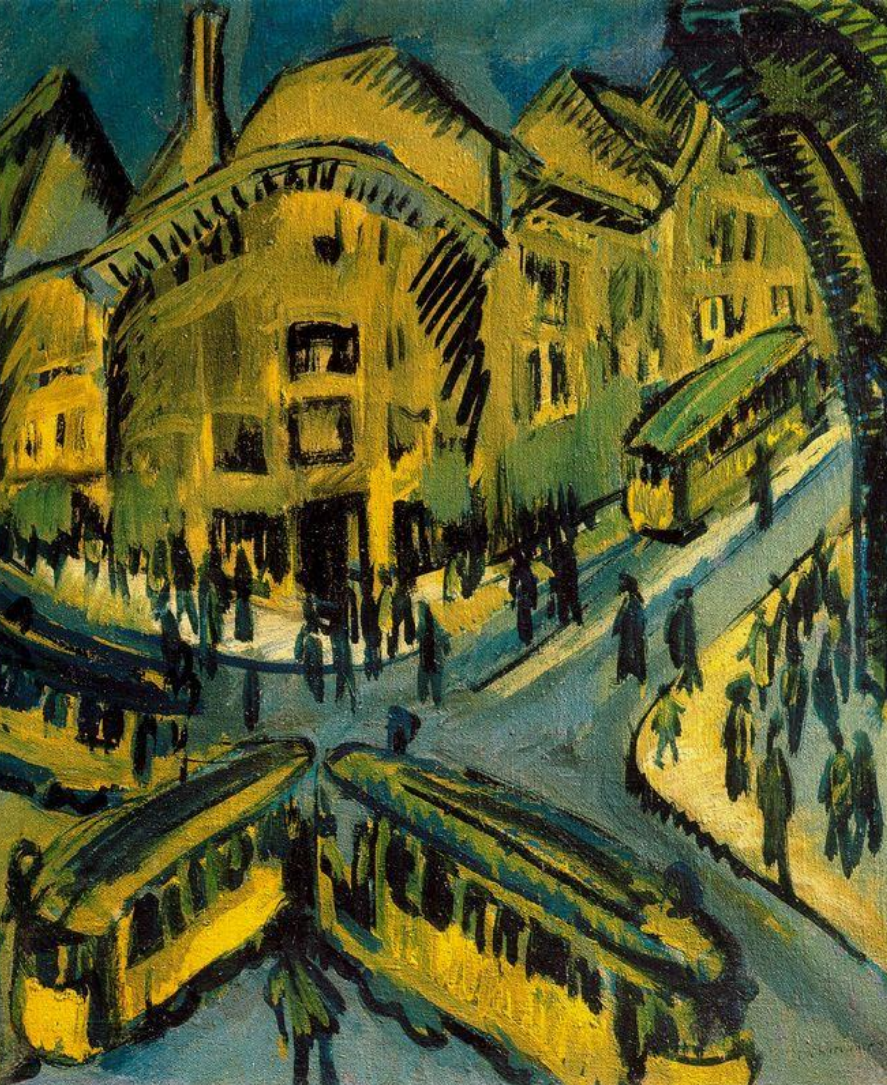# Enhancing indicators on urban public transport in combination with geostatistics
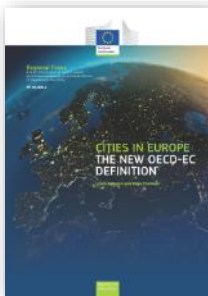
Hugo Poelman

European Commission

DG Regional and Urban Policy

GIS team

Harmonised indicators on European cities?

- EU-OECD definition of cities
- Eurostat city statistics (Urban Audit)
- Copernicus Urban Atlas land use data
- EFGS – GEOSTAT population grid (1 km²)
- But: comparable indicators on public transport in urban areas remain problematic…

Aim of the analysis

- Develop comparable indicators on
  - **Access** to public transport in urban areas
  - **Frequency** and **speed** of urban public transport
- Using standardised data sources
- Referring to **harmonised** concepts
  - City definitions
 - Spatial distribution of population

Tools

- Various ArcGIS Toolbox tools: spatial join, buffer, median center, network dataset, service areas, XY to line, etc.

- Python scripts: data conversion and accessibility analysis

- SAS and SAS Enterprise Guide: analysis of trip frequency and speed; graphs

- Cartography using ArcMap and ArcScene

# Measuring access to public transport: input data

- Location of all public transport stops
- Timetables of services: 2 groups:
  - bus and tram
  - train and metro
- Population per building block based on:
  - detailed population grids
  - census tracts
  - neighbourhood statistics
  - plus disaggregation using land use data and/or imperviousness if needed

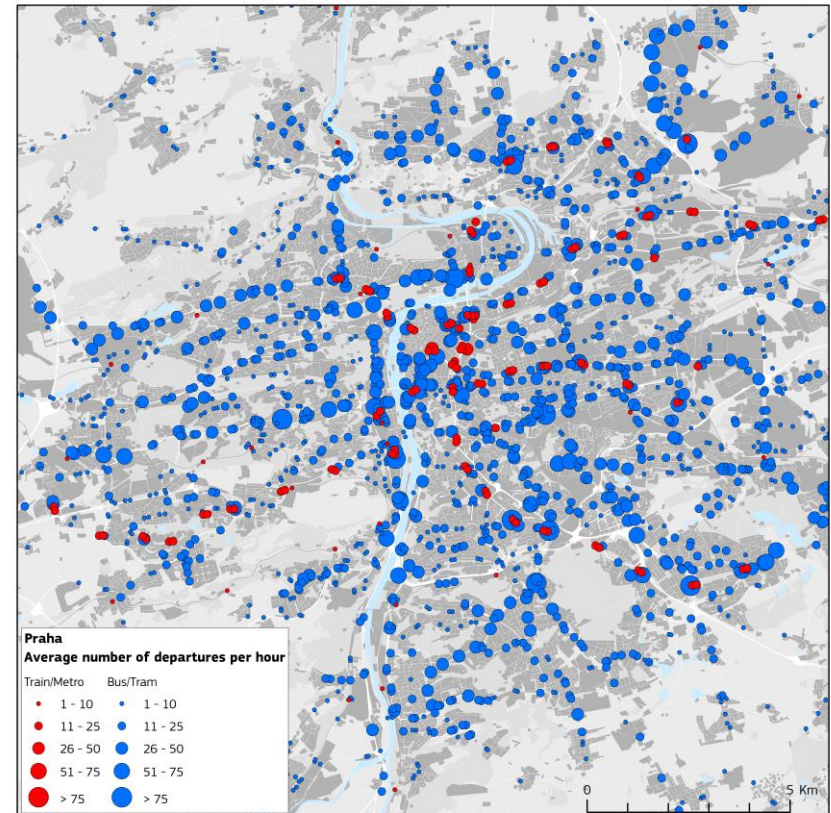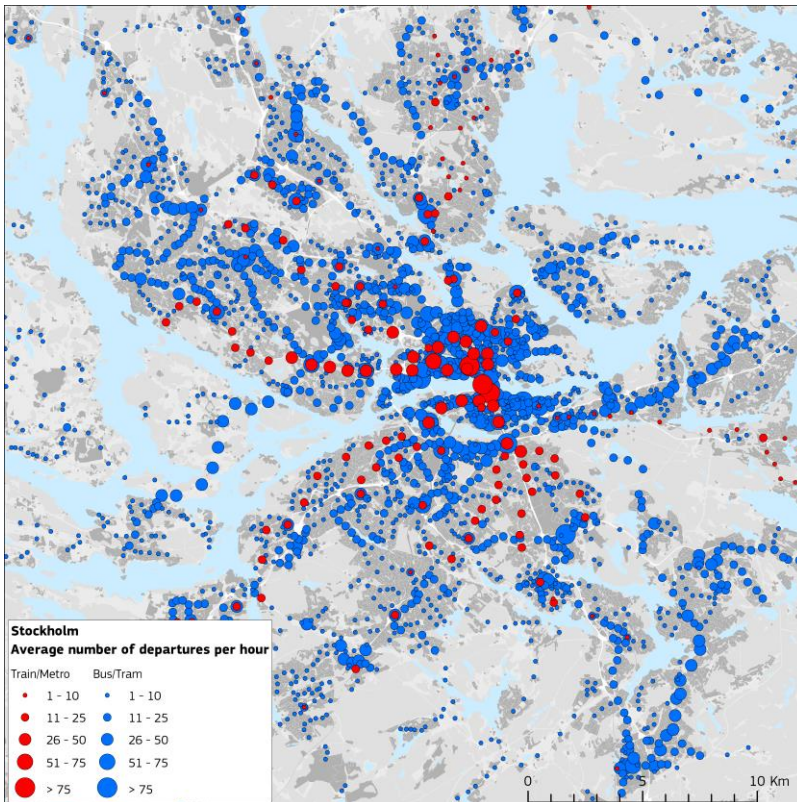# Timetables: General Transit Feed Specification model

