Chair for Information Architecture

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AN INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS (GIS)

ETH
Eidgenössische Technische Hochschule Zürich
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LESSON OBJECTIVES

Understand what a GIS is

Understand how spatial data is represented in a GIS

Look at some GIS applications

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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.

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WHAT IS AN INFORMATION SYSTEM?

SYSTEM USED FOR:

WHAT IS AN INFORMATION SYSTEM?

SYSTEM USED FOR:

storing

capturing

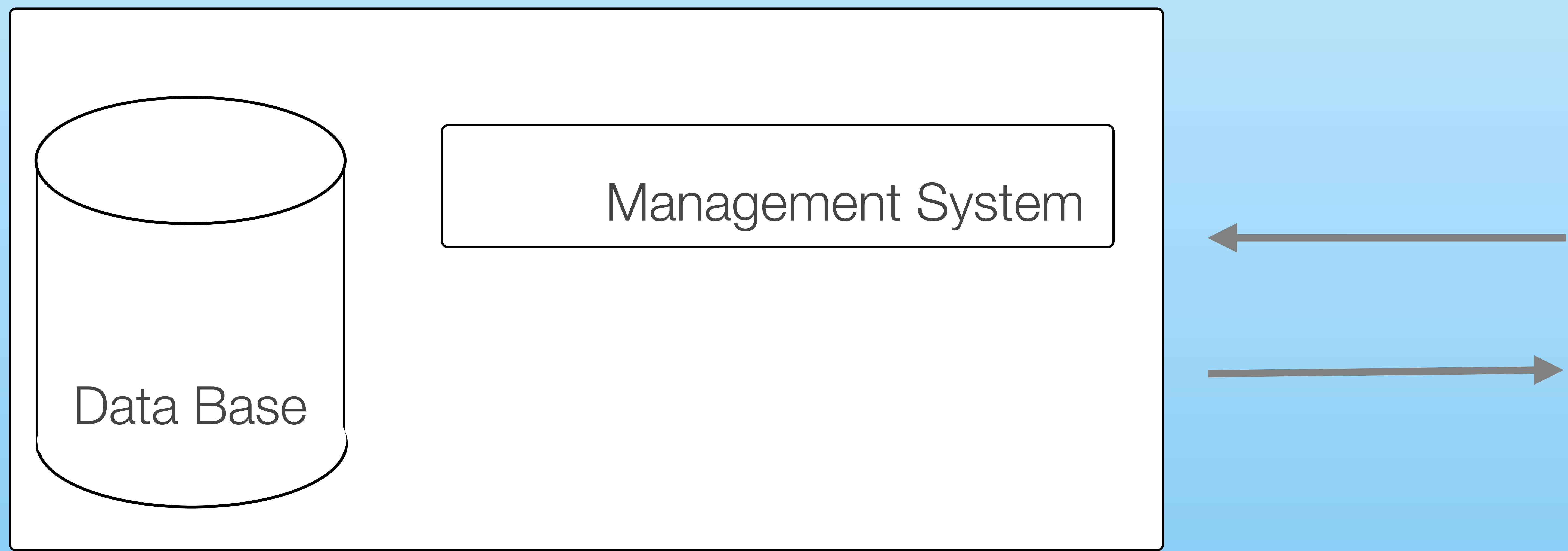
analyzing

manipulating

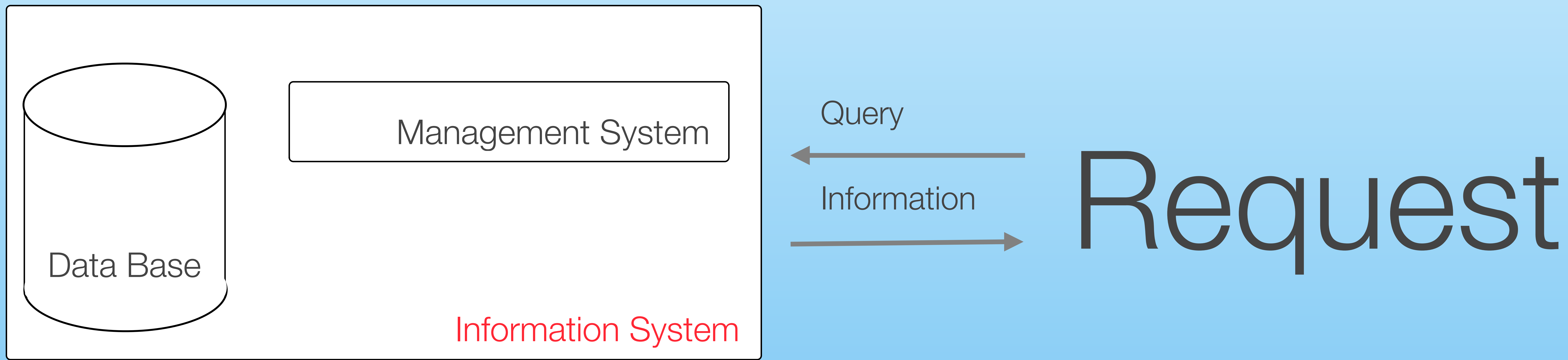
updating

DATA

WHAT IS AN INFORMATION SYSTEM?



WHAT IS AN INFORMATION SYSTEM?



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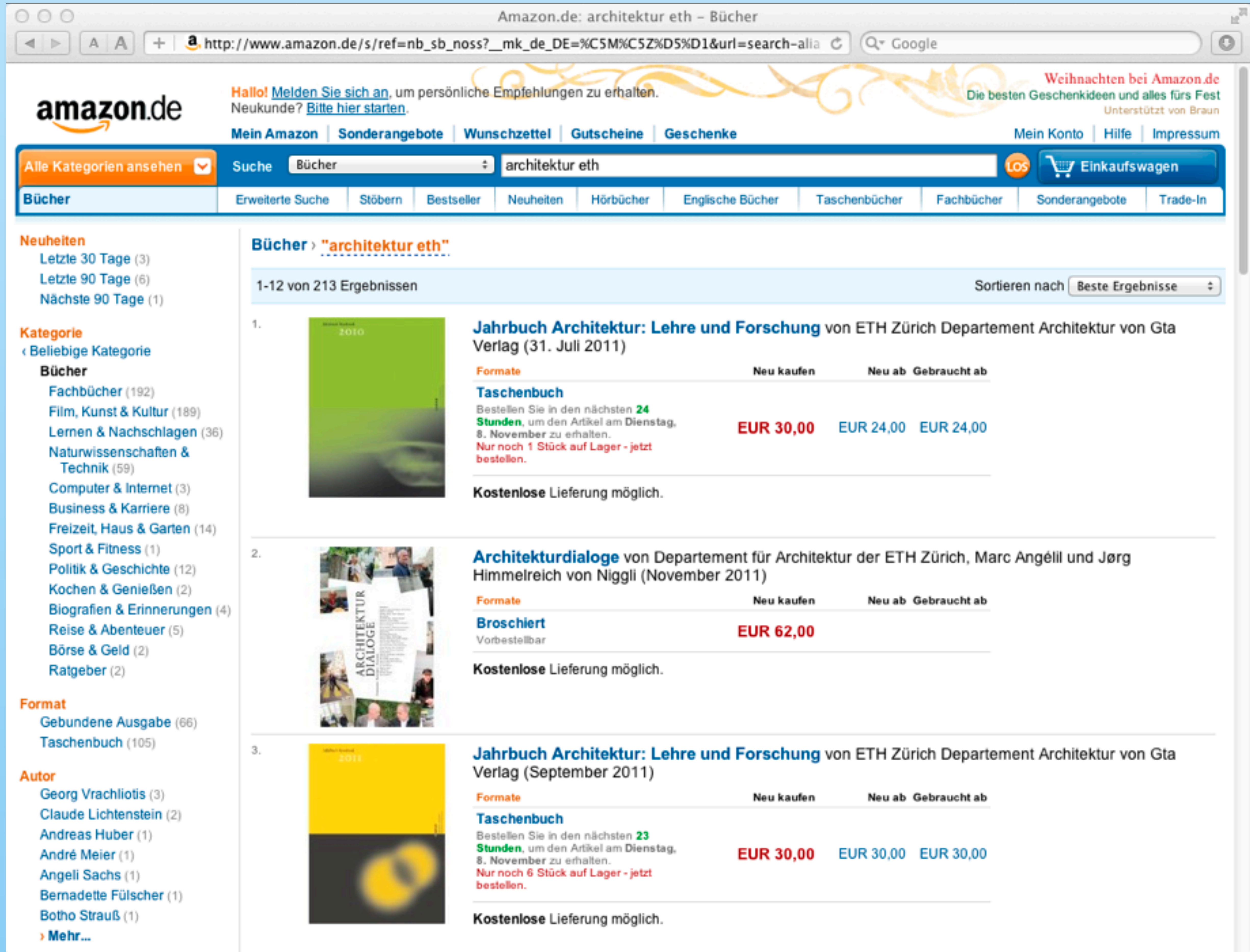

Query from Amazon.de as an example of an information system
Source: http://www.amazon.de

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

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WHAT IS A GIS?

Information System

+

Geographic Position

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

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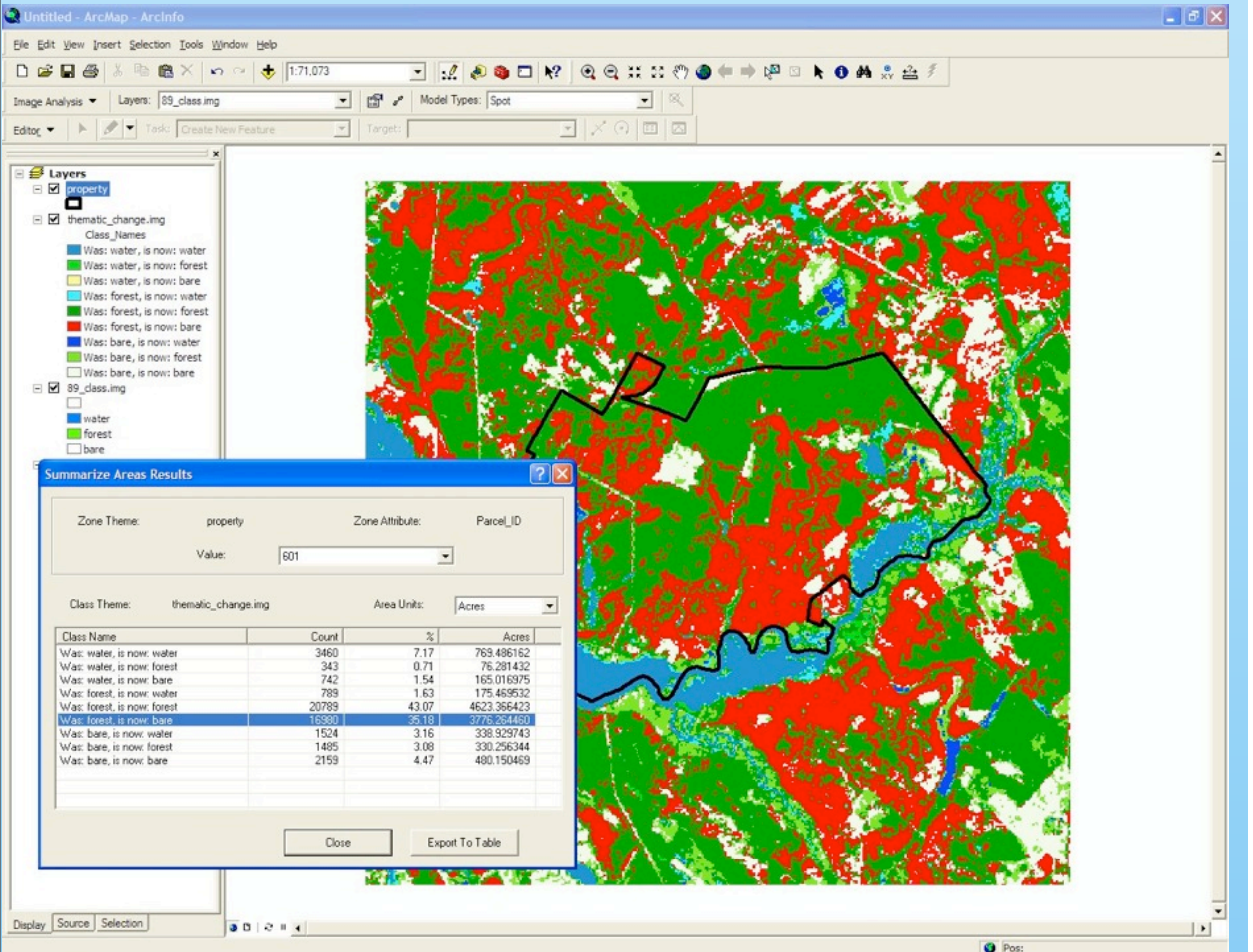
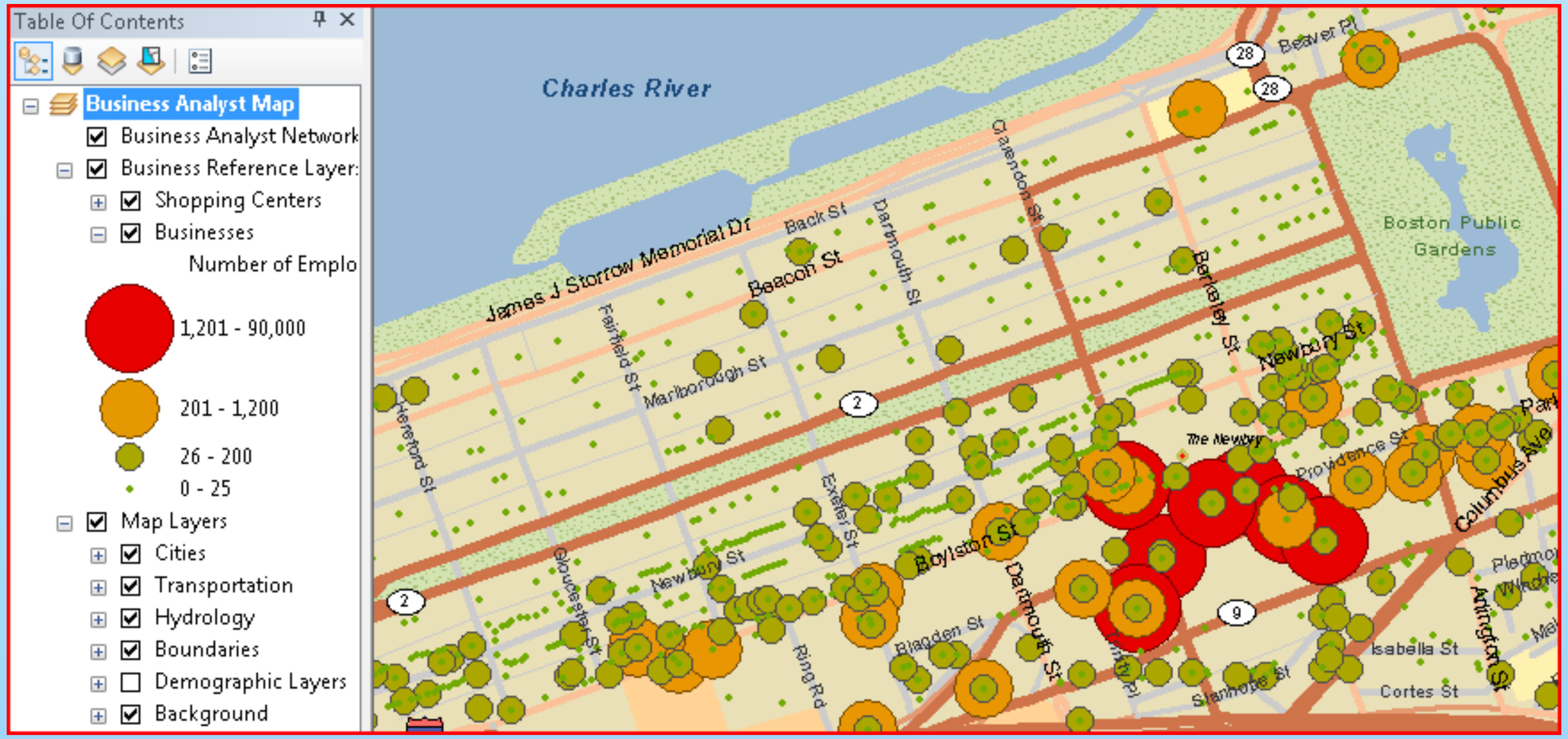
WHAT IS A GIS?



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%3E
as of 11/06/2011

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

GIS DEFINITION



Example of a Network Analyses
Source: MIT GIS Library
http://libraries.mit.edu/sites/news/files/2011/10/BA_libblog.png

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.

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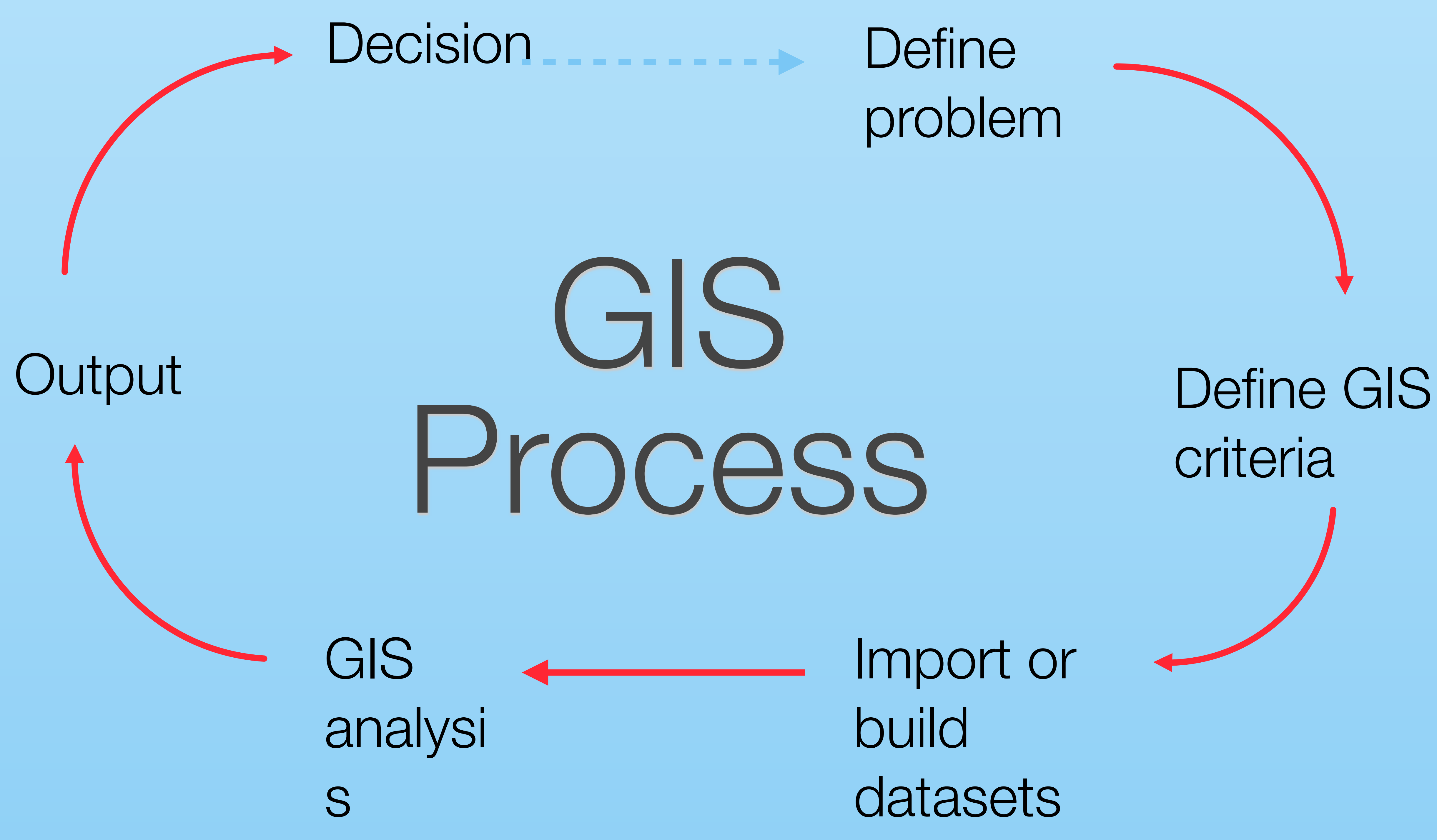

