



# LAND-USE MONITORING IN OECD URBAN AREAS

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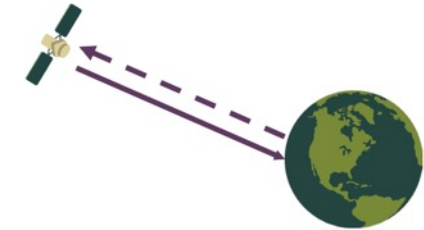
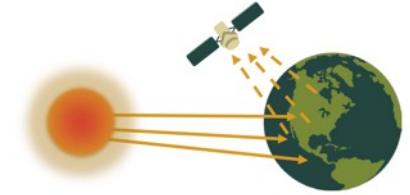
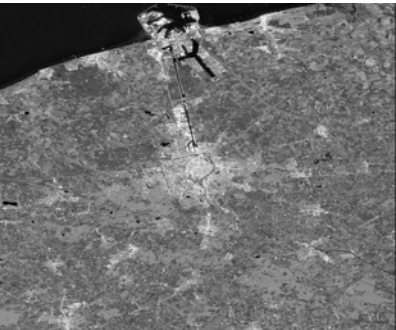

# Context and objectives

- **Context**
  - Land and built-up area major **environmental** and **economic** factors
  - But land-use monitoring **slow**
- **Aim**
  - Monitoring in **near real-time land-use** in OECD functional urban areas (FUA = city + commuting zone)
- **How?**
  - By using public **Sentinel satellite imagery** data and **Deep Learning models** trained on the **Copernicus urban atlas**
- **Applications**
  - **Urban expansion:** speed, density, shape
  - **Land conversion** (deforestation, afforestation, agricultural expansion)
  - **Land artificialisation**, loss of natural areas
- **Indicator characteristics**
  - Near real-time, yearly indicators
  - **Coverage:** European OECD FUAs, potentially non-European FUAs
  - 10 m spatial resolution



# Project description

# Sentinel satellite constellation

	Sentinel 1	Sentinel 2
Type	Synthetic Aperture Radar (SAR) Active Sensors 	Multi-spectral Passive Sensors 
Resolution	10 m	10 - 30 m
Time revisit	6 days with 2 satellites	5 days with 2 satellites
Example		