© 2007, 2008

Location of stops

Bus and tram

Train and metro
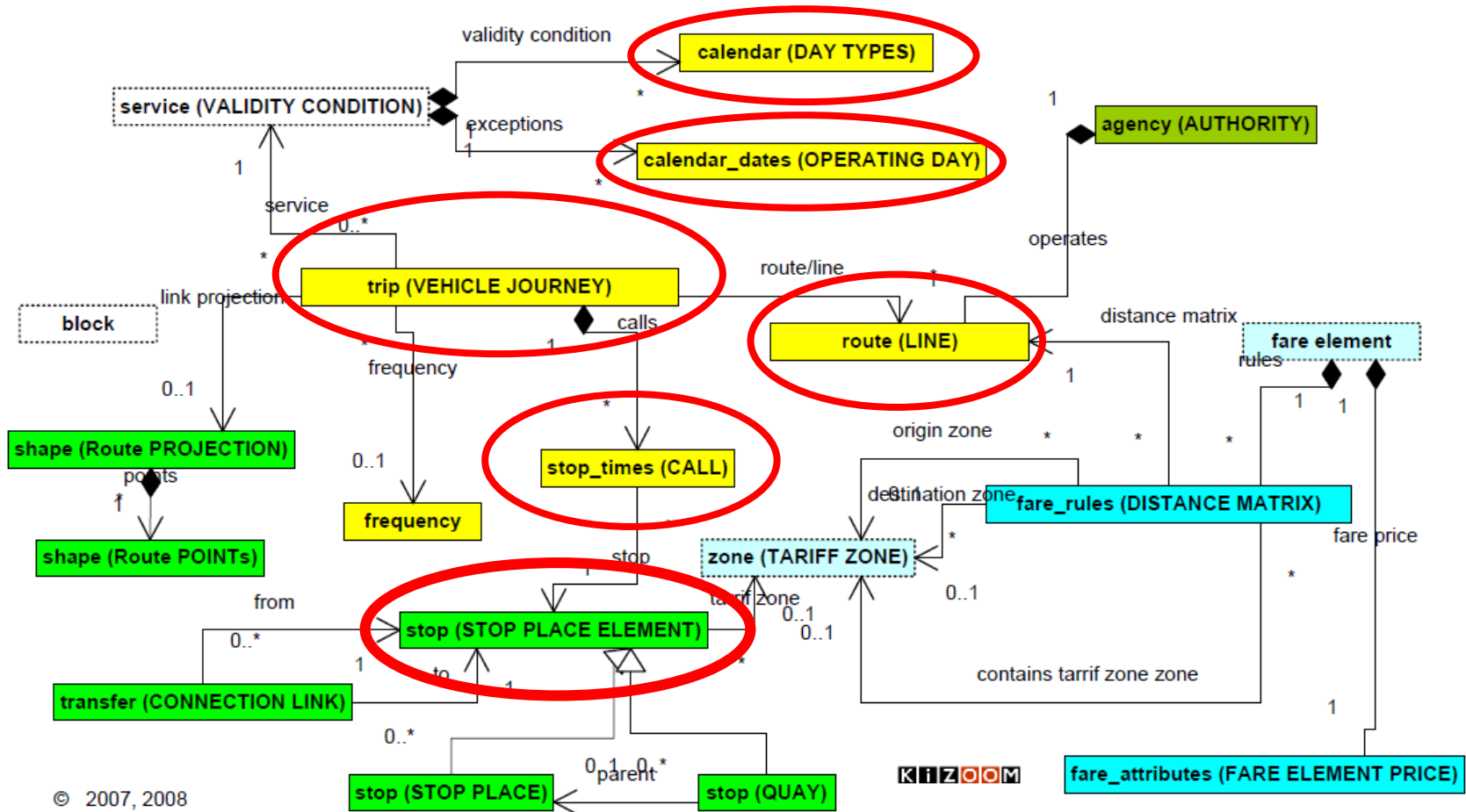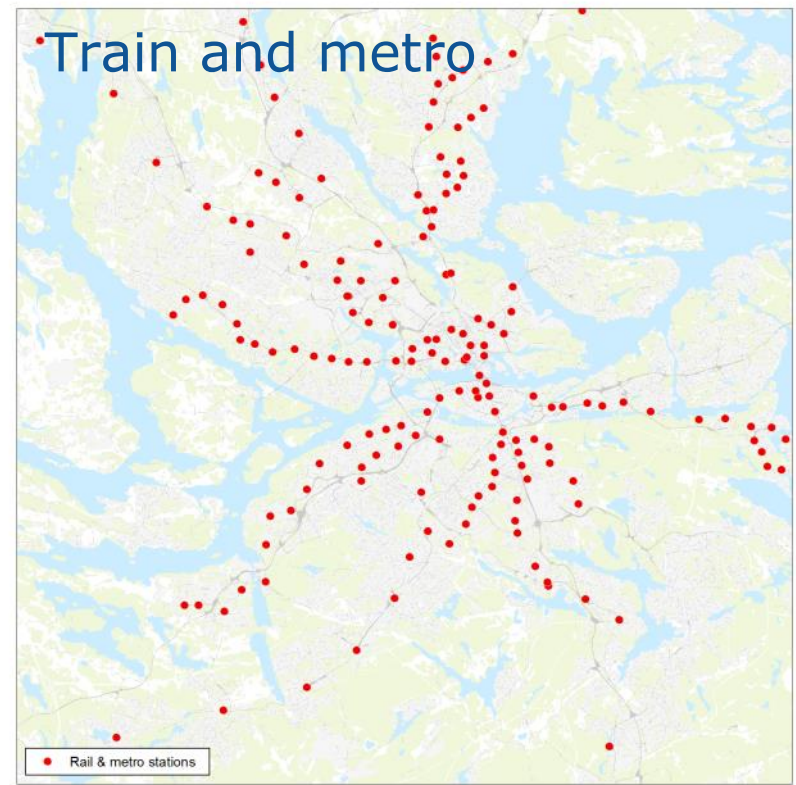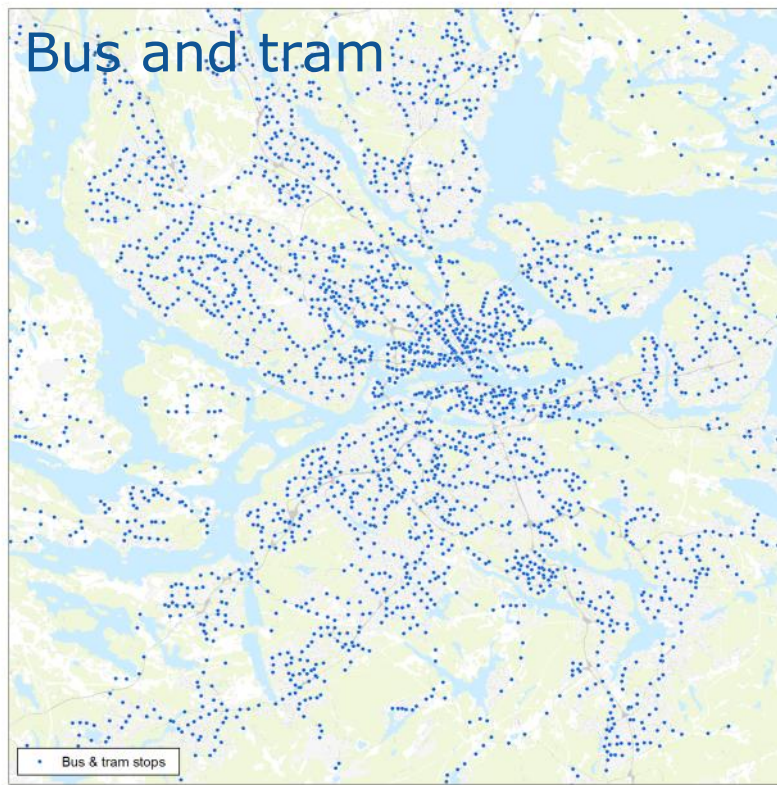
Stockholm

Average stops an hour from 6:00 to 20:00 on a normal week day

Stockholm
Average number of departures per hour

Train/Metro	Bus/Tram
1 - 10	1 - 10
11 - 25	11 - 25
26 - 50	26 - 50
51 - 75	51 - 75
> 75	> 75

0   5   10 Km

Praha
Average number of departures per hour

Train/Metro	Bus/Tram
1 - 10	1 - 10
11 - 25	11 - 25
26 - 50	26 - 50
51 - 75	51 - 75
> 75	> 75