GIS Process
Source: Reference is stated here

GEOGRAPHIC INFORMATION SYSTEM

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

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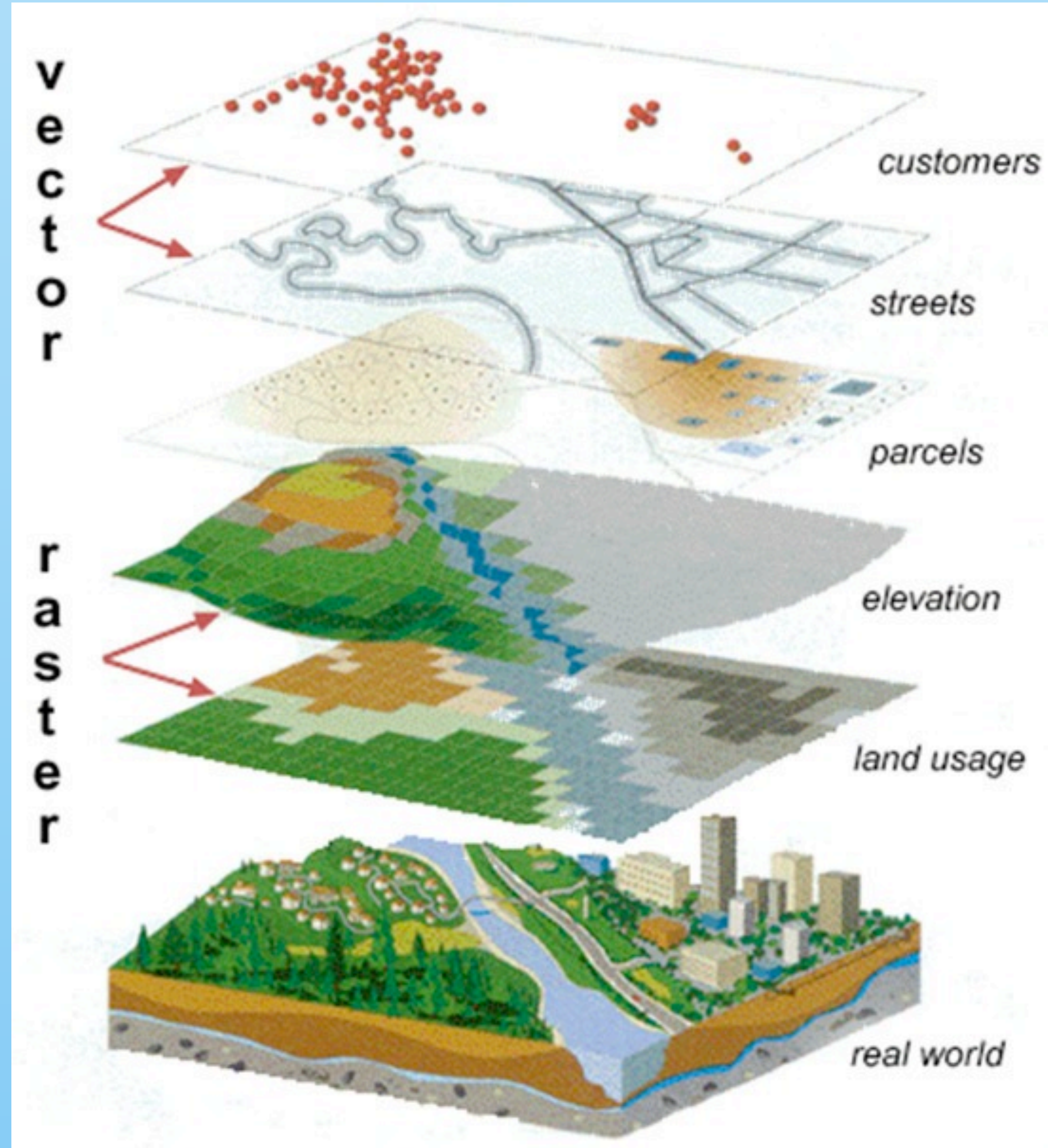
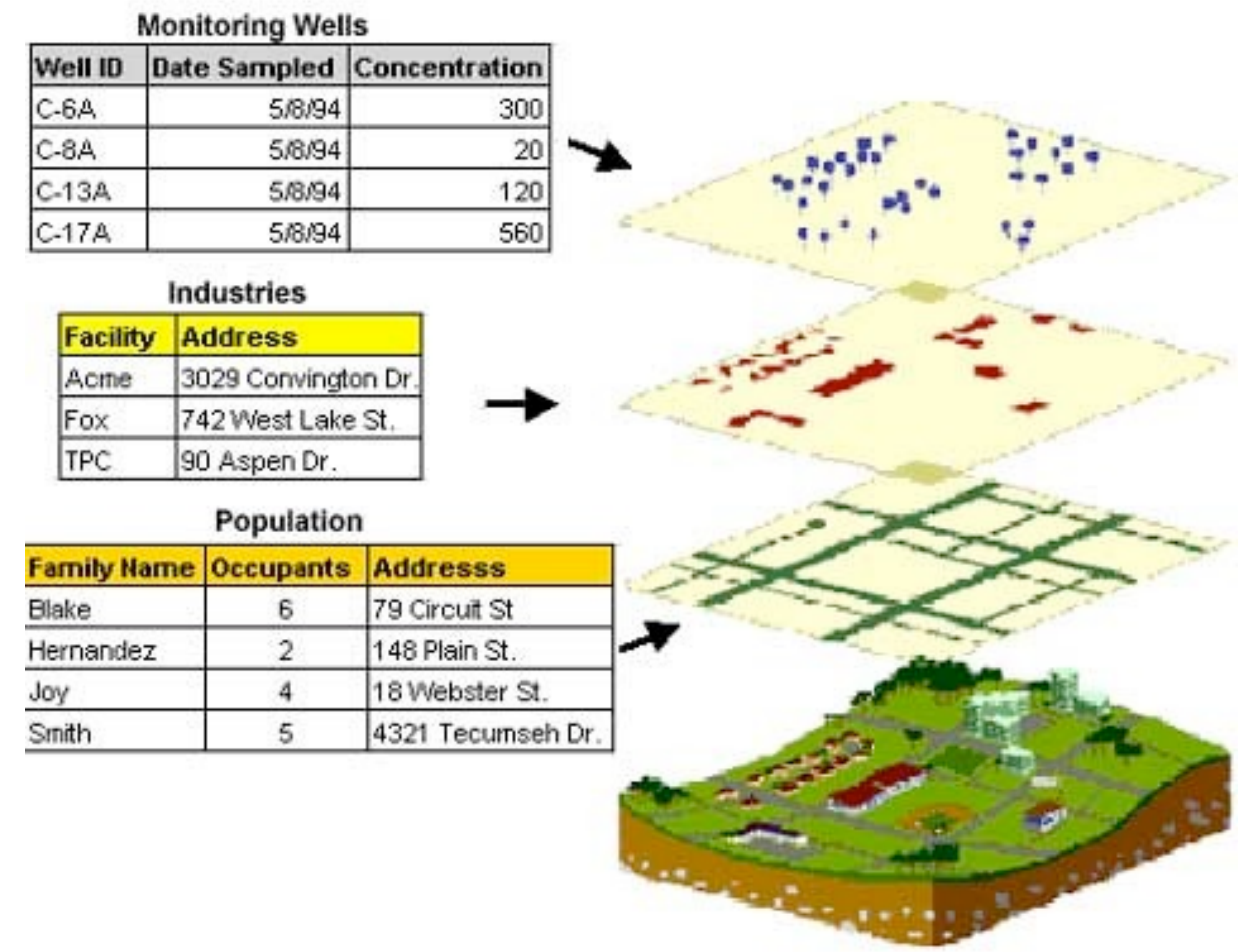
REPRESENTING SPATIAL ELEMENTS



Raster

Vector

Real World



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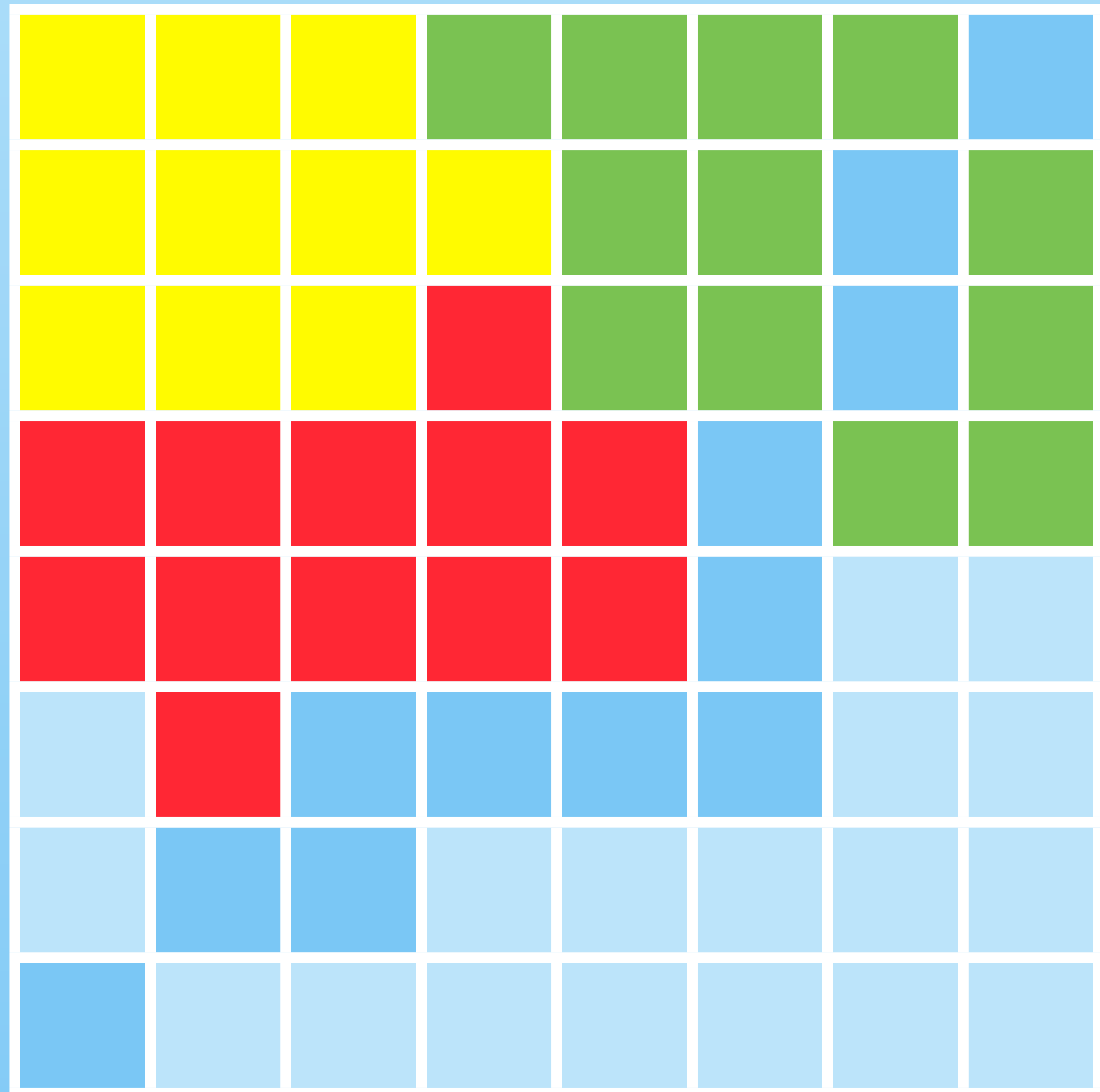

Raster - 1

- 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.)
-

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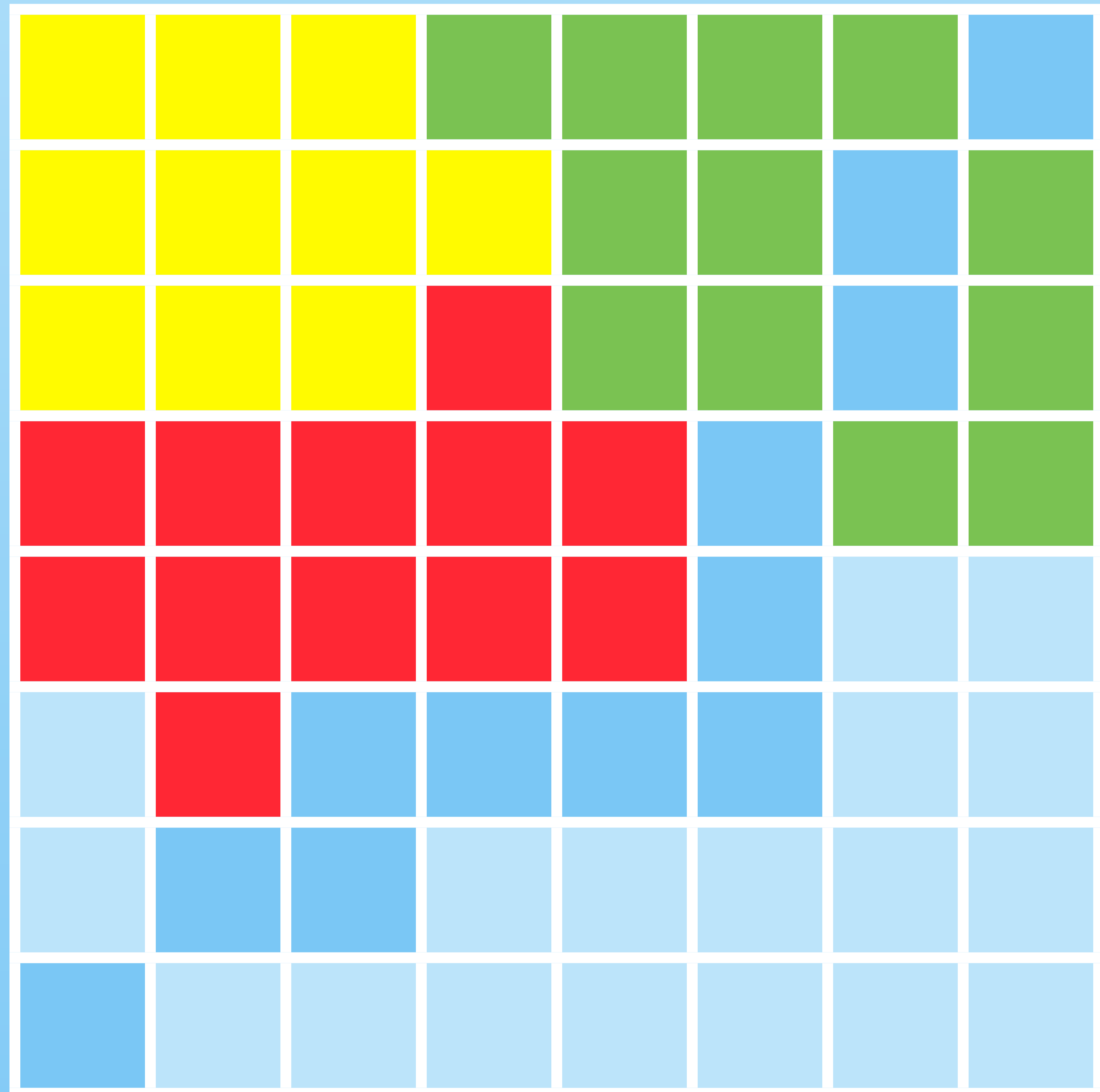

REPRESENTING SPATIAL ELEMENTS

Raster - 2

- smaller grid cells = higher resolution
- descriptive problems between discrete and continuos 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

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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.

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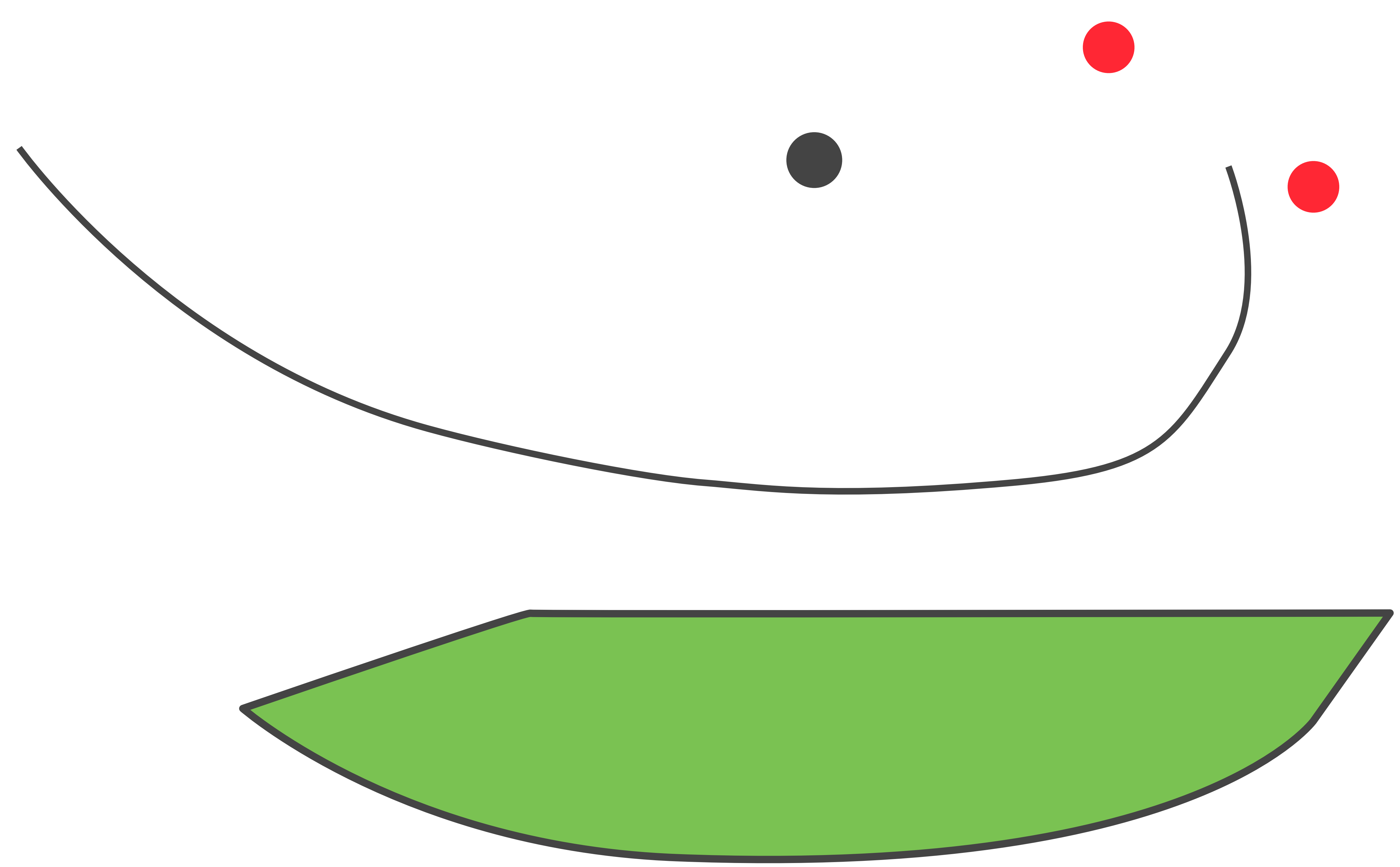
ENTITY REPRESENTATIONS



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.

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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.

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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

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PROJECTION AND COORDINATE SYSTEMS

Ellipsoids

Earth is no sphere but **geoid**

Geographic coordinate systems use **ellipsoids**

Shape of Earth an 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

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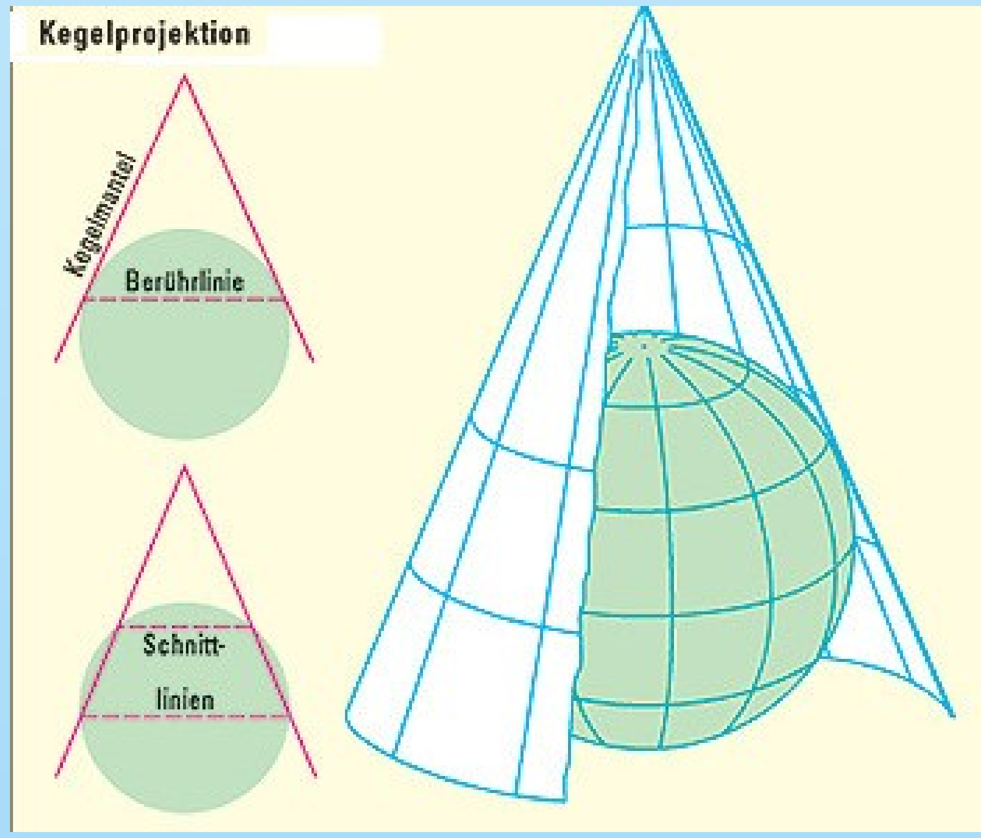