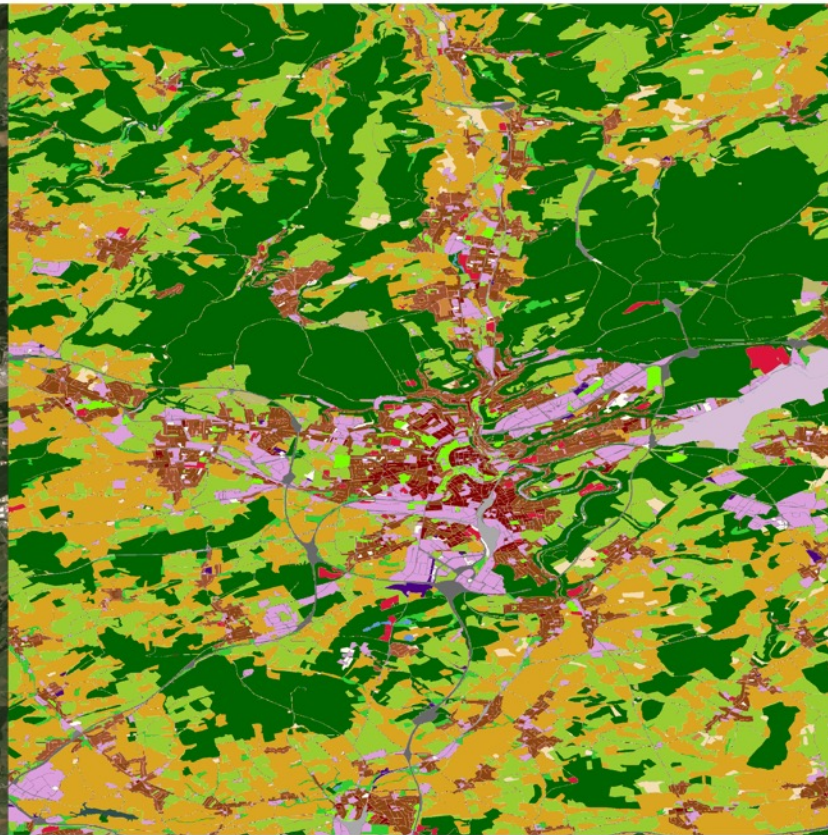
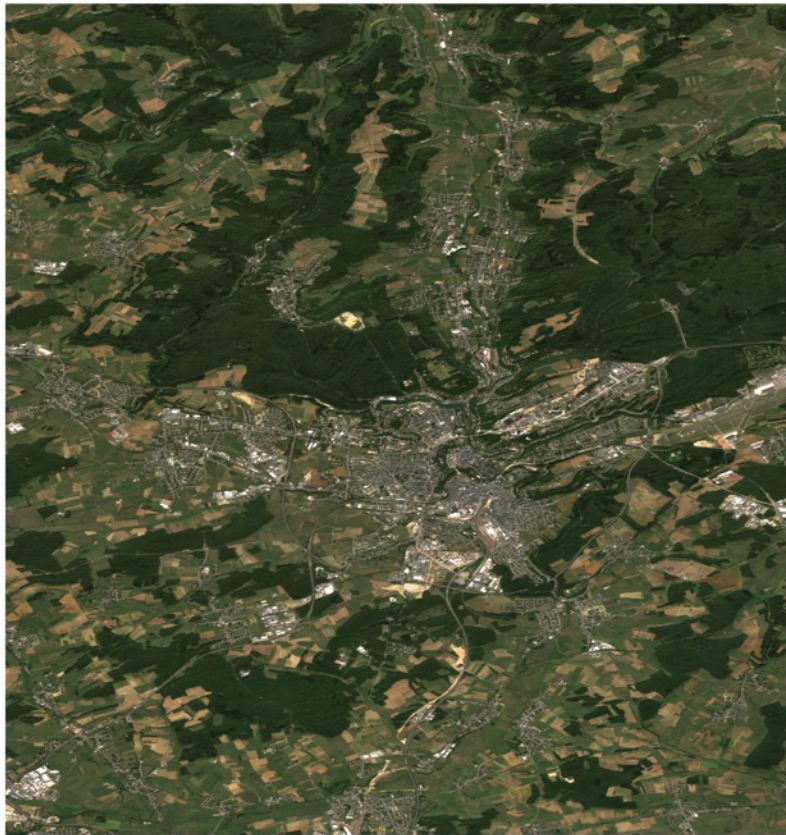


