A grayscale point cloud of a mountain range, rendered with a dense collection of points, serving as a background for the slide.

# Spatial Information for Spatial Planning Data, Modelling, Analysis

**Hartmut Müller**

**Chair of FIG Commission 3  
Spatial Information Management**

Session 1 The geo-information and spatial planning nexus,  
Tuesday 20 July, 15:30-17:00

Joint FIG Commission 3&8 Workshop  
Prato, Italy, 20-21 July 2021



# Spatial Planning ↔ Spatial Information

## Torremolinos Charter, 1983

### European Regional/Spatial Planning Charter

#### The concept of regional/spatial planning

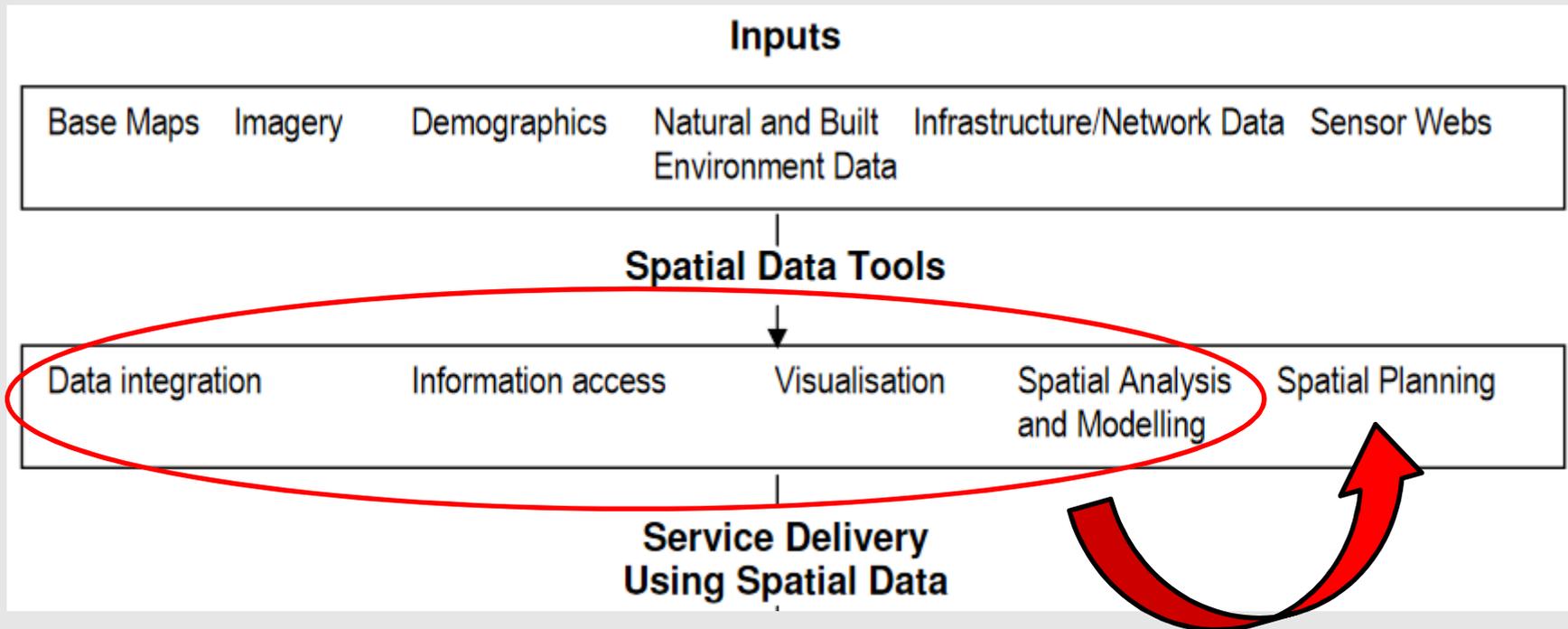


8. Regional/spatial planning gives geographical expression to the economic, social, cultural and ecological policies of society.

9. It is at the same time a scientific discipline, an administrative technique and a policy developed as an interdisciplinary and comprehensive approach directed towards balanced regional development and the physical organisation of space according to an overall strategy.



# How can Spatial Information support Spatial Planning?



Source: Hartmut Müller, Spatial Information Management, an Effective Tool to Support Sustainable Urban Management, 46th ISOCARP Congress 2010, Nairobi, Kenya



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Hochschule Mainz

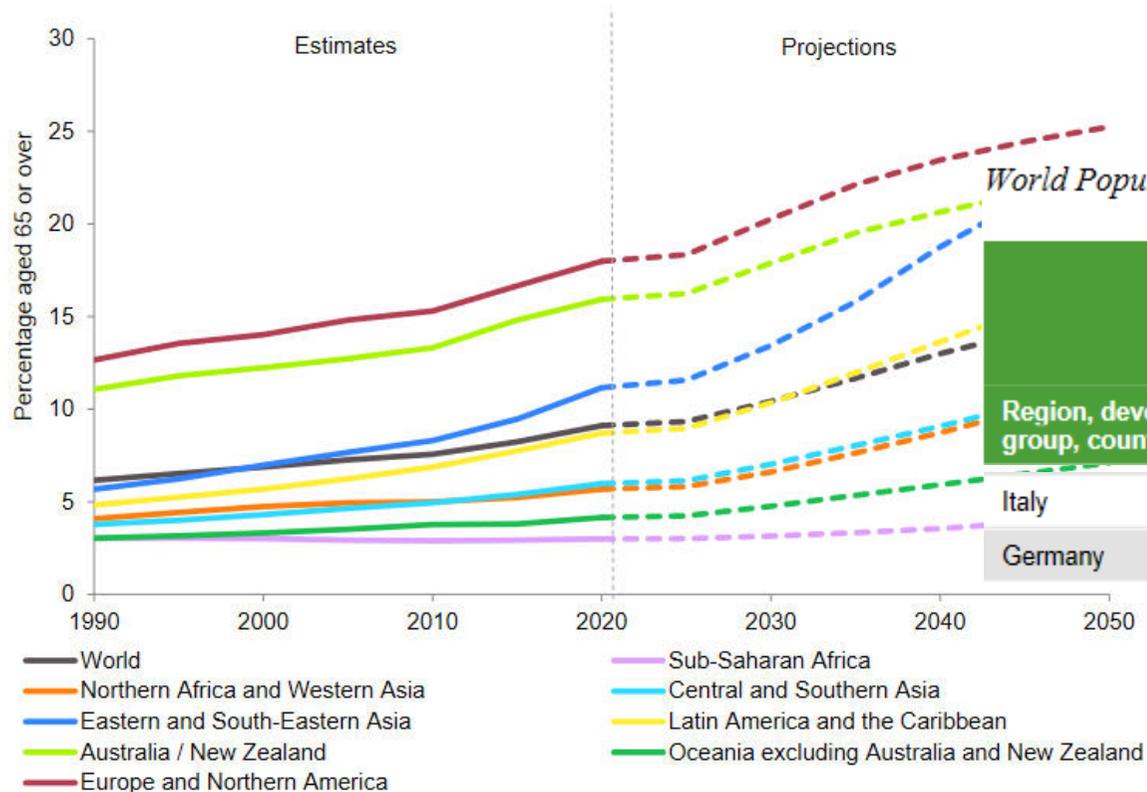
# **Planning for spatial inclusion in Germany. What about the elderly?**