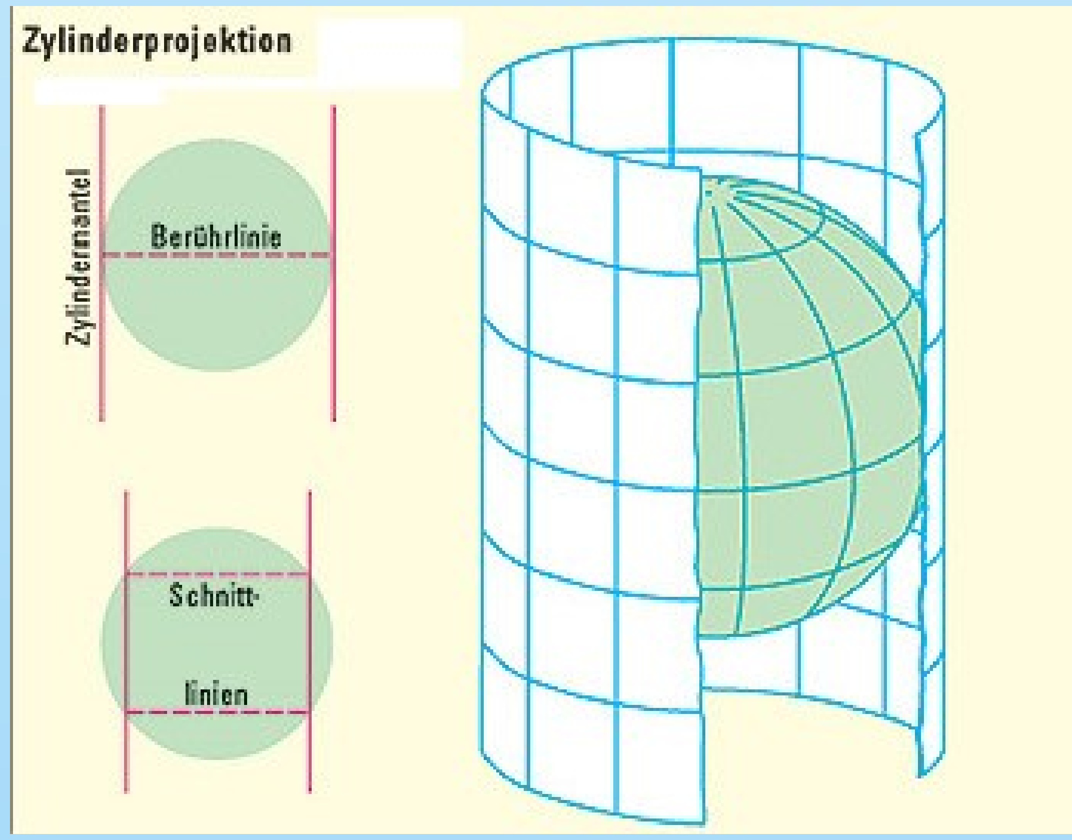

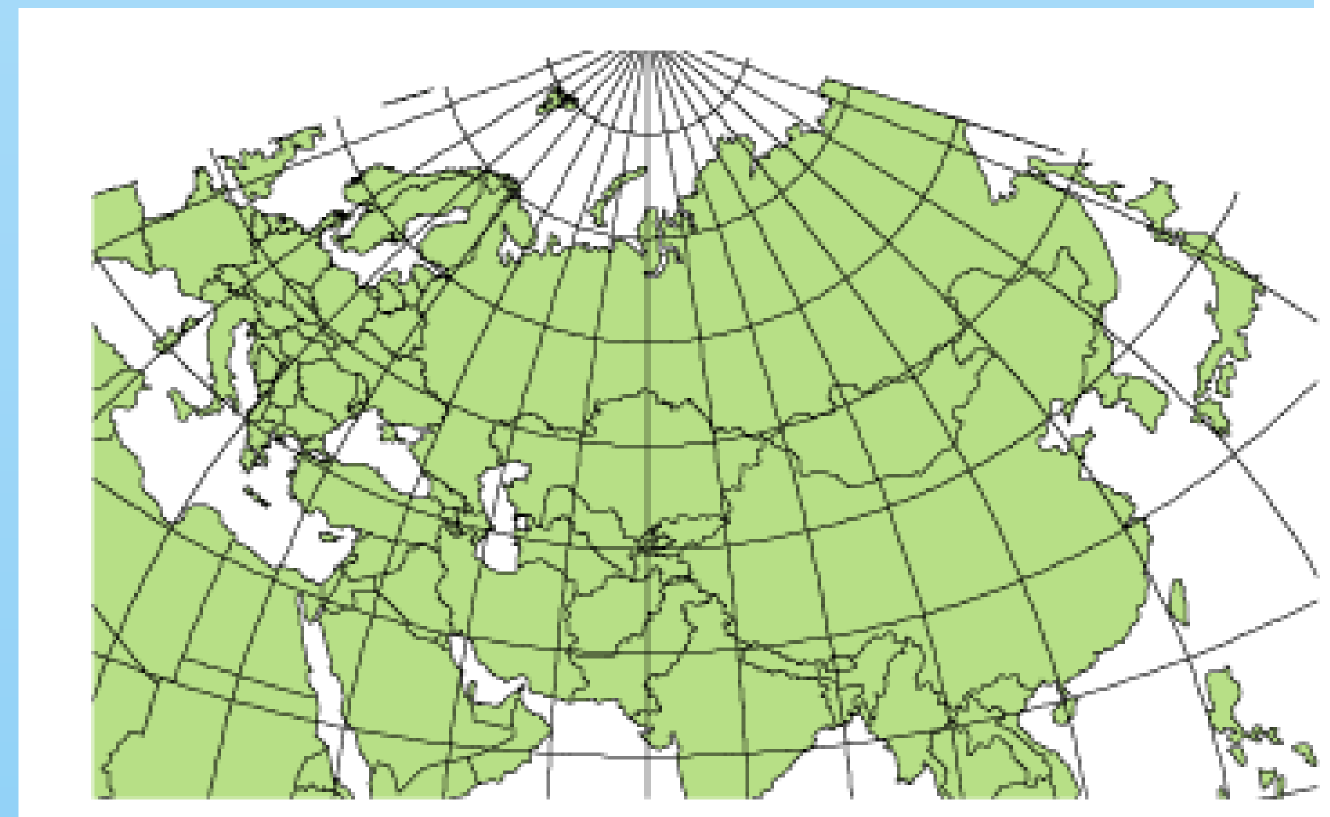

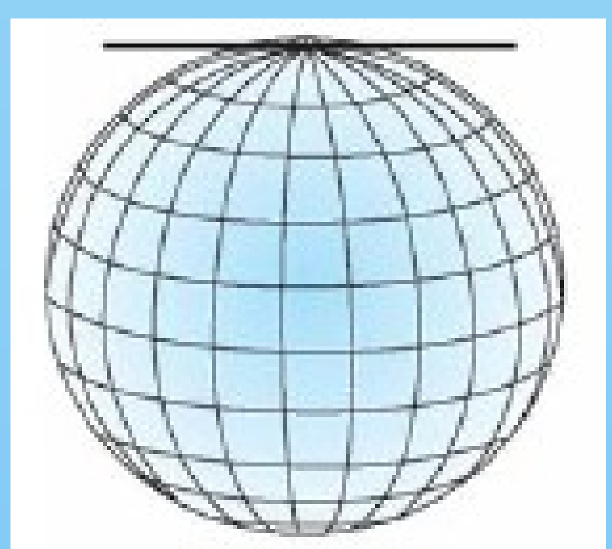

äquatorial

schräg

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

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GIS FUNCTIONALITY

Data Assembly / Creation

Data Storage

Spatial Data Analysis and Manipulation

Spatial Data Output

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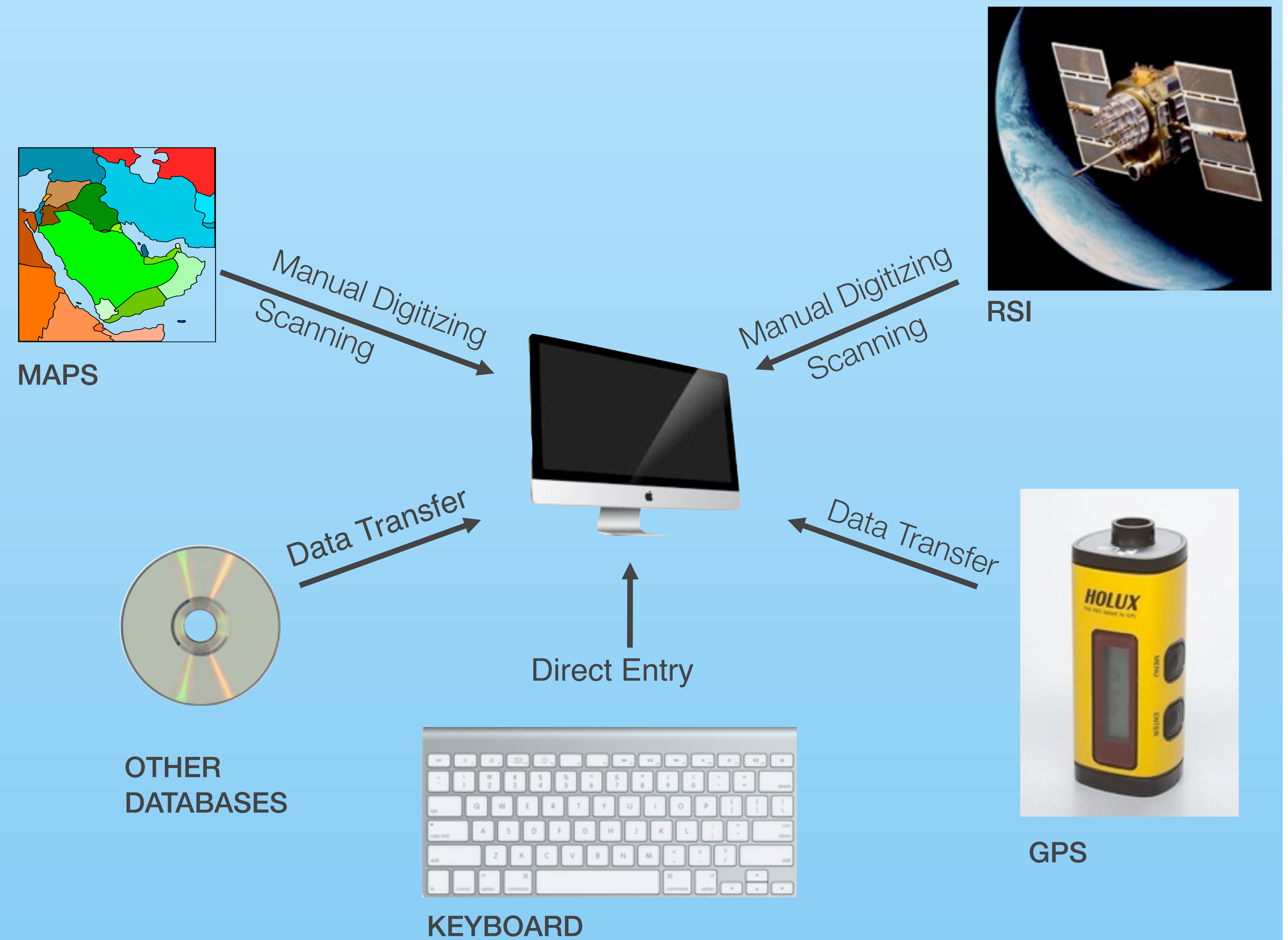
GIS FUNCTIONALITY



Data Assembly / Creation

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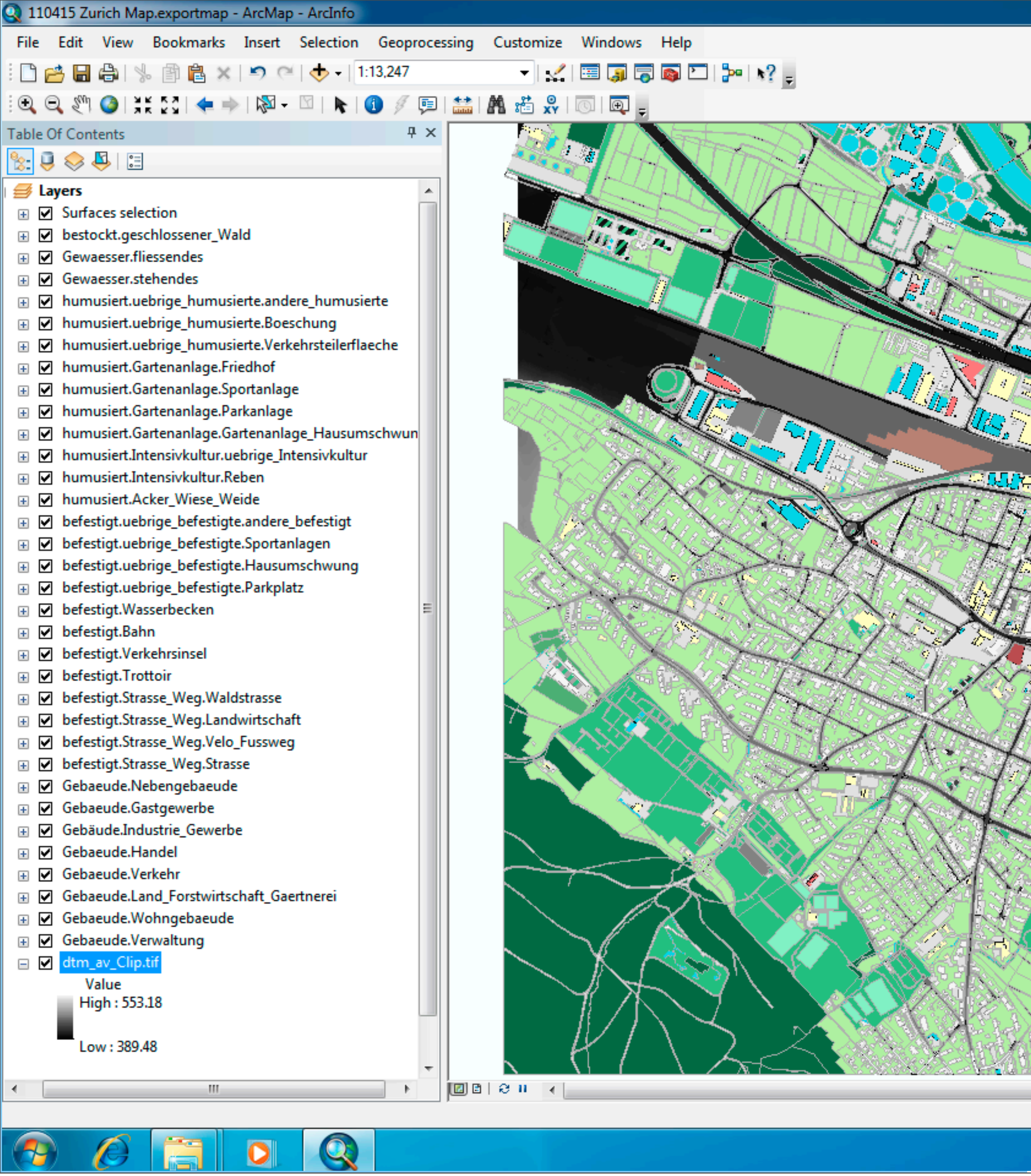

GIS FUNCTIONALITY

Data Assembly / Creation

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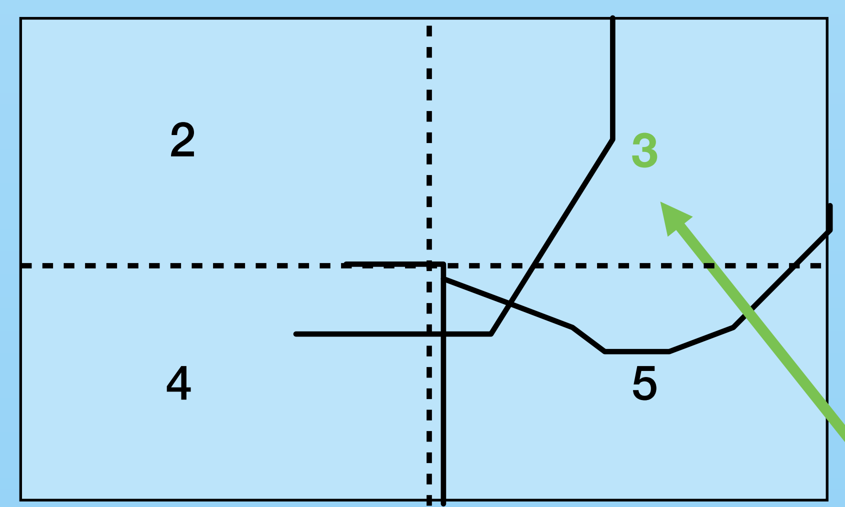
GIS FUNCTIONALITY

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

Data Assembly / Creation

Data Storage

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GIS FUNCTIONALITY

Spatial Data Analysis and Manipulation

Common Manipulation

Reclassification

Map Projection changes

Common Analysis

Buffering

Overlay

Network

Data Assembly / Creation

Data Storage

Spatial Data Analysis and Manipulation

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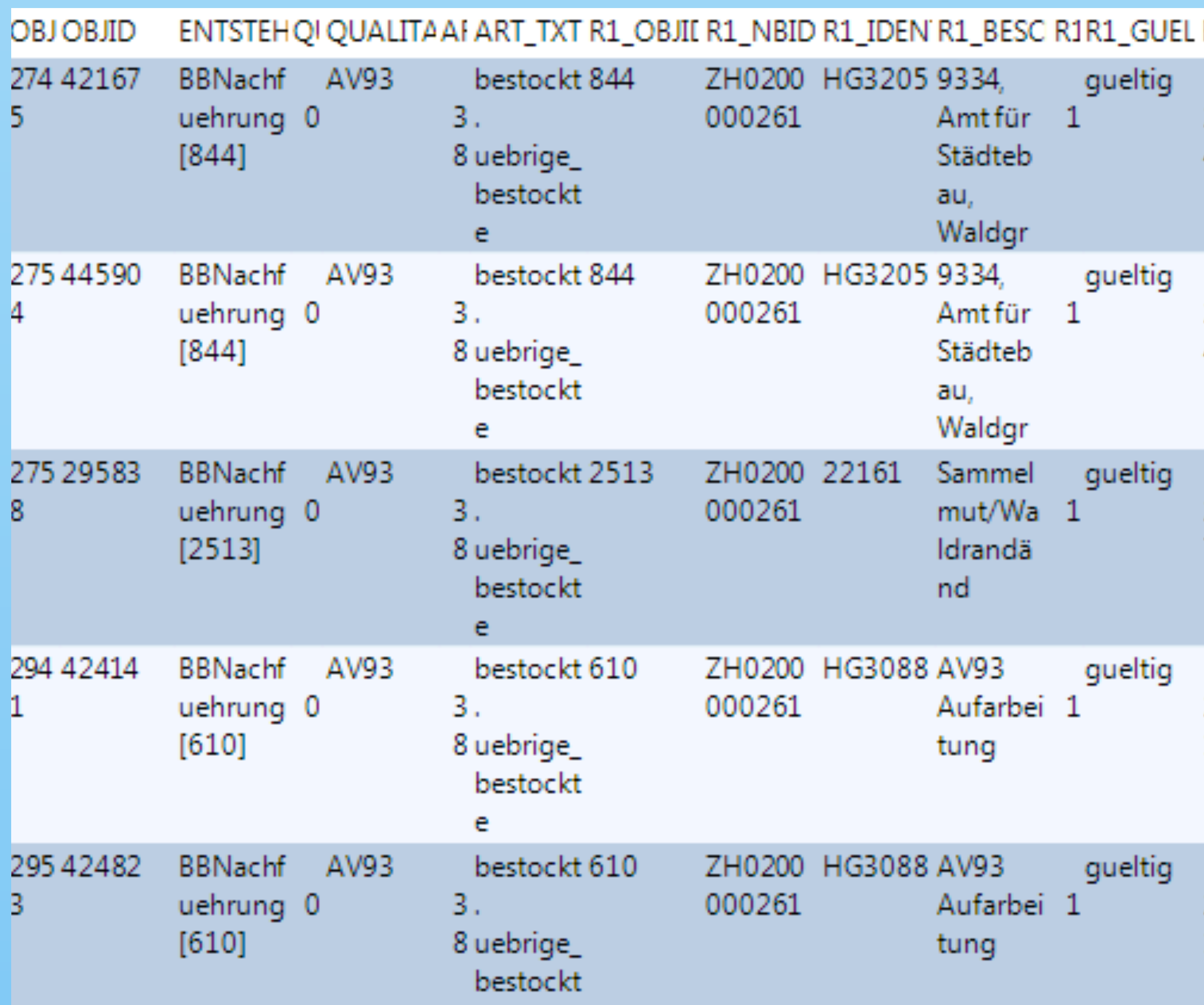
GIS FUNCTIONALITY



OBJ	OBJID	ENTSTEH	QI	QUALITA	AF	ART_TXT	R1_OBJI	R1_NBID	R1_IDEN	R1_BESC	R1	R1_GUEL
274 5	42167	BBNachfuehrung [844]	0	AV93	3 . 8	bestockt uebrige_bestockte	844	ZH0200000261	HG3205	9334, Amt für Städtebau, Waldgr	1	gueltig
275 4	44590	BBNachfuehrung [844]	0	AV93	3 . 8	bestockt uebrige_bestockte	844	ZH0200000261	HG3205	9334, Amt für Städtebau, Waldgr	1	gueltig
275 8	29583	BBNachfuehrung [2513]	0	AV93	3 . 8	bestockt uebrige_bestockte	2513	ZH0200000261	22161	Sammelmut/Waldrandänd	1	gueltig
294 1	42414	BBNachfuehrung [610]	0	AV93	3 . 8	bestockt uebrige_bestockte	610	ZH0200000261	HG3088	AV93 Aufarbeitung	1	gueltig
295 3	42482	BBNachfuehrung [610]	0	AV93	3 . 8	bestockt uebrige_bestockt	610	ZH0200000261	HG3088	AV93 Aufarbeitung	1	gueltig

Data Assembly / Creation

Data Storage

Spatial Data Analysis and Manipulation

Spatial Data Output

Tables

Maps

Interactive Displays

3-D Perspective View

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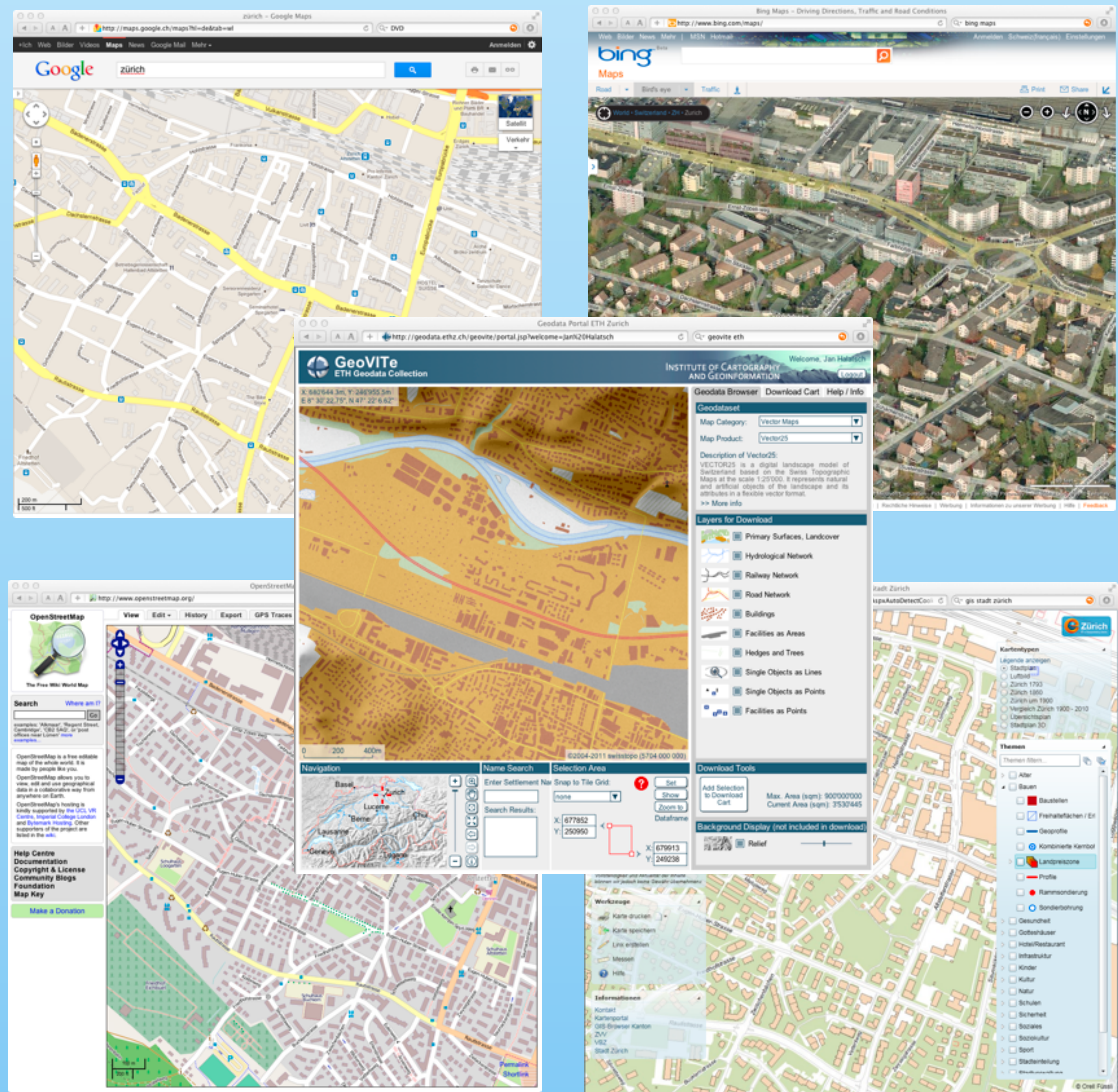