# The Copernicus Urban Atlas

## Urban Atlas 2018 for Luxembourg

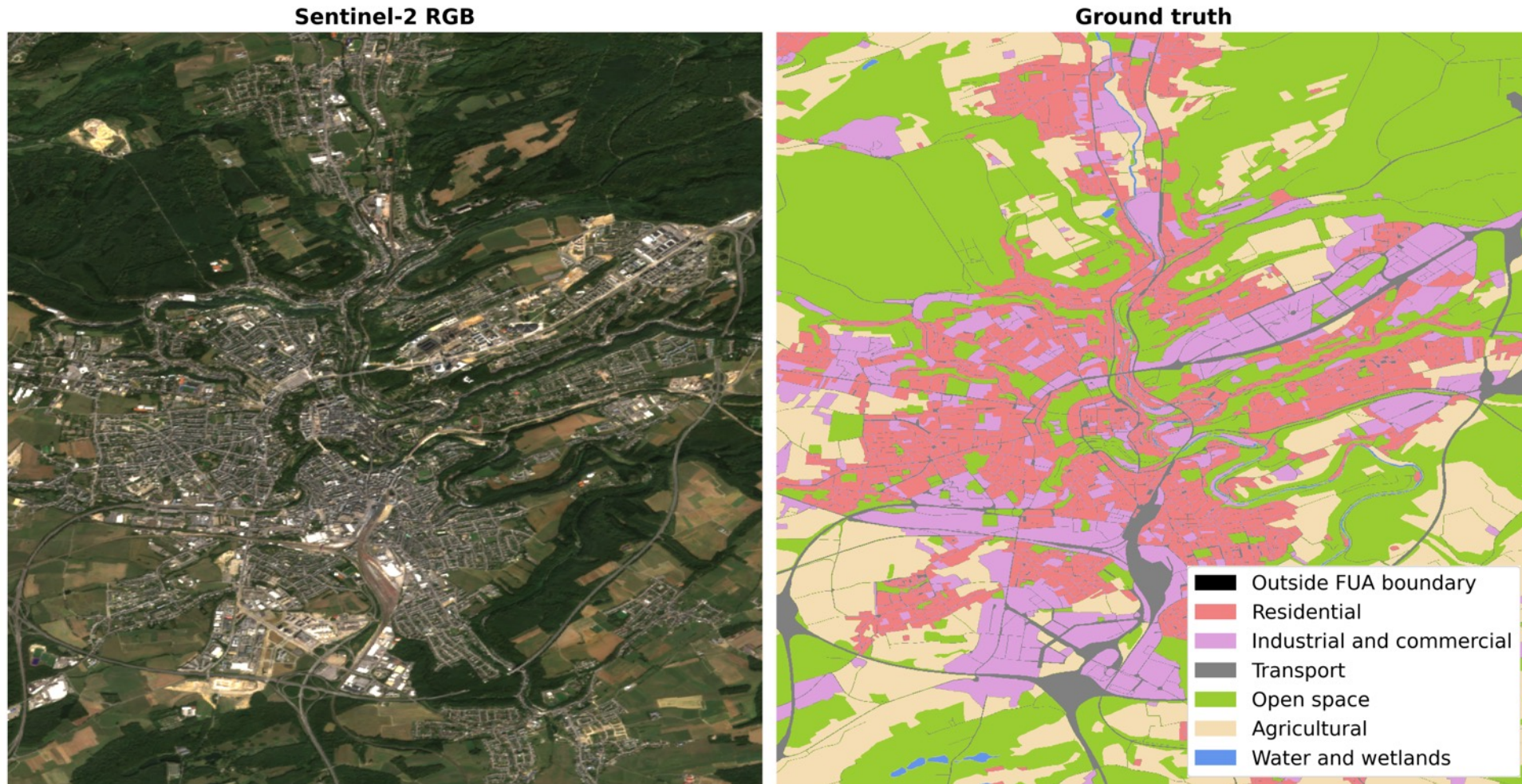
Sentinel-2 RGB

Urban Atlas 2018



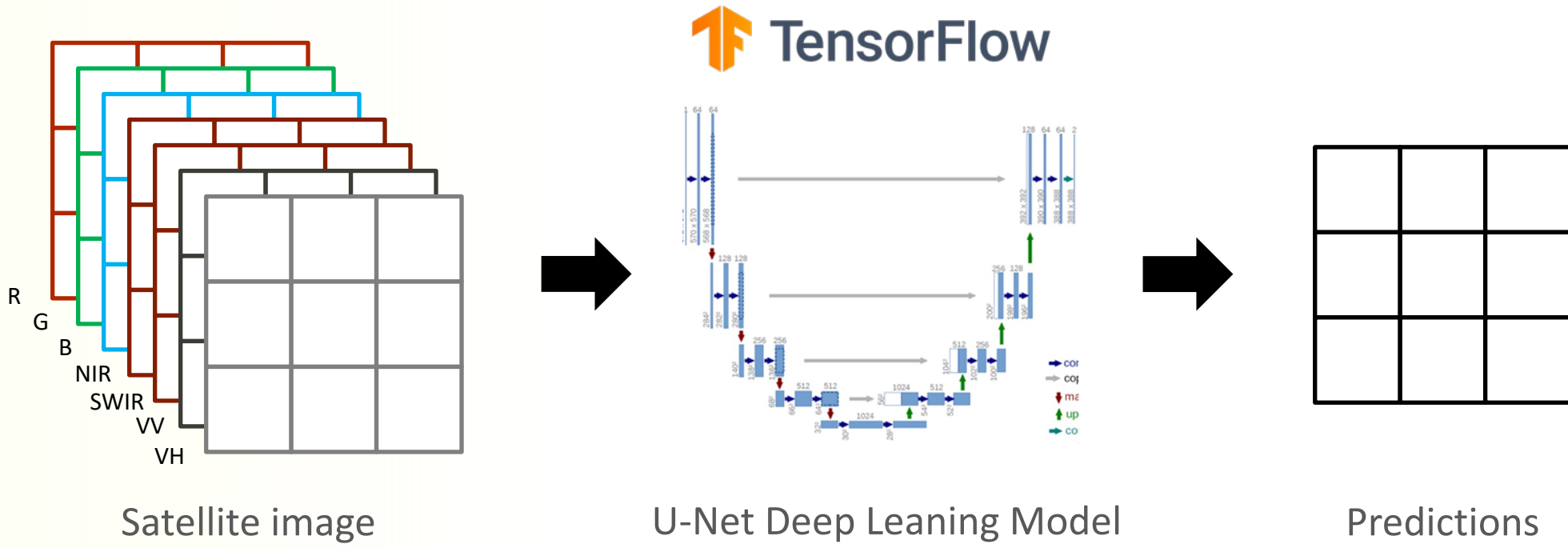
- Outside FUA boundary
- Continuous urban fabric (S.L. : > 80%)
- Discontinuous dense urban fabric (S.L. : 50% - 80%)
- Discontinuous medium density urban fabric (S.L. : 30% - 50%)
- Discontinuous low density urban fabric (S.L. : 10% - 30%)
- Discontinuous very low density urban fabric (S.L. : < 10%)
- Isolated structures
- Industrial, commercial, public, military and private units
- Fast transit roads and associated land
- Other roads and associated land
- Railways and associated land
- Port areas
- Airports
- Mineral extraction and dump sites
- Construction sites
- Land without current use
- Green urban areas
- Sports and leisure facilities
- Arable land (annual crops)
- Permanent crops (vineyards, fruit trees, olive groves)
- Pastures
- Complex and mixed cultivation patterns
- Orchards at the fringe of urban classes
- Forests
- Herbaceous vegetation associations (natural grassland, moors...)
- Open spaces with little or no vegetation (beaches, dunes, bare rocks, glaciers)
- Wetlands
- Water