**Jonathan Albrecht  
Dorothea Enners  
Konstantin Geist  
Hartmut Müller  
Markus Schaffert**

# Ageing World Population

World Population Ageing 2019

Figure I.1. Share of total population aged 65 years or over, by region, 1990-2050



World Population Ageing 2019

Region, development group, country or area	Population aged 65 years or over (thousands)		Percentage aged 65 years or over	
	2019	2050	2019	2050
Italy	13,934	19,585	23.0	36.0
Germany	18,009	24,040	21.6	30.0

Source: United Nations Department of Economic and Social Affairs, Population Division (2019). *World Population Prospects 2019*.

Everyone? What about the elderly?

11 SUSTAINABLE CITIES  
AND COMMUNITIES



**Sustainable Development Goal 11:**  
***“Make cities inclusive, safe, resilient and sustainable”***



Infographic: Making the Cities of Tomorrow More Inclusive

<https://www.worldbank.org/en/topic/inclusive-cities>

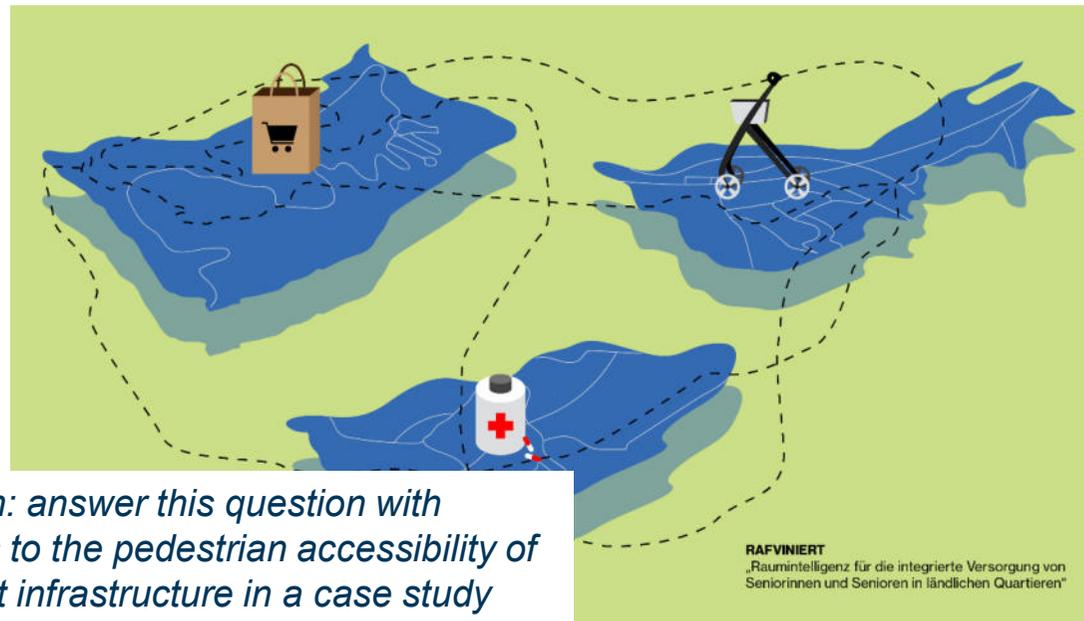
“urban inclusion requires providing affordable necessities such as housing, water and sanitation. Lack of access to essential infrastructure and services is a daily struggle for many disadvantaged households”

<https://www.worldbank.org/en/topic/inclusive-cities>

## Spatial inclusion

*Studies in German rural areas show that the walking distance from the house to the supermarket, pharmacy, bus stop, etc. is sometimes far - too far, for many seniors. And what about cities?*

Do small and medium-sized cities offer good conditions for the spatial integration of older people?