GIS DATA SOURCES FOR URBAN PLANNING, DESIGN

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/

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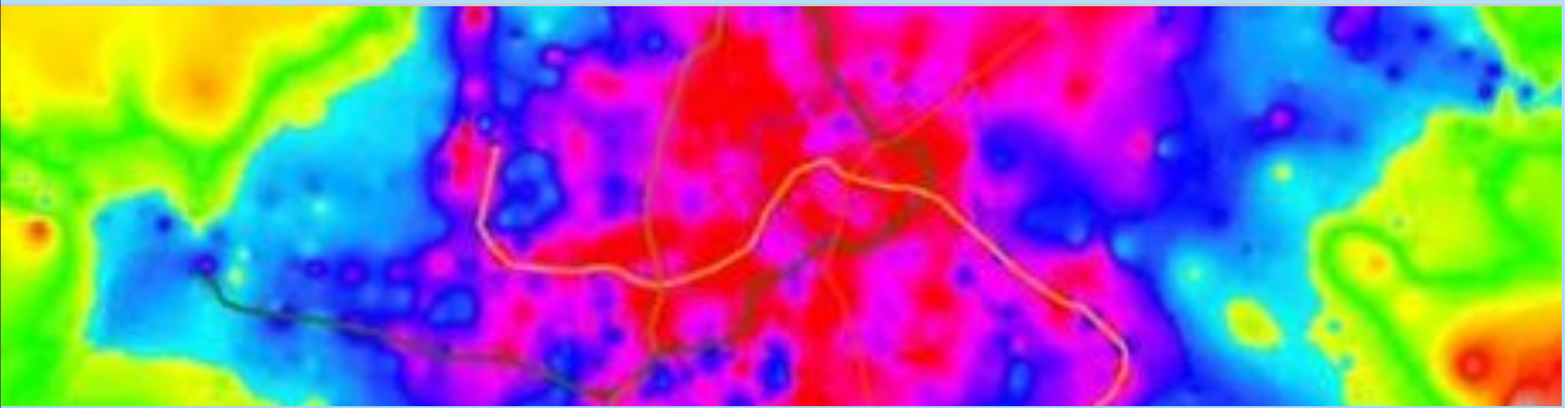
GIS IN URBAN PLANNING



Information of Wien.at - GIS platform

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

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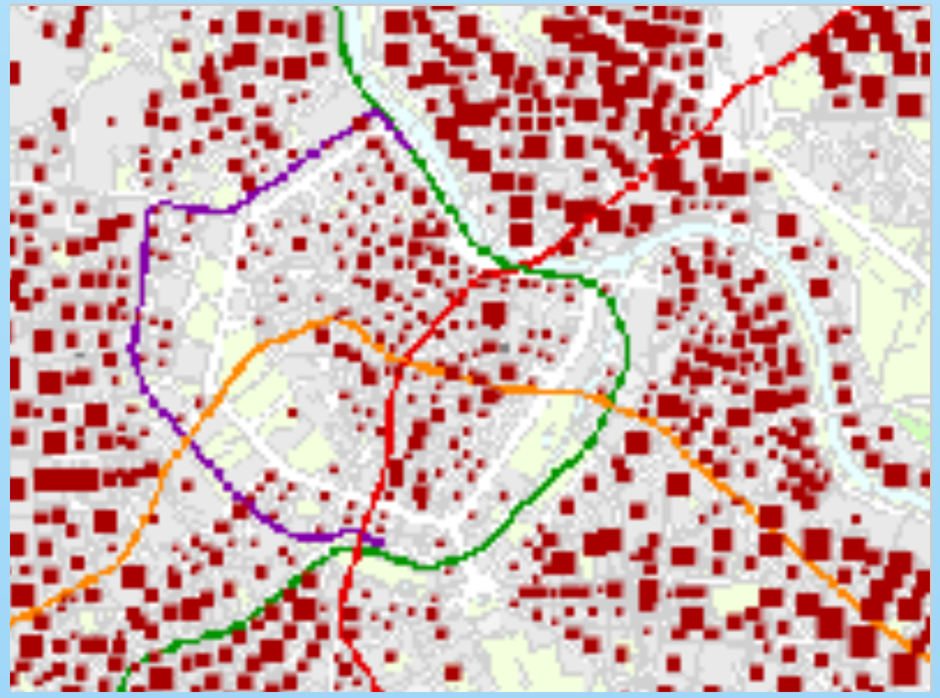
GIS IN URBAN PLANNING



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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

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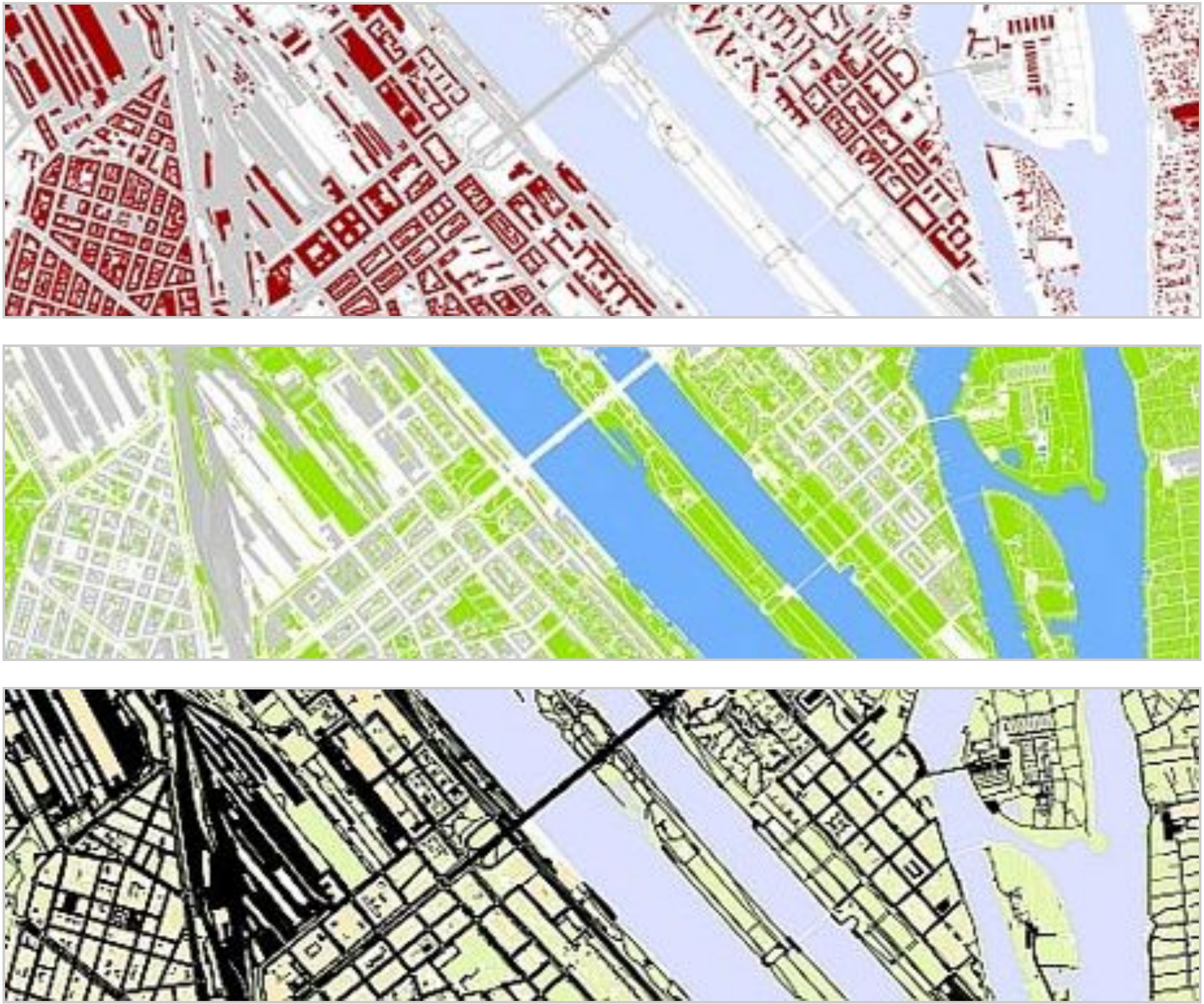
GIS IN URBAN PLANNING



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GEO-COMMUNICATION

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

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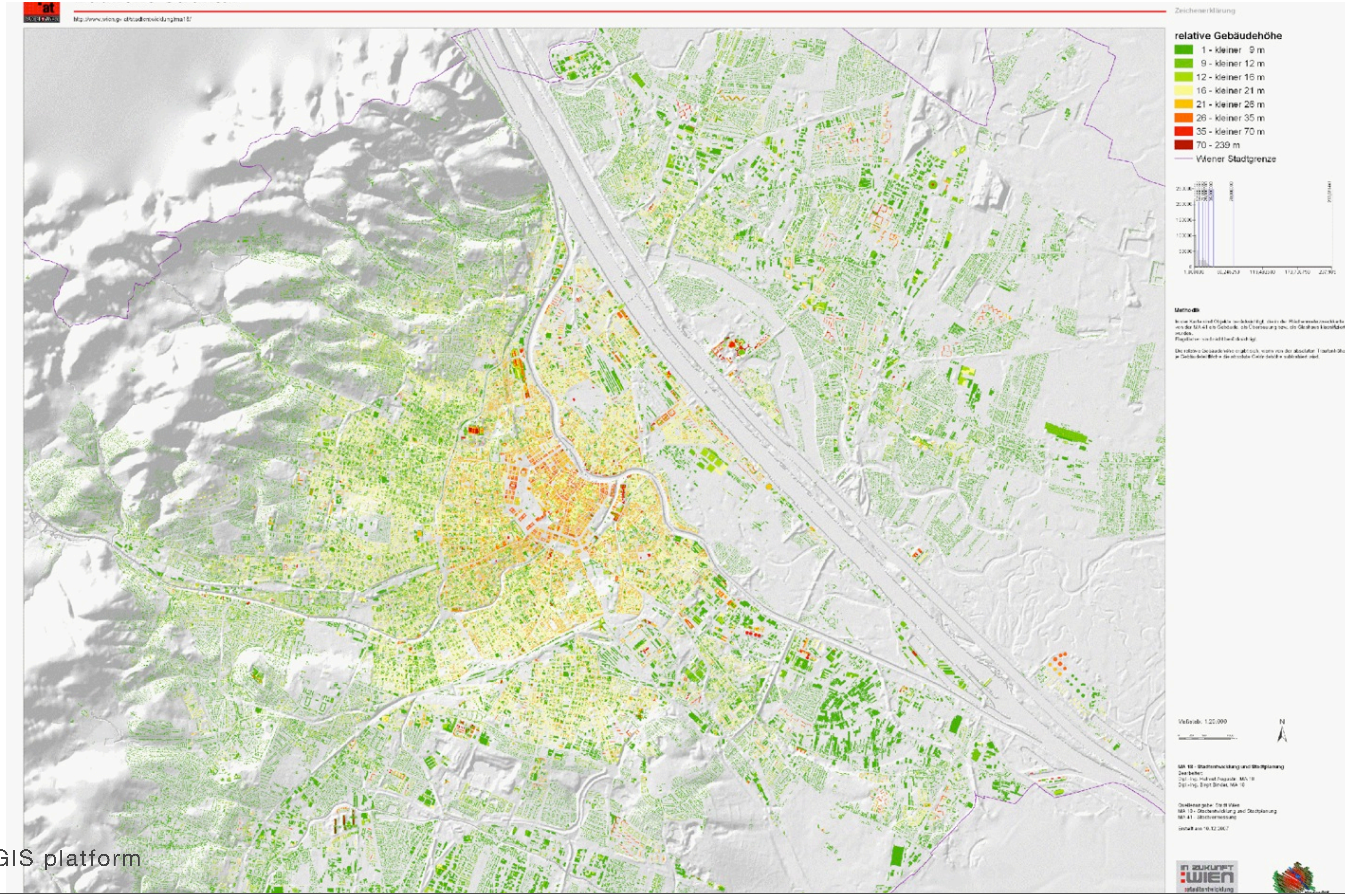
EXAMPLES



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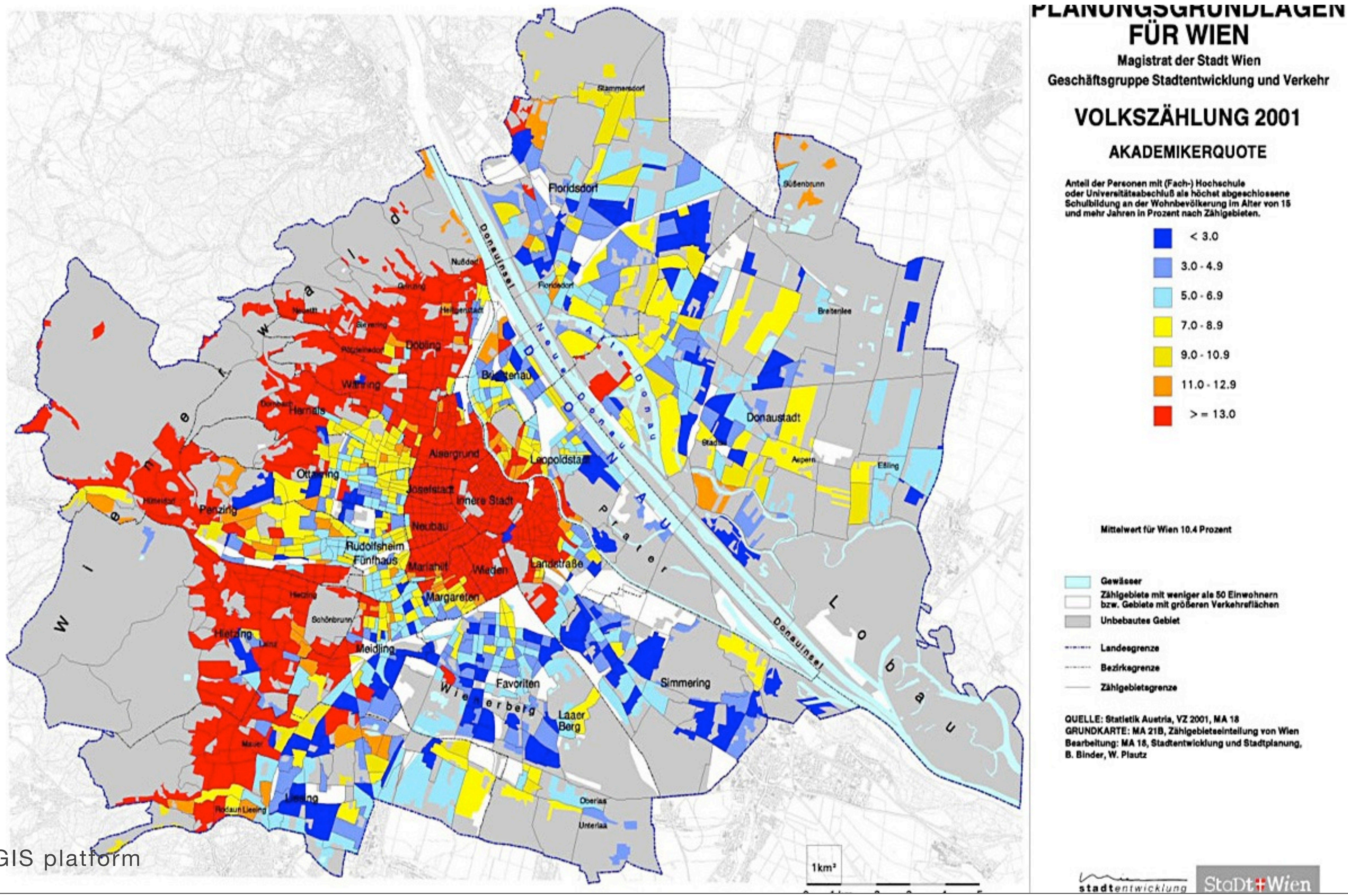

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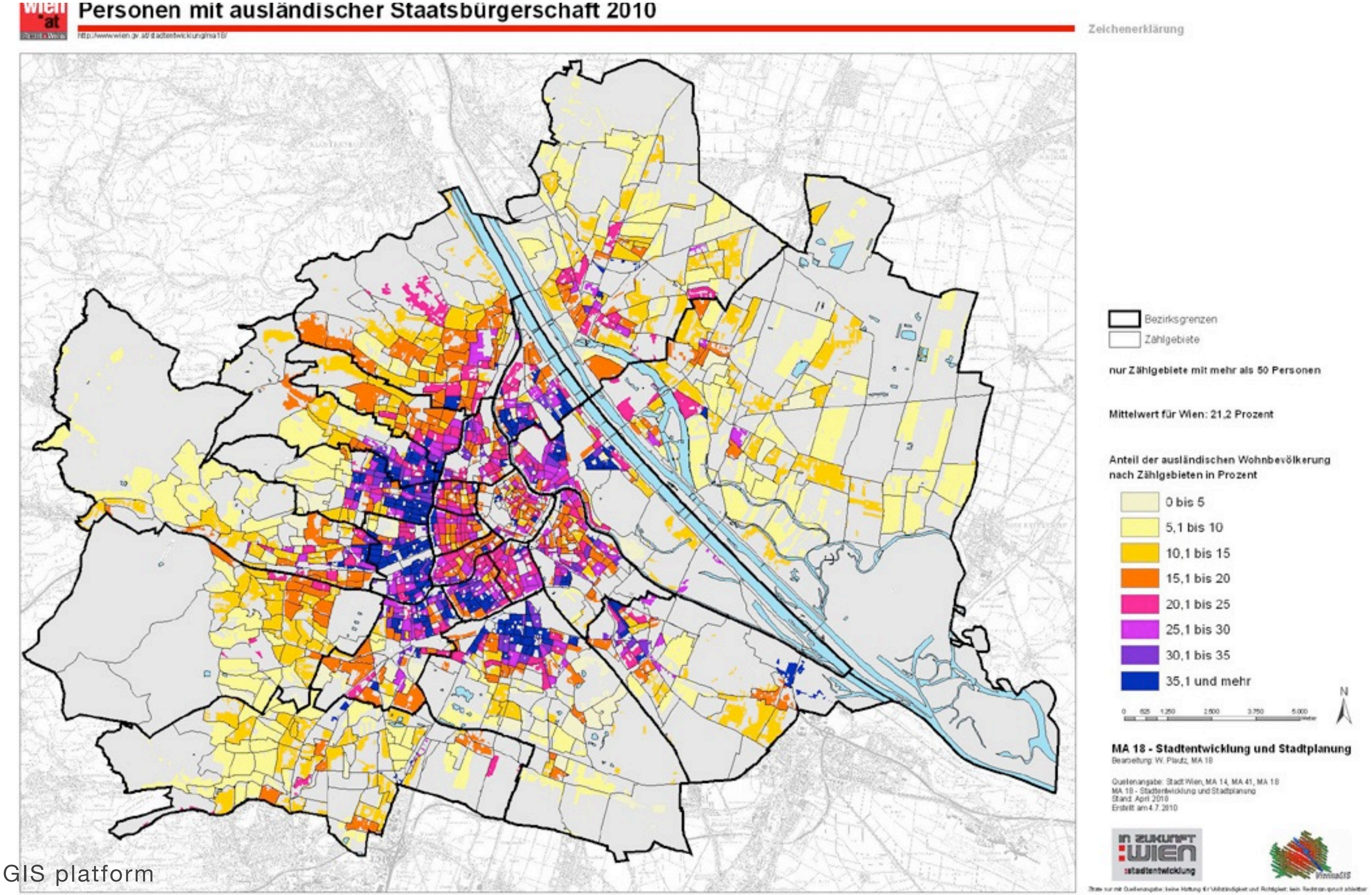

