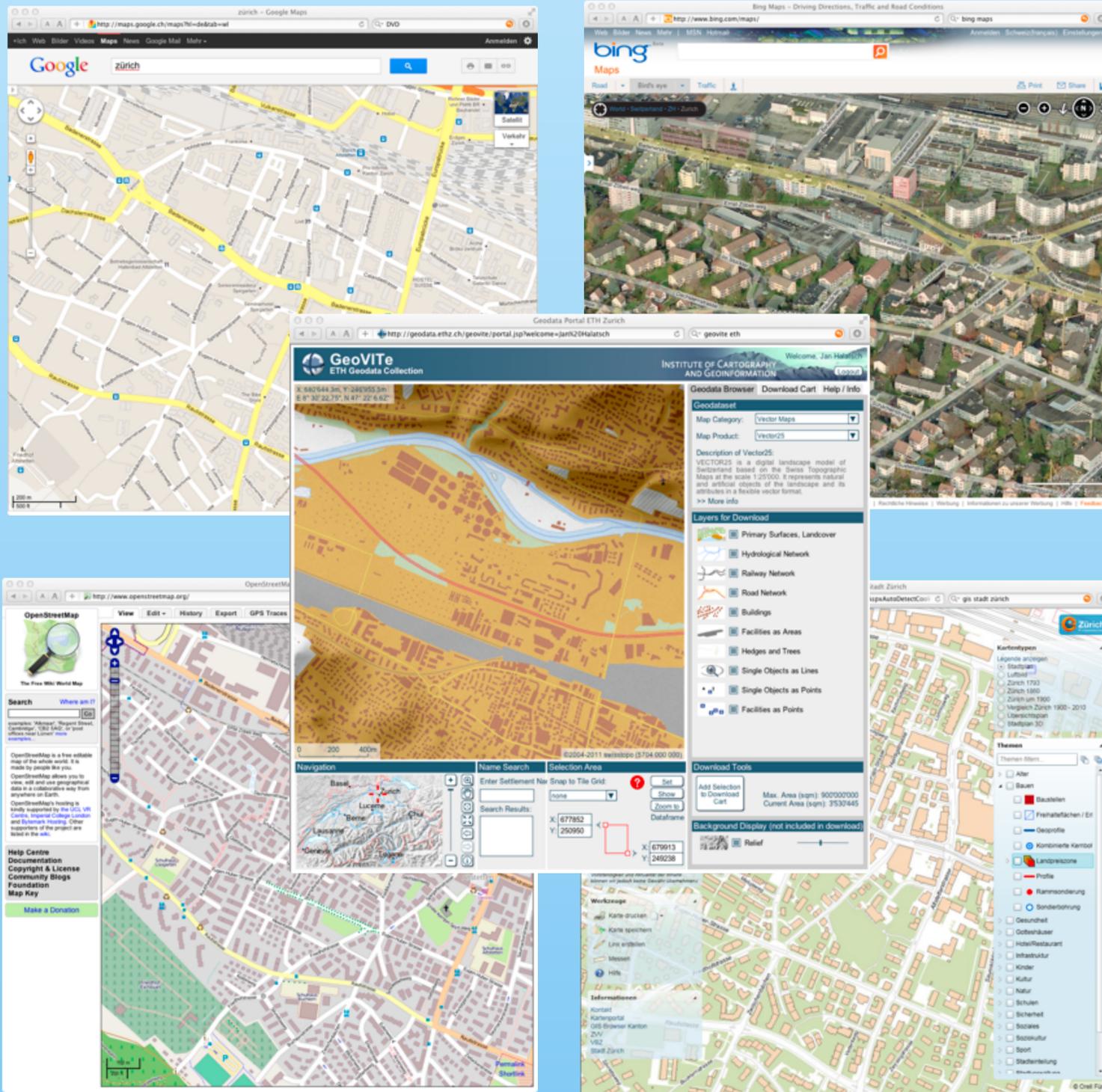
- <http://www.openstreetmap.org/>
- Open source, world-wide, vector data
- Information can be accessed from ArcMap

## ZüriPlan

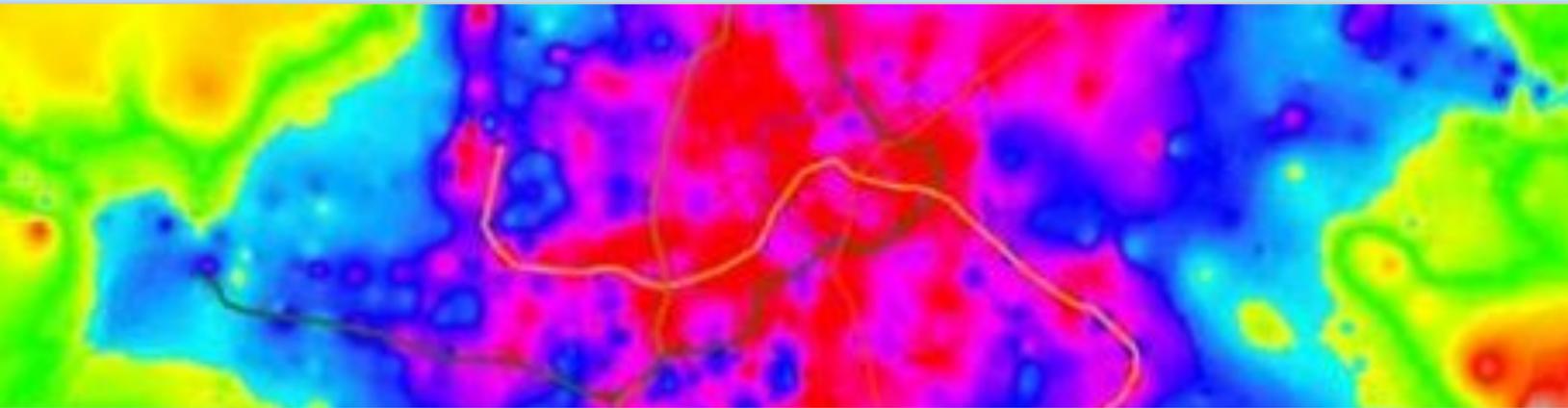
- <http://www.stadtplan.stadt-zuerich.ch/zueriplan/stadtplan.aspx>

## GeoVite

- <http://geodata.ethz.ch/geovite/>



# GIS IN URBAN PLANNING



## **SPATIAL ANALYSIS**

- Used to understand spatial interdependencies
- Geo data is combined with modern analyses

## **THEMATIC MAPS**

- Maps focusing on isolated theme
- Direct input for urban planning & design

## **GEO-COMMUNICATION**

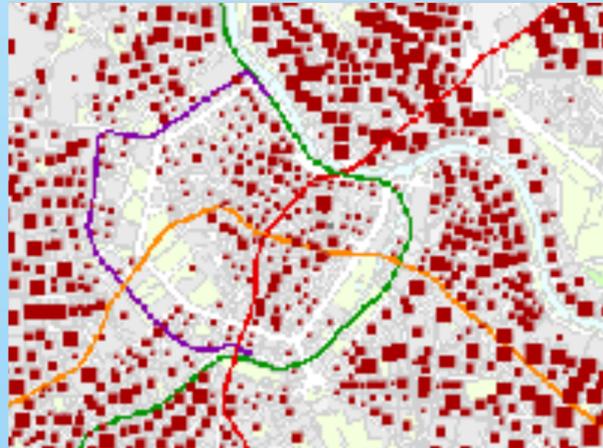
- Design of maps for communicating information
- Information visualization

## **GEO-COMMUNICATION**

- Value-added services for public or private

Information of Wien.at - GIS platform

# GIS IN URBAN PLANNING



## POPULATION SIZE PER BLOCK

- Can reflect the organic structure of a city.
- Depend on changes over time.
- Difficult on statistical evaluation.

## POPULATION SIZE PER GRID

- Regular structure, not considering urban structure
- Same size, easy to use for statistical reports

Information of Wien.at - GIS platform

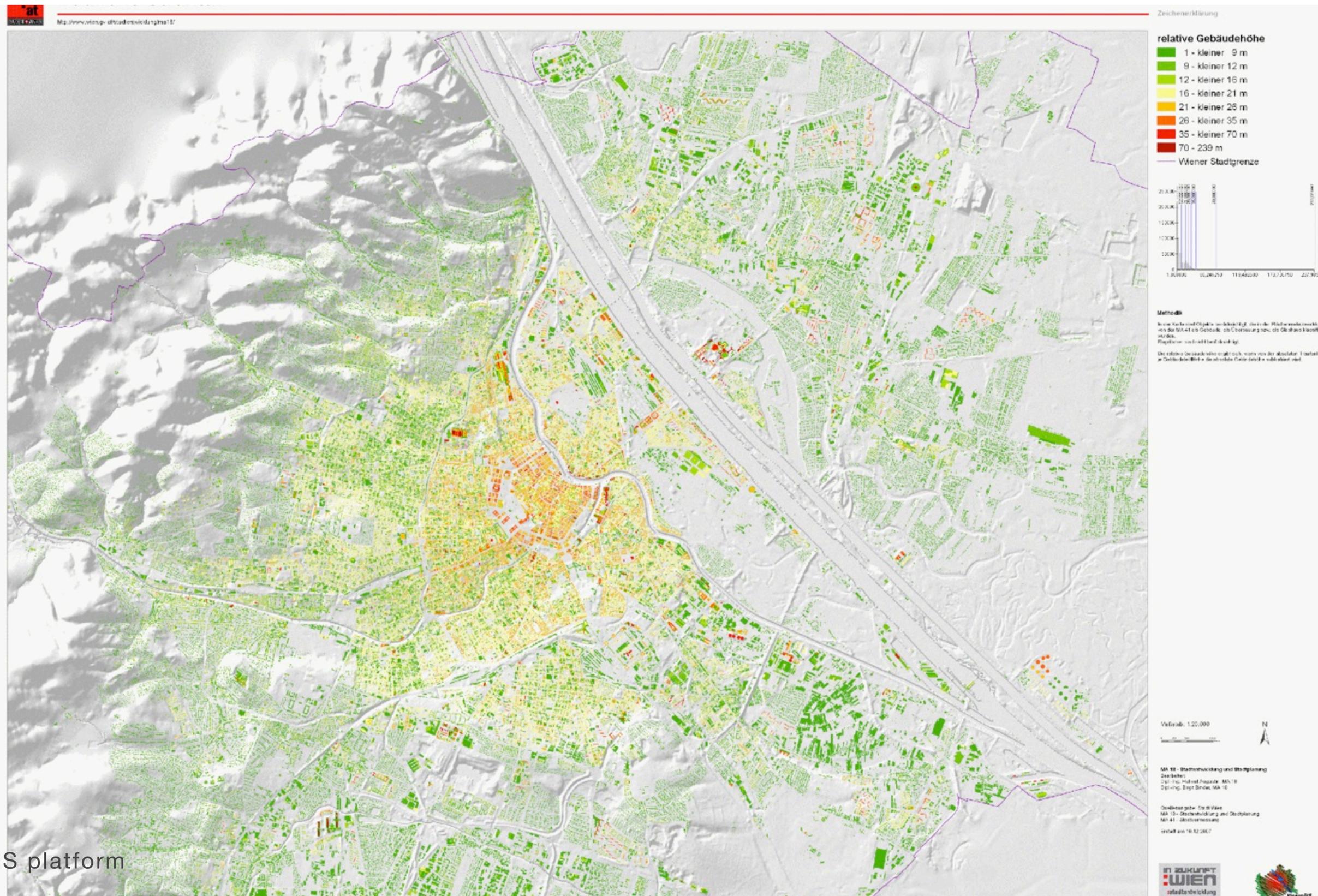
# GIS IN URBAN PLANNING



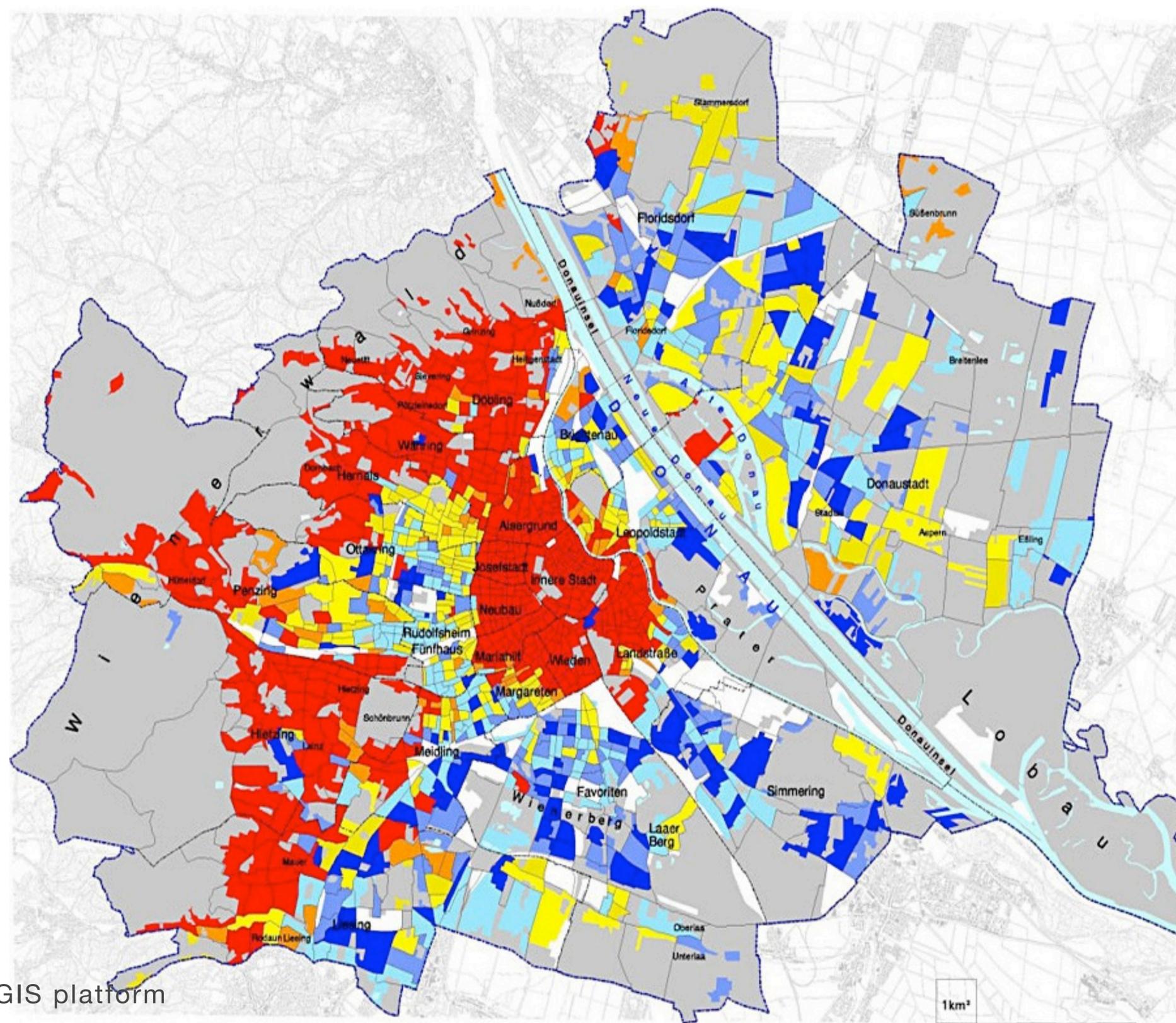
## GEO-COMMUNICATION

- Examples reflecting on different foci
- Building structure
- Open-space structure
- Traffic structure

# EXAMPLES



# EXAMPLES



## PLANUNGSGRUNDLAGEN FÜR WIEN

Magistrat der Stadt Wien  
Geschäftsgruppe Stadtentwicklung und Verkehr

### VOLKSZÄHLUNG 2001

#### AKADEMIKERQUOTE

Anteil der Personen mit (Fach-) Hochschule oder Universitätsabschluss als höchst abgeschlossene Schulbildung an der Wohnbevölkerung im Alter von 15 und mehr Jahren in Prozent nach Zählgelieten.