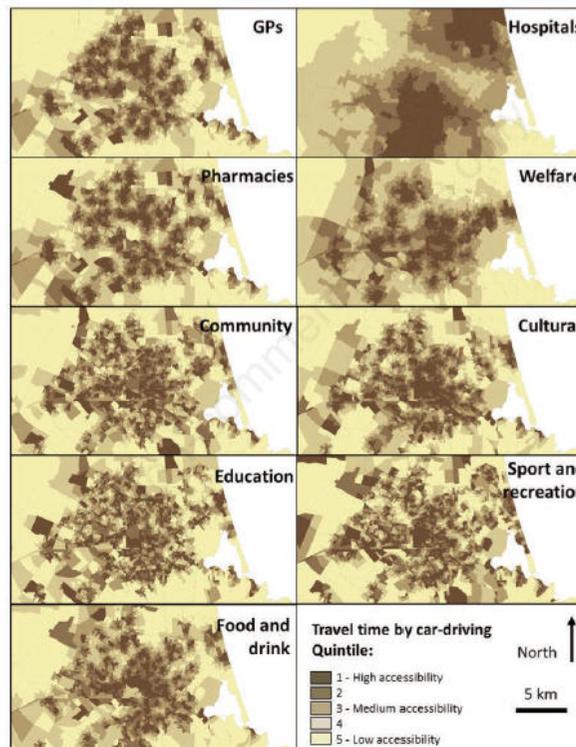


Graphic: V. Liebler

*Our aim: answer this question with regards to the pedestrian accessibility of relevant infrastructure in a case study*

# GIS and Spatial Planning: accessibility studies

Accessibility analyses are today frequently used in urban planning. They use GIS, calculate on street network and often display the results in an areal representation



*So what is lacking? Planner's demand:*

Increasing efforts are being made to combine individual thematic layers (as in the example on the left) in a joint presentation of results (using indicator sets)

e.g. walkability index, walkscore, bikeability index, – for a neighbourhood, the city, the county, ...

Vannier et al. (2020): Travel driving-time maps from the place of residency (population weighted centroid by meshblocks) to the main facility, by service type. Zoom in Christchurch - Ōtautahi city/NZ

# Accessibility studies for the elderly

It is a fairly recent phenomenon to combine such index calculations with additional geodata to make the results more realistic.



Alves et al. (2021): An Application of the Walkability Index for Elderly Health

*So what is lacking? Senior's demand:*

I cannot take slopes or stairways any more

I am 80, but can walk like I was 35 years old



# Accessibility studies for the elderly

It is a fairly recent phenomenon to combine such index calculations with additional geodata to make the results more realistic.

*So what is geoinformatics' contribution?*



Alves et al. (2021): An Application of the Walkability Index for Elderly Health

Integrate geodata from various sources (official geodata, with VGI, demographic data,) ... Using spatial data infrastructures

Using geodata from various sources, an attempt is made to:

- provide a realistic index-representation of neighbourhood walkability
- Identify more realistic supply deficits for senior citizens

# Accessibility studies for the elderly

It is a fairly recent phenomenon to combine such index calculations with additional geodata to make the results more realistic.



*So what is geoinformatics' contribution?*

We applied this idea in two medium sized German cities:  
Kempten (Bavaria) and Goslar (Lower Saxony) ~ 50.000 inhabitants each

Using geodata from various sources, an attempt is made to:

- provide a realistic index-representation of neighbourhood walkability
- Identify more realistic supply deficits for senior citizens

## Data base

### – OpenStreetMap

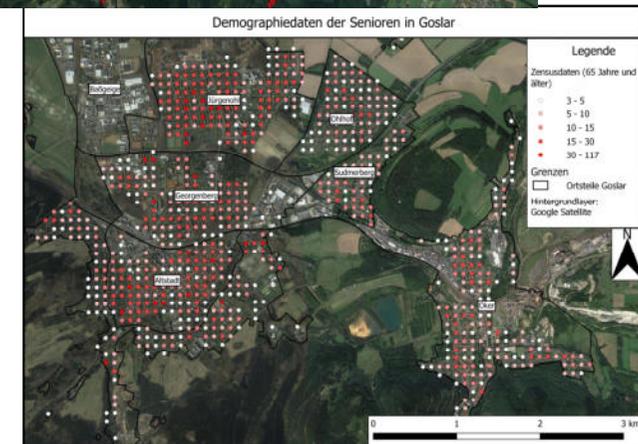
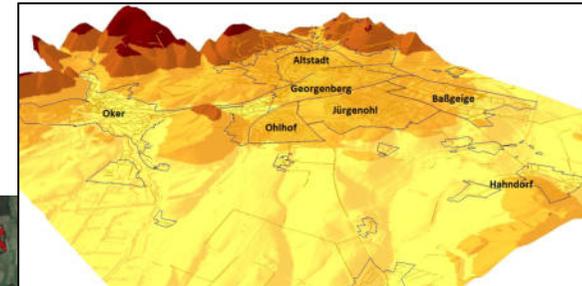
- Street Network
- Amenities / Utilities
- Barriers
- VGI

### Geobase Data (by federal mapping agency)

- DGM1, digital heights
- House coordinates

### German Census data

- Population data
- Open official data (100x100m)
- As of 2011 (next 2022)