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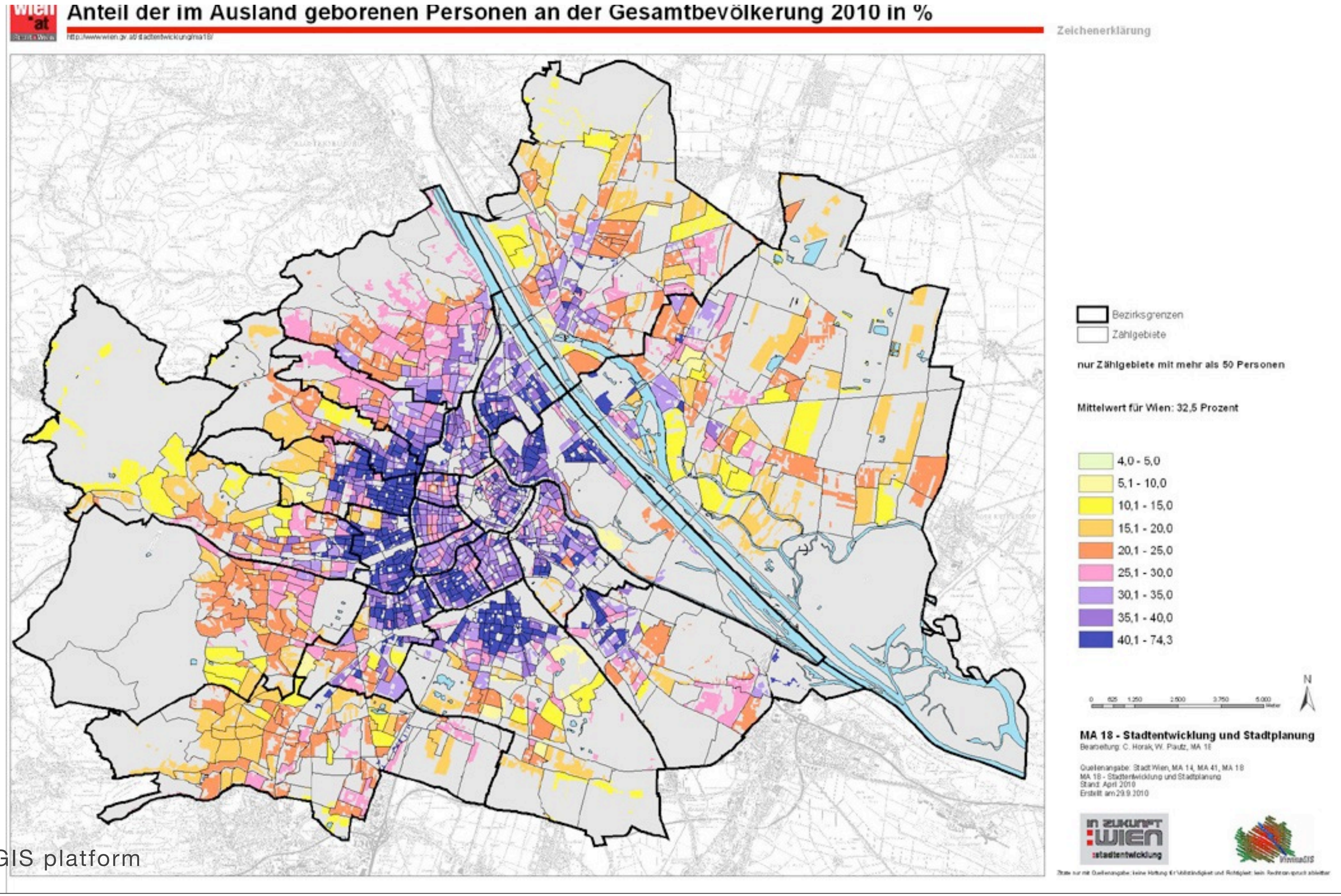

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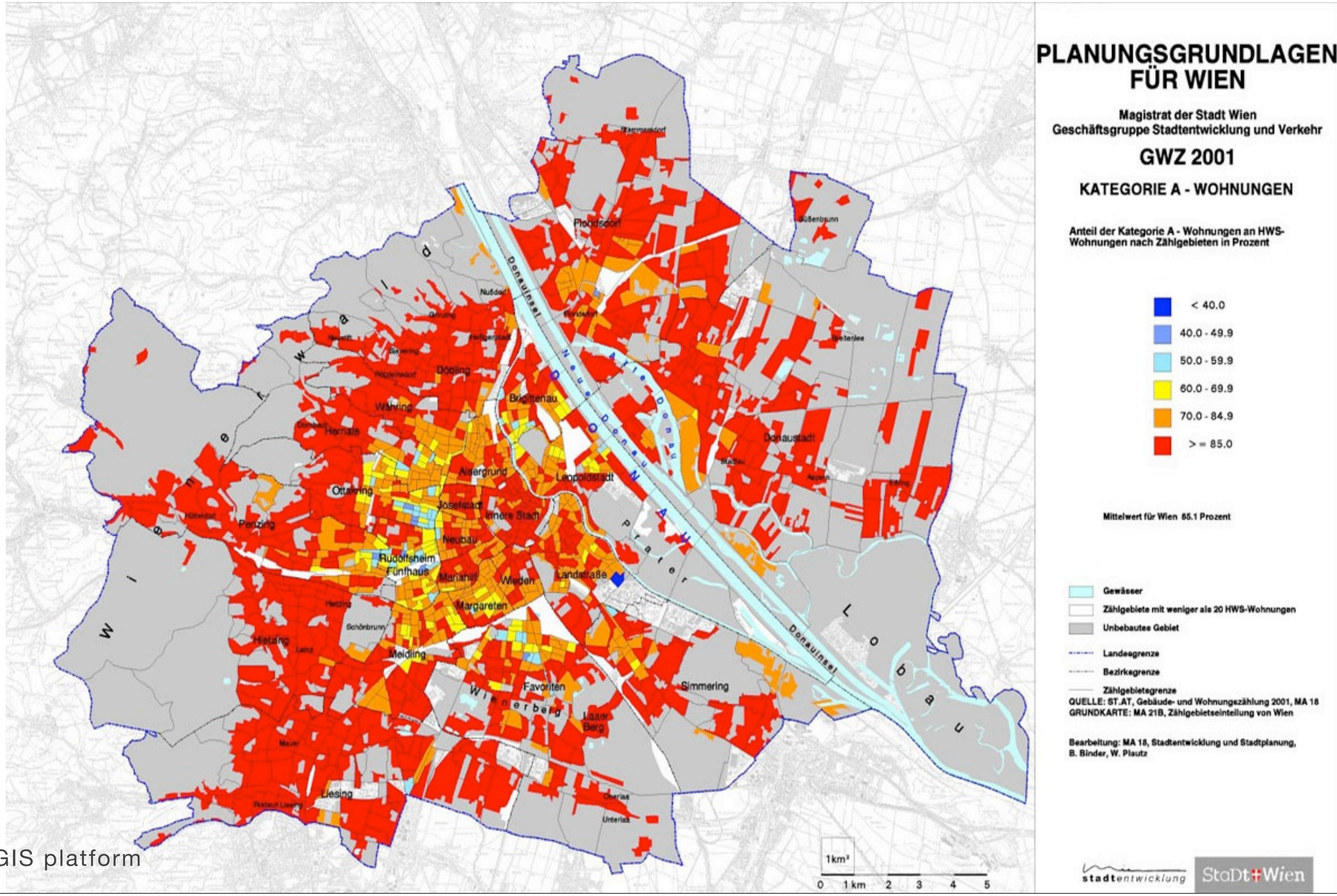

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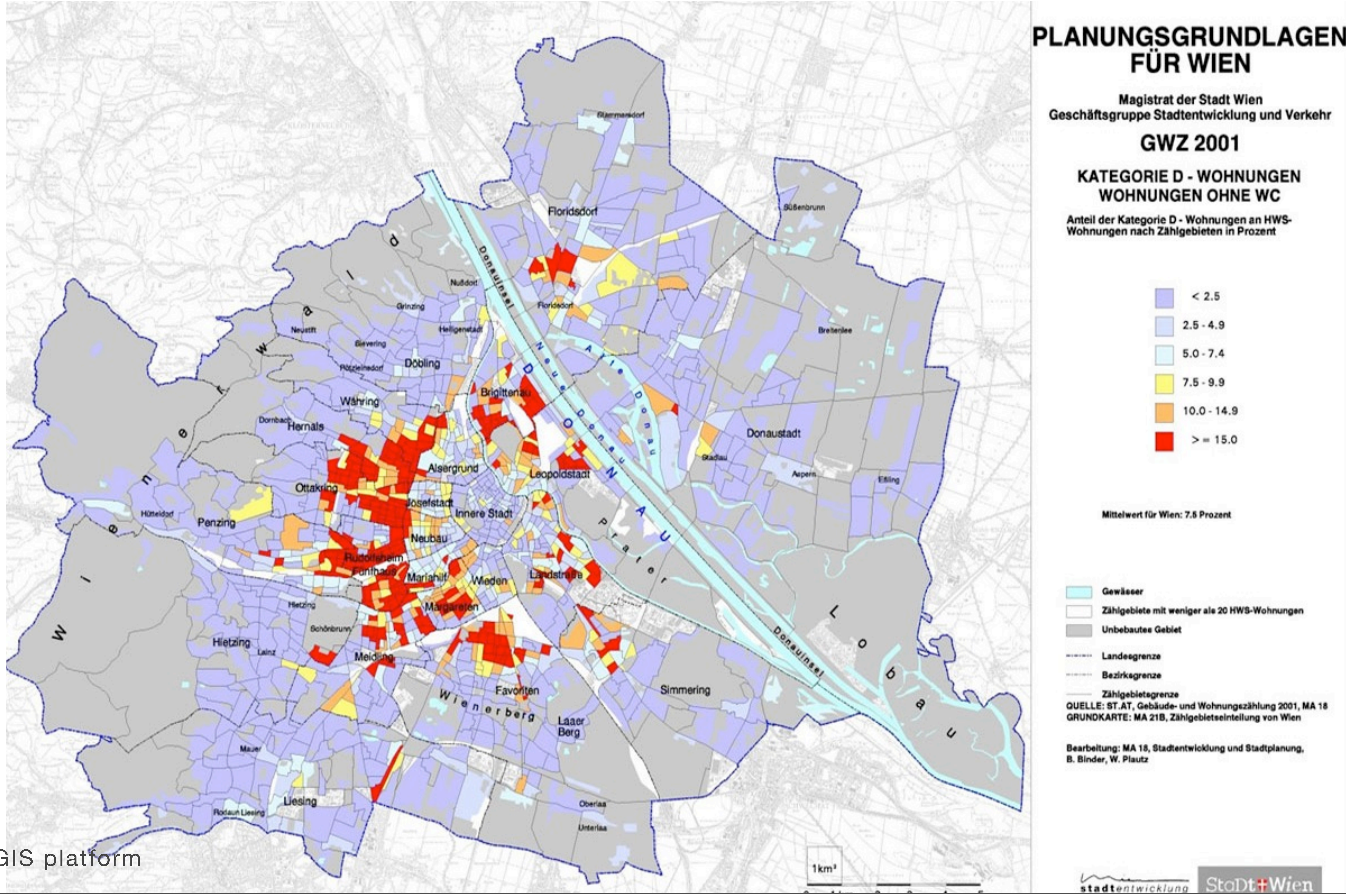

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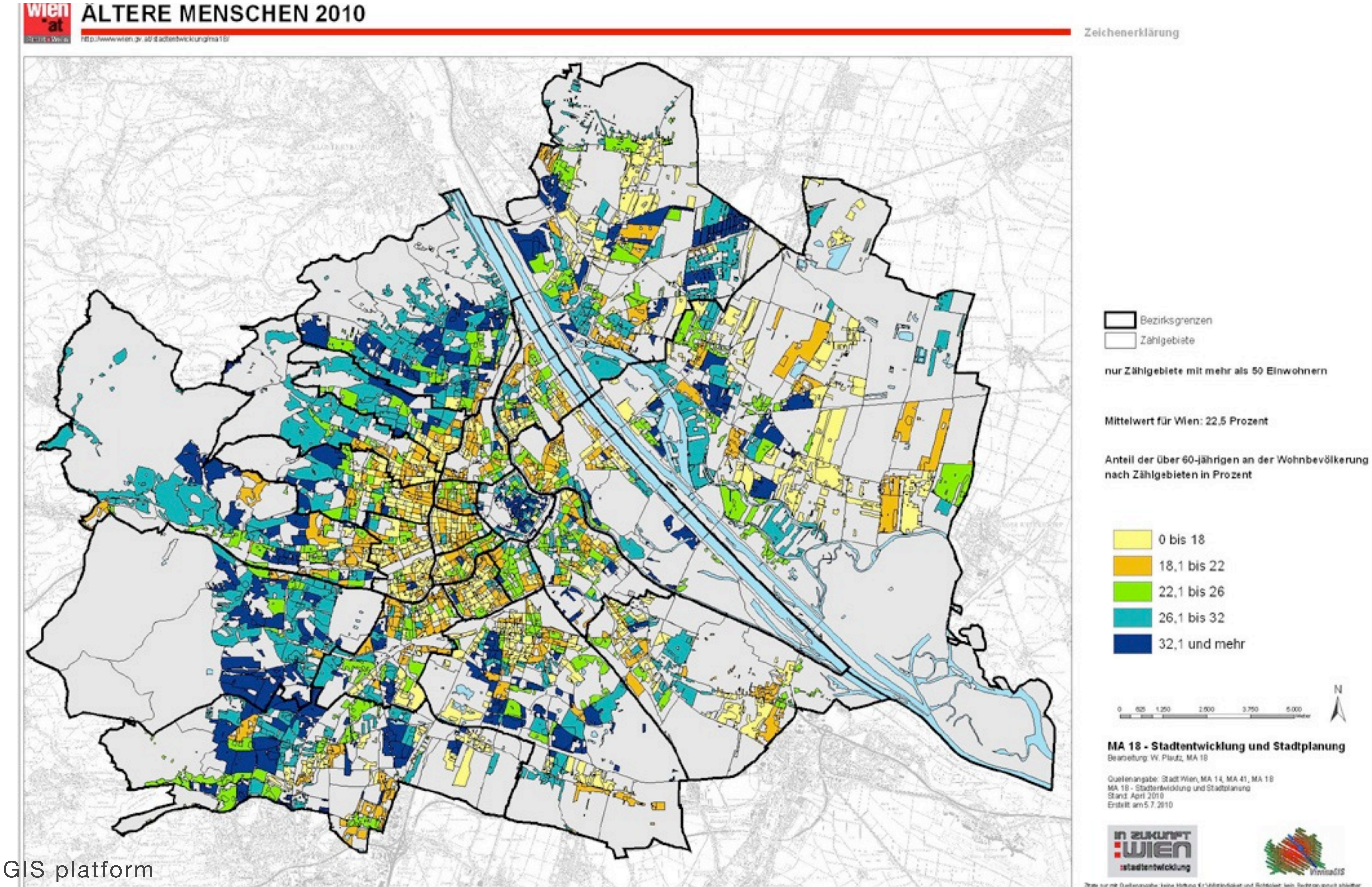

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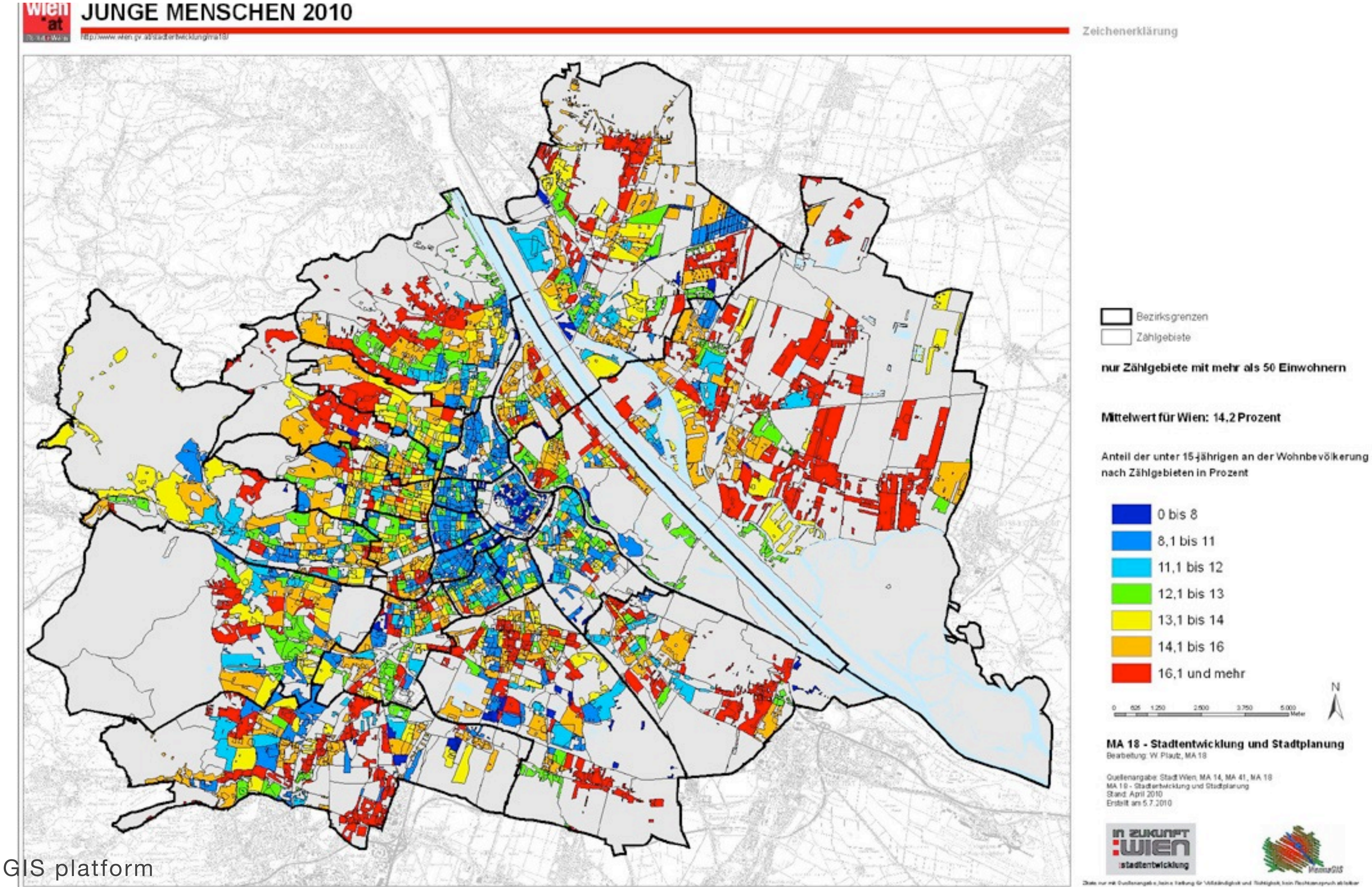

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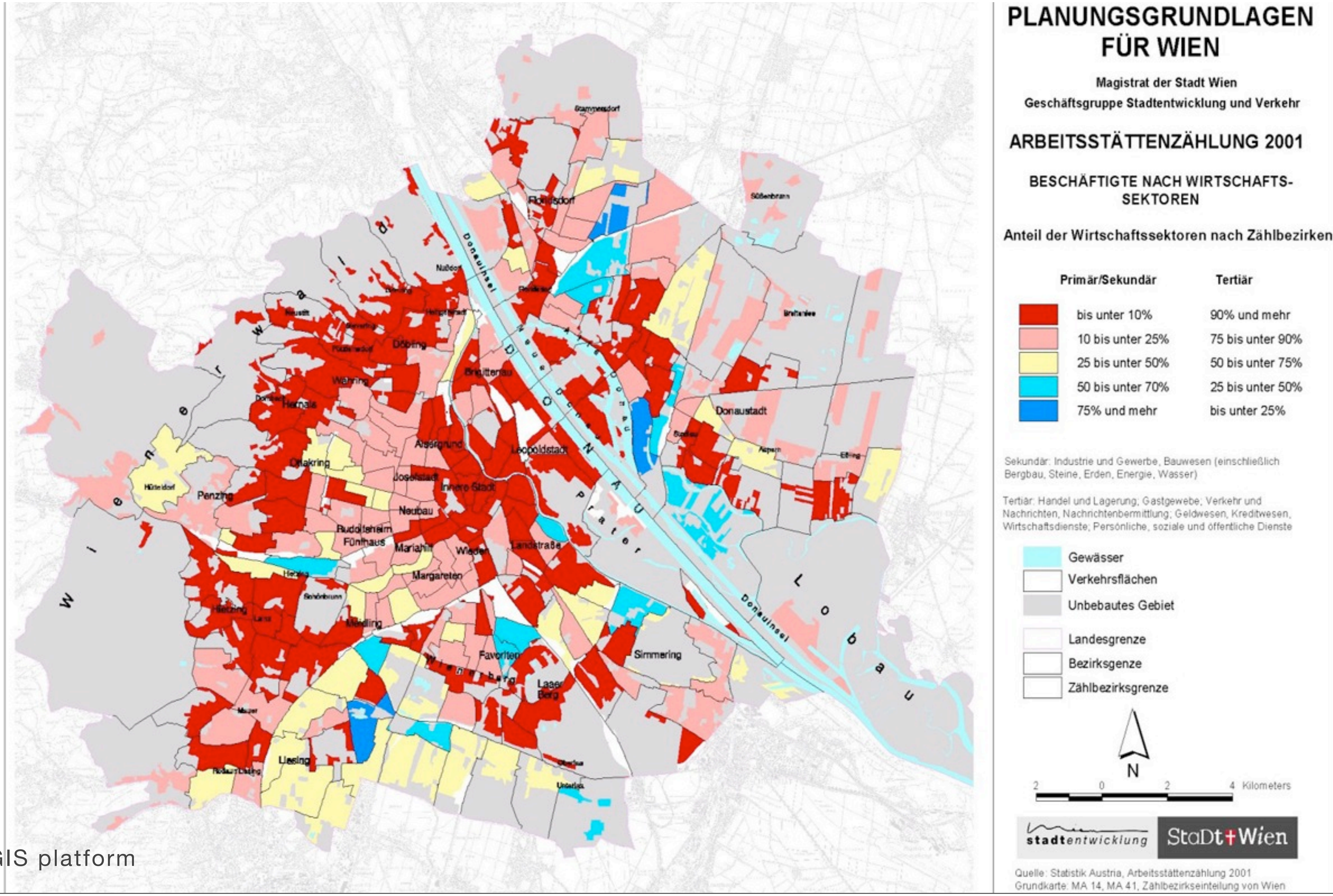