- < 3.0
- 3.0 - 4.9
- 5.0 - 6.9
- 7.0 - 8.9
- 9.0 - 10.9
- 11.0 - 12.9
- >= 13.0

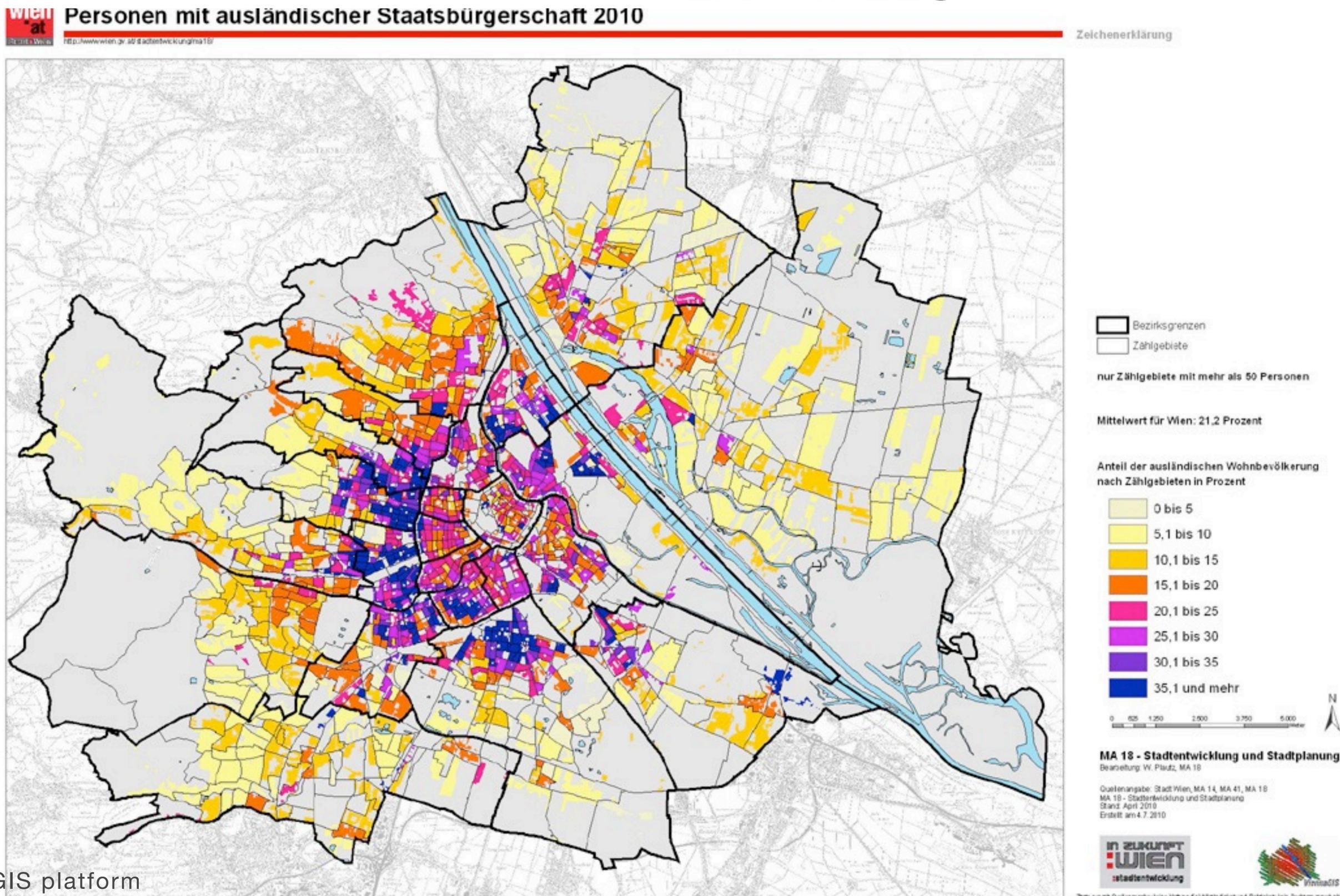
Mittelwert für Wien 10.4 Prozent

- Gewässer
- Zählgeliete mit weniger als 50 Einwohnern bzw. Geliete mit größeren Verkehrsflächen
- Unbebautes Geliet
- Landesgrenze
- Bezirksgrenze
- Zählgelietsgrenze

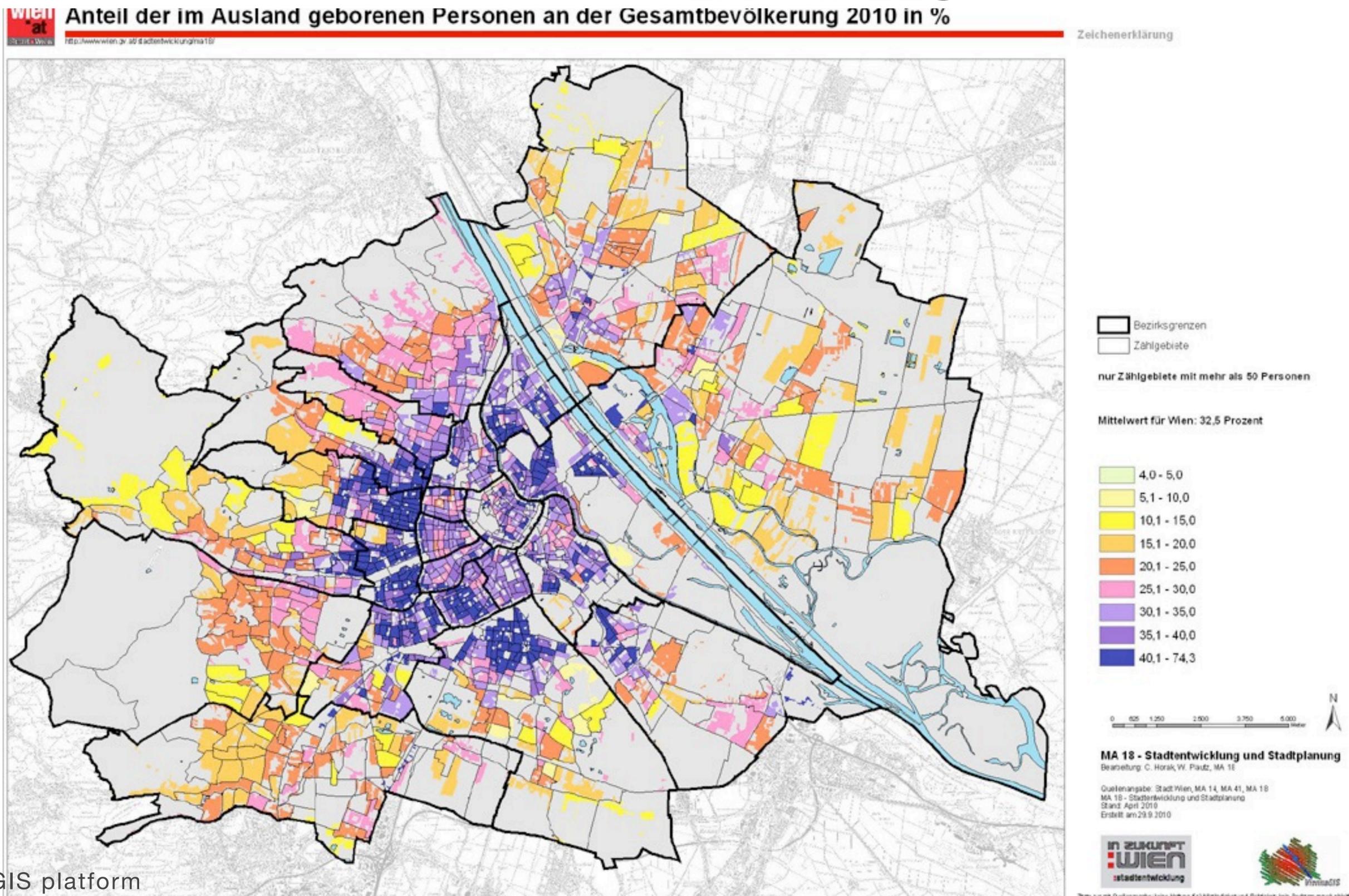
QUELLE: Statistik Austria, VZ 2001, MA 18  
GRUNDKARTE: MA 21B, Zählgelietseinteilung von Wien  
Bearbeitung: MA 18, Stadtentwicklung und Stadtplanung, B. Binder, W. Plautz