# Calculations

## Inclination / slope

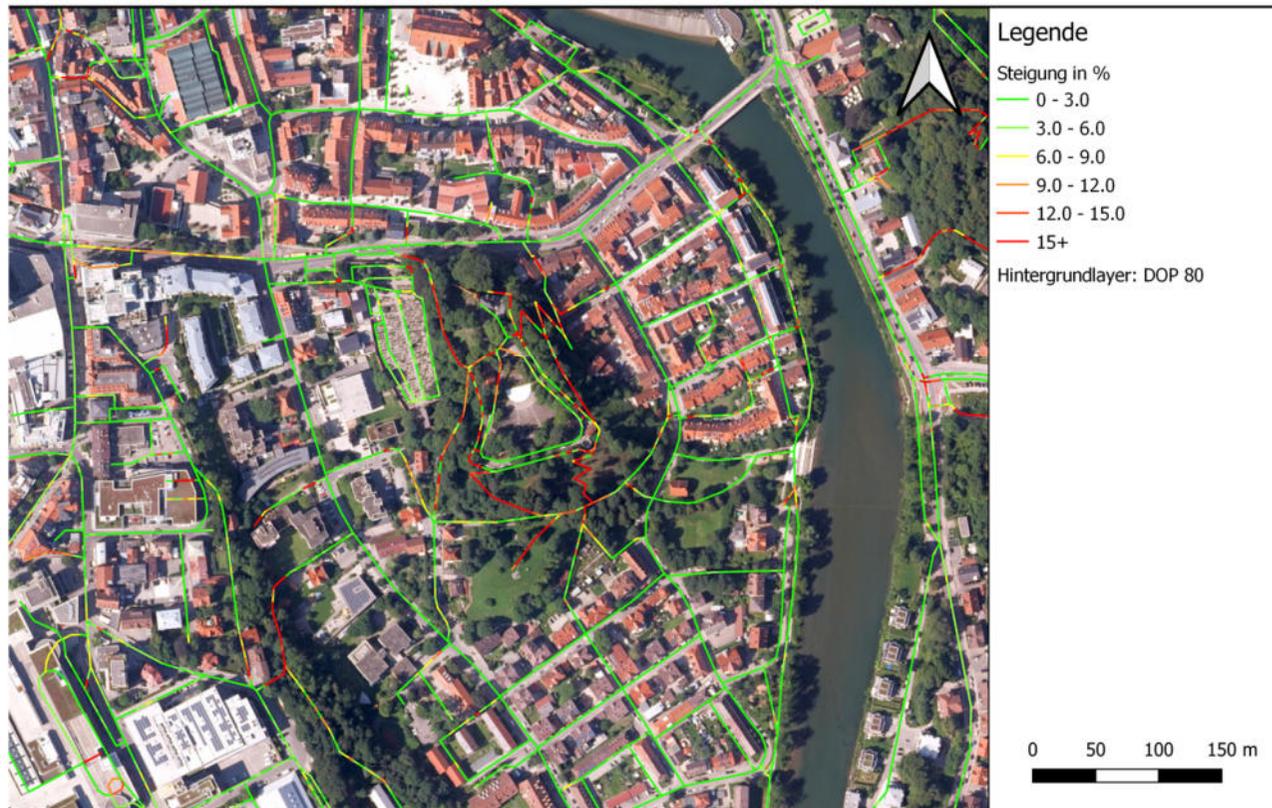
- **Lines broken down into segments**
- **Determination of:**
  - Height of the start and end point
  - Length of the segments

## Incline calculated from height difference and length

$$\text{Incline} = \frac{\text{height difference}}{\text{horizontal distance}} * 100$$

# Calculations

## Straßen mit Neigung Kempten



→ inclinations make a difference in a cities' (senior) walkability

## Calculations

### Walking time for the way there and back (per segment)

- **Speed depending on the incline**
  - Experience from literature for seniors: 1 m/s
- **Segment length**
- **Special case of stairs**

## Network analysis

- **Accessibility of the nearest facilities**
- **Starting points**
  - House coordinates of residential buildings
  - Center of census grid cells
- **Endpoints**
  - Utilities
- **Barriers**
  - Point data with certain attributes (no access)
  - Stairs
  - Inclination (e.g.)  $> 15\%$

## Network analysis

- **Export the routes as tables**
- **Facilities that can be reached within 20 minutes**
  - Get value
  - Otherwise no value

## Accessibility index

- **Combining accessibility to different types of amenities /utilities together using the WalkScore**
- **WalkScore**
  - How easy are different utilities accessible from the place of residence
  - Popular in USA, Canada and Australia
- **Weighting of the supply facilities**

# Calculations

Category / classes (basic need)	Weight
<b>Mobility</b>	<b>10</b>
Train station	5
Bus stop	5
<b>Health care</b>	<b>40</b>
Pharmacy	10
Doctors / hospital	25
Care facilities	5
<b>Groceries</b>	<b>50</b>
Baker	8
Kiosk	2
Grocery store	25
Butcher	8
Other food	7

- Somehow subjective
- in your city/ use case the weighting might differ

## Essential utilities

# Calculations

Accessible in [min]	Example of a category weight	Score value depending on accessibility
Below 5	10	10
5 - 10	10	7,5
10 - 15	10	5
15 - 20	10	2,5
Above 20	10	0