0   5 Km

Regional
and urban
Policy

Service areas around stops

- Stops near to each other are clustered

  - stops at both sides of a street; bus stations

  - sum of available departures per cluster

- Service areas

  - 5 minutes walking distance for bus and tram

  - 10 minutes for train and metro

 - created using comprehensive street network, accessible to pedestrians

Frequency classes

- Number of departures per service area

  - In overlapping areas: maximum value of the overlapping service areas

- Frequency classes of departures

  - High: > 10 departures an hour

  - Medium: more than 4 but less than 10 an hour

  - Low: less than 4 an hour

  - Null: no public transport stops within walking distance

Typology of frequency classes

Very high	Access to more than ten departures an hour for both medium- and high-speed modes
High	Access to more than ten departures an hour for one mode, but not both
Medium	Access to between four and ten departures an hour on one or both modes, but no access to more than ten departures and hour
Low	less than four departures an hour for one or both modes, but no access to more than four departures an hour
Null	No access within walking distance

Population distribution

Urban Atlas: land use

Population by block

Population density
|	
1 - 10	251 - 500
11 - 50	501 - 1000
51 - 100	1001 - 2000
101 - 250	> 2000
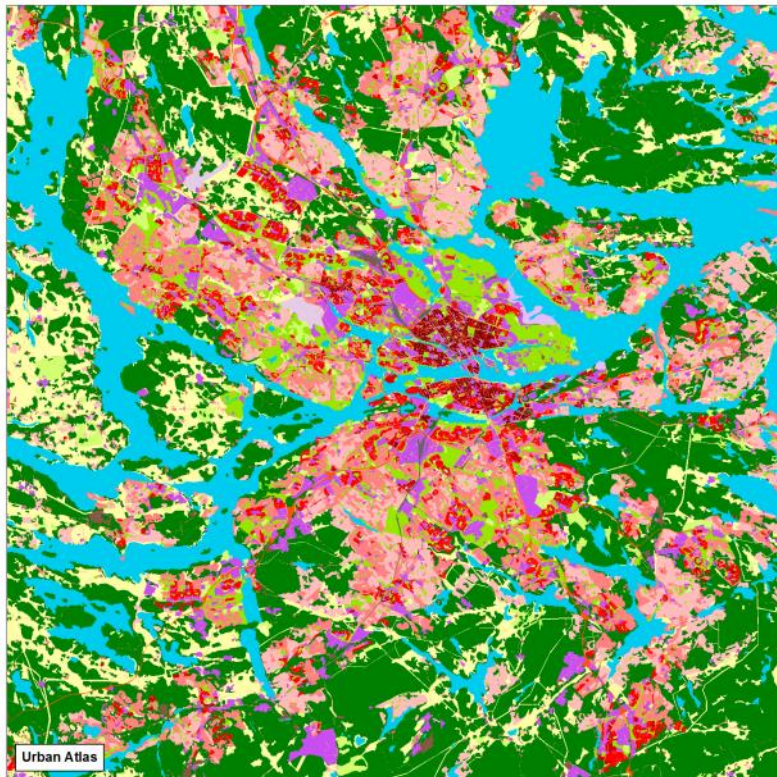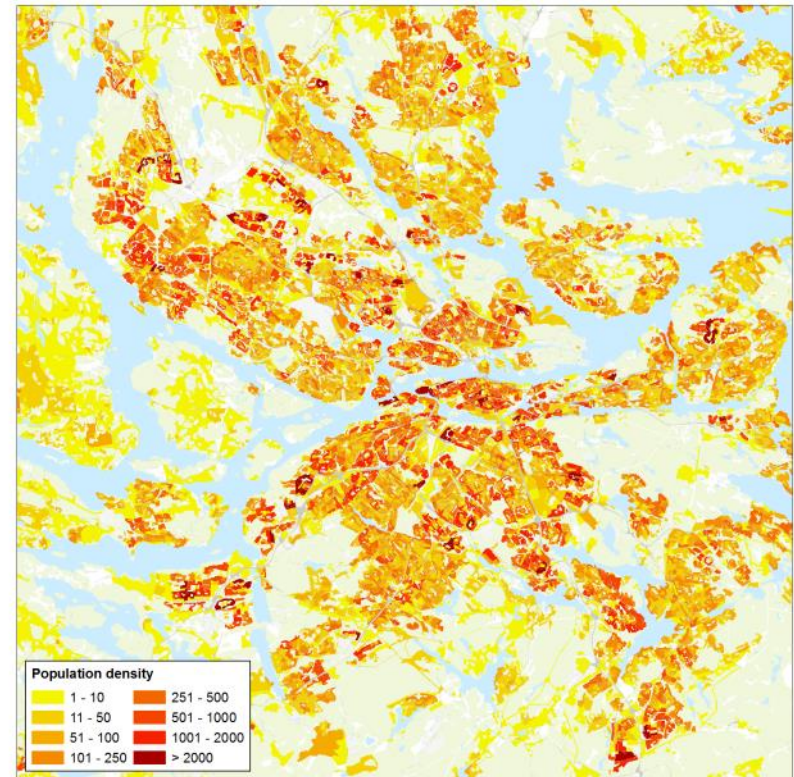
Various spatial levels:
City, Urban Centre, Greater City
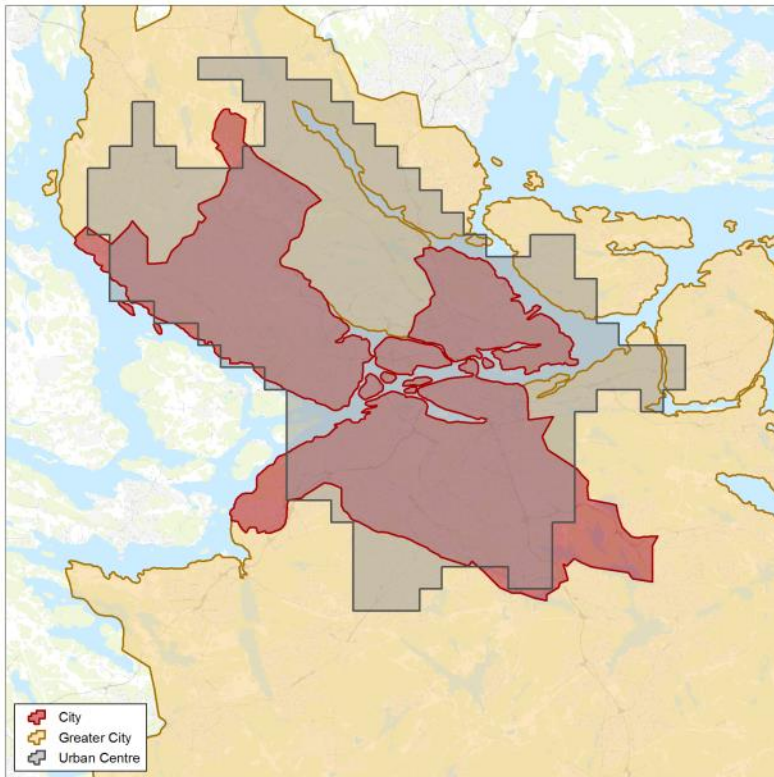
- **City**: administrative unit
- **Urban centre**: cluster of densely populated grid cells
- **Greater city**: cluster of municipalities, if urban centre substantially exceeds the administrative city