# Class aggregation used in the analysis



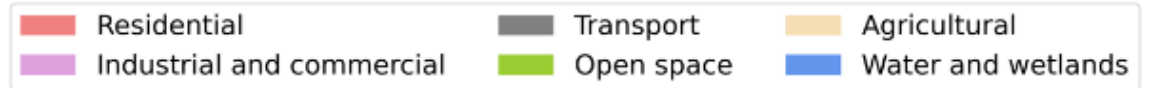


# Pipeline overview



Training and testing with the EU urban atlas on aggregated classes

# Model predictions on Amsterdam



**Amsterdam**  
**Acc = 0.85, F1 macro = 0.76**

Sentinel-2 RGB



Prediction



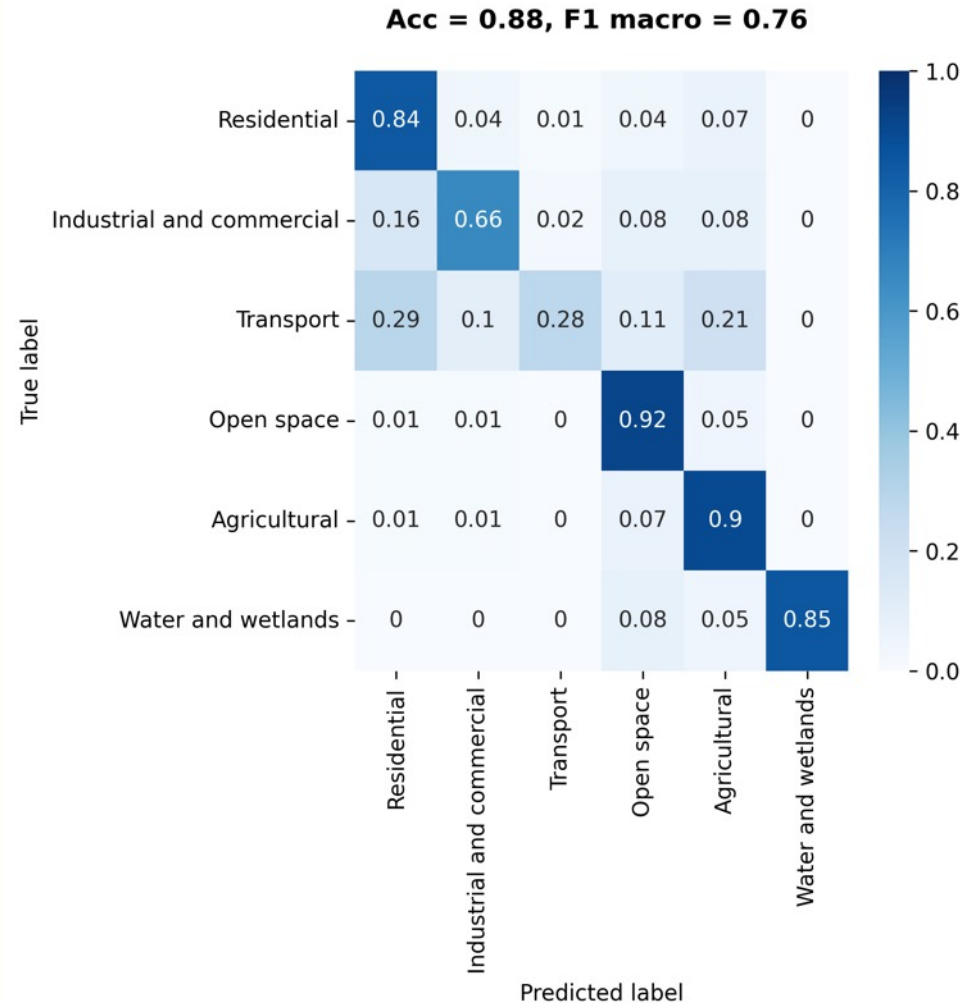
Ground truth







# Overall performance very good, except for transportation networks



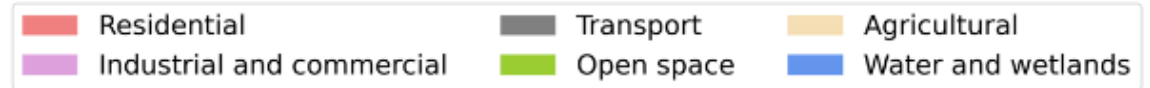
Accuracy	Results
1	Perfect
0.9-1	Excellent
0.7-0.9	Very Good
0.6-0.7	Good
0.4-0.6	Fair
0-0.4	Poor