- Combining weighting of an amenities category with its distance

## Distance-sensitive weighting

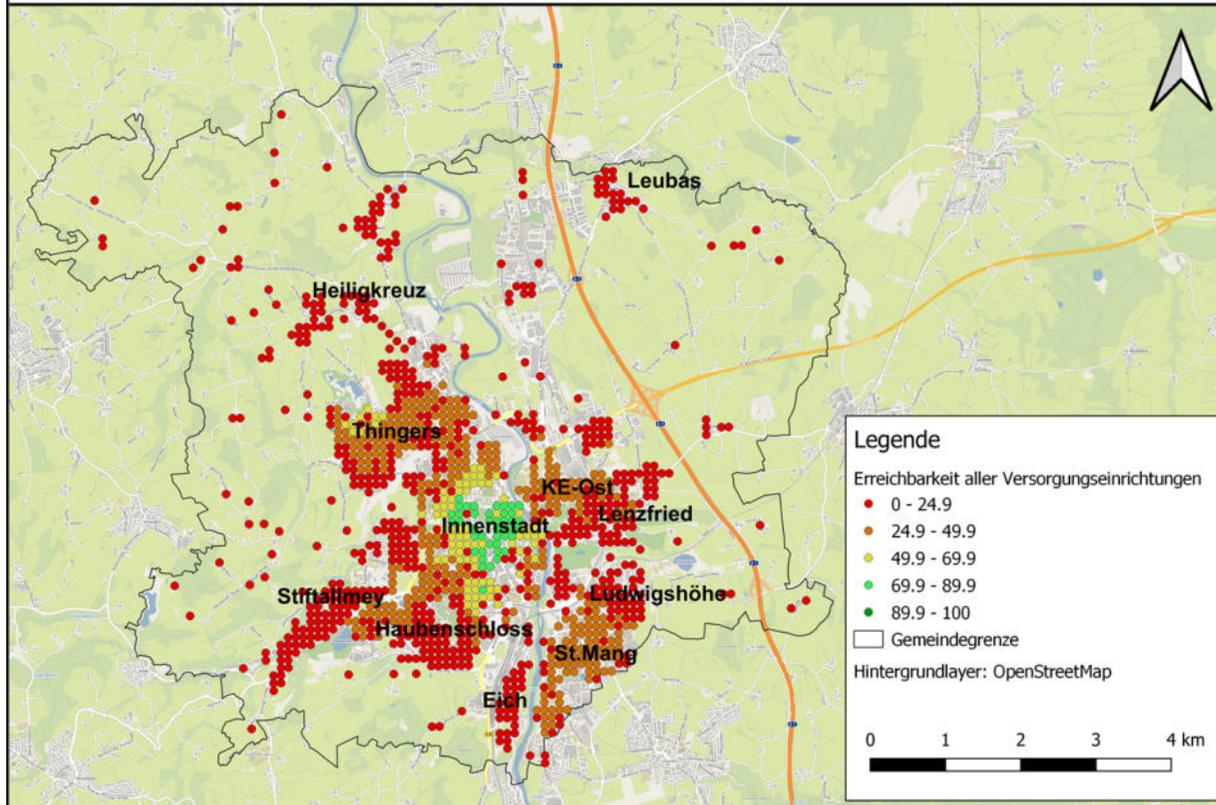
## Accessibility index

- **Sum of weights**
- **A maximum of 100 points are possible per point of view**
- **We differentiated in:**
  - All amenities/ utilities
  - Essential facilities

# Results

## Kempton

Vergleich der Erreichbarkeiten aller Versorgungseinrichtungen in Kempton (10%)