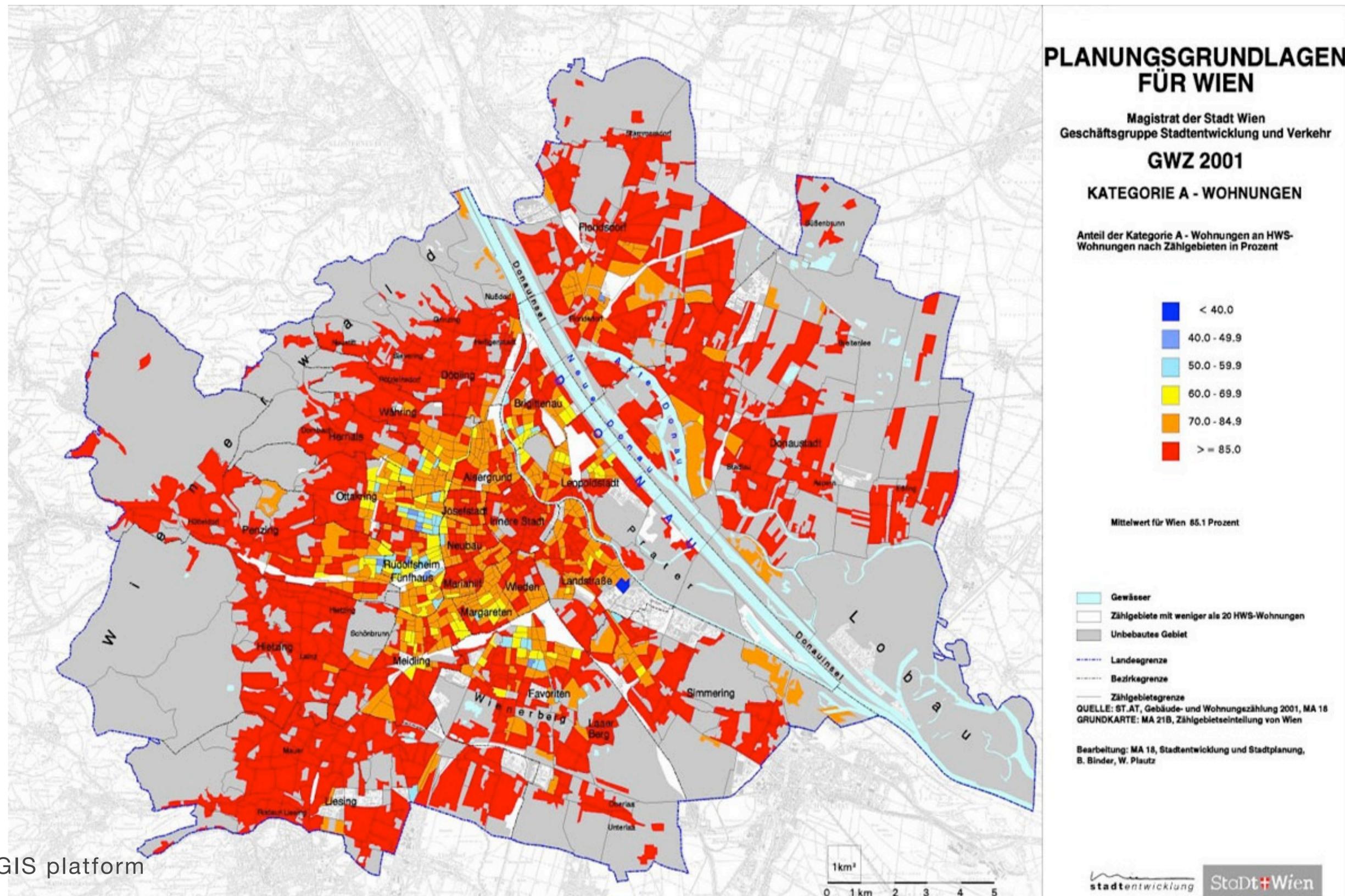
# EXAMPLES



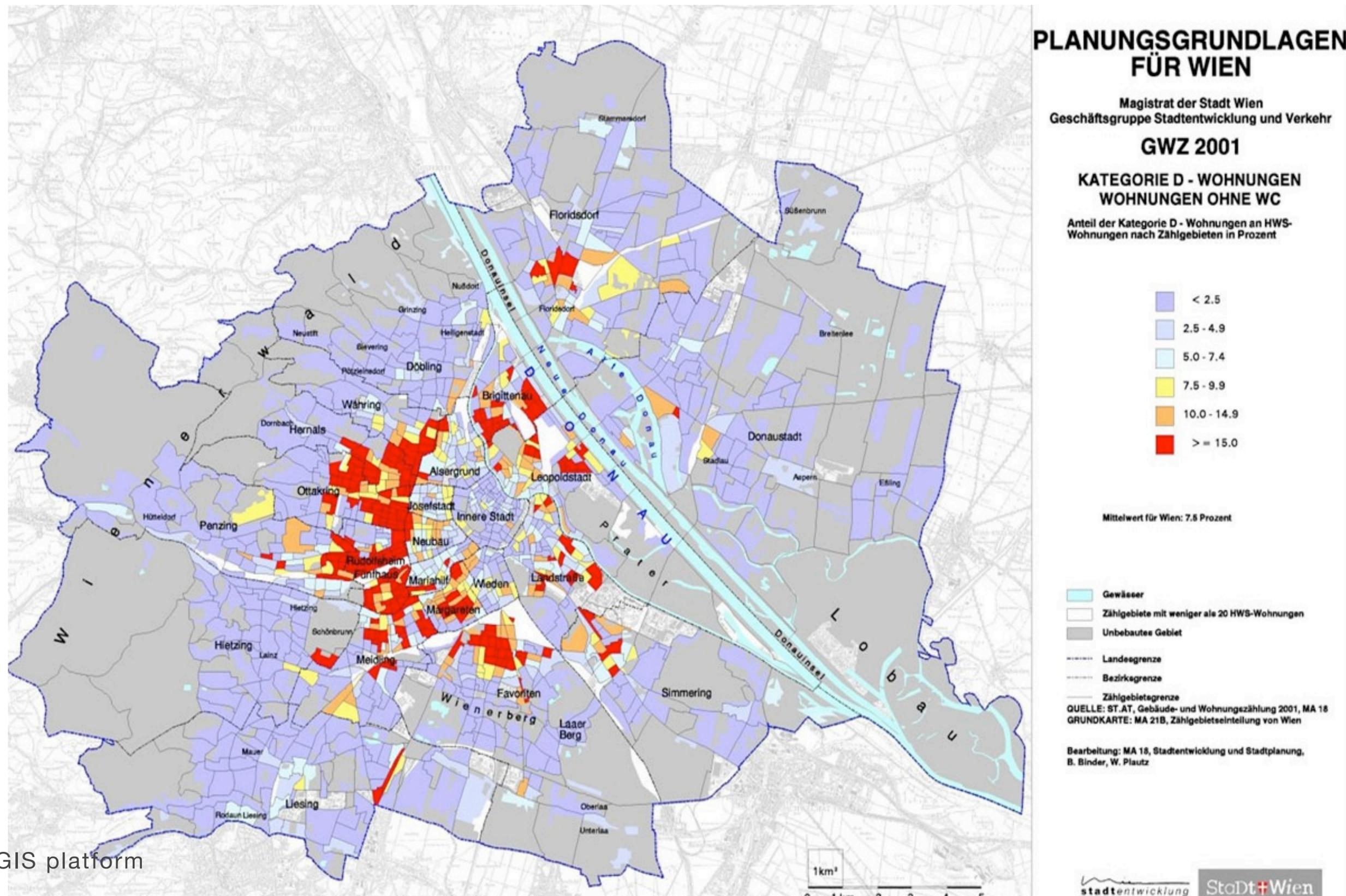
# EXAMPLES



# EXAMPLES



# EXAMPLES



## PLANUNGSGRUNDLAGEN FÜR WIEN

Magistrat der Stadt Wien  
Geschäftsgruppe Stadtentwicklung und Verkehr

### GWZ 2001

#### KATEGORIE D - WOHNUNGEN WOHNUNGEN OHNE WC

Anteil der Kategorie D - Wohnungen an HWS-Wohnungen nach Zählgelbieten in Prozent

- < 2.5
- 2.5 - 4.9
- 5.0 - 7.4
- 7.5 - 9.9
- 10.0 - 14.9
- >= 15.0

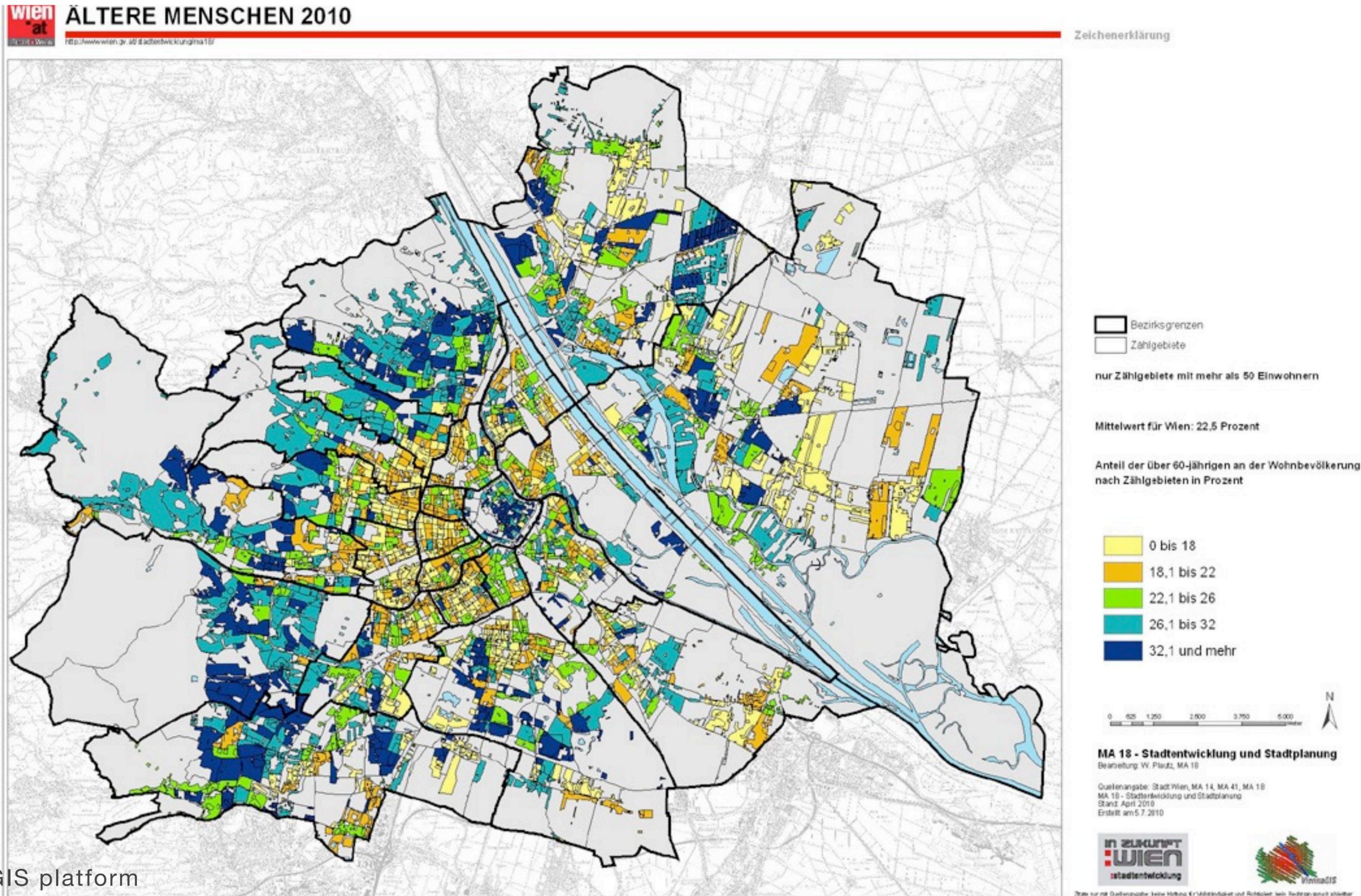
Mittelwert für Wien: 7.6 Prozent

- Gewässer
- Zählgelbiete mit weniger als 20 HWS-Wohnungen
- Unbebautes Gebiet
- Landesgrenze
- Bezirksgrenze
- Zählgelbiete-grenze

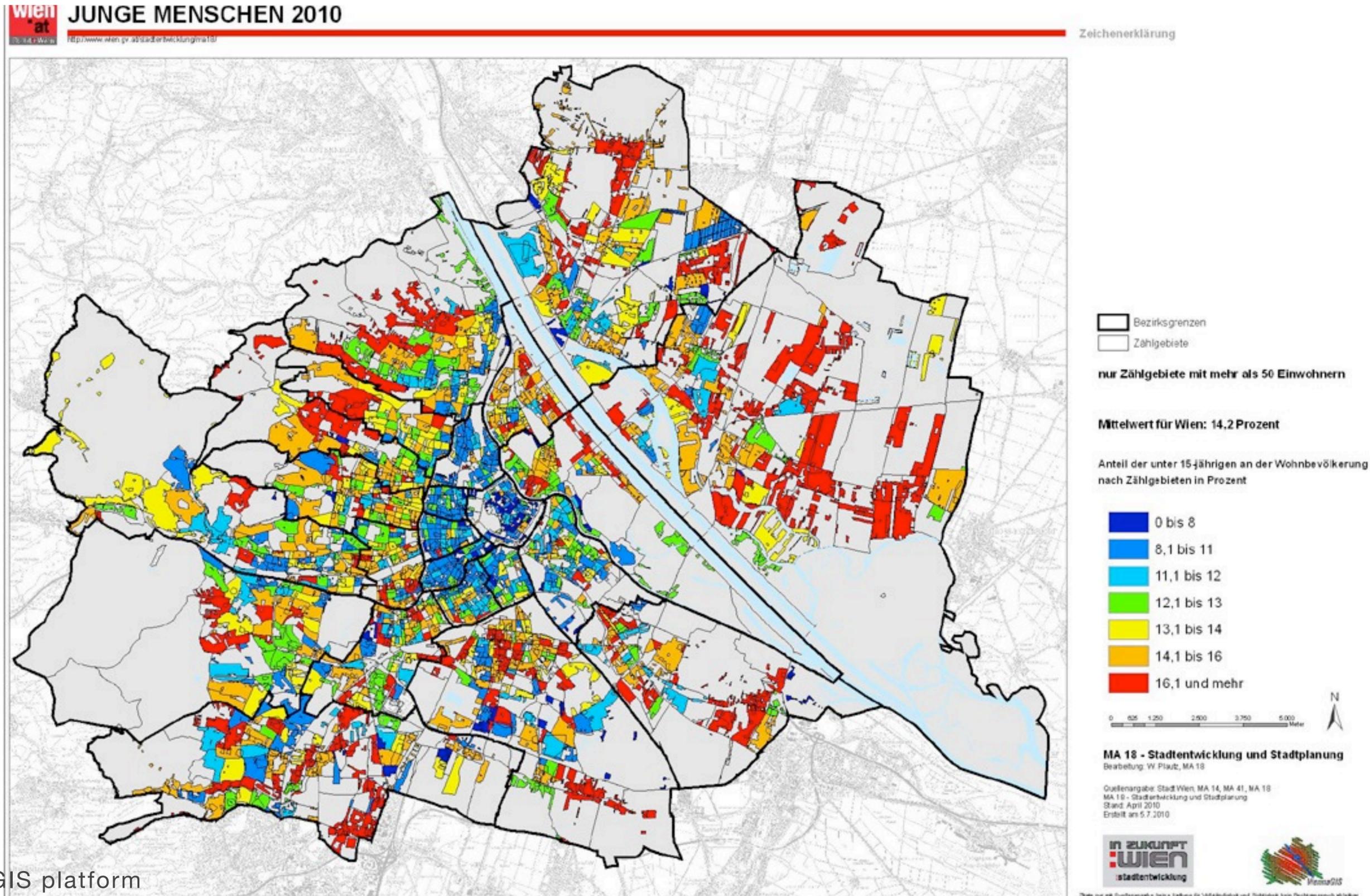
QUELLE: ST.AT, Gebäude- und Wohnungszählung 2001, MA 18  
GRUNDKARTE: MA 21B, Zählgelbiete-einteilung von Wien