**Illustration: Predictions in  
non-European FUAs**



# Metropolitan area of San Francisco (2020)



Sentinel-2 RGB

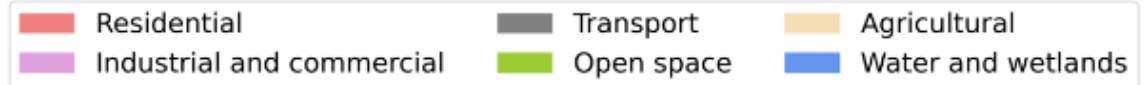


Prediction

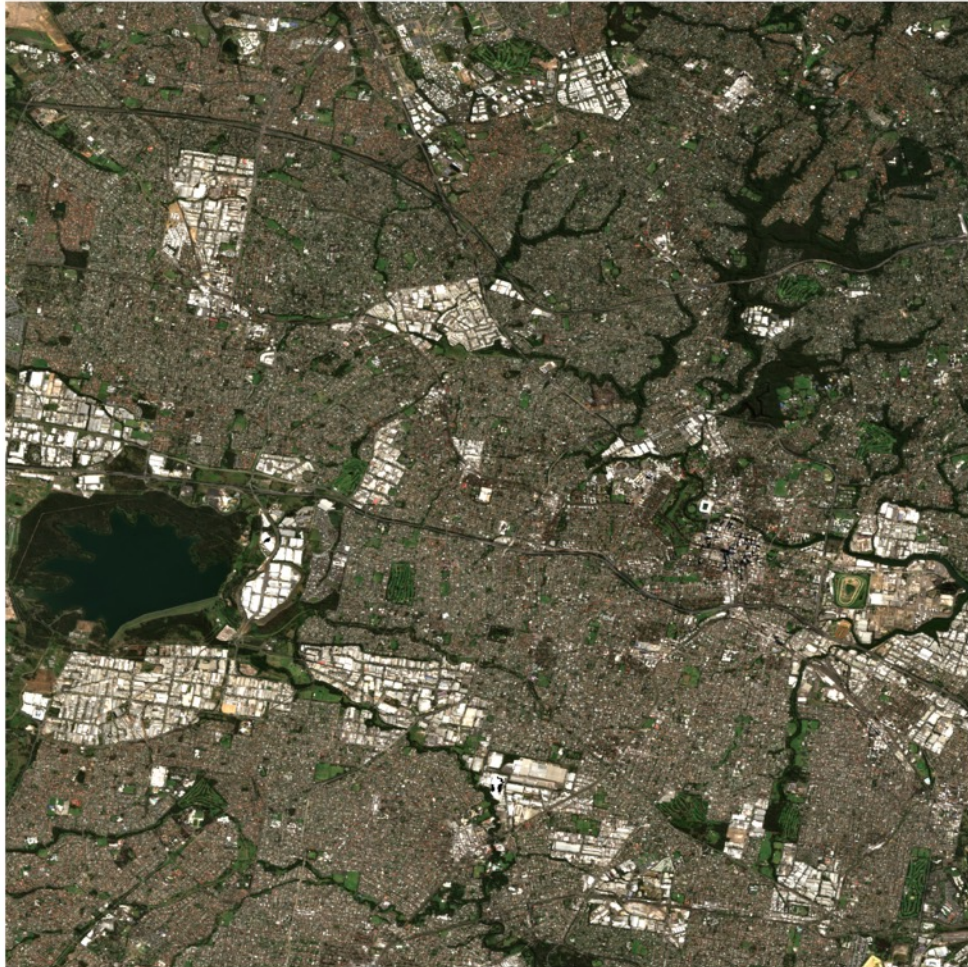




# Metropolitan area of Sydney (2020)



Sentinel-2 RGB

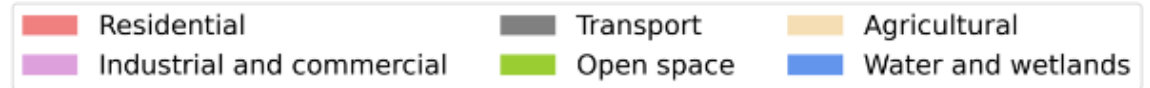