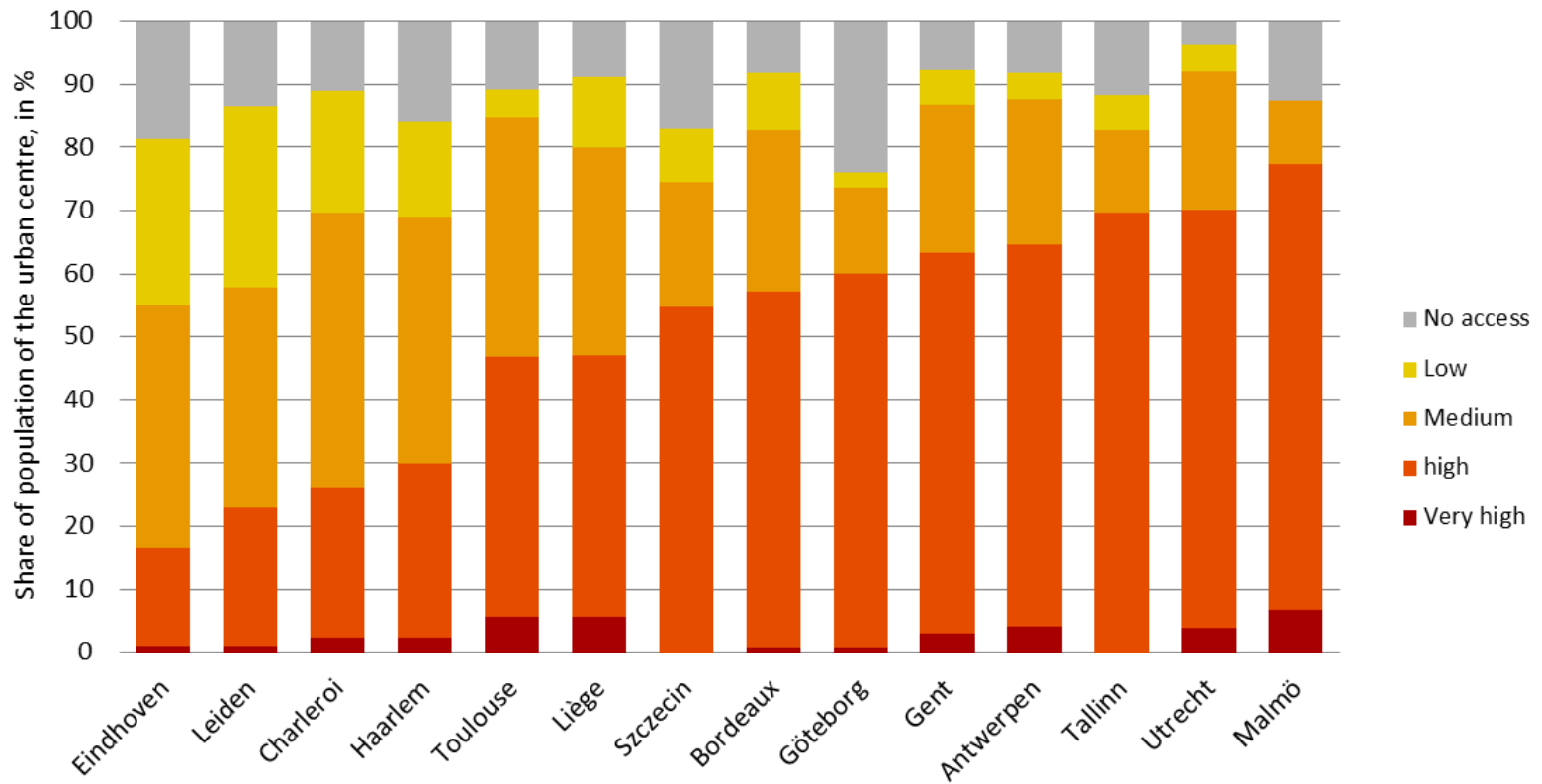# Stockholm: areas and population by access to public transport and its frequency

Access to a public transport by frequency of stops:

- Null
- Low
- Medium
- high
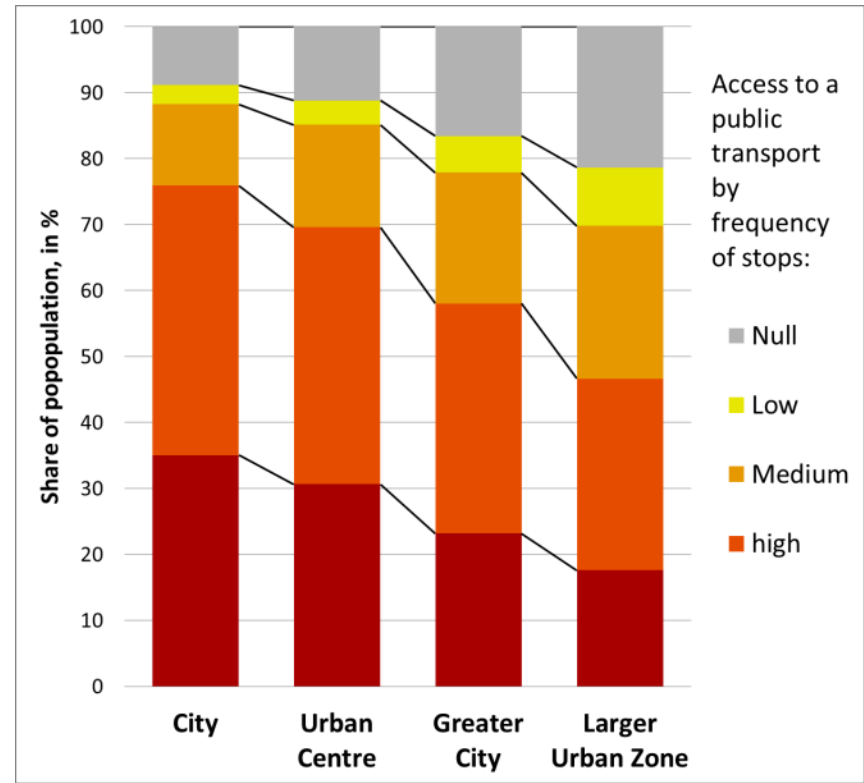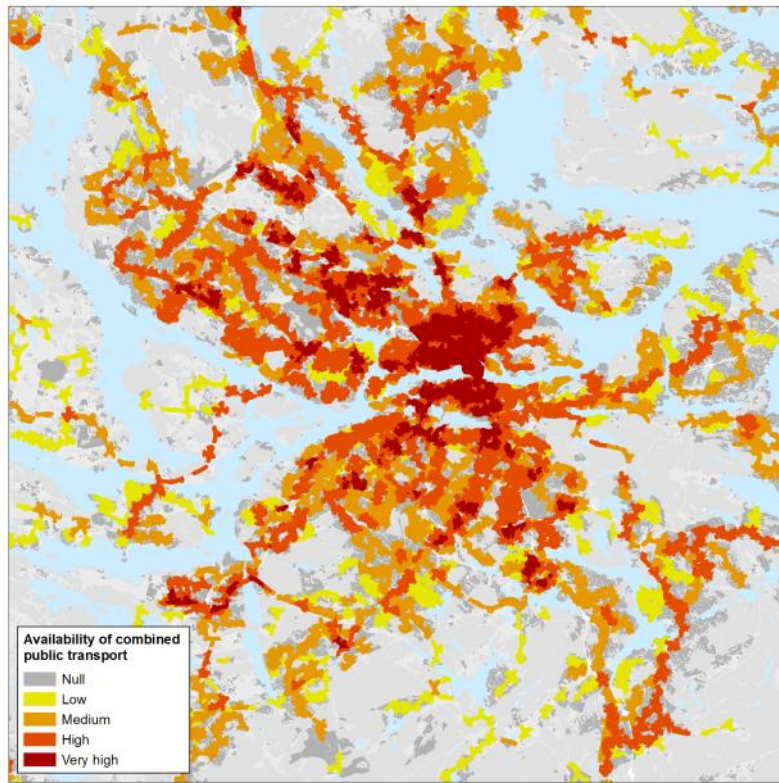
844,000 inh.   1,135,000 inh.   1,542,000 inh.   2,042,000 inh.

Access to public transport in large European cities

Share of population of the urban centre, in %

Cities (left to right): Dublin, Den Haag, Budapest, Amsterdam, Helsinki / Helsingfors, Praha, Berlin, Manchester, Stockholm, København, Athina, Torino, Marseille, Bruxelles / Brussel

Legend:
- No access
- Low
- Medium
- high
- Very high
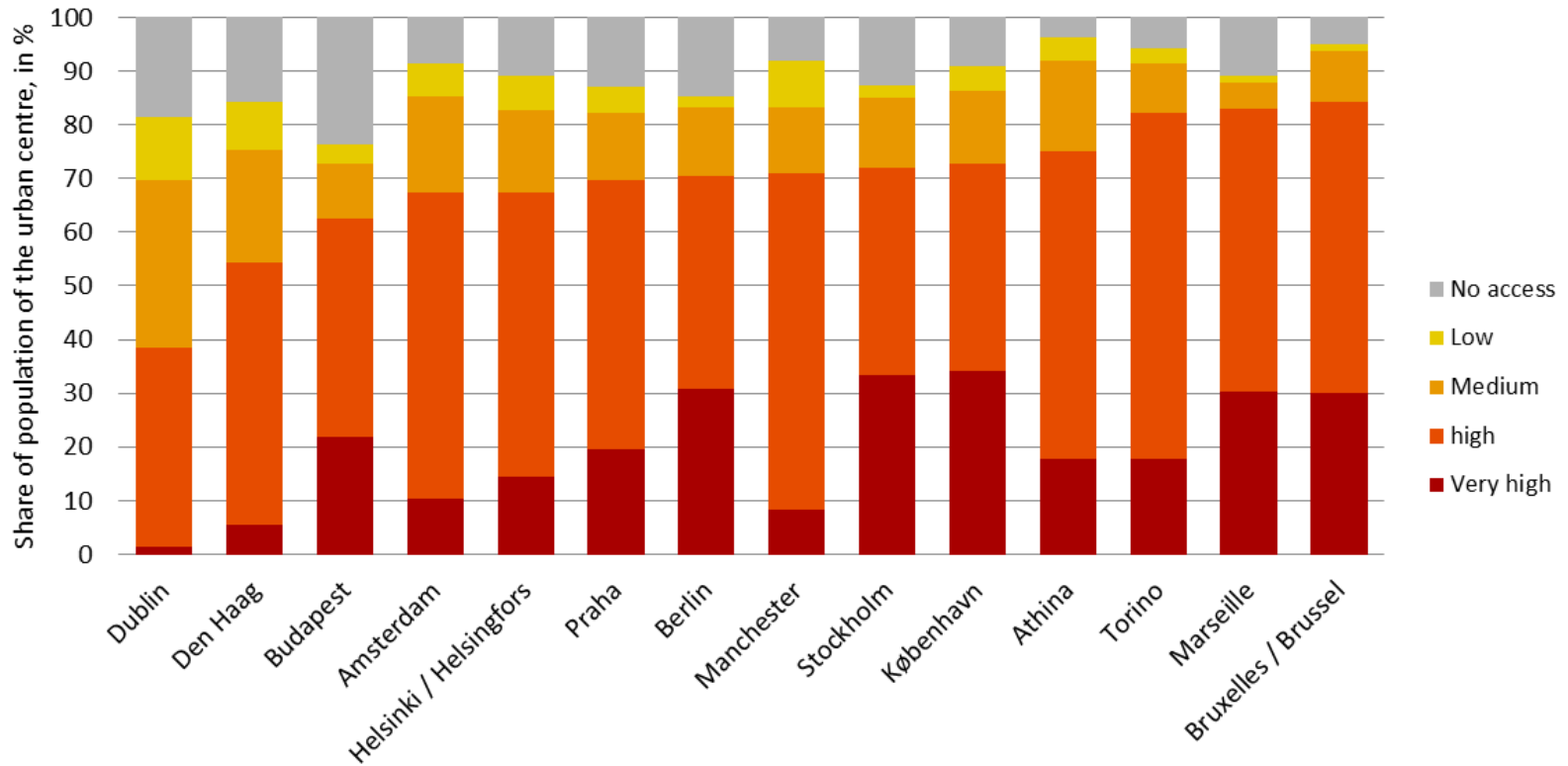
Access to public transport in mid-size European cities