Bearbeitung: MA 18, Stadtentwicklung und Stadtplanung,  
B. Binder, W. Plautz

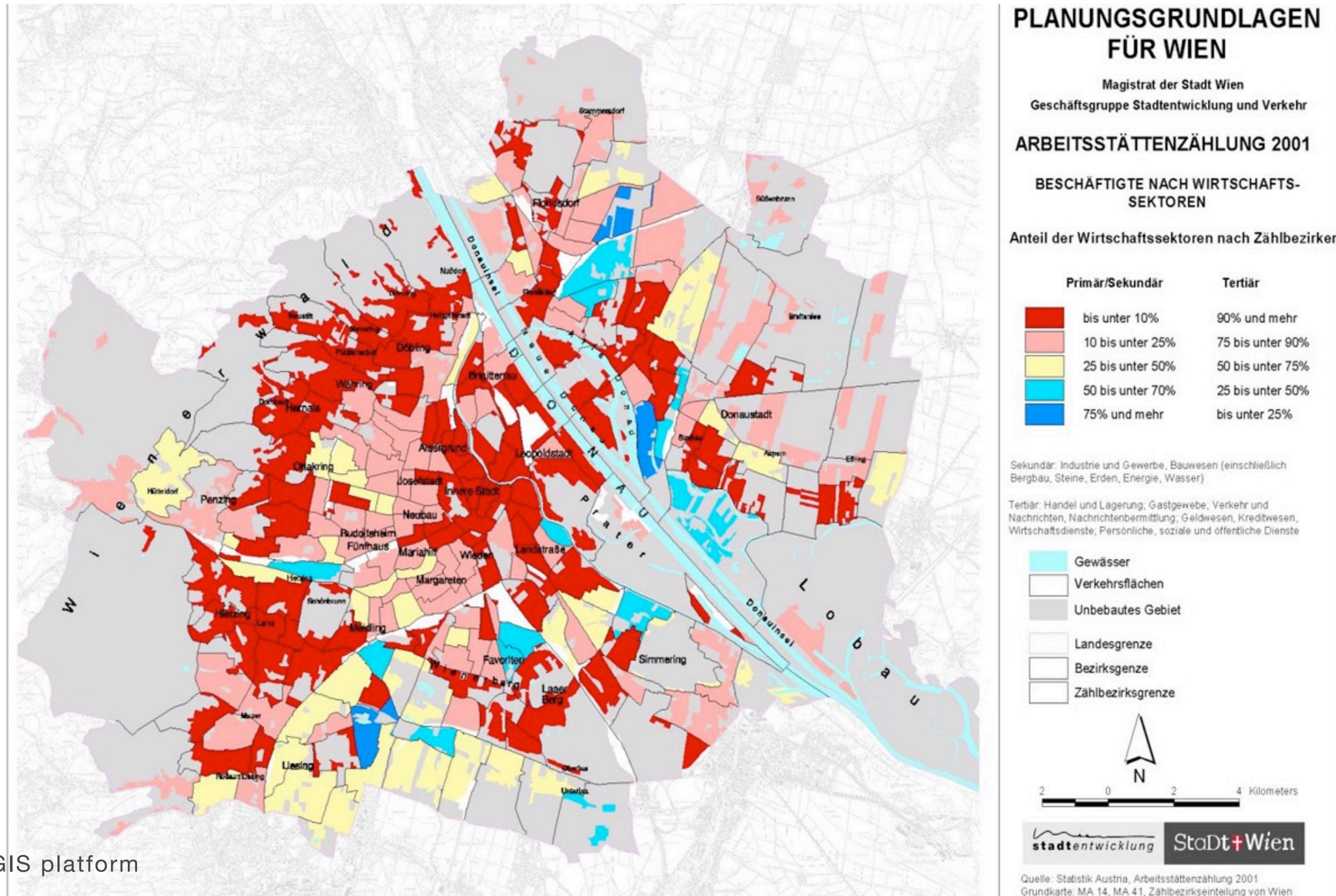
# EXAMPLES



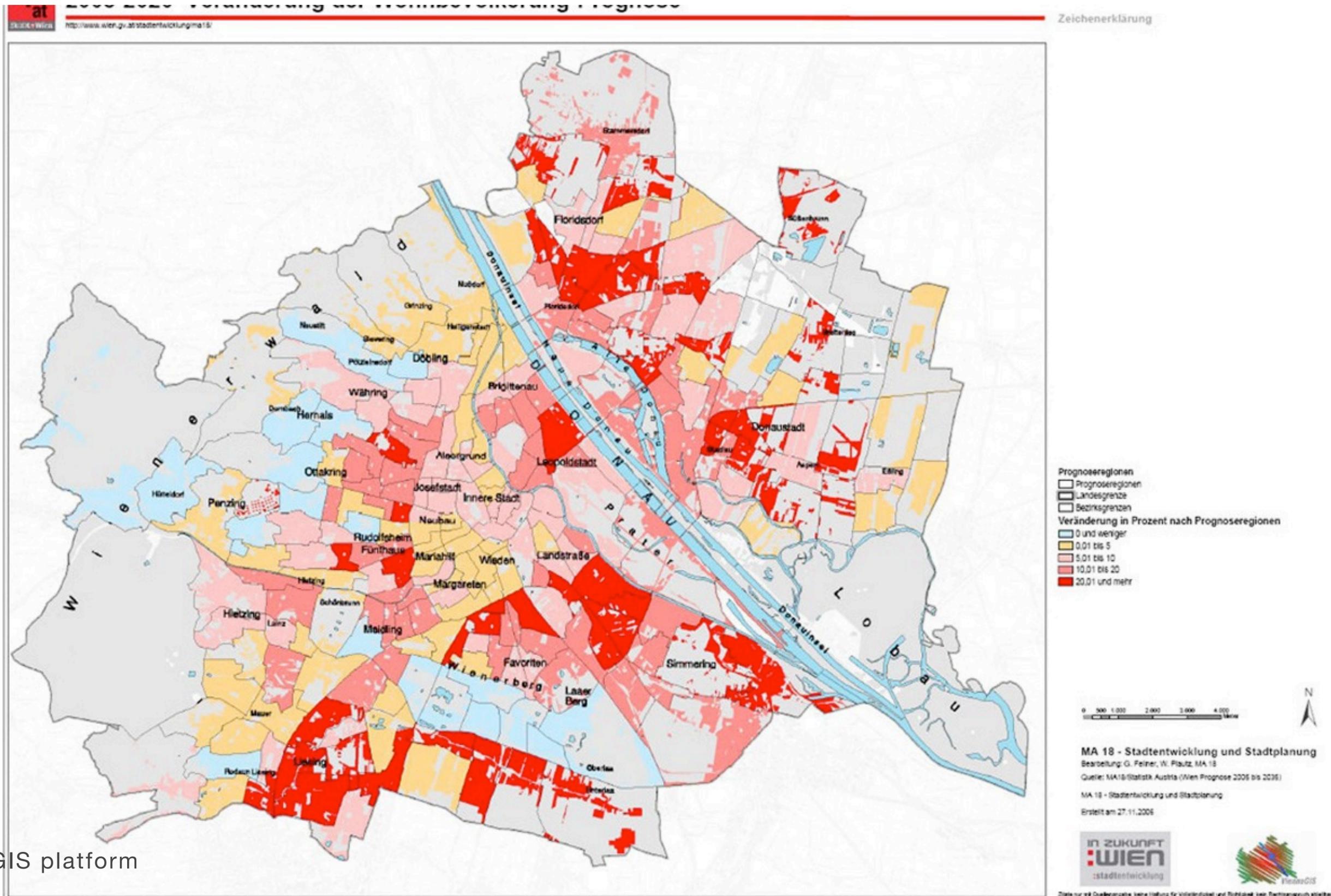
# EXAMPLES



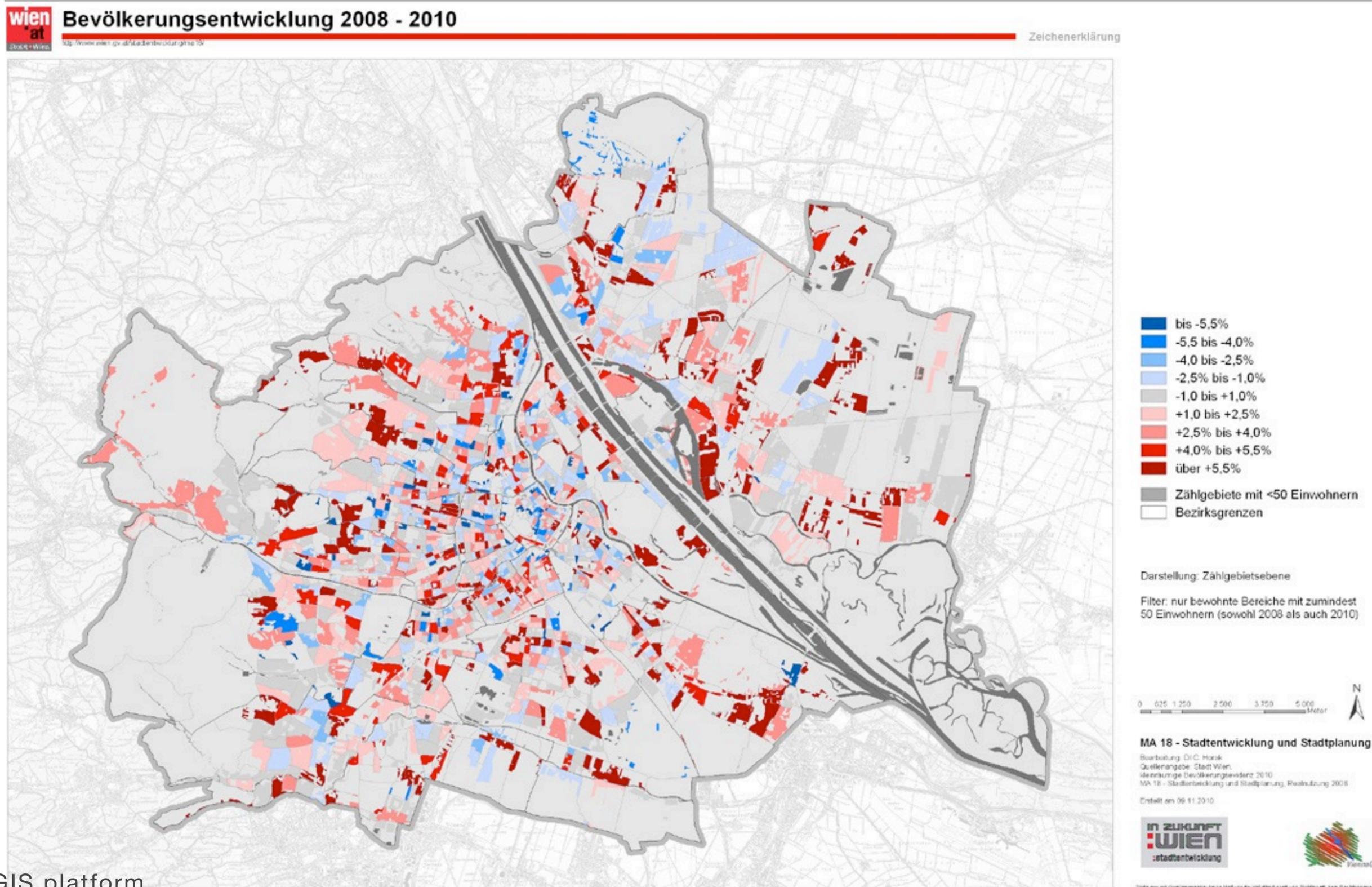
# EXAMPLES



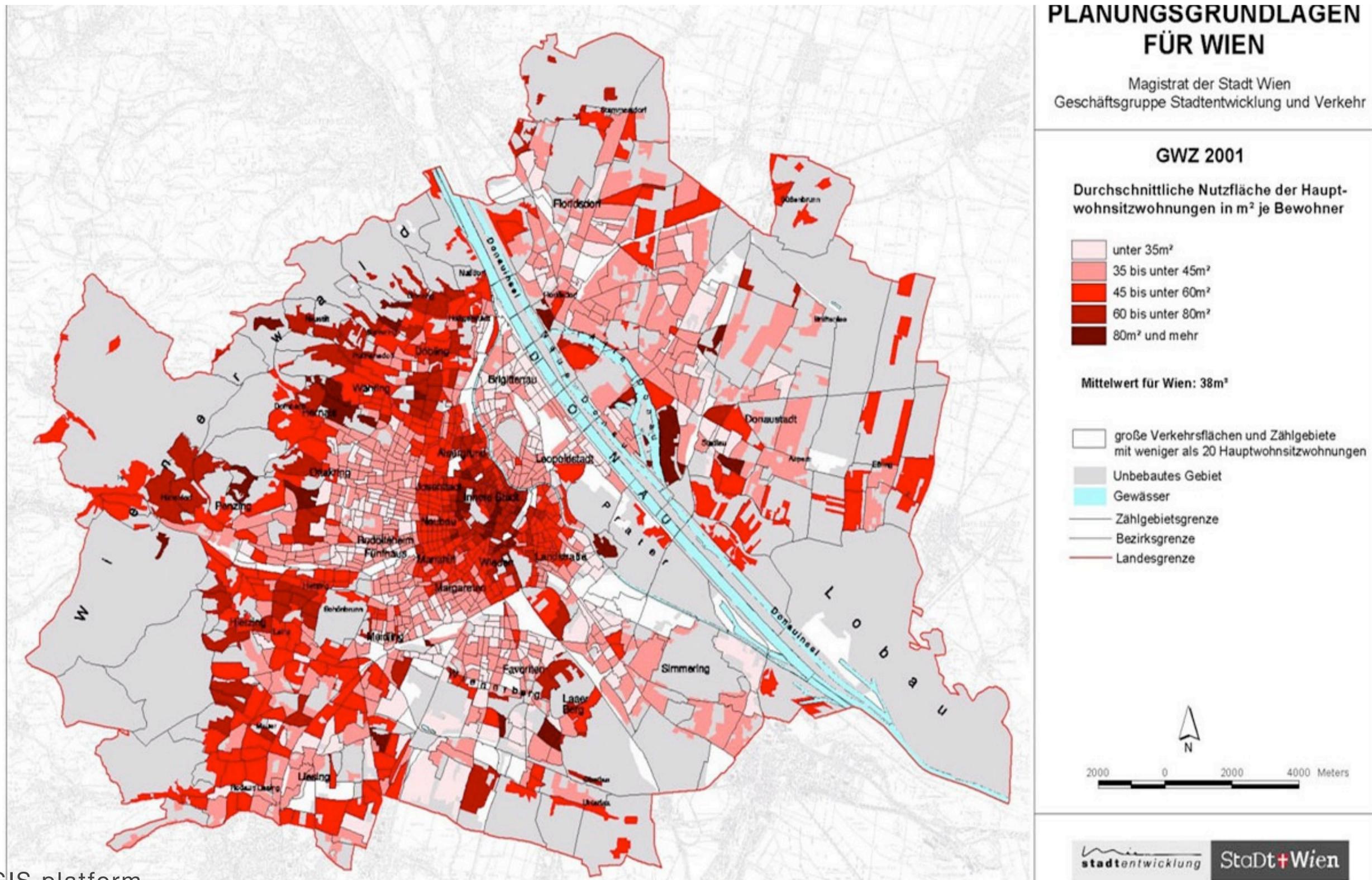
# EXAMPLES



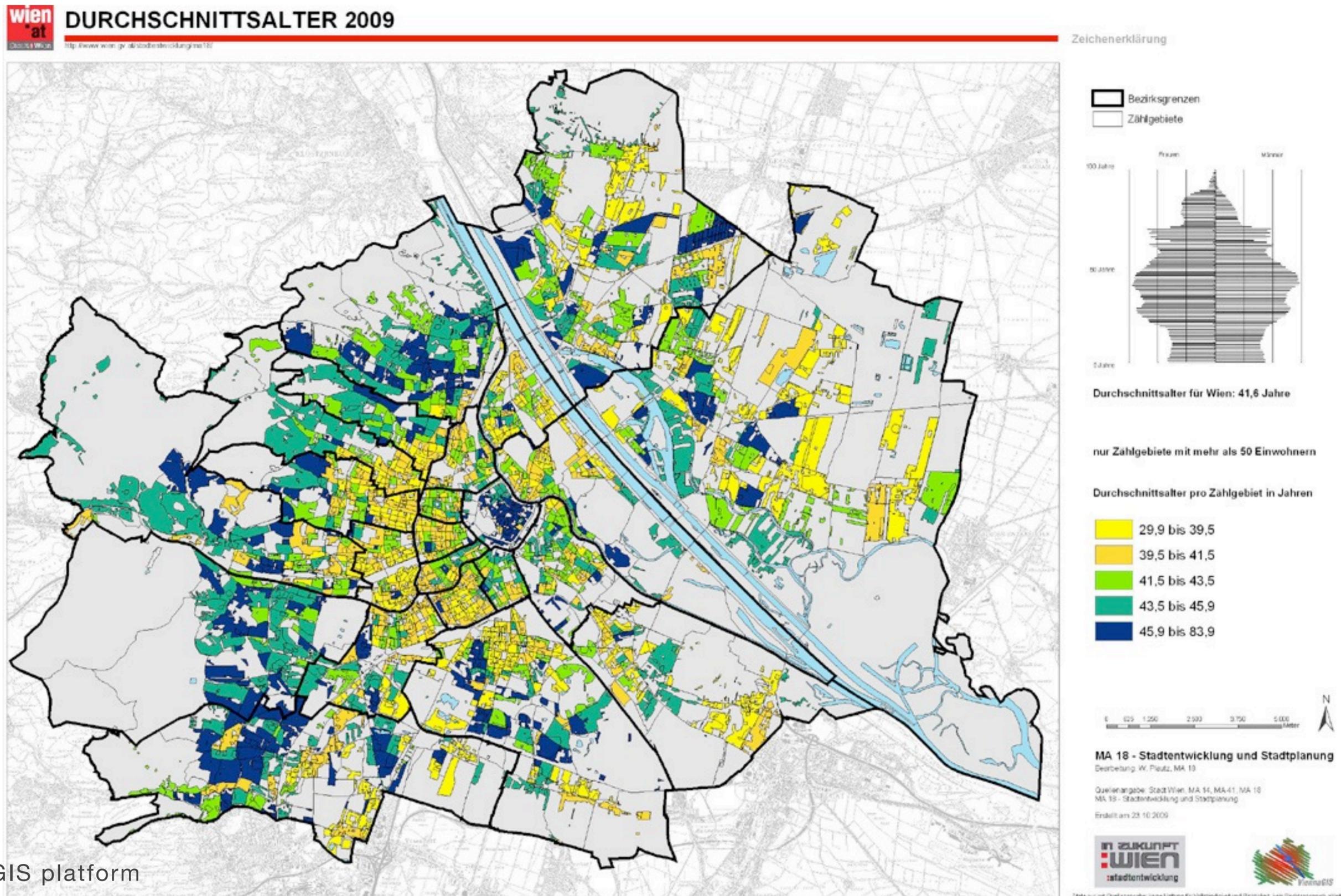
# EXAMPLES



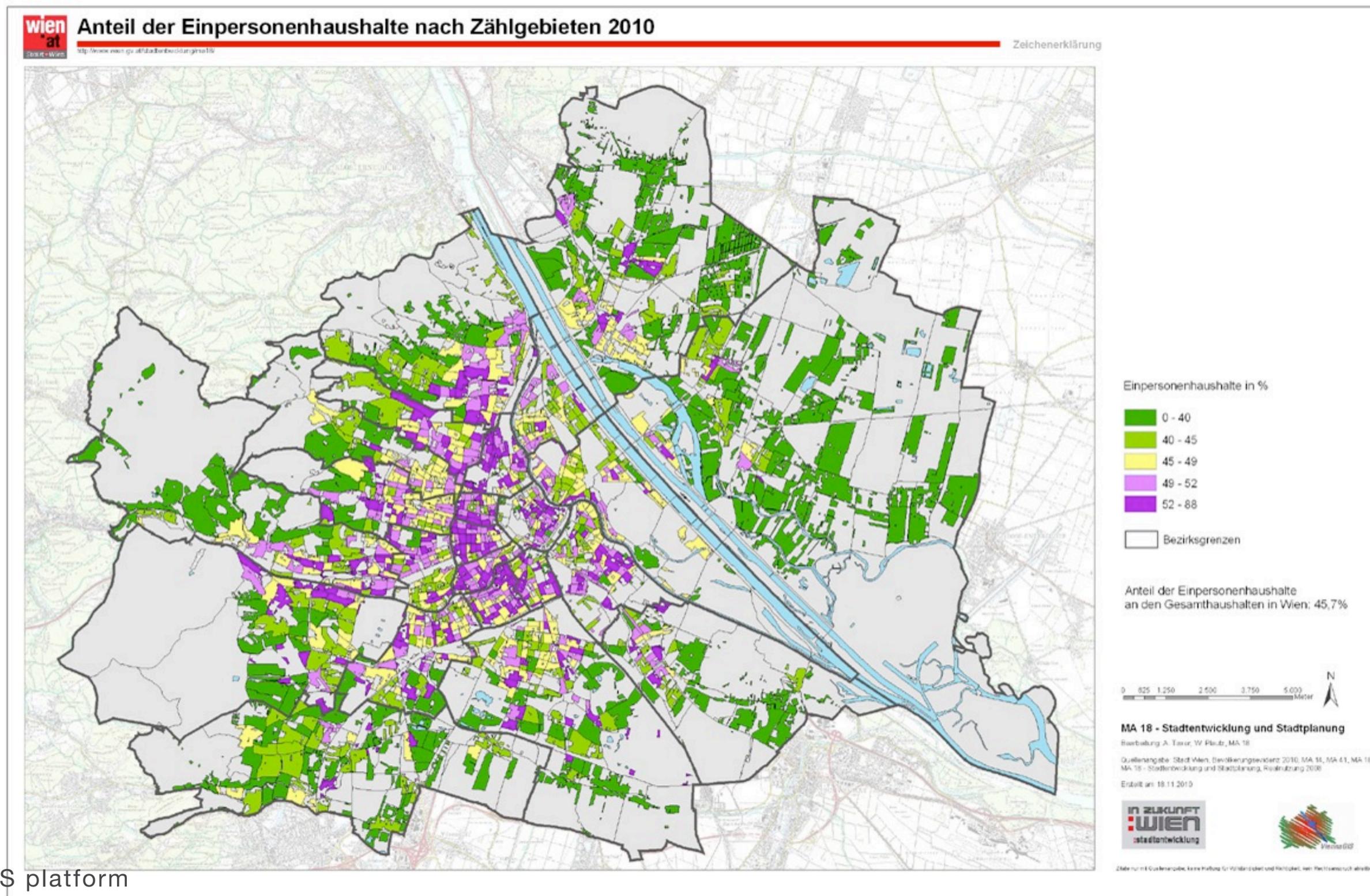
# EXAMPLES



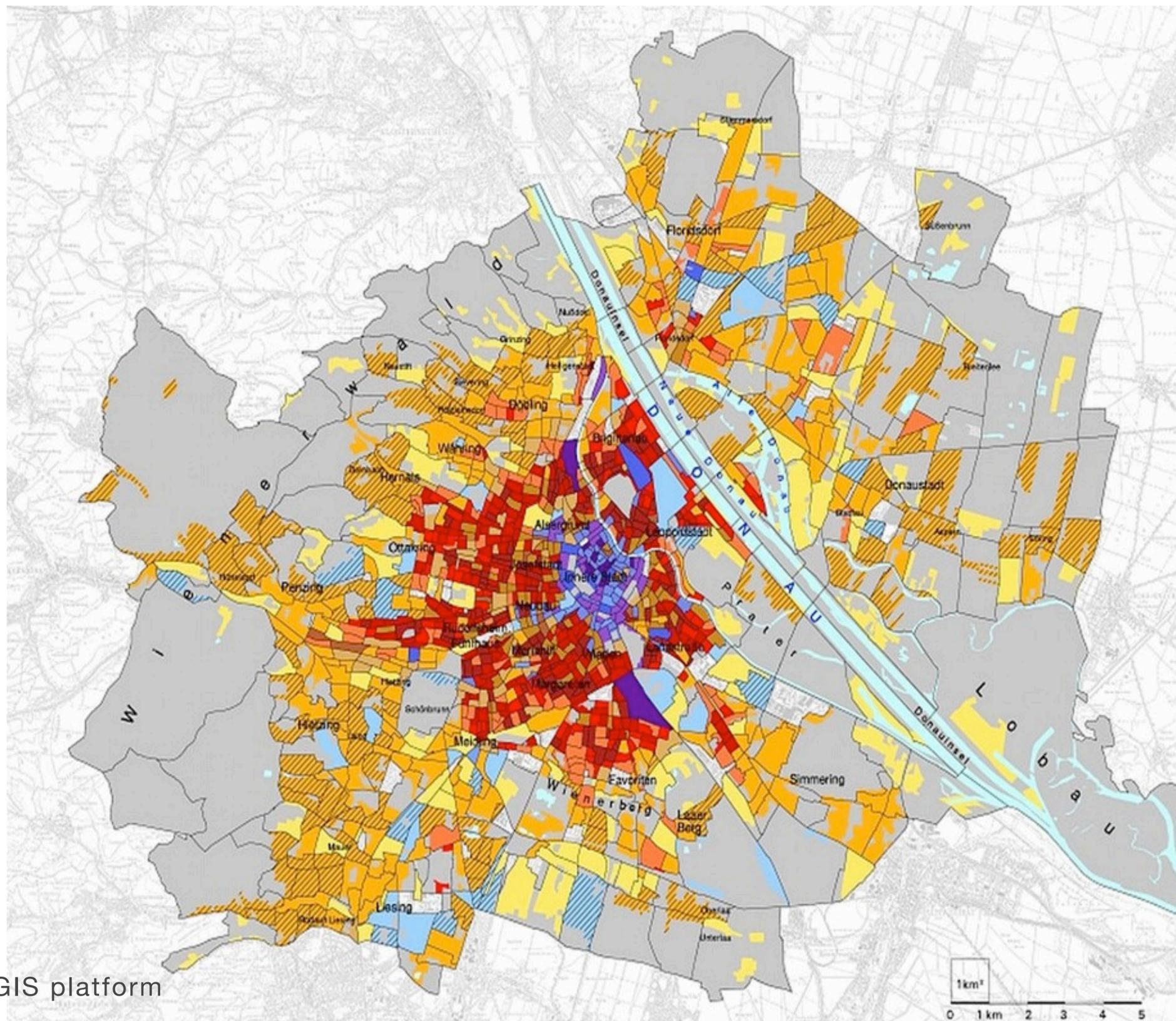
# EXAMPLES



# EXAMPLES



# EXAMPLES



## PLANUNGSGRUNDLAGEN FÜR WIEN

Magistrat der Stadt Wien

Geschäftsgruppe Stadtentwicklung und Verkehr

### EINWOHNERDICHTEN-ARBEITSPLATZDICHTEN 2001

Verteilung der Wohn- und Arbeitsbevölkerung im Stadtgebiet

Dargestellt sind Typen von Zählgebieten nach dem Mengenverhältnis von Wohnnutzung und wirtschaftlicher Nutzung sowie nach der Intensität der Flächennutzung

Nutzungstypen	Intensität der Flächennutzung			
	hoch	mittel	niedrig	sehr niedrig
Wohngebiet	1	2	3	4
Wohngebiet mit Betrieben	5	6		
Mischgebiet	7	8	9	10
Betriebsgebiet mit Wohnnutzung	11	12	13	14
Betriebsgebiet 1)	15	16	17	18