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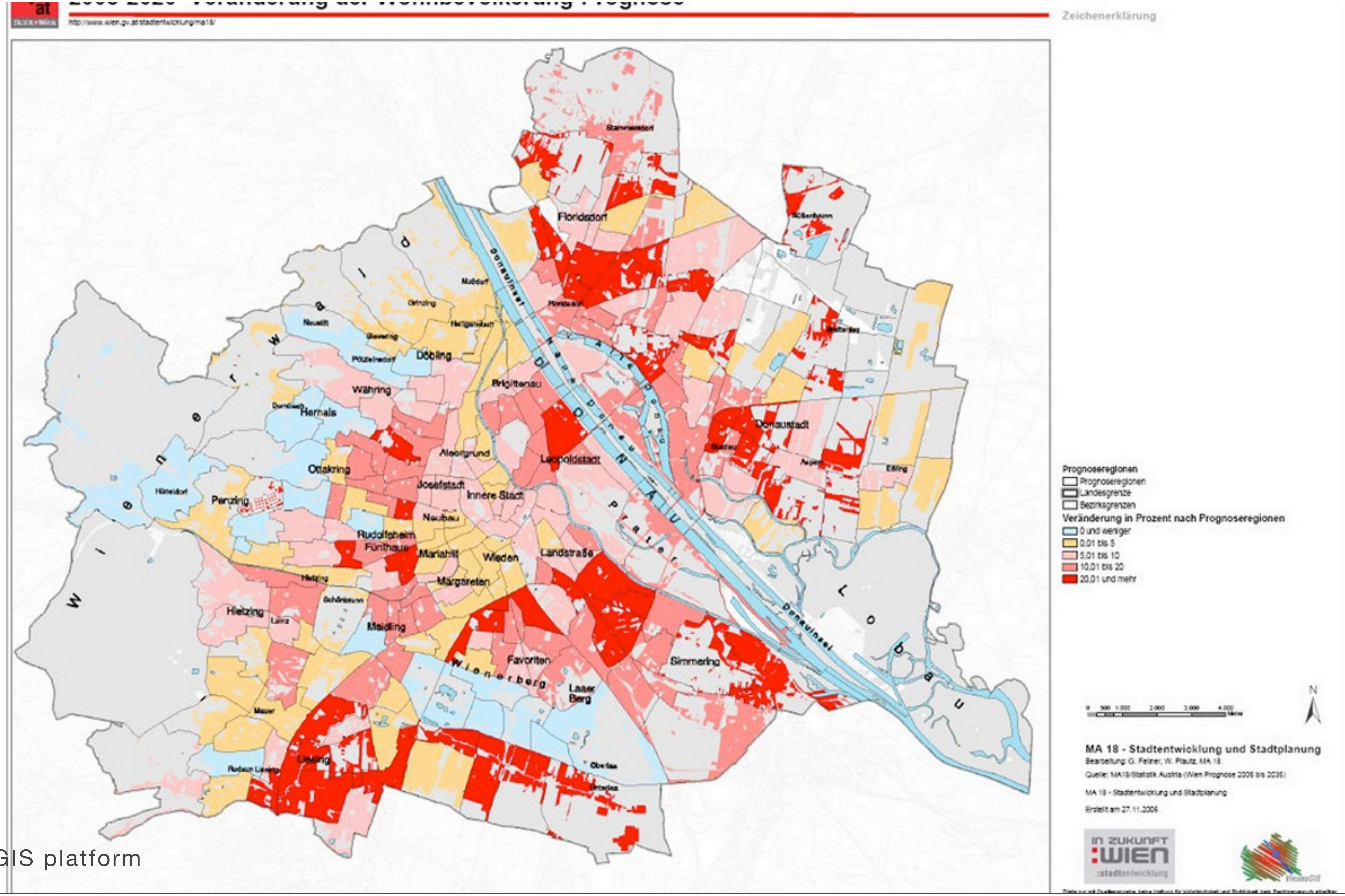

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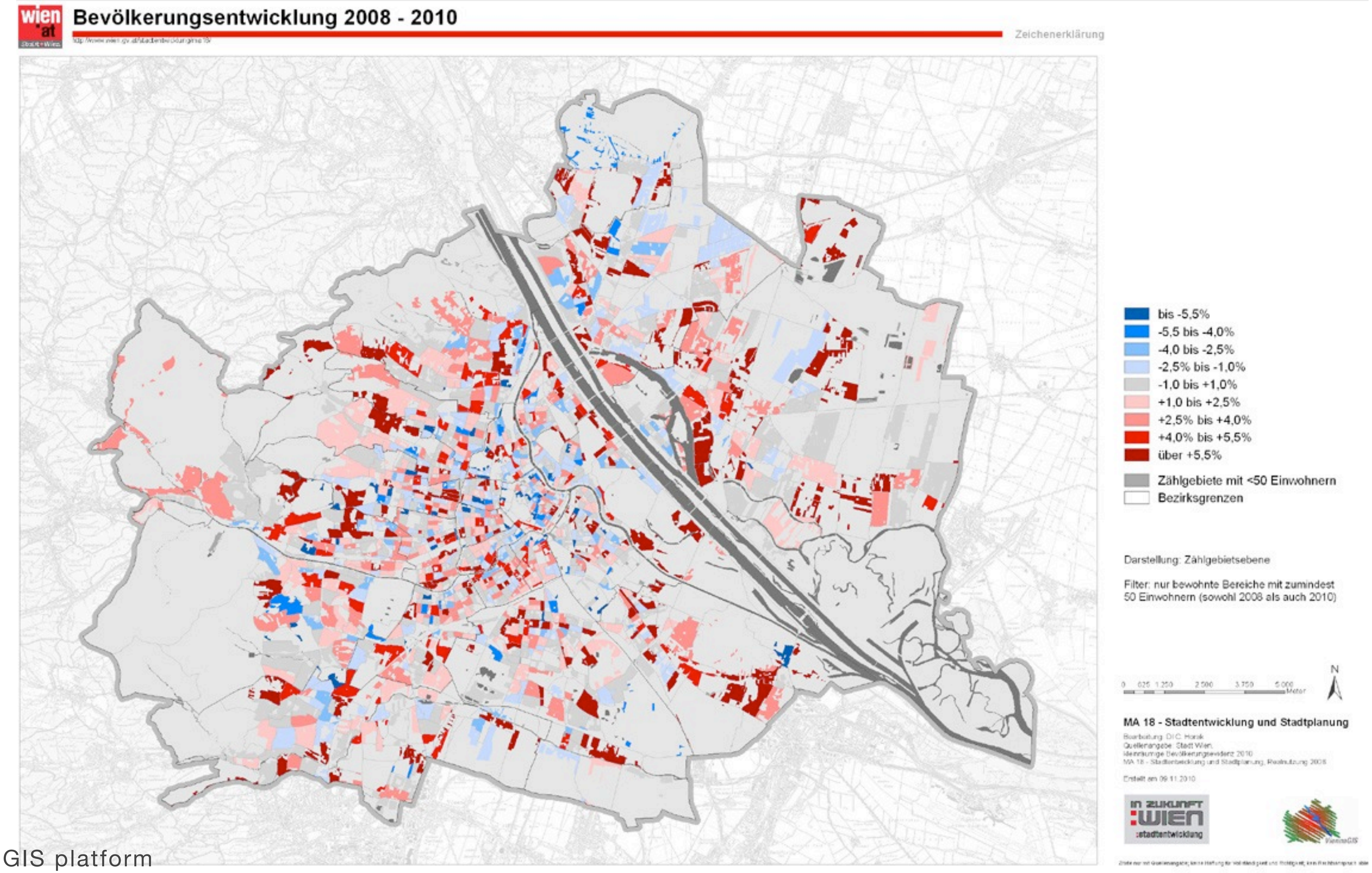

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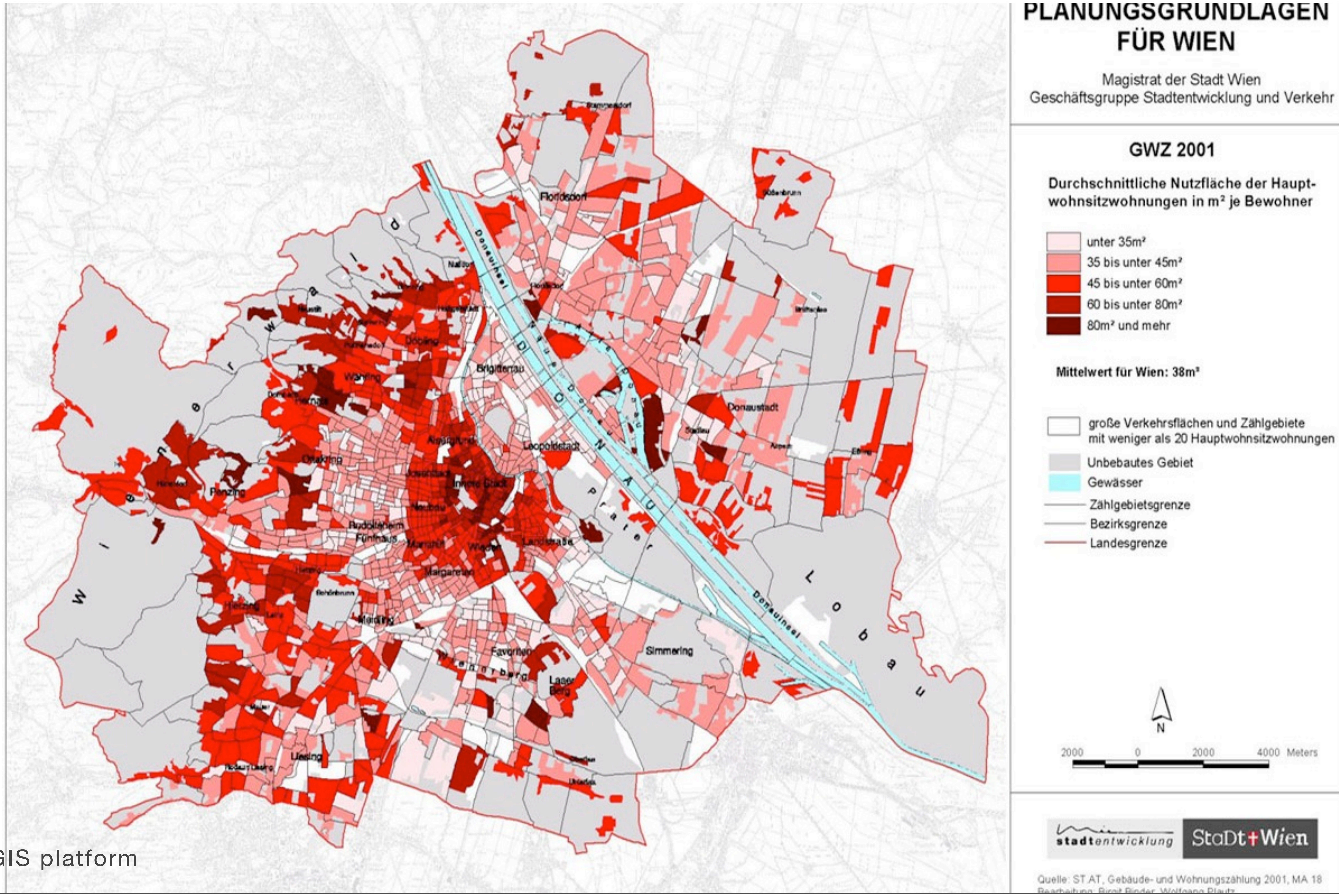

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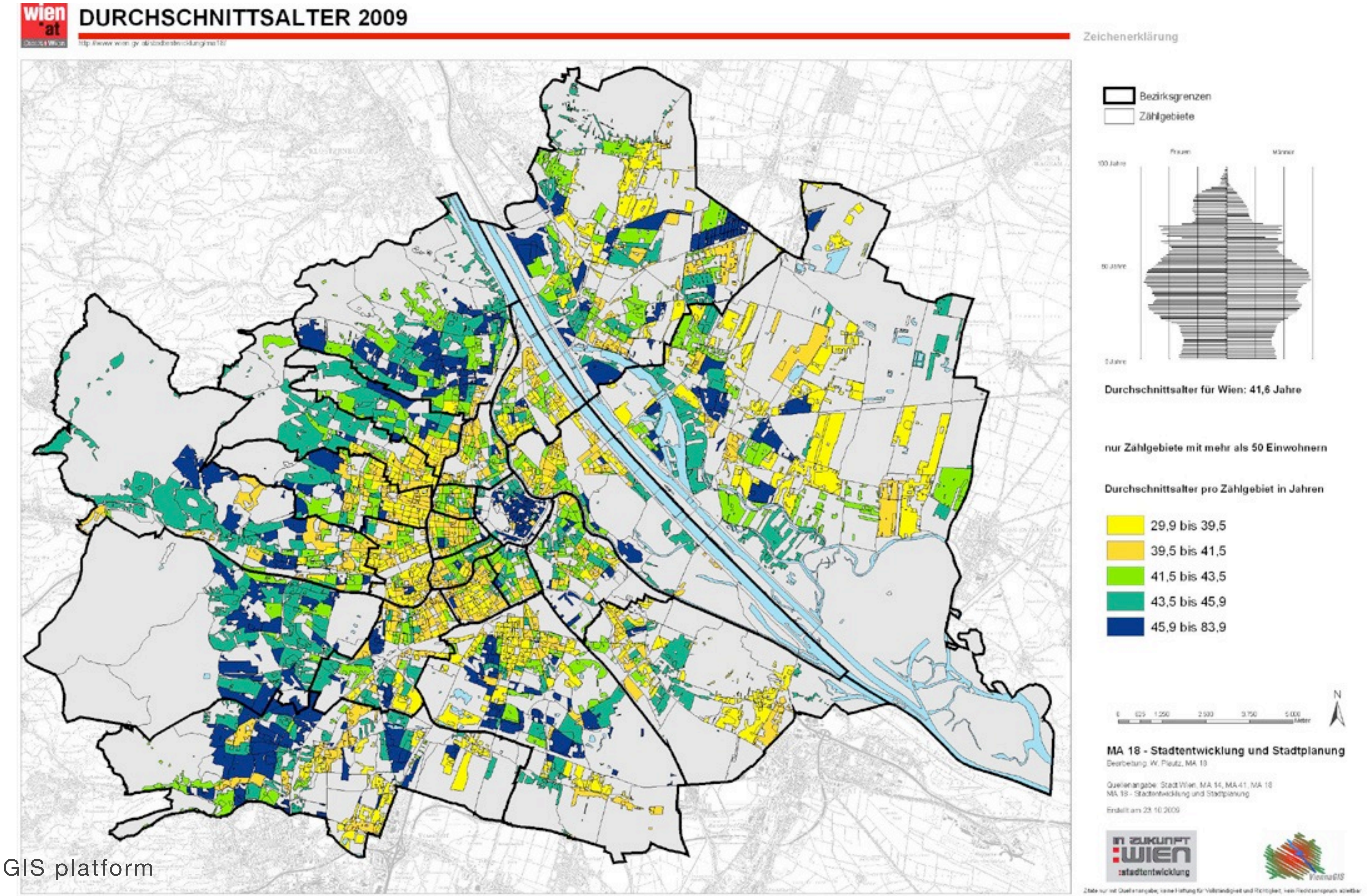

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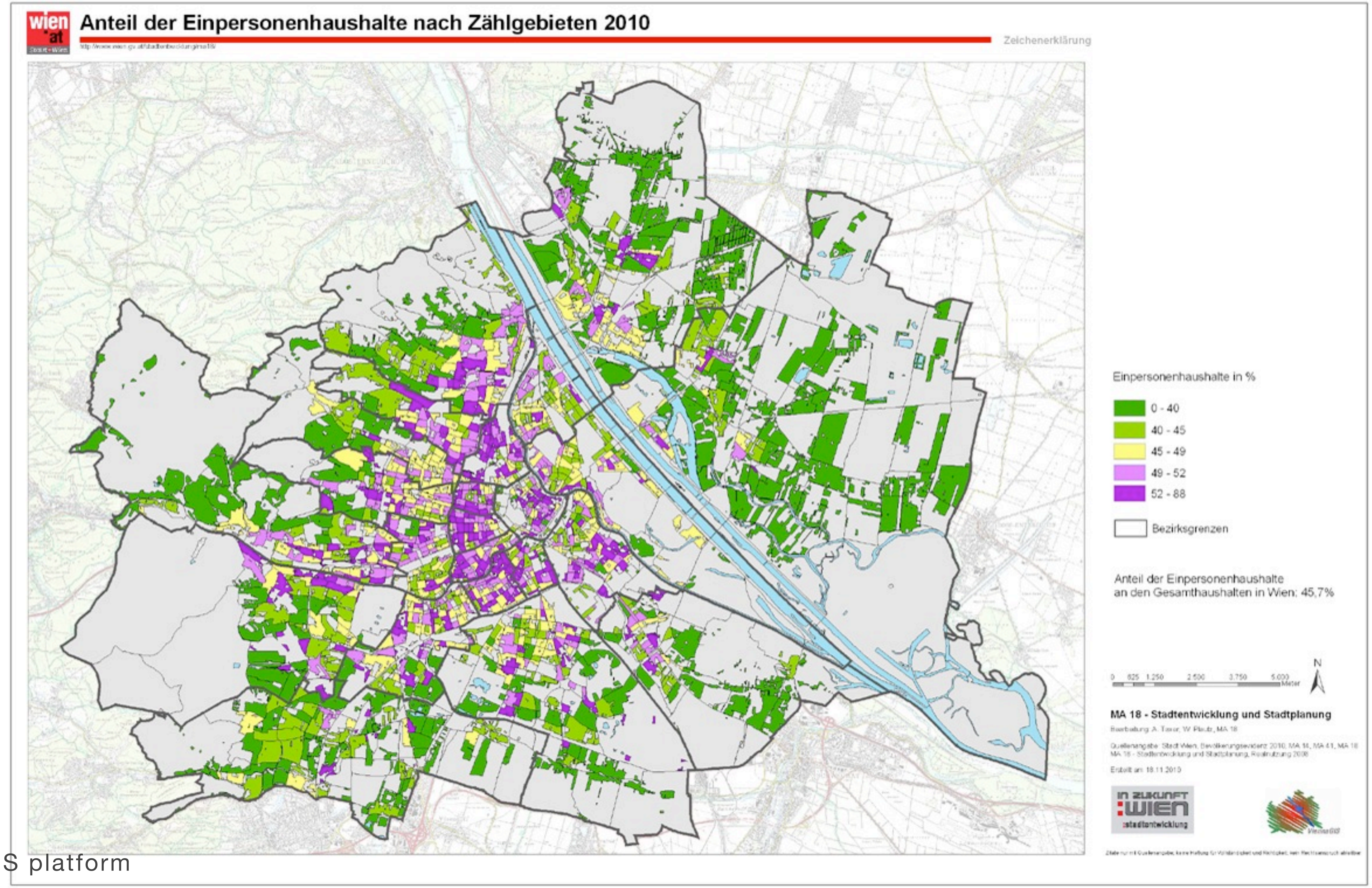

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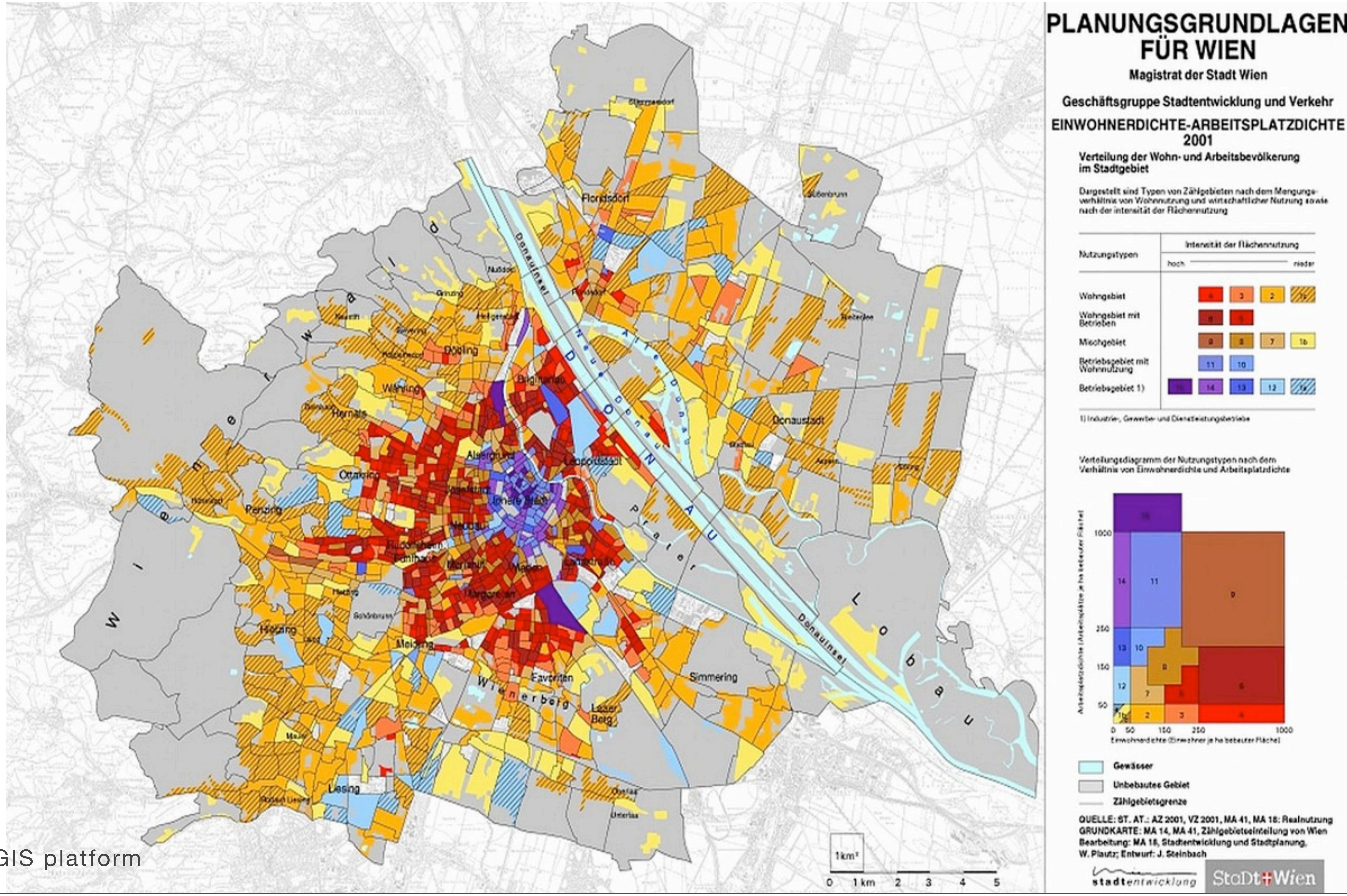