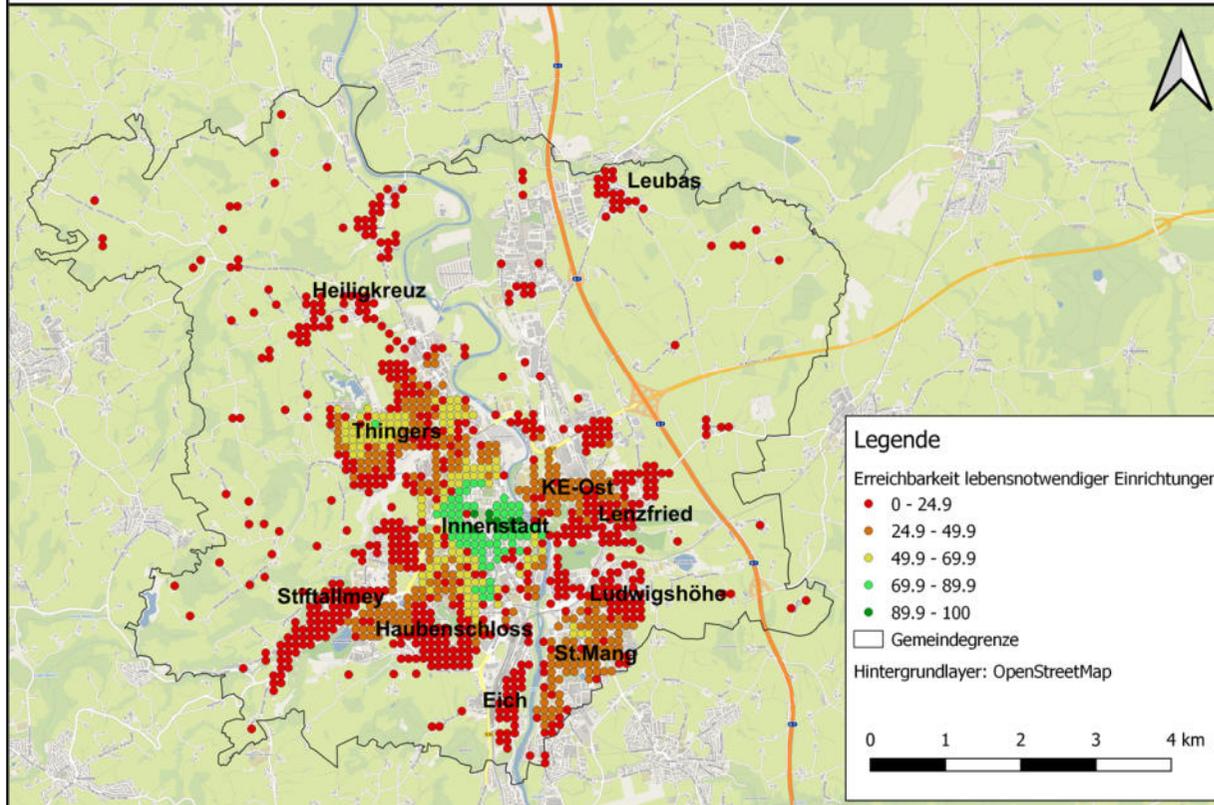


## The availability index for Kempton

# Results

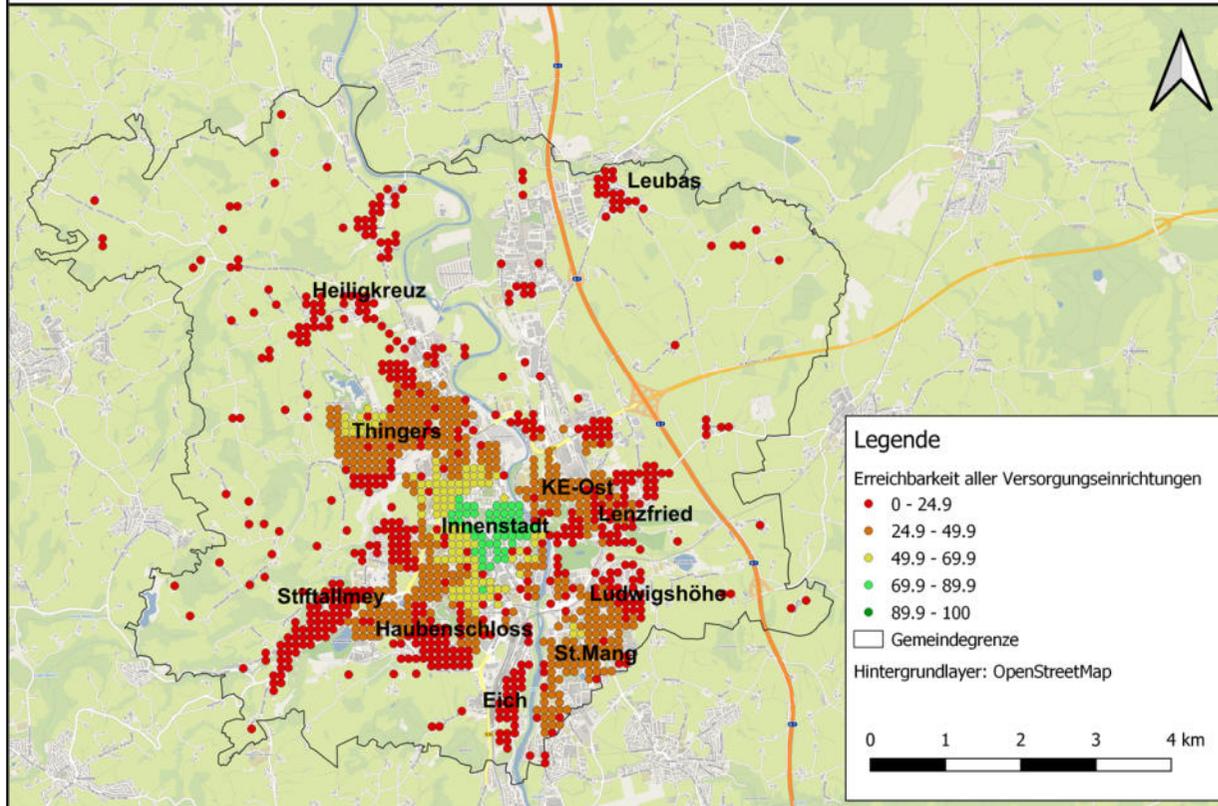
**Kempton**

Vergleich der Erreichbarkeiten lebensnotwendiger Einrichtungen in Kempton (10%)



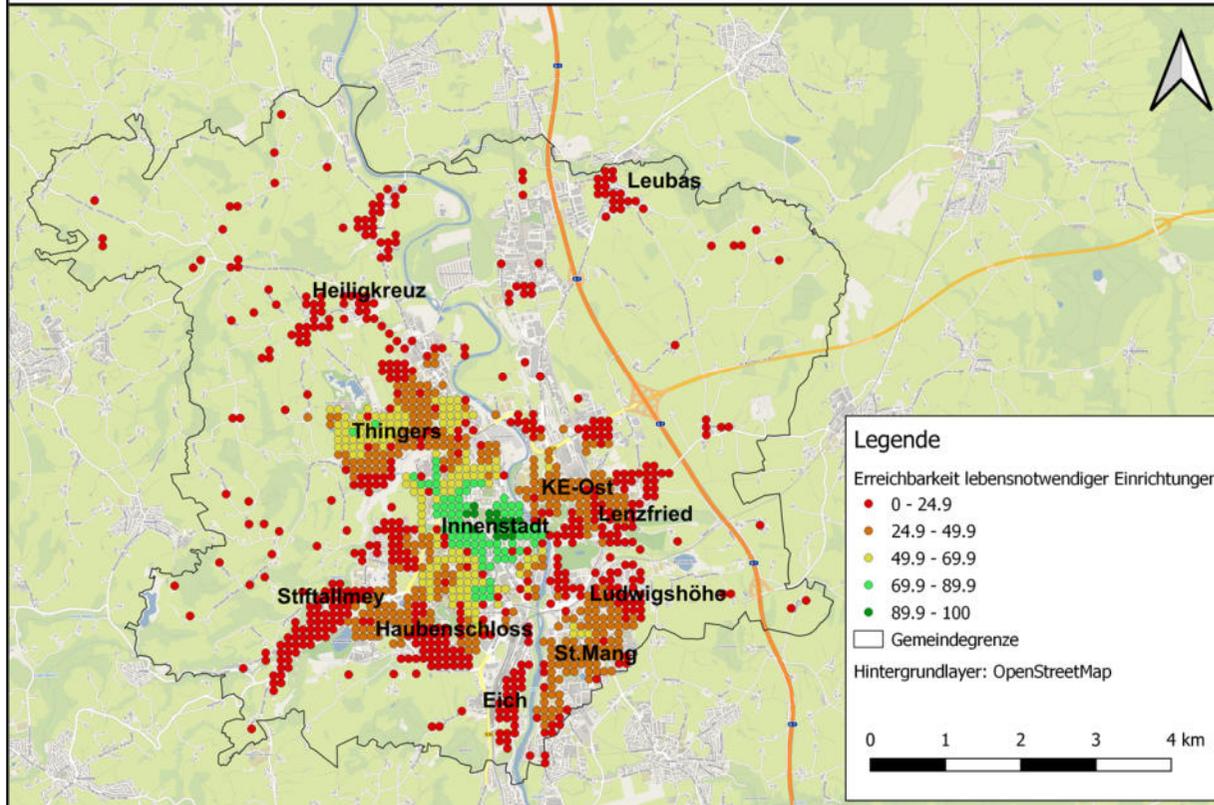
The availability index for Kempton

Vergleich der Erreichbarkeiten aller Versorgungseinrichtungen in Kempton (15%)