1) Industrie, Gewerbe- und Dienstleistungsbetriebe

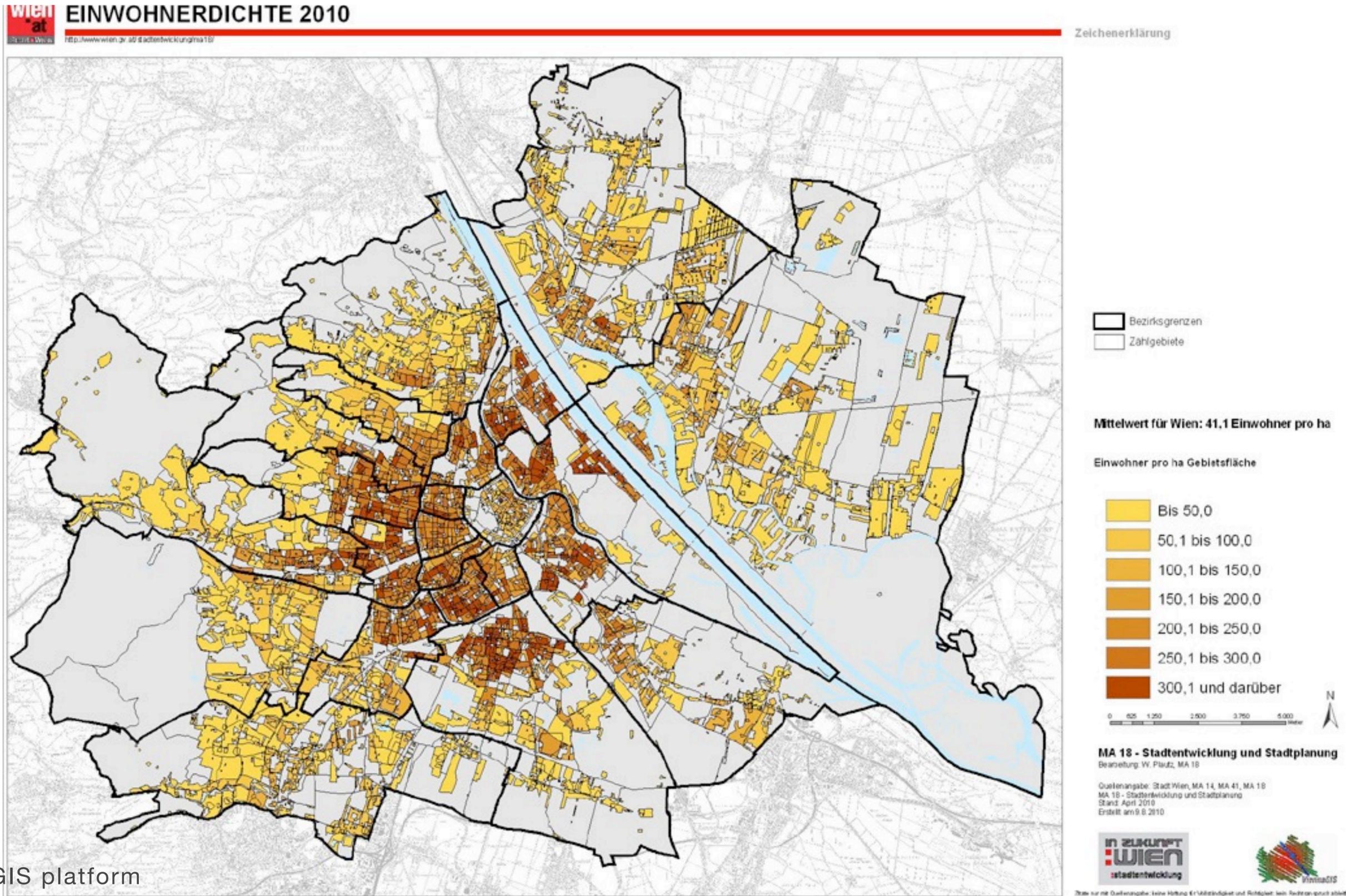
Verteilungsdiagramm der Nutzungstypen nach dem Verhältnis von Einwohnerdichte und Arbeitsplatzdichte

■ Gewässer  
■ Unbebautes Gebiet  
 Zählgebietsgrenze

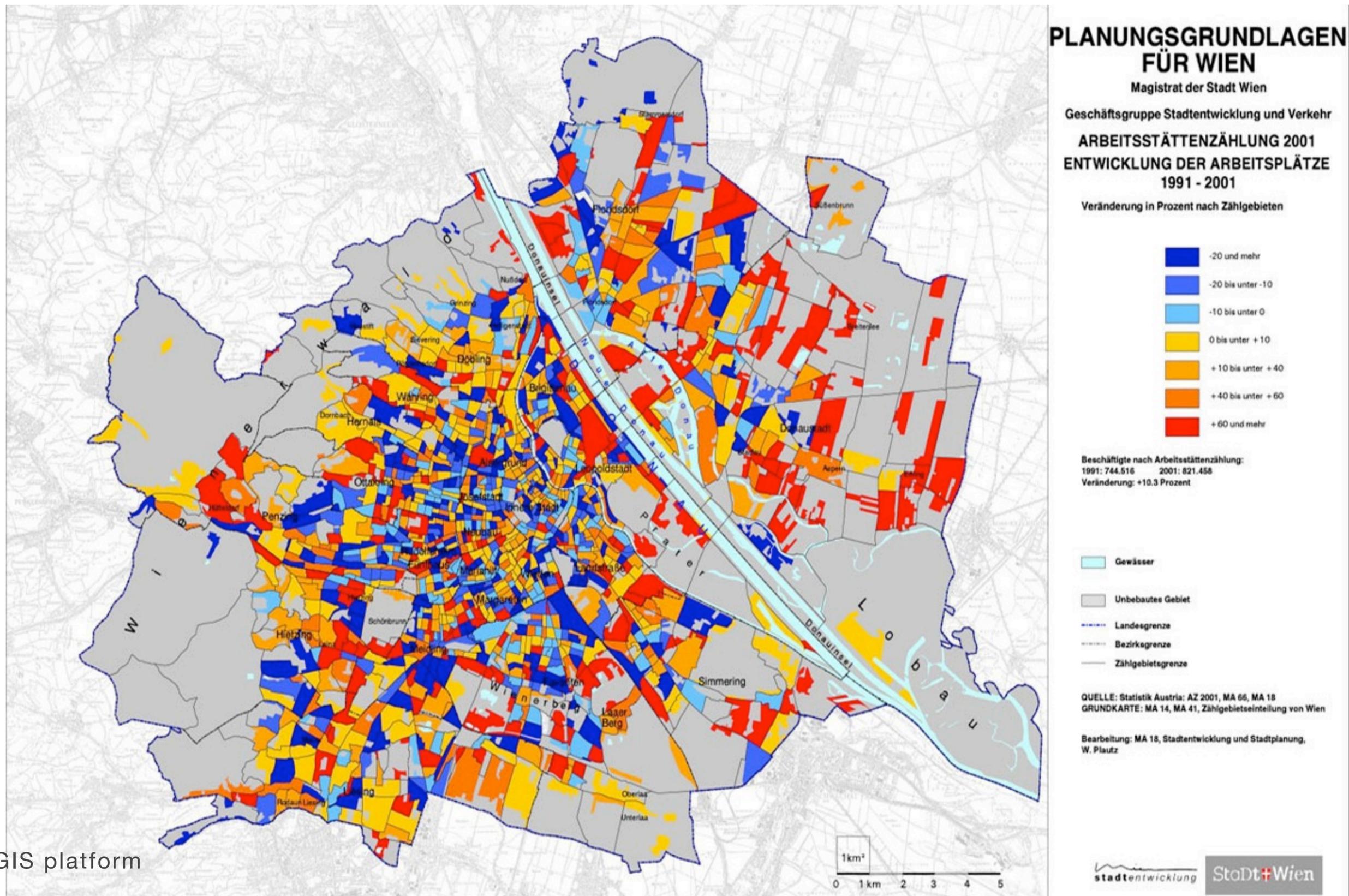
QUELLE: ST. AT.: AZ 2001, VZ 2001, MA 41, MA 18: Realnutzung  
 GRUNDKARTE: MA 14, MA 41, Zählgebieteinteilung von Wien  
 Bearbeitung: MA 18, Stadtentwicklung und Stadtplanung,  
 W. Plautz; Entwurf: J. Steinbach