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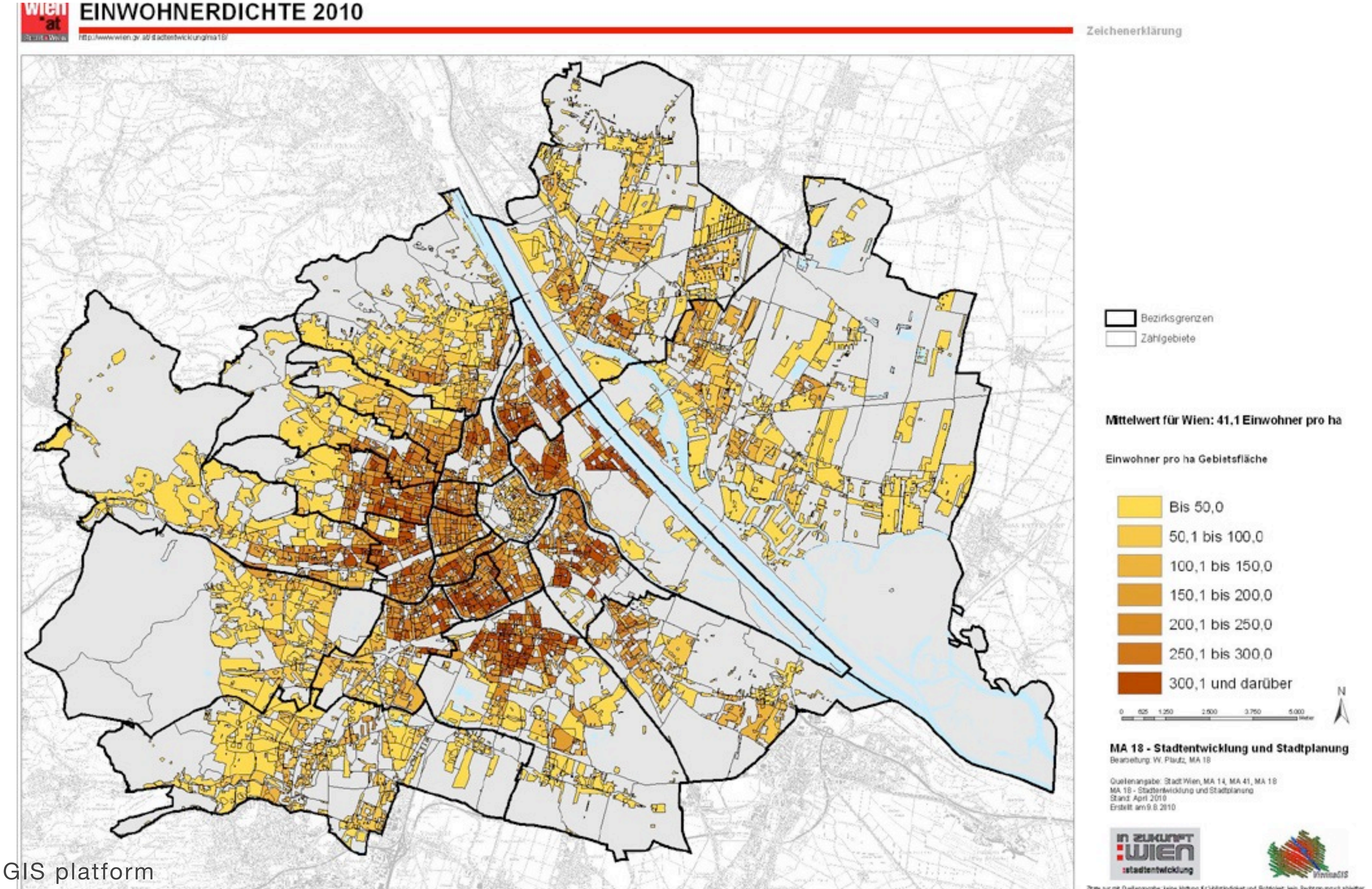

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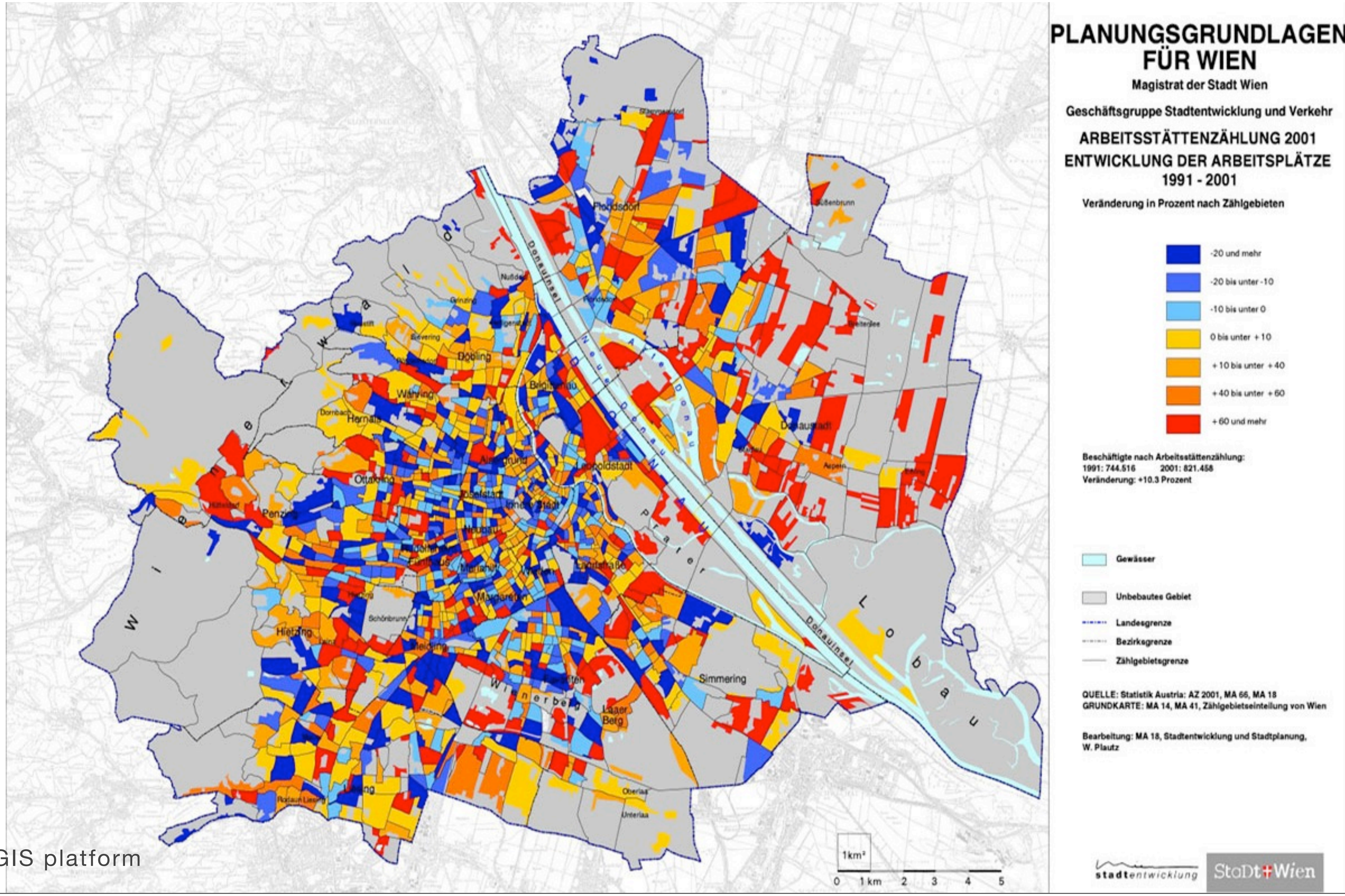

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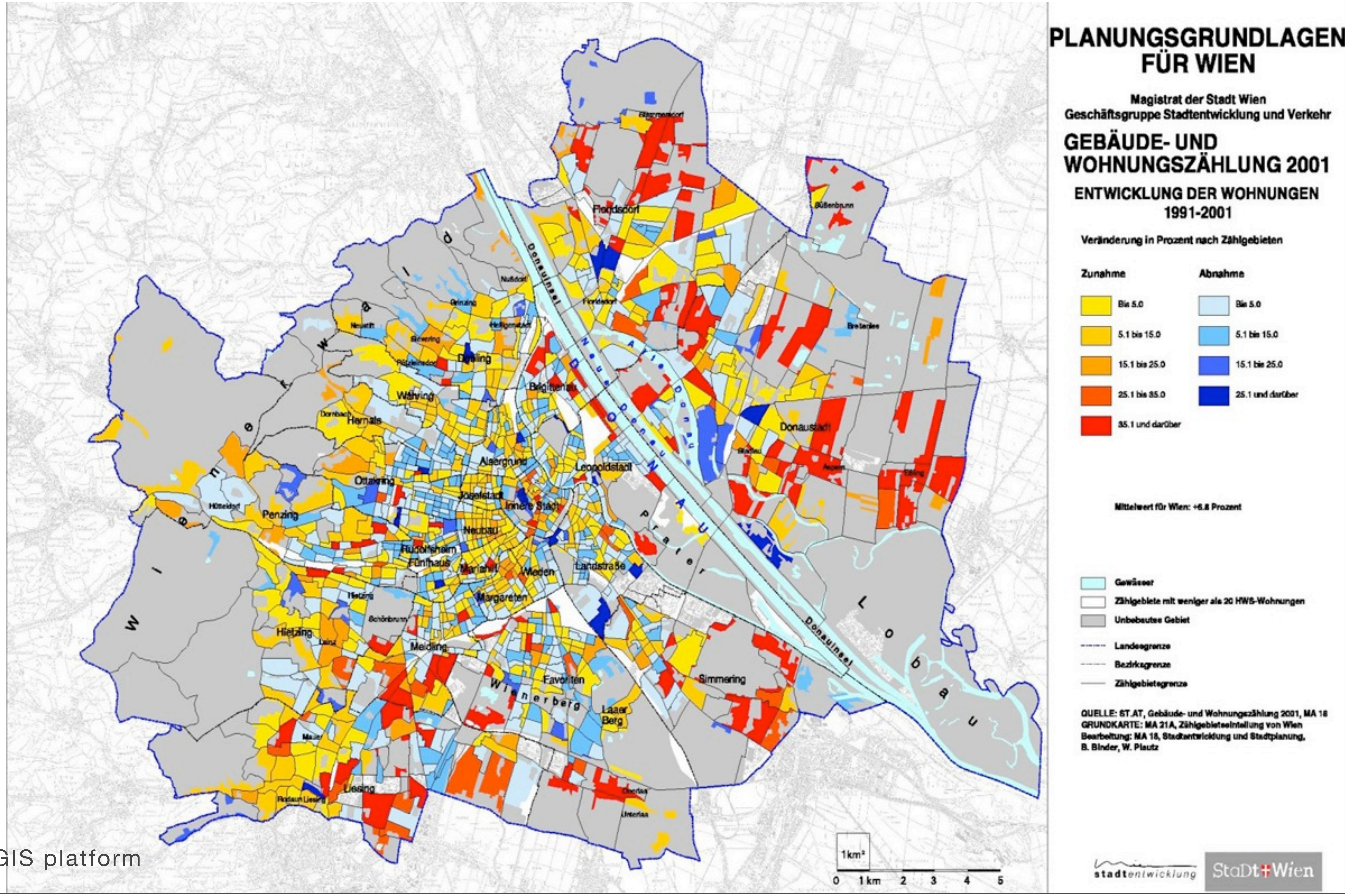

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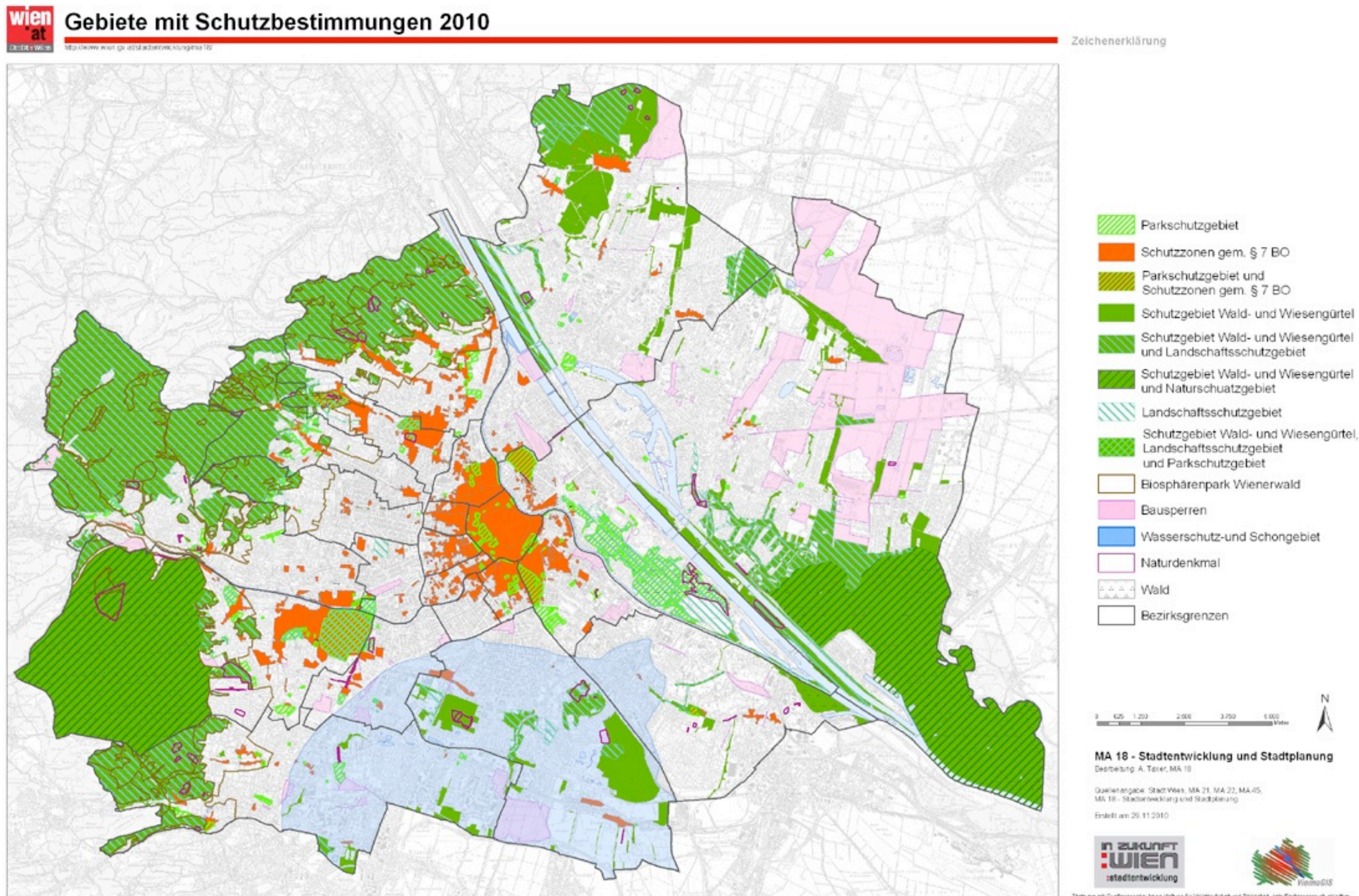

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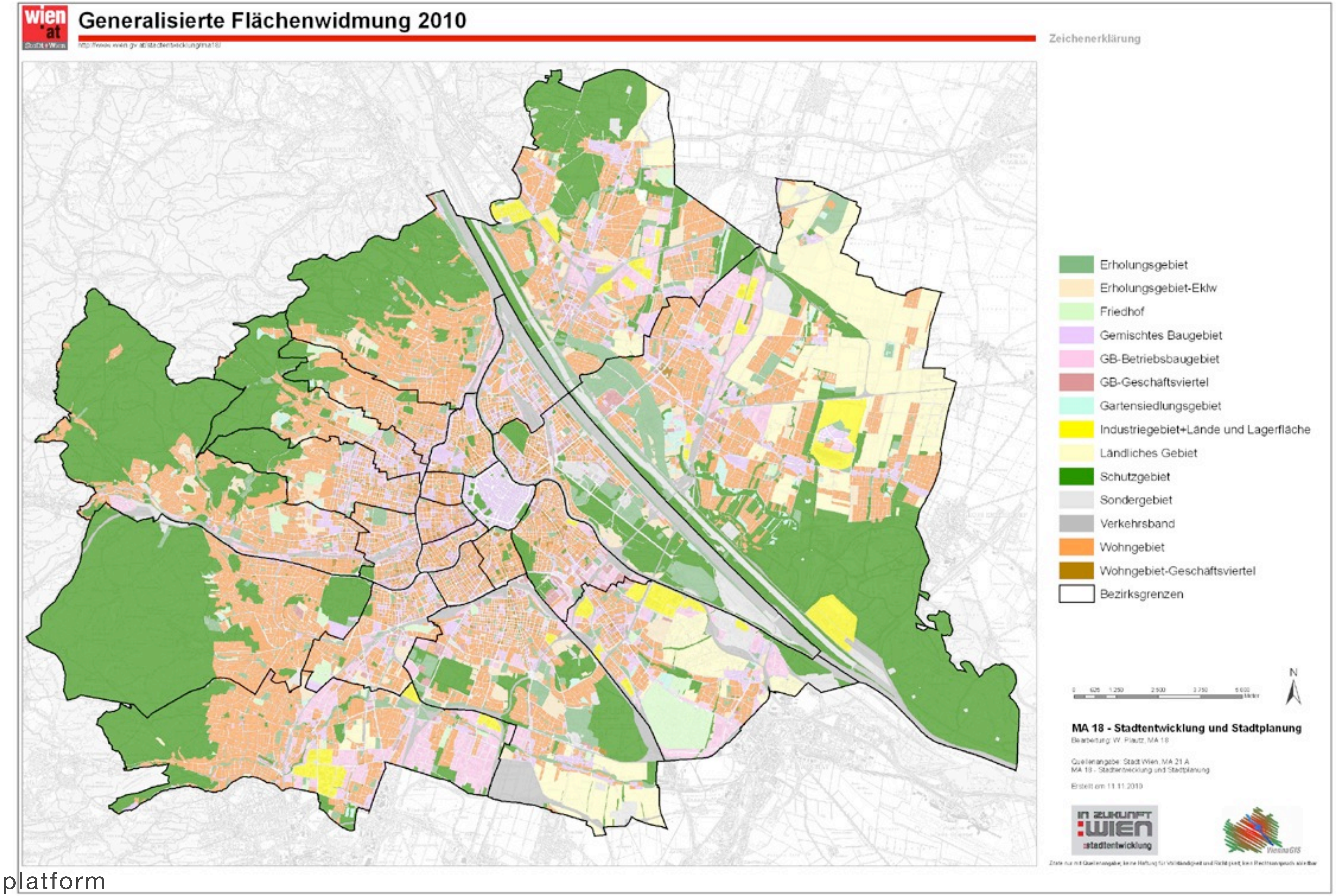

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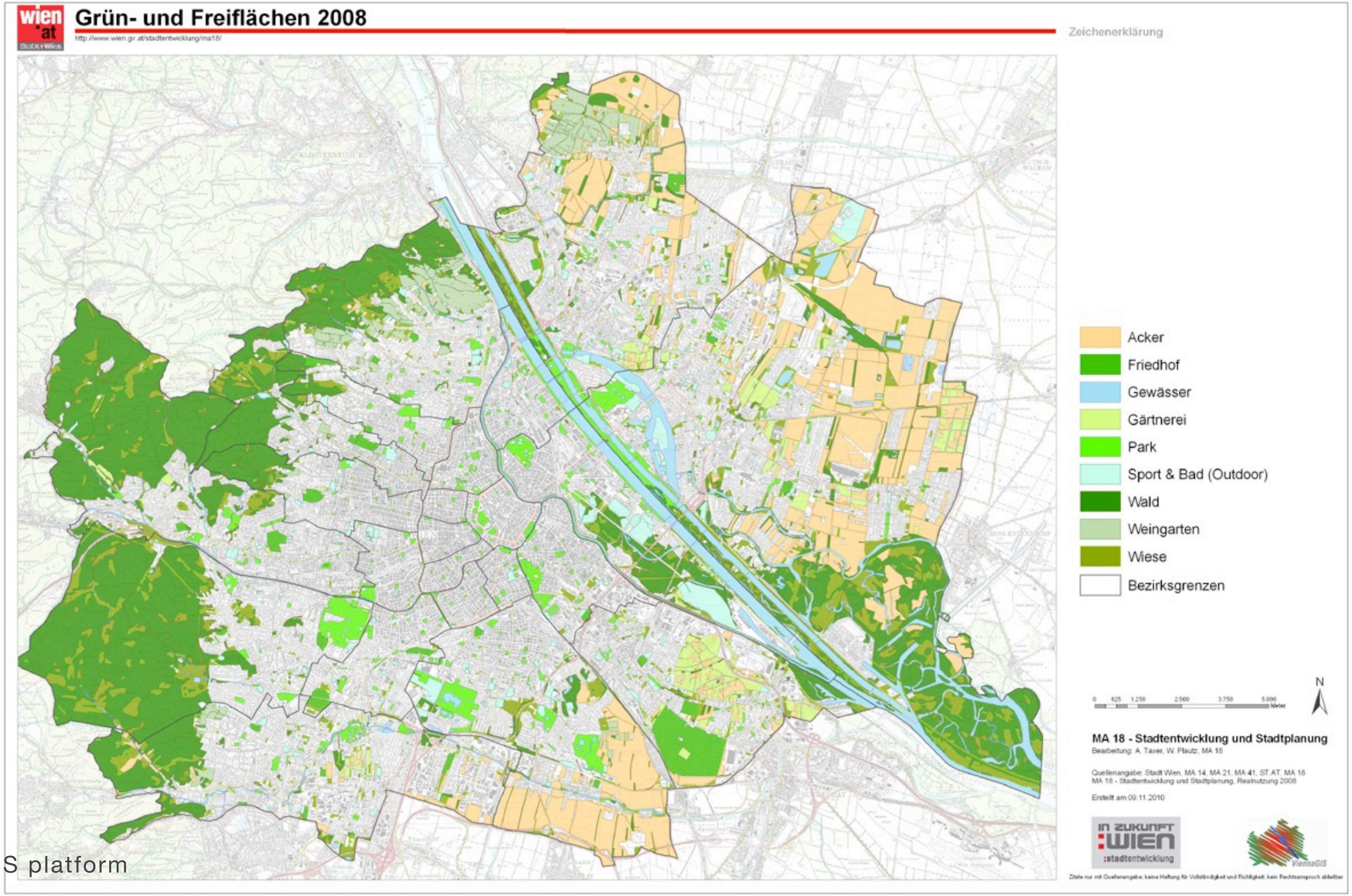