Population density, job density and typology of frequencies

Population density
(250x250 m cell size)

Dublin
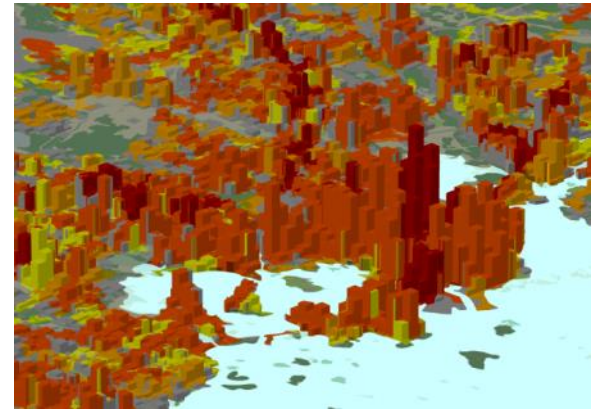
Helsinki

Job density
(workplace-based
employment)
(250x250 m cell size)

Regional
and urban
Policy
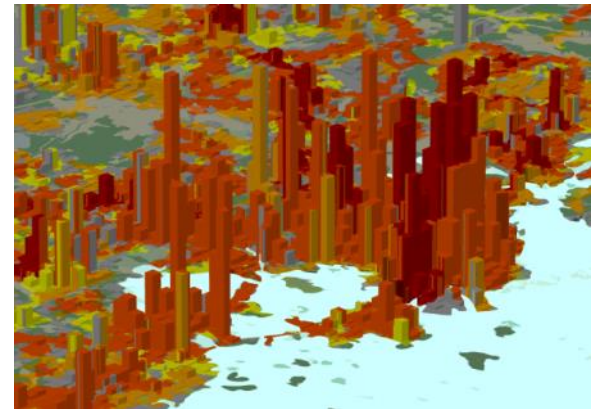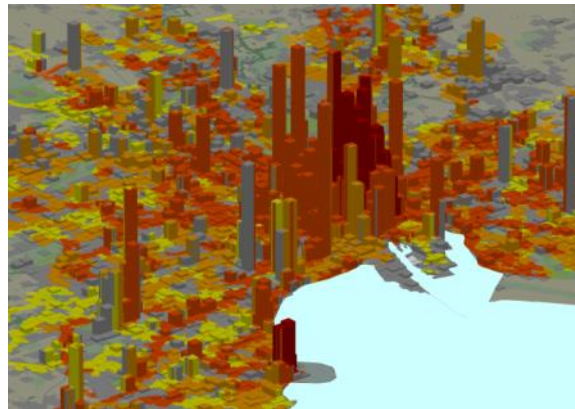
Population distribution and number of departures in large cities*