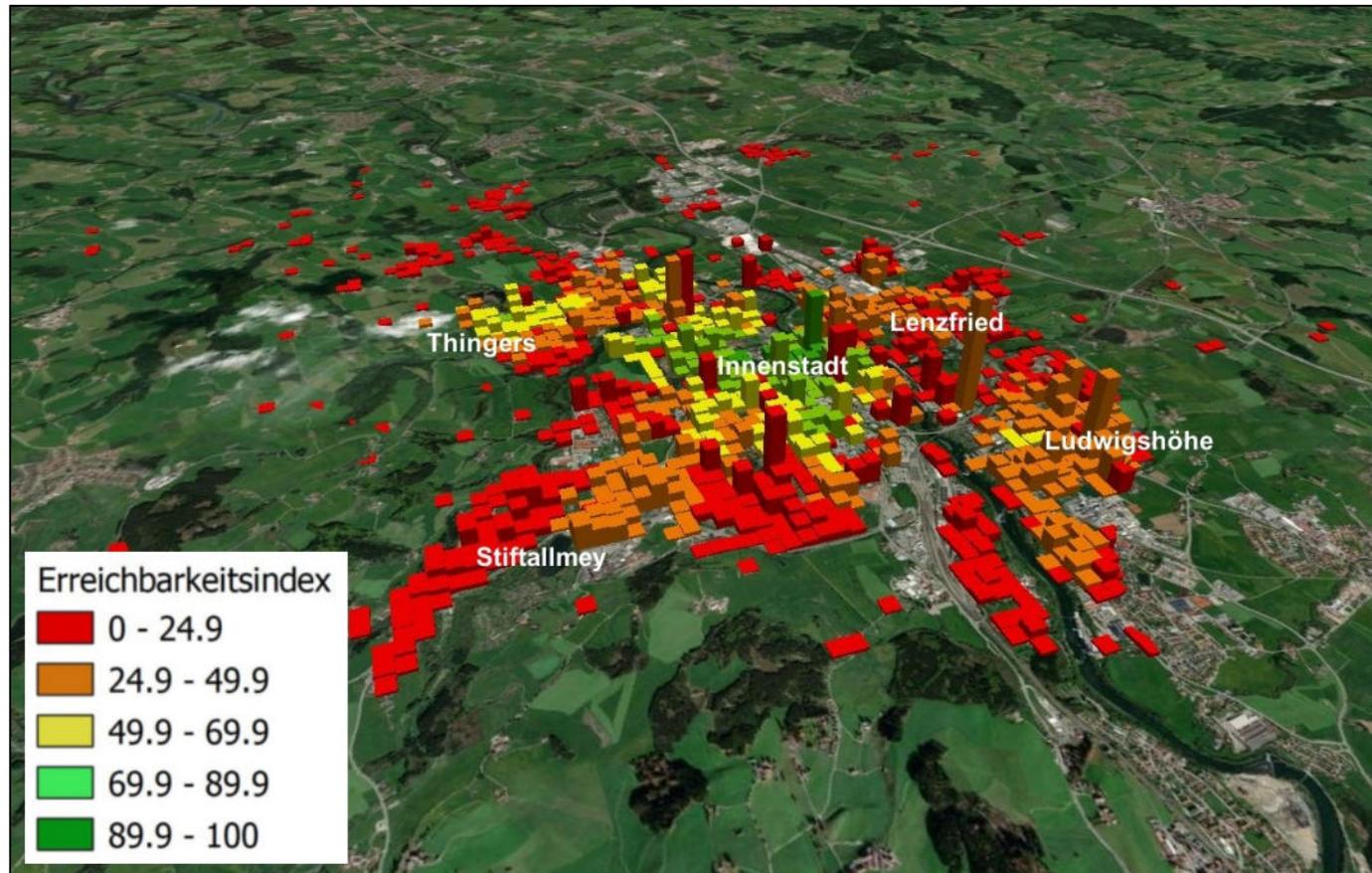
The availability index for Kempton

Vergleich der Erreichbarkeiten lebensnotwendiger Einrichtungen in Kempton (15%)