stadentwicklung StoDt+Wien

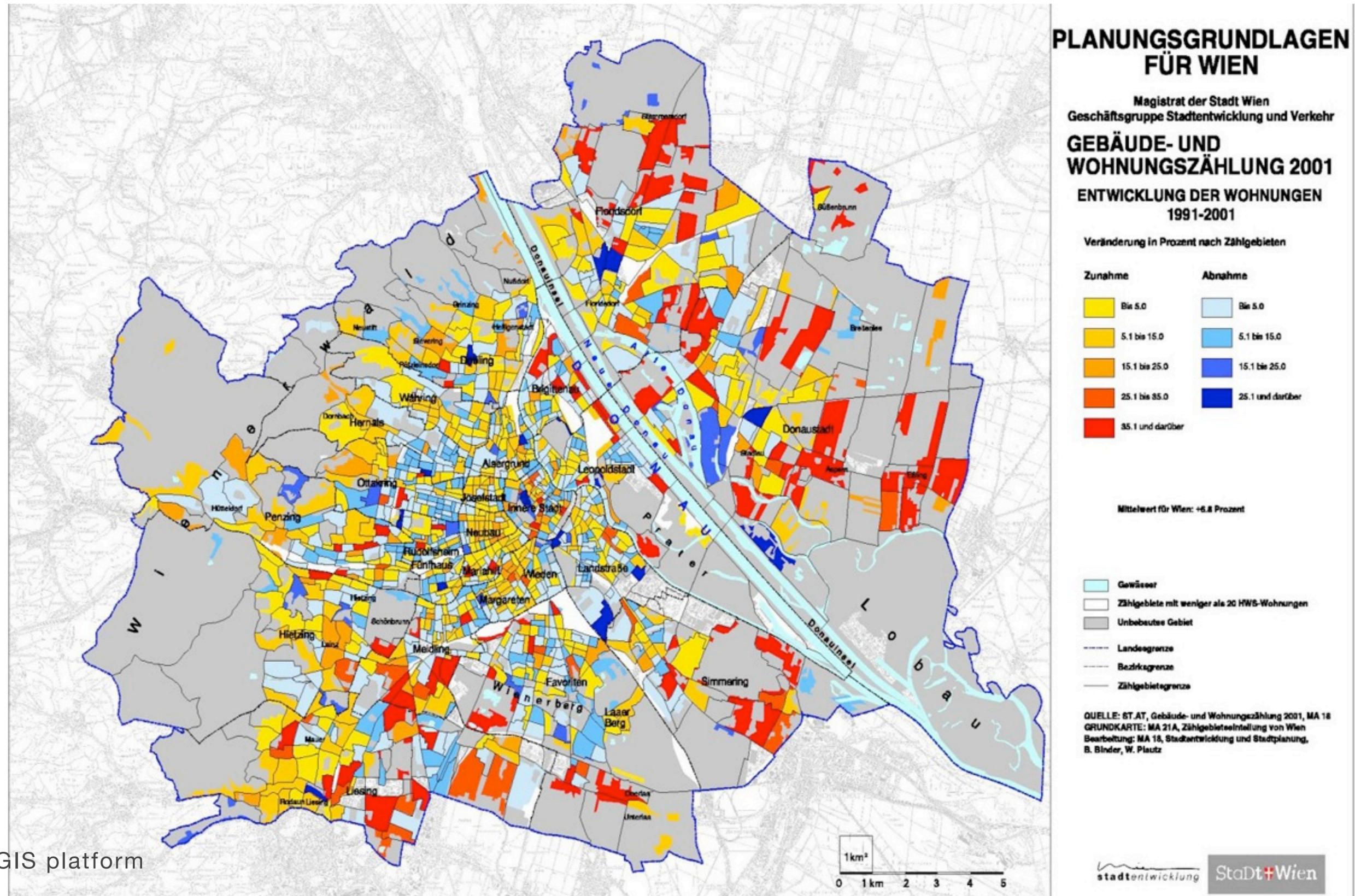
# EXAMPLES



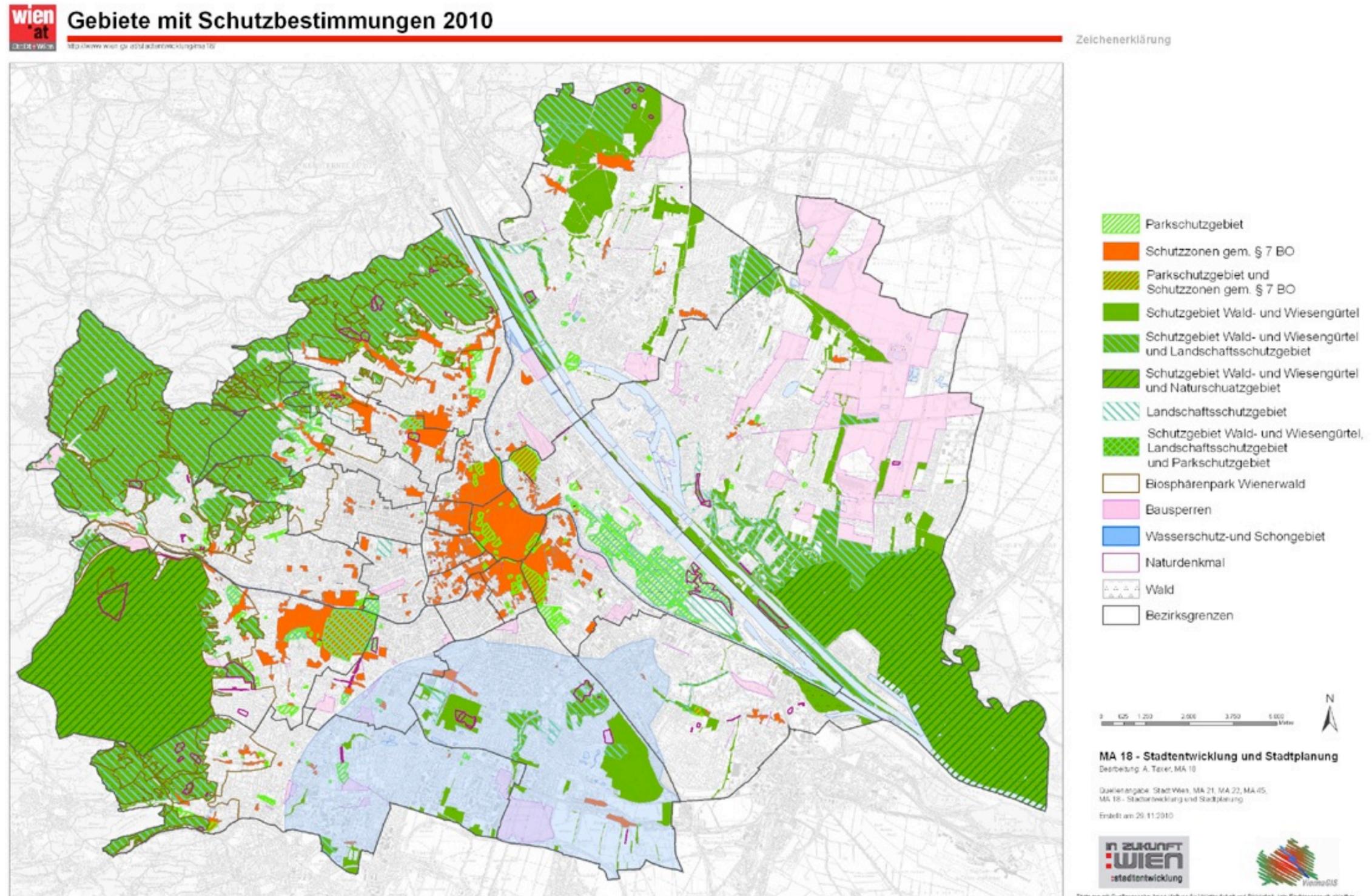
# EXAMPLES



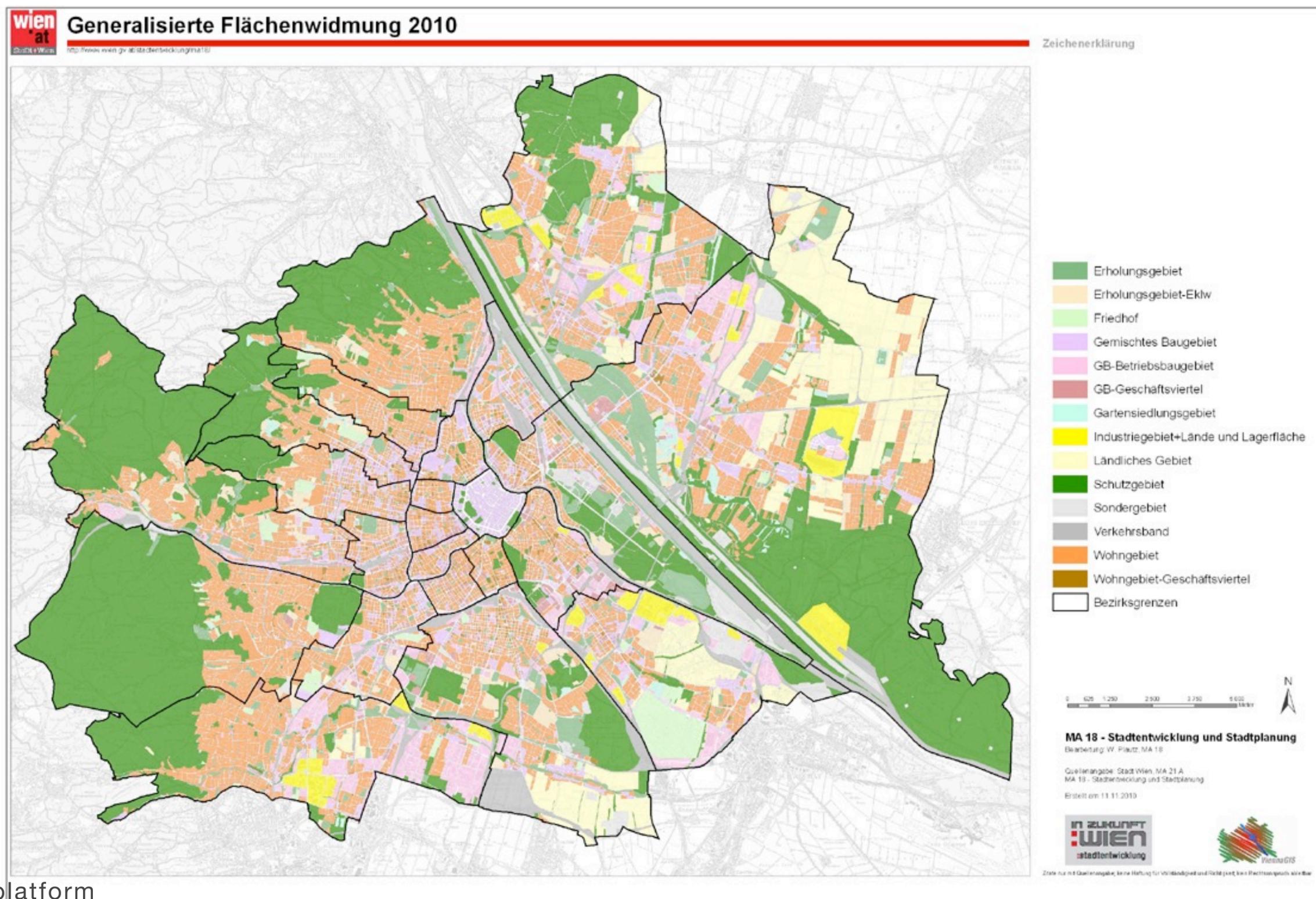
# EXAMPLES



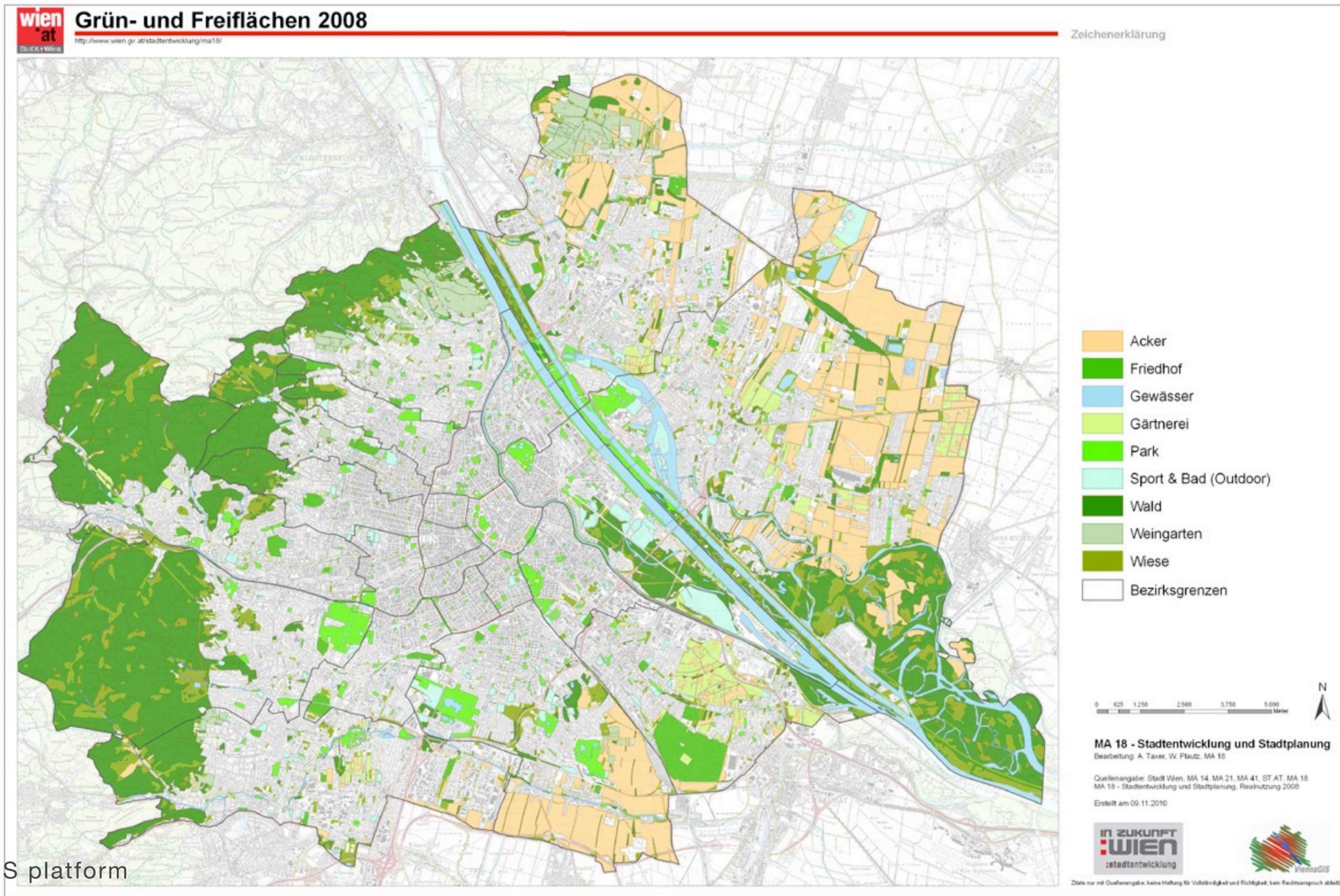
# EXAMPLES



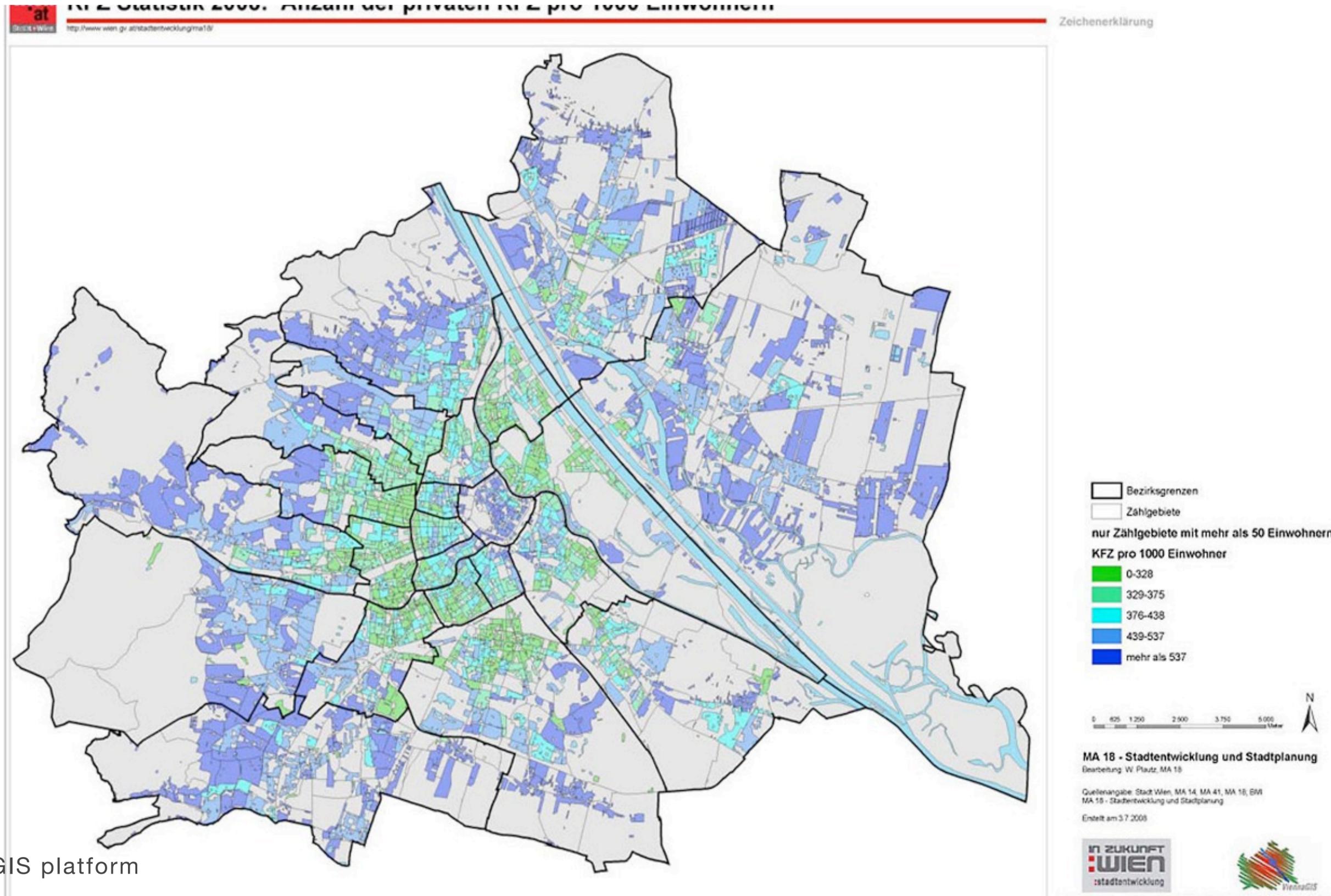
# EXAMPLES



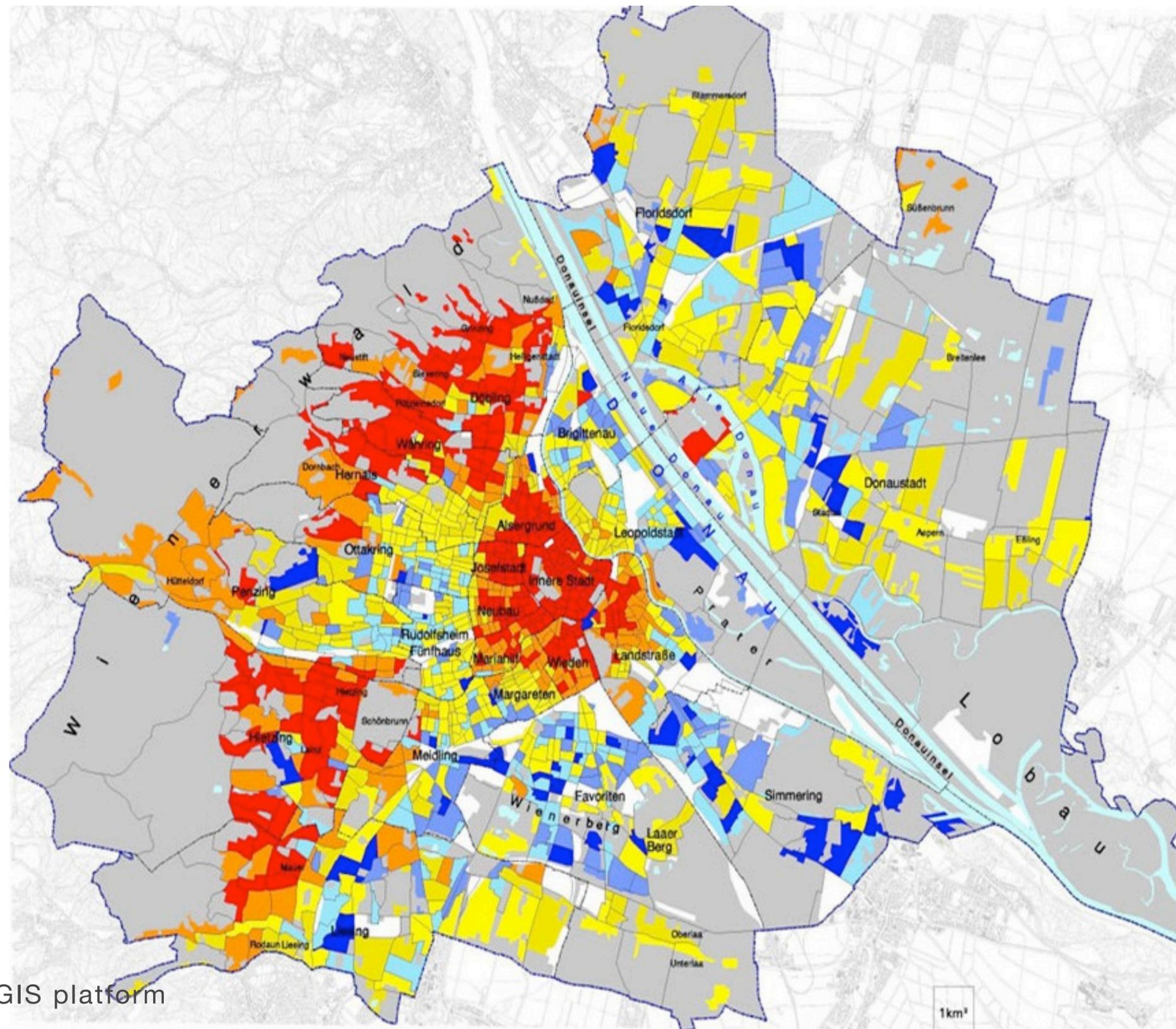
# EXAMPLES



# EXAMPLES



# EXAMPLES



**FÜR WIEN**  
 Magistrat der Stadt Wien  
 Geschäftsgruppe Stadtentwicklung und Verkehr

**VOLKSZÄHLUNG 2001**  
**MATURANTENQUOTE**

Anteil der Personen mit Matura, (Fach-) Hochschule oder Universitätsabschluss als höchst abgeschlossene Schulbildung an der Wohnbevölkerung im Alter von 15 und mehr Jahren in Prozent nach Zählgemeinschaften.