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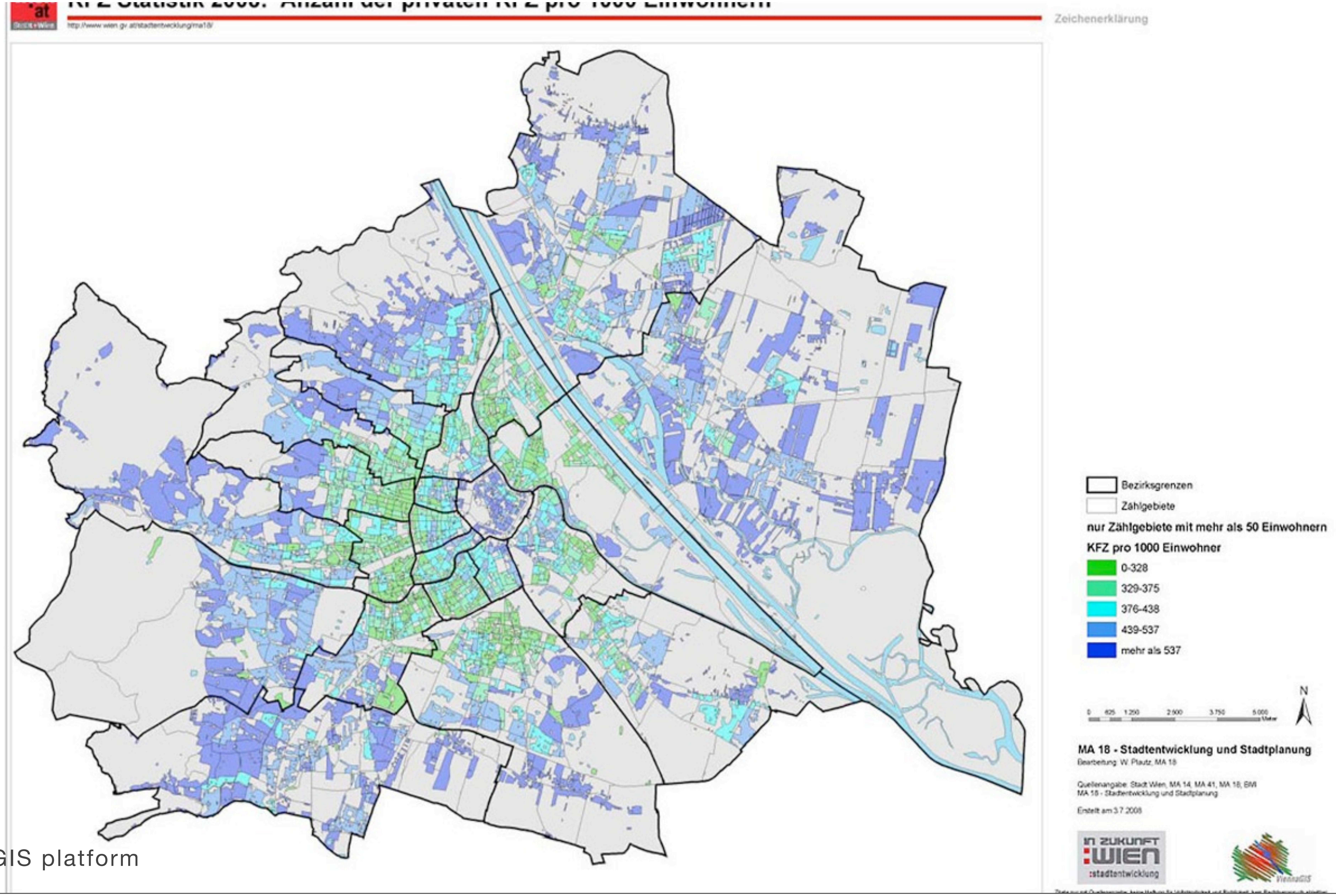

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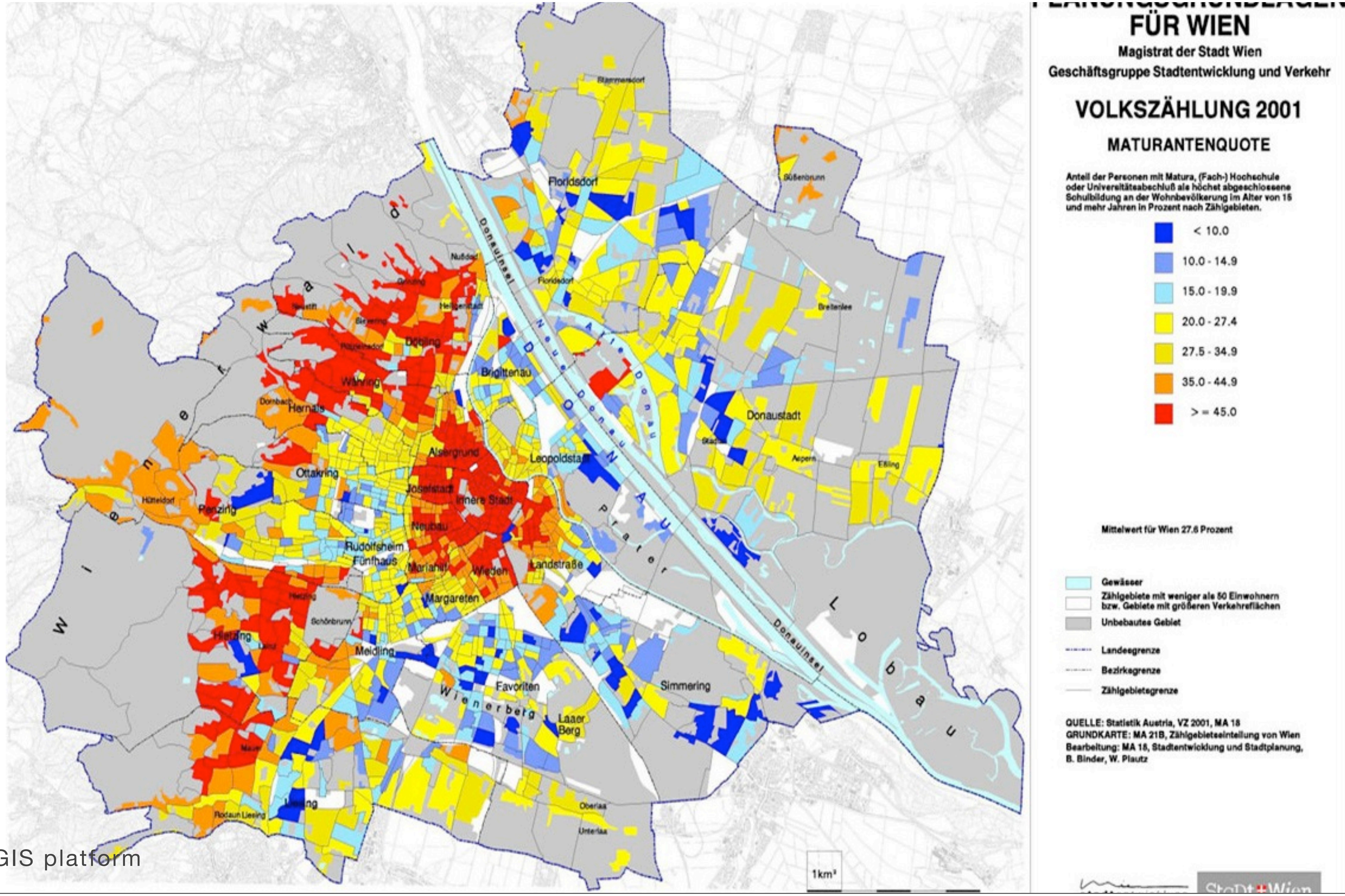

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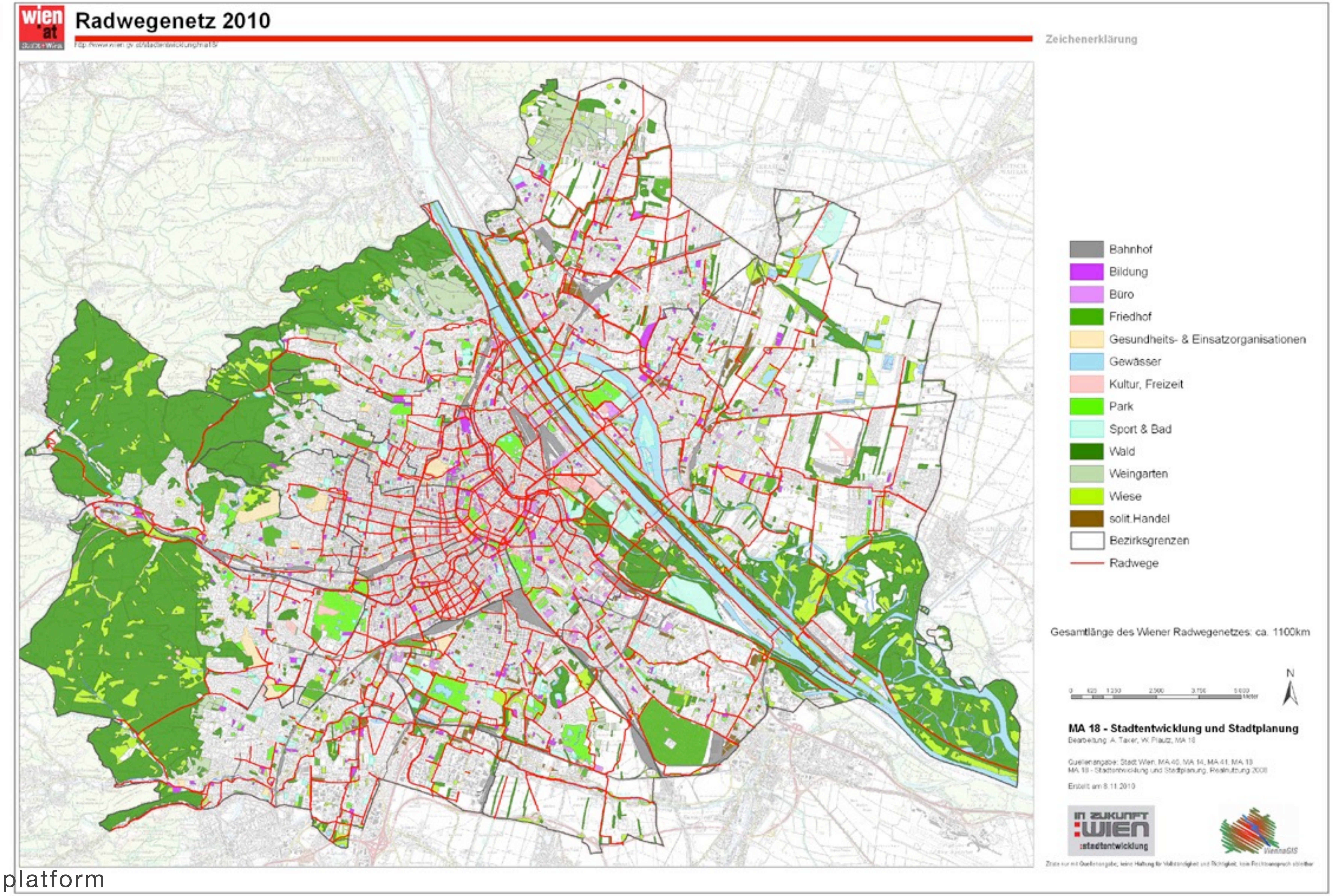

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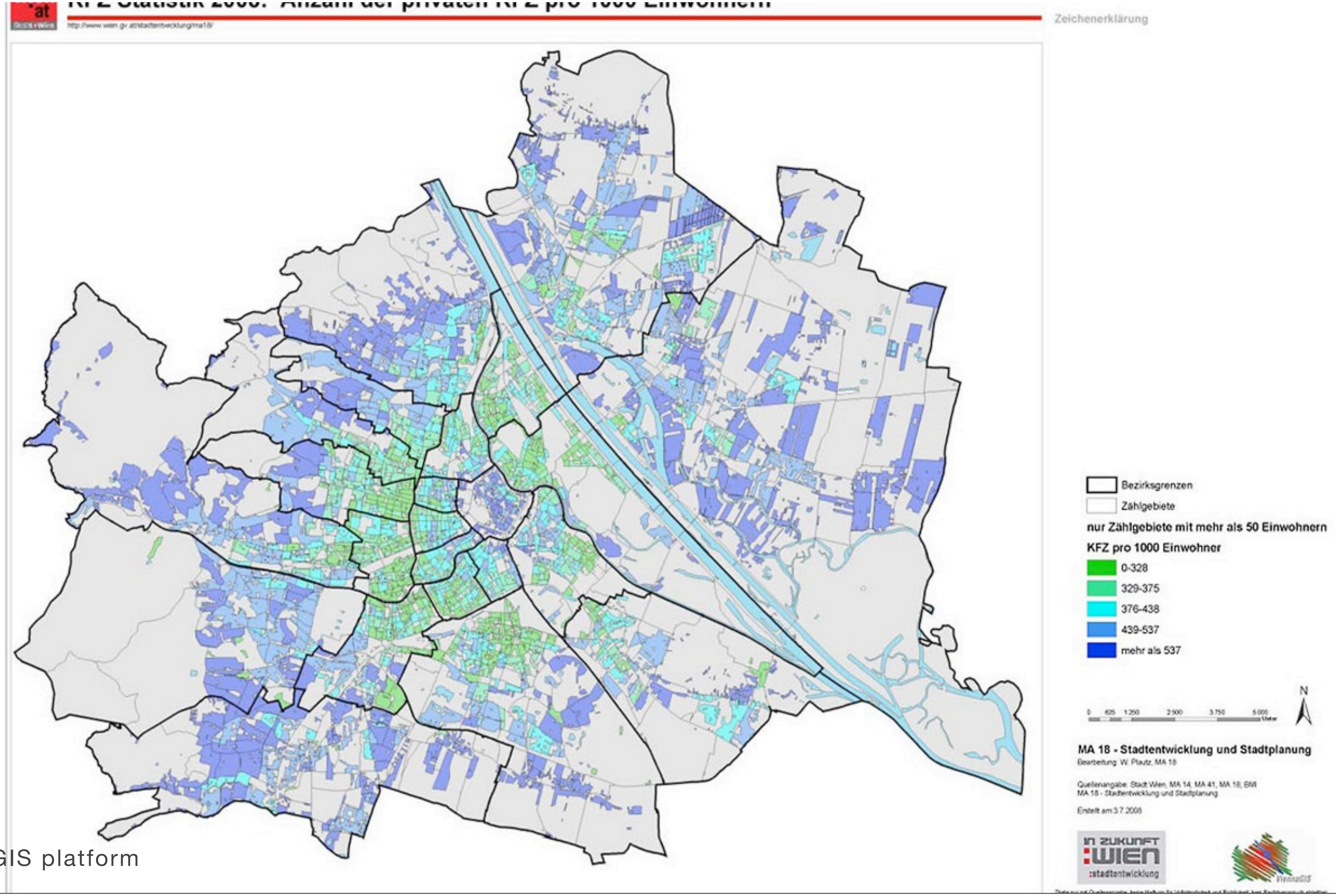

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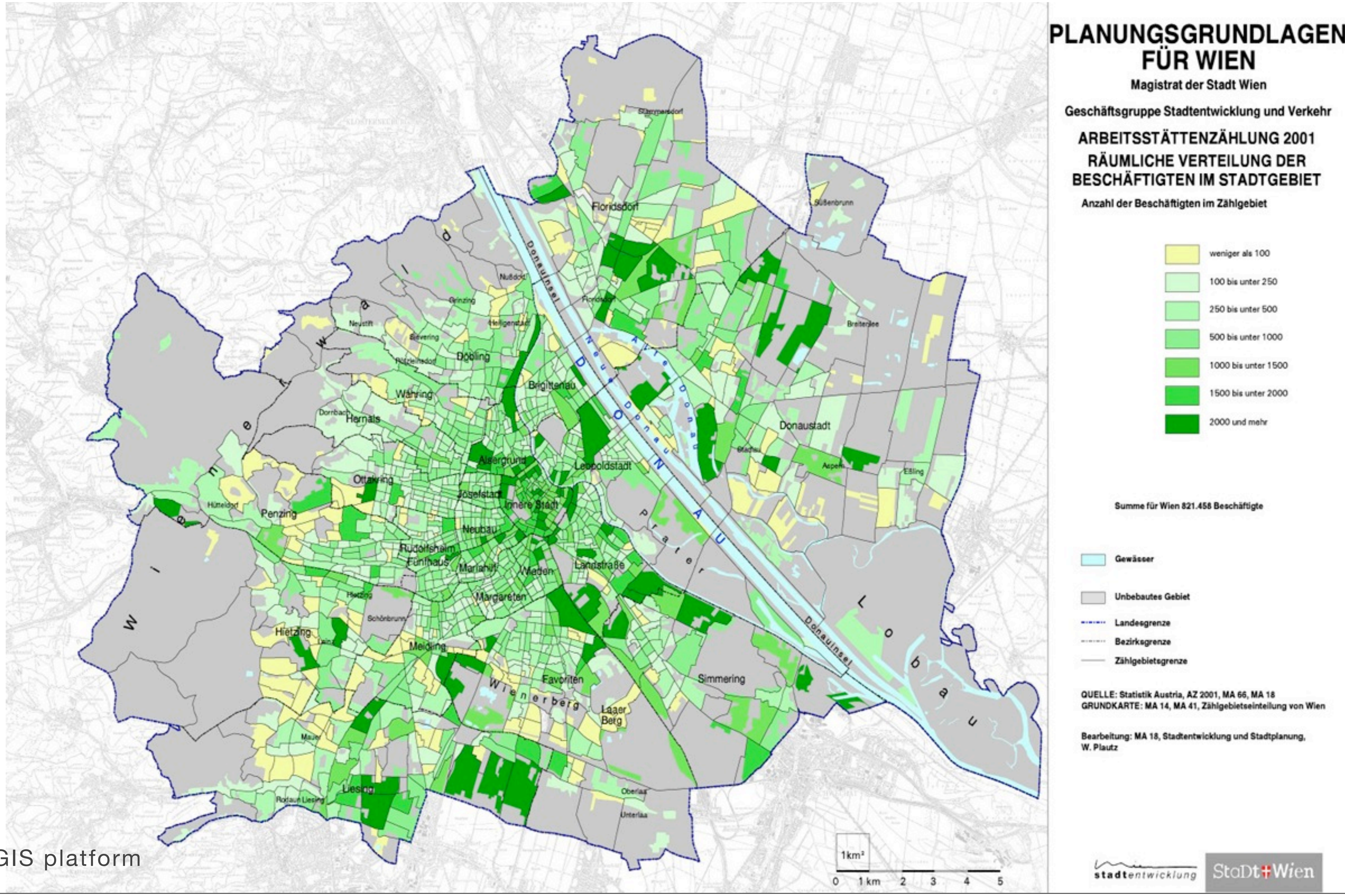
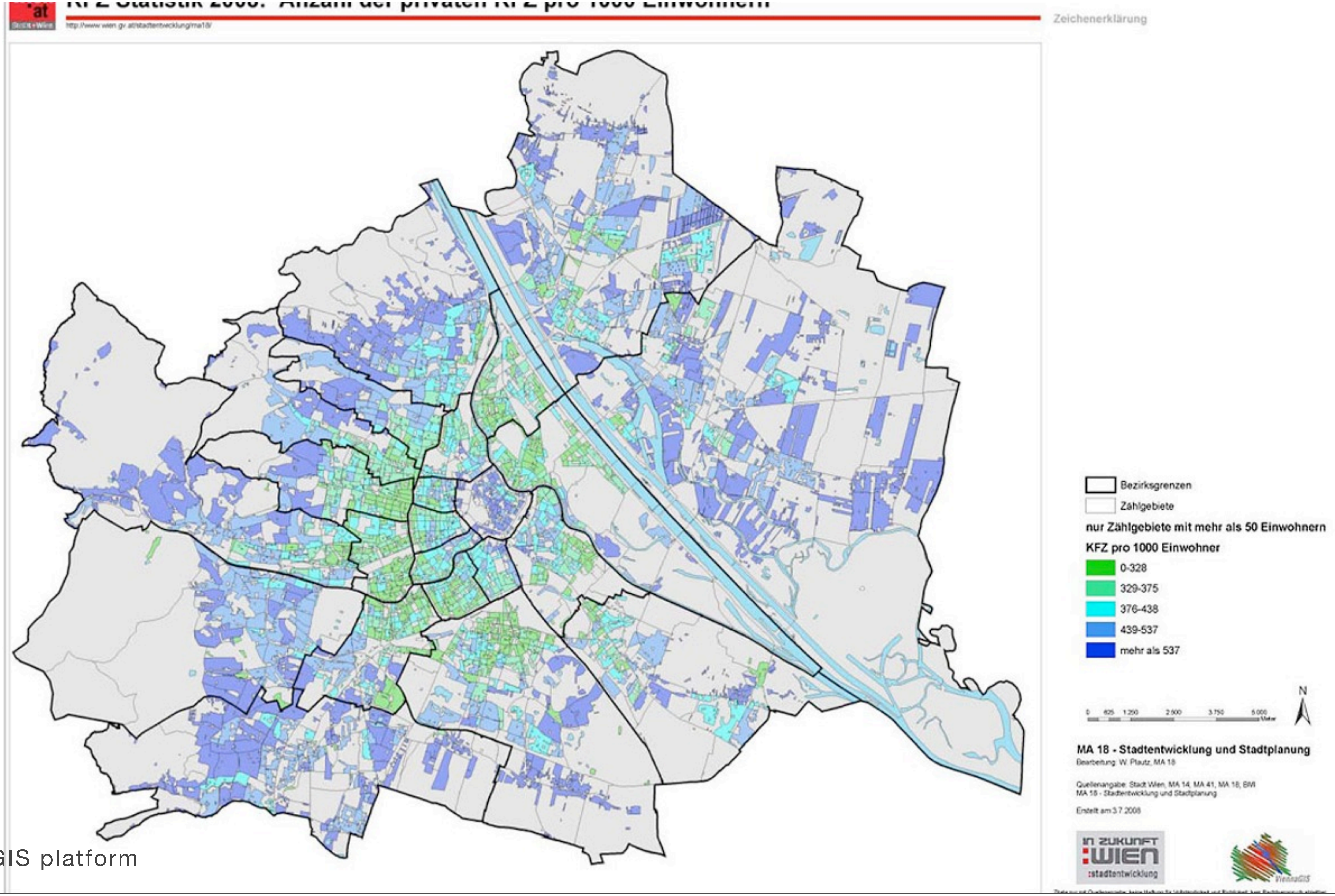
EXAMPLES



Information of Wien.at - GIS platform

EXAMPLES



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