## The availability index for Kempton

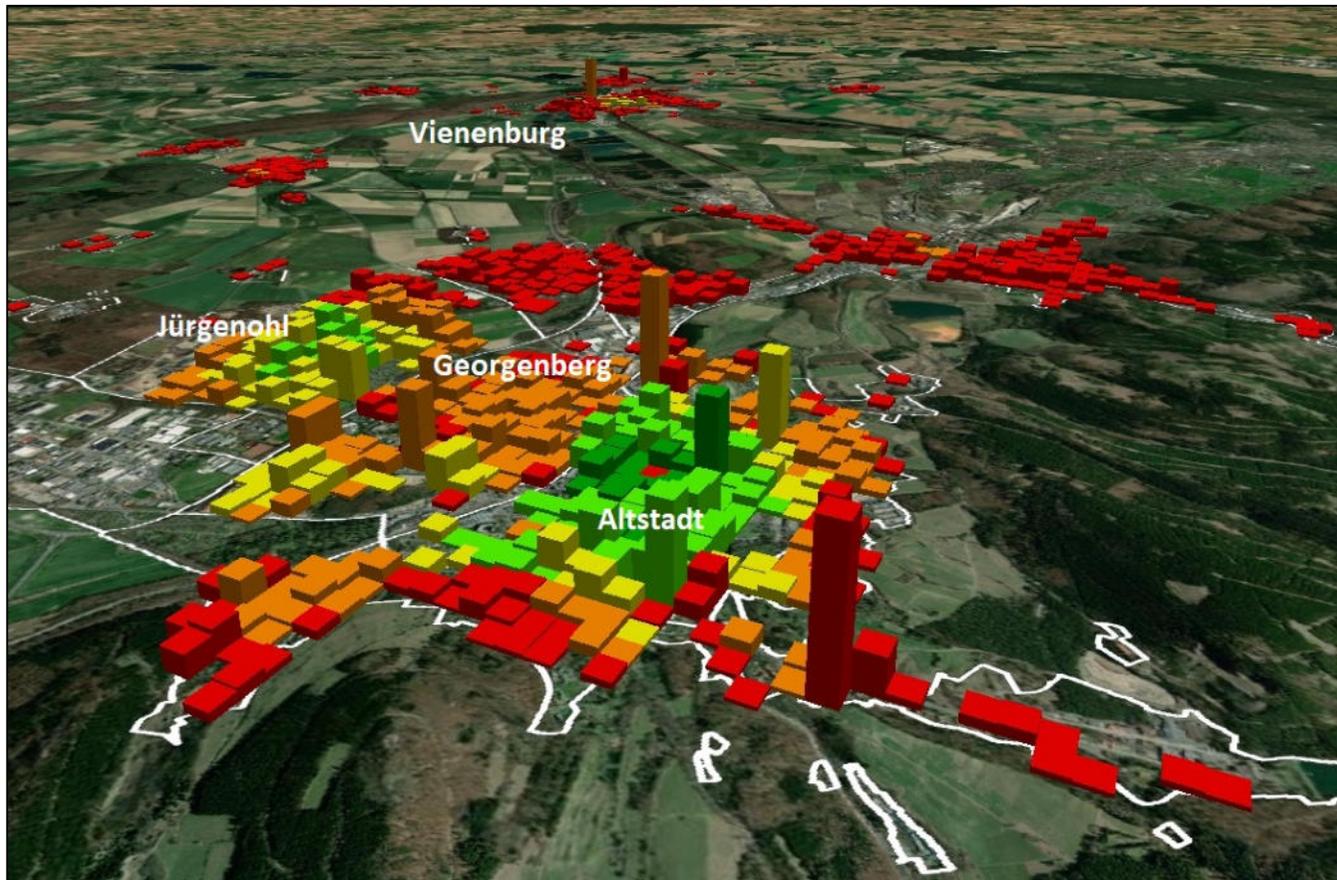
# Results



The availability index for Kempton

# Results

Goslar



The availability index for Kempton

## Some conclusions

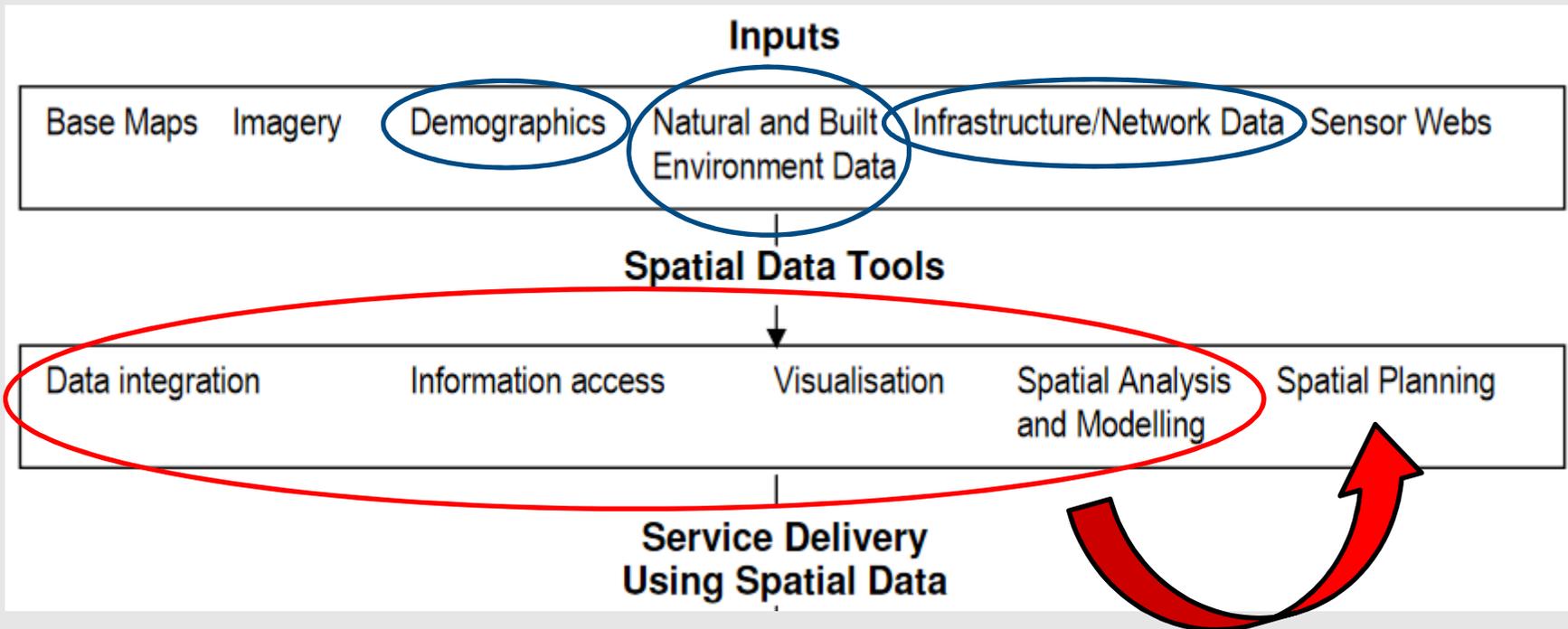
- Combination of geodata of different types can generate added value
  - ex.: impact of terrain slope on accessibility for senior citizens
- Significant results can be achieved with freely available geodata
- Results were well received by the city administrations
- Data quality is crucial
  - topological consistency of the street network,
  - thematic quality of street segment attributes (surface, ...),
  - completeness of amenities, barriers, etc. in OSM data,
  - timeliness of census data

Literature used in this presentation:

Alves, F., Cruz, S., Rother, S., & Strunk, T. (2021). An Application of the Walkability Index for Elderly Health—WIEH. The Case of the UNESCO Historic Centre of Porto, Portugal. *Sustainability* 2021, 13, 4869.

Vannier C.; Campbell M; Kingham S. (2020): Pathways to urban health and well-being: measuring and modelling of community services' in a medium size city, *Geospat Health* 15(1). doi: 10.4081/gh.2020.808.

# How can Spatial Information support Spatial Planning?



Source: Hartmut Müller, Spatial Information Management, an Effective Tool to Support Sustainable Urban Management, 46th ISOCARP Congress 2010, Nairobi, Kenya