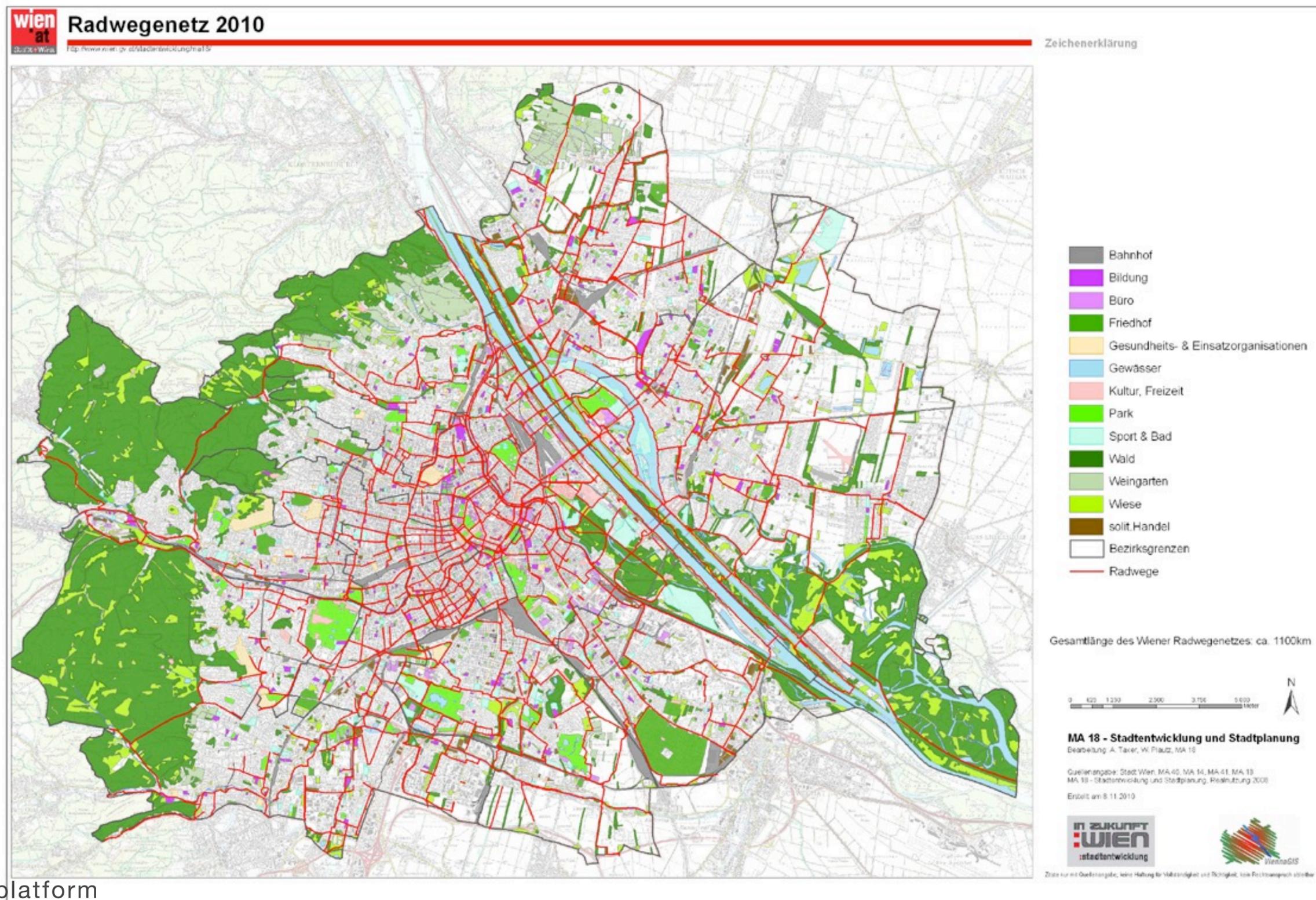
Blue	< 10.0
Light Blue	10.0 - 14.9
Yellow	15.0 - 19.9
Orange	20.0 - 27.4
Light Green	27.5 - 34.9
Dark Green	35.0 - 44.9
Red	> = 45.0

Mittelwert für Wien 27.6 Prozent

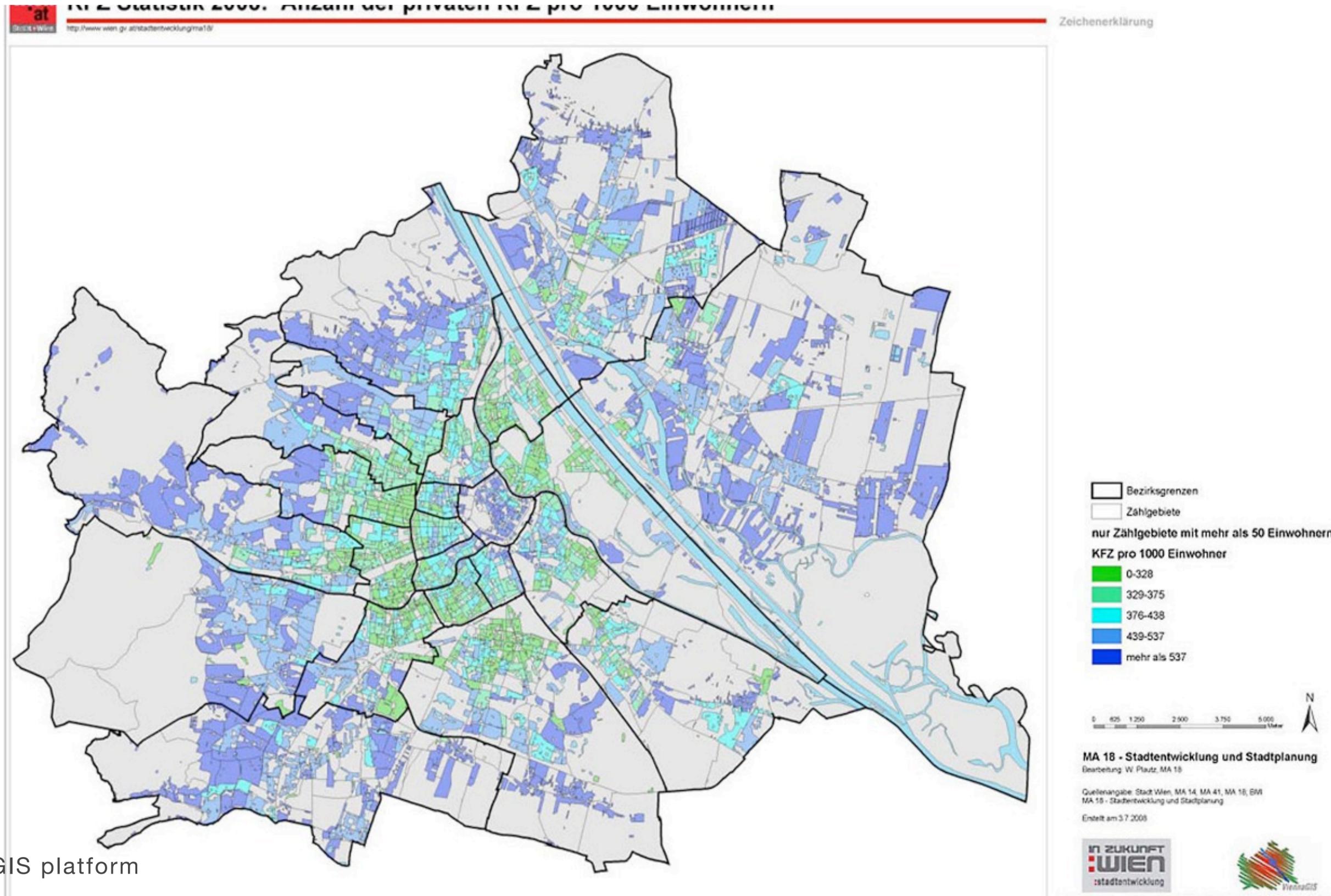
- Gewässer
- Zählgemeinschaften mit weniger als 50 Einwohnern bzw. Gebiete mit größeren Verkehrsflächen
- Unbebautes Gebiet
- Landeegrenze
- Bezirksgrenze
- Zählgemeinschaftsgrenze

QUELLE: Statistik Austria, VZ 2001, MA 18  
 GRUNDKARTE: MA 21B, Zählgemeinschaftseinteilung von Wien  
 Bearbeitung: MA 18, Stadtentwicklung und Stadtplanung, B. Binder, W. Plautz

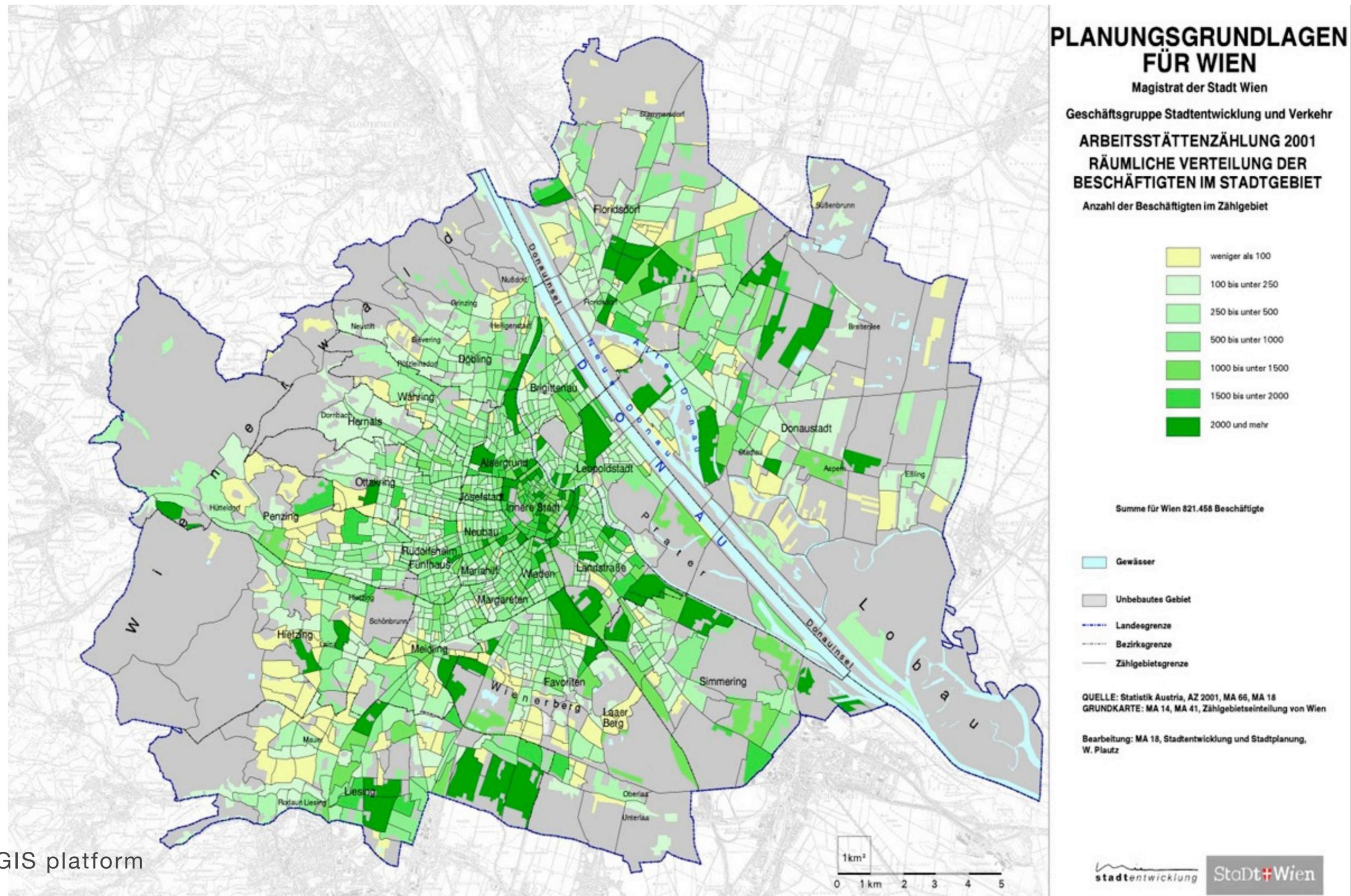
# EXAMPLES



# EXAMPLES



# EXAMPLES



# EXAMPLES