and urban Policy   * cities: defined as urban centres
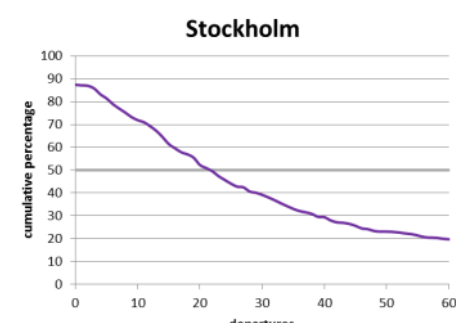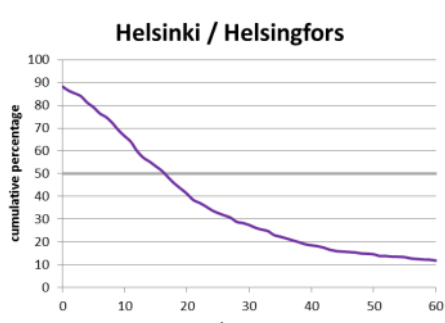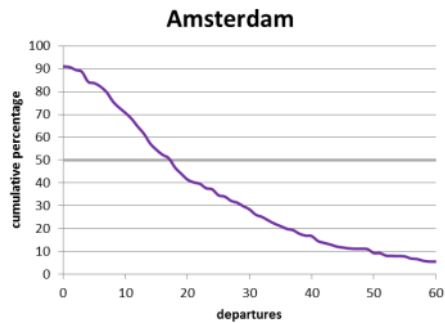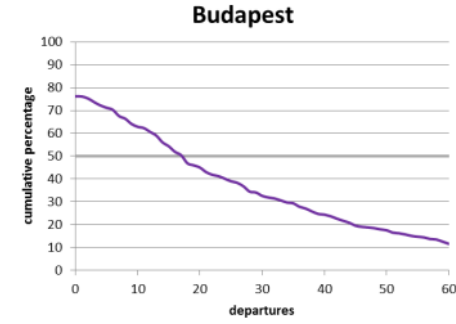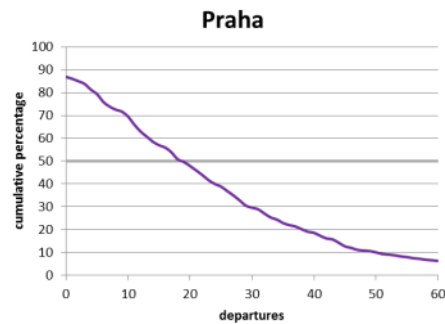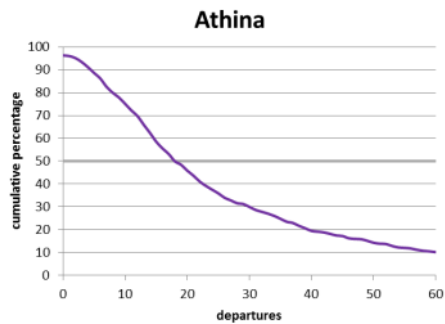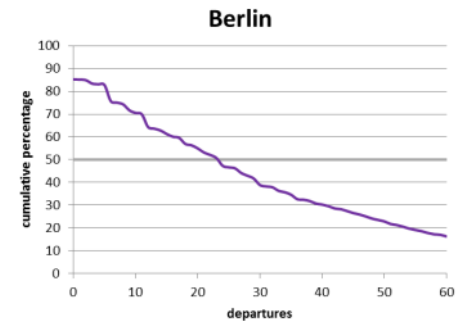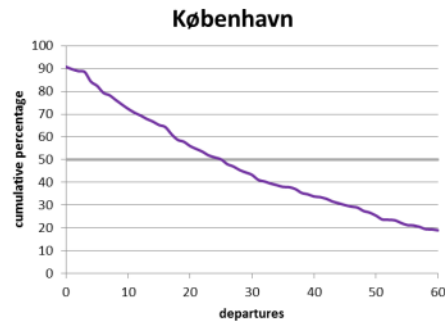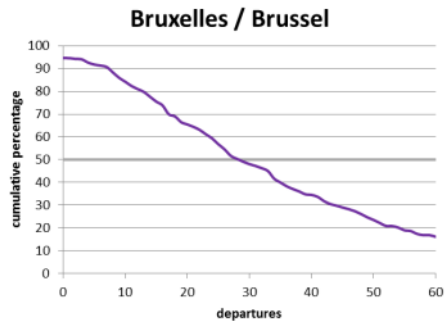
Population distribution and number of departures in mid-size cities*
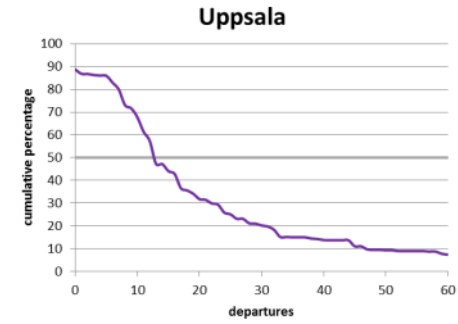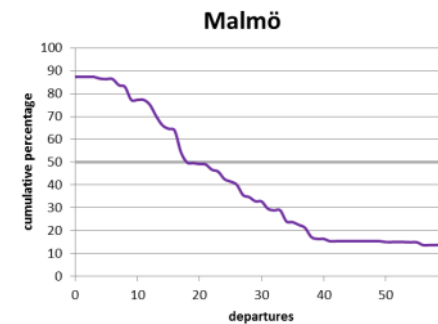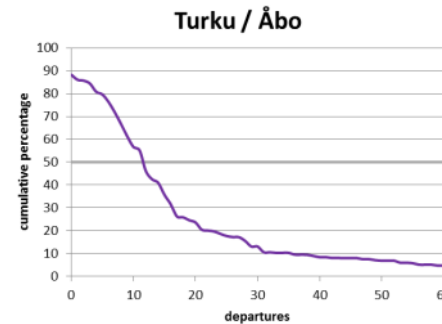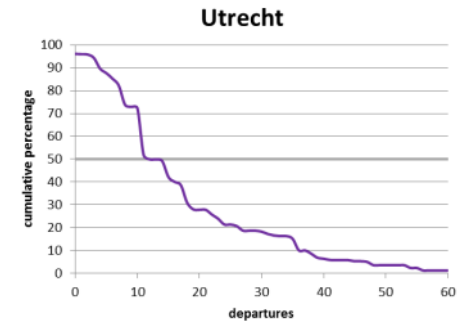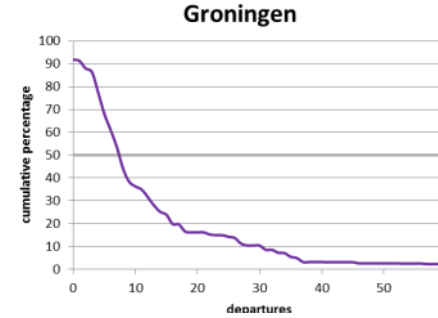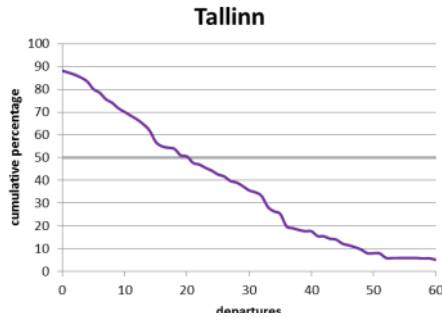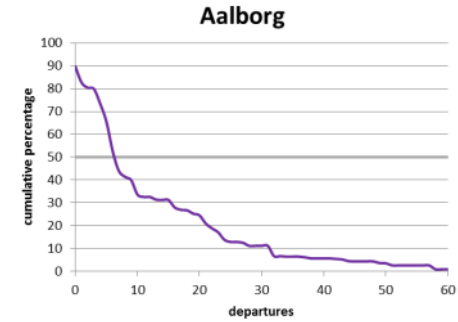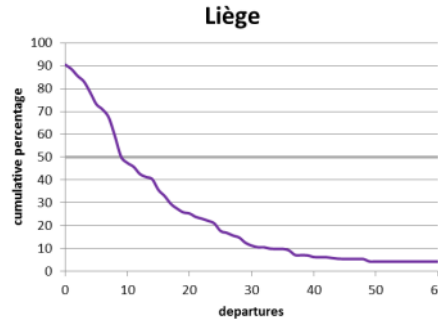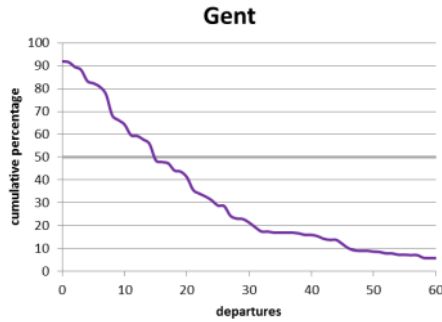
Y% of population has access to more than X departures an hour and urban Policy   * cities: defined as urban centres

Median number of departures an hour

- Number of departures to which 50% of the urban population has easy access
  - Varies between 7.4 and 28.3 departures in bigger cities
  - Between 3.5 and 20.2 in medium-sized cities

Population-weighted median number of hourly departures in Urban Centres

Number of departures
- 1 - 4
- 4 - 10
- 10 - 20
- 20 - 30

Urban centre size (inhabitants)
- 50000 - 100000
- 100001 - 250000
- 250001 - 500000
- 500001 - 1000000
- 1000001 - 5000000
- > 5000000
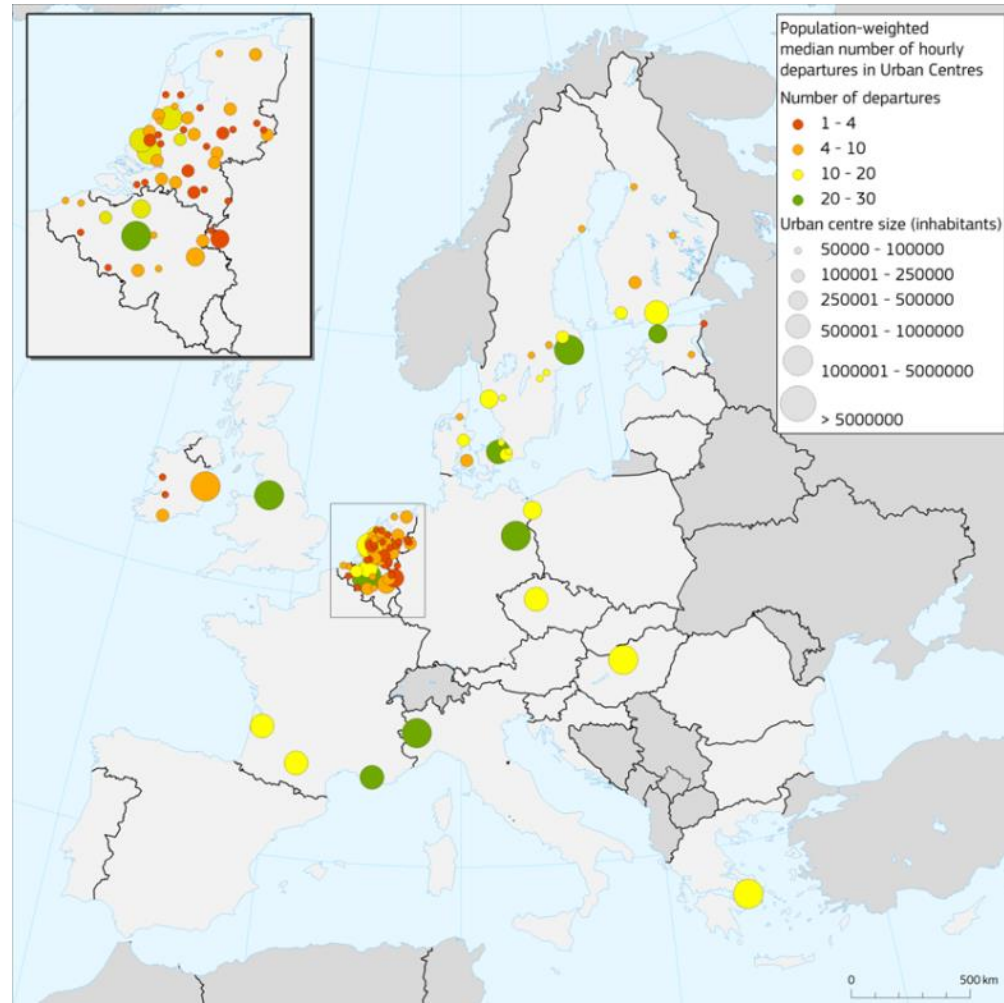
Measuring total trip length and speed

- Complement the indicators on accessibility

- Focus on public transport **inside** the cities

- Assess performance of the networks, in terms of speed and frequency of specific transport modes

- Synthesize indicators at city level

Trip length and speed: input data

- Location of stops, including values of XY coordinates (in meters), spatially joined with the boundaries of the cities

- Table StopTimes: all departure times and arrival times of all trips at all relevant stops

- Trips identifiers, including route identifiers

Praha
● metro stops
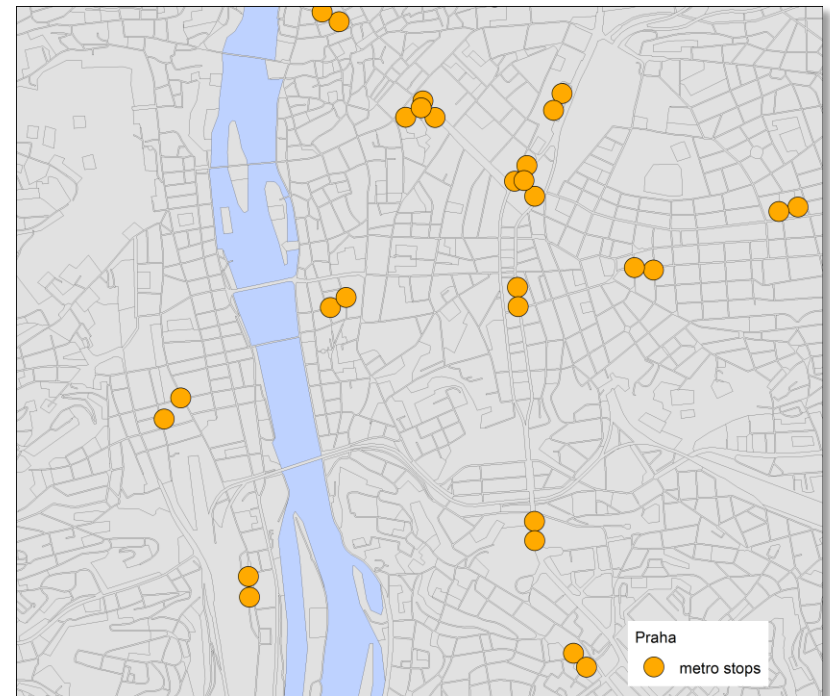
Establish the connections

- Unit of analysis: "connection": segment of a trip between a departure stop and the next arrival stop.

- Selection of all departures and arrivals inside the city, on a typical working day

- For each departure, determine what the next arrival is and calculate the travel time of this connection

Praha
- metro stops
- metro connections
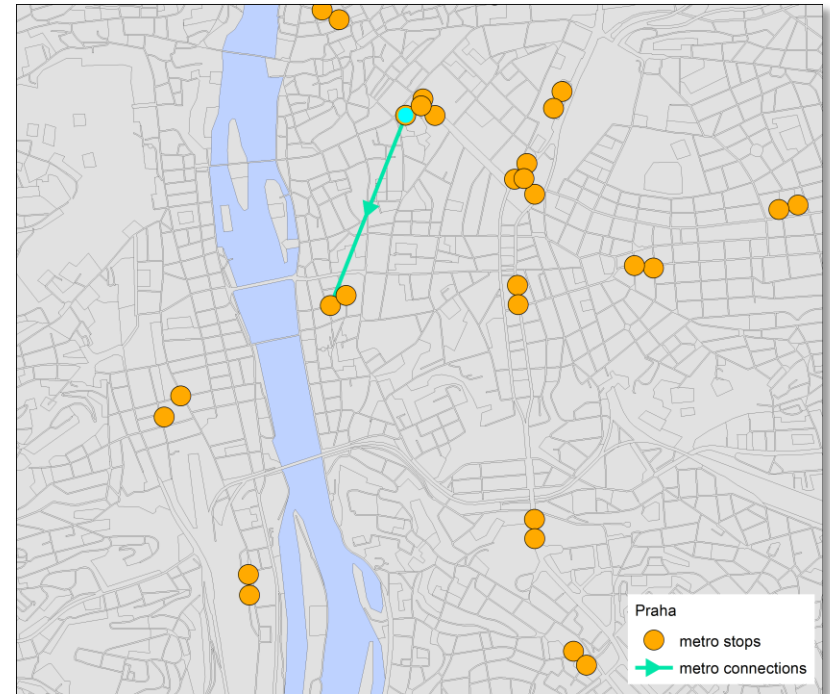
Calculate length and speed

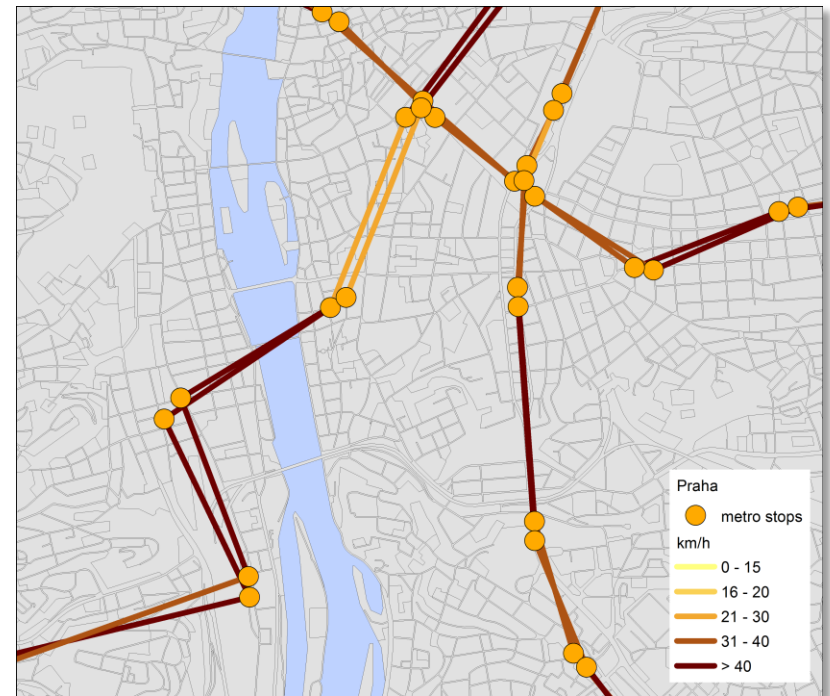- Combine with the stops point features to calculate Euclidian distance of the connection and the trip speed along it

- Aggregation of speed and trip length by connection, trip, route, transport mode, city

Praha
- ● metro stops
- km/h
  - 0 - 15
  - 16 - 20
  - 21 - 30
  - 31 - 40
  - > 40

Mapping the results by connection

- Straight lines representing the connections (XY to line tool)
- Schematic representation of networks
- Only feasible for relatively simple networks

tram
km/h

- 0 - 15
- 16 - 20
- 21 - 30
- 31 - 40
- > 40

metro
km/h

- 0 - 15
- 16 - 20
- 21 - 30
- 31 - 40
- > 40
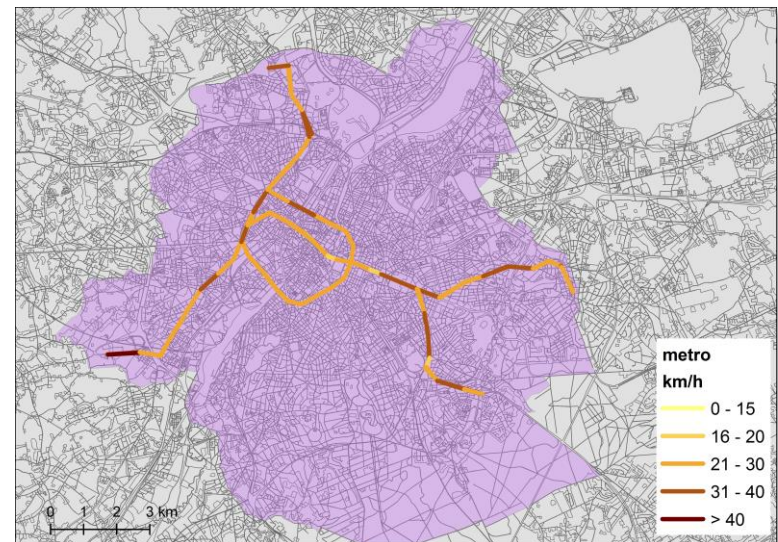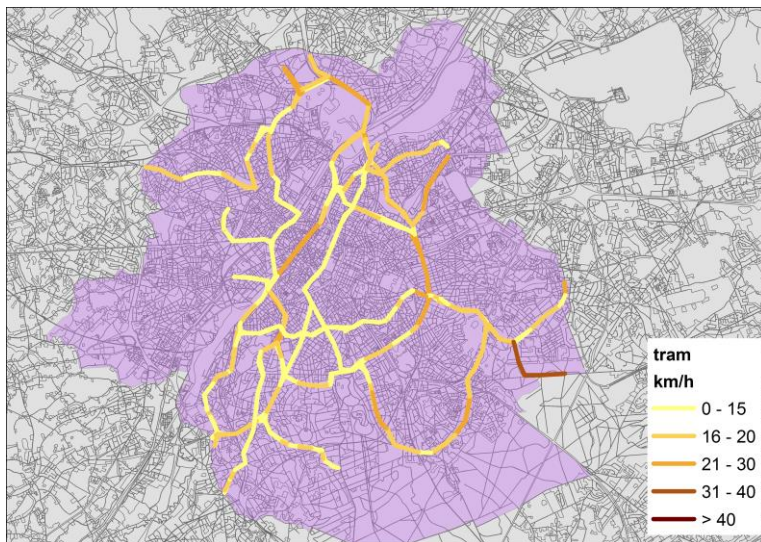
Brussels (city): average Euclidian speed by
segment of the tram and the metro network

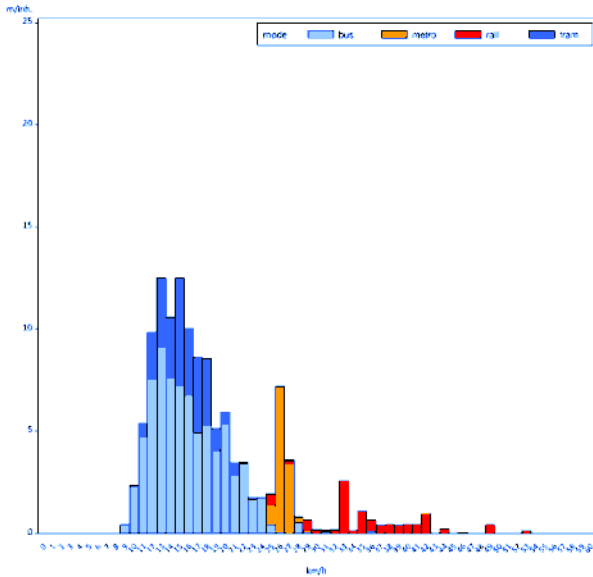# Total trip length and speed by urban centre

Brussels

Dublin

Stockholm

Trip length per inhabitant by trip speed
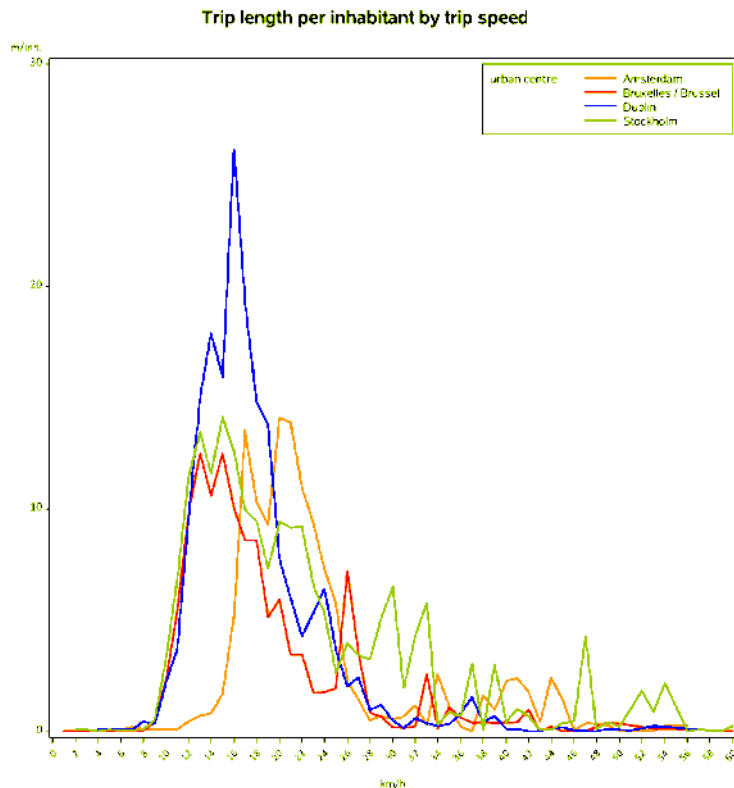
Distribution by trip speed

Cumulative distribution by trip speed

Regional and urban Policy

Summary indicators by urban centre

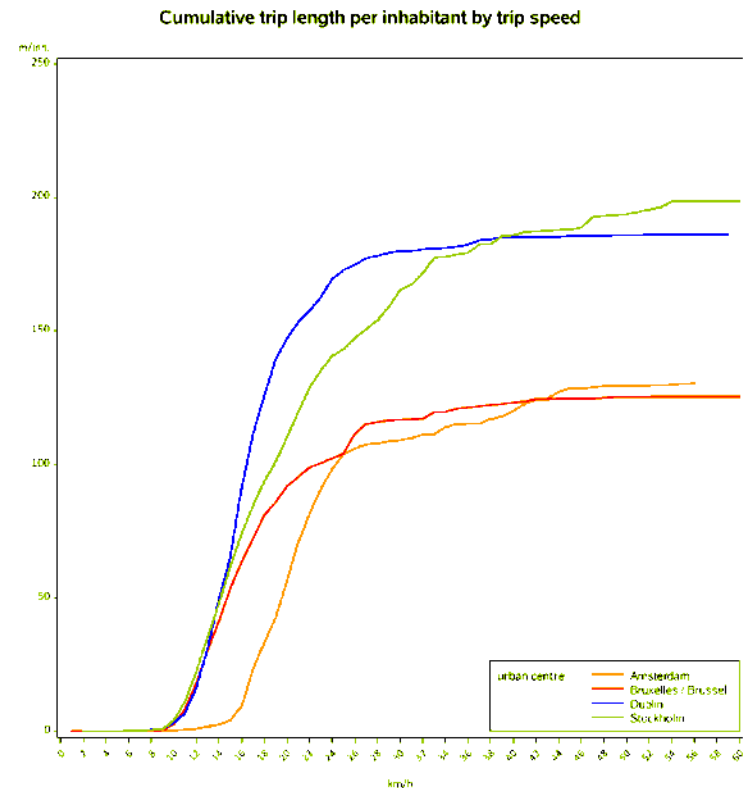|	large urban centres (>= 500,000 inh.)		medium-sized urban centres (200,000 - 500,000)	
	min	max	min	max
population without access to services (%)	**3.7**	**23.8**	**3.9**	**24.1**
median number of departures	**7.4**	**28.3**	**3.5**	**20.2**
modal split of length of all trips (%)				
tram	-	45.5	-	34.5
metro	-	15.7	-	-
train	-	19.0	0.5	8.2
bus	45.8	100.0	60.1	98.7
length of all trips, by inhabitant (m/inh.)	**76.8**	**349.1**	**43.4**	**228.2**
average trip speed (km/h)	**13.5**	**24.8**	**15.0**	**21.1**
tram	12.0	25.0	13.2	23.6
metro	24.6	42.4		
train	35.0	49.5	27.0	49.3
bus	13.5	23.1	13.6	19.8

Conclusion

- A harmonised way of assessing access to public transport and services' performance

- Gives an internationally comparable method of assessment

- Could also be used to develop regional indicators

- Uses quite big data: millions of departures, thousands of bus, tram, train and metro stops

Challenges

- Timeliness and spatial resolution of population distribution data

- Spatial distribution of employment data

- A more harmonised implementation of public transport data standards

- Documentation and conversion of data according to national standards

- Availability of open data (timetables), data licensing policy

- Theoretical versus real-life transport offer

Sources

- Delineation of cities: EC-OECD city definition

- Population distribution: national statistical institutes, GEOSTAT 2006 grid

- Copernicus Urban Atlas 2006 land use data

- Road network: TomTom MultiNet

- Public transport data:
  BE: VVM De Lijn, STIB-MIVB, SRWT-TEC, NMBS-Infrabel;
  CZ (Praha): urban transport: www.infoprovsechny.cz; DK: Rejseplanen.dk;
  EE: www.peatus.ee; IE: dublinked.ie;
  FR: open data portals of cities/départements and of SNCF;
  IT (Torino): open data Torino; NL: OV-9292; PL (Szczecin): ZDITM;
  FI: www.matka.fi, HSL; SE: www.trafiklab.se;
  UK: Data.gov.uk (NapTAN and NPTDR);
  various cities: http://www.gtfs-data-exchange.com/agencies; Die Bahn; station locations from EuroRegionalMap (EuroGeographics)

References

- Eurostat city statistics (Urban Audit): http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/city_urban

- Copernicus Urban Atlas: http://land.copernicus.eu/local/urban-atlas

- European Forum for Geography and Statistics: http://www.efgs.info/

- Eurostat GEOSTAT project: http://epp.eurostat.ec.europa.eu/portal/page/portal/gisco_Geographical_information_maps/geostat_project

- Population estimates for the Urban Atlas polygons: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/30408/1/qms_h08_intesa_deliverable_2_2_eur_26437.pdf

- Cities in Europe: the new OECD-EU definition: http://ec.europa.eu/regional_policy/sources/docgener/focus/2012_01_city.pdf

- General Transit Feed Specification: https://developers.google.com/transit/gtfs/

Questions ?

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