Prediction





# Metropolitan area of Bogota D.C. (2020)



Sentinel-2 RGB



Prediction



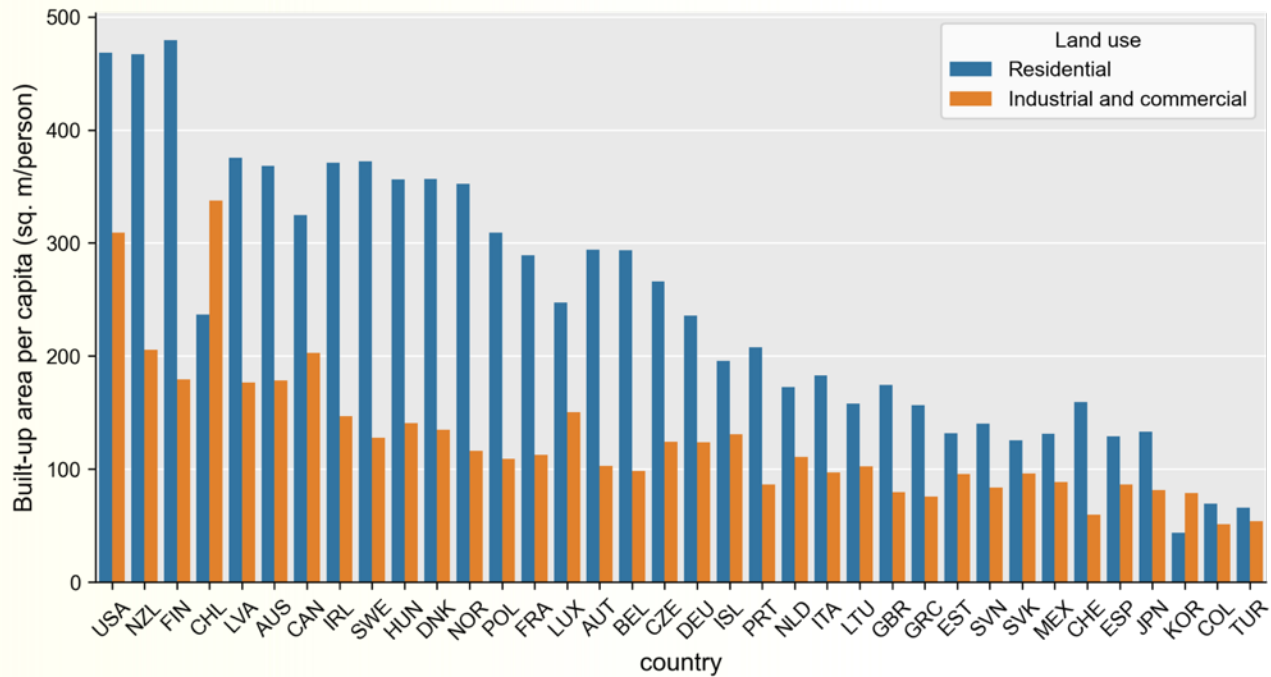


# Analysis

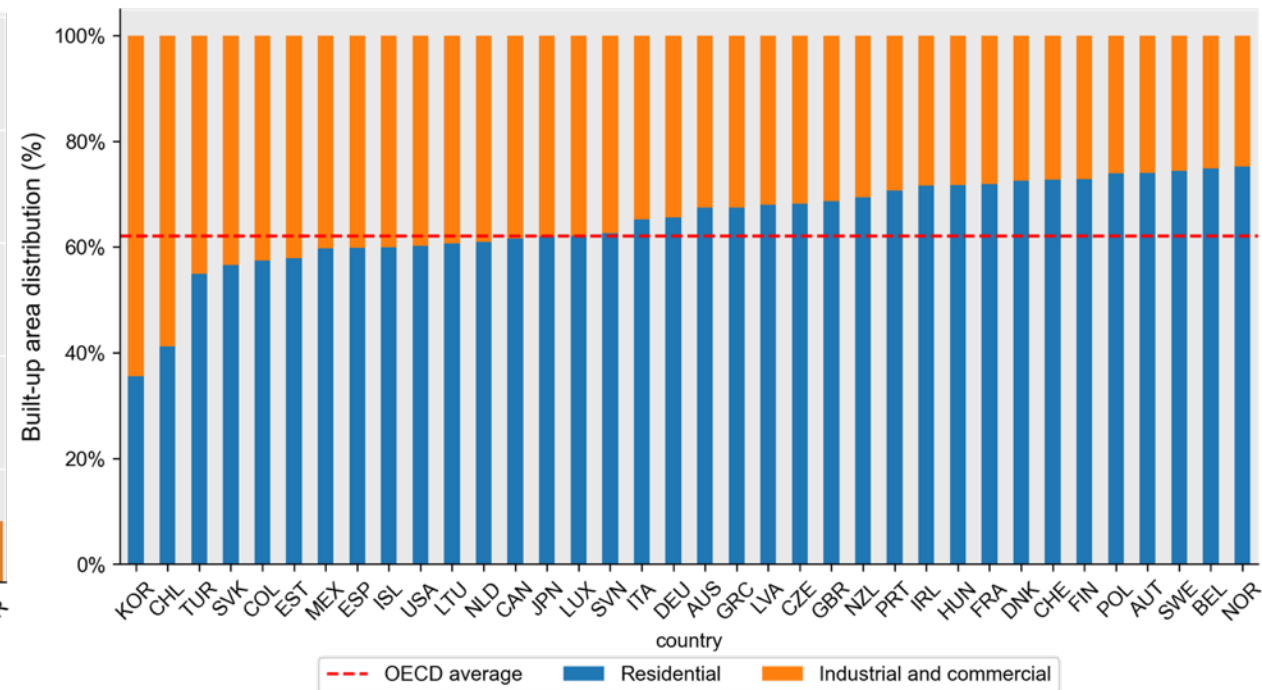


# Built-up area per capita varies substantially across countries

## Built-up area per capita and by land use, 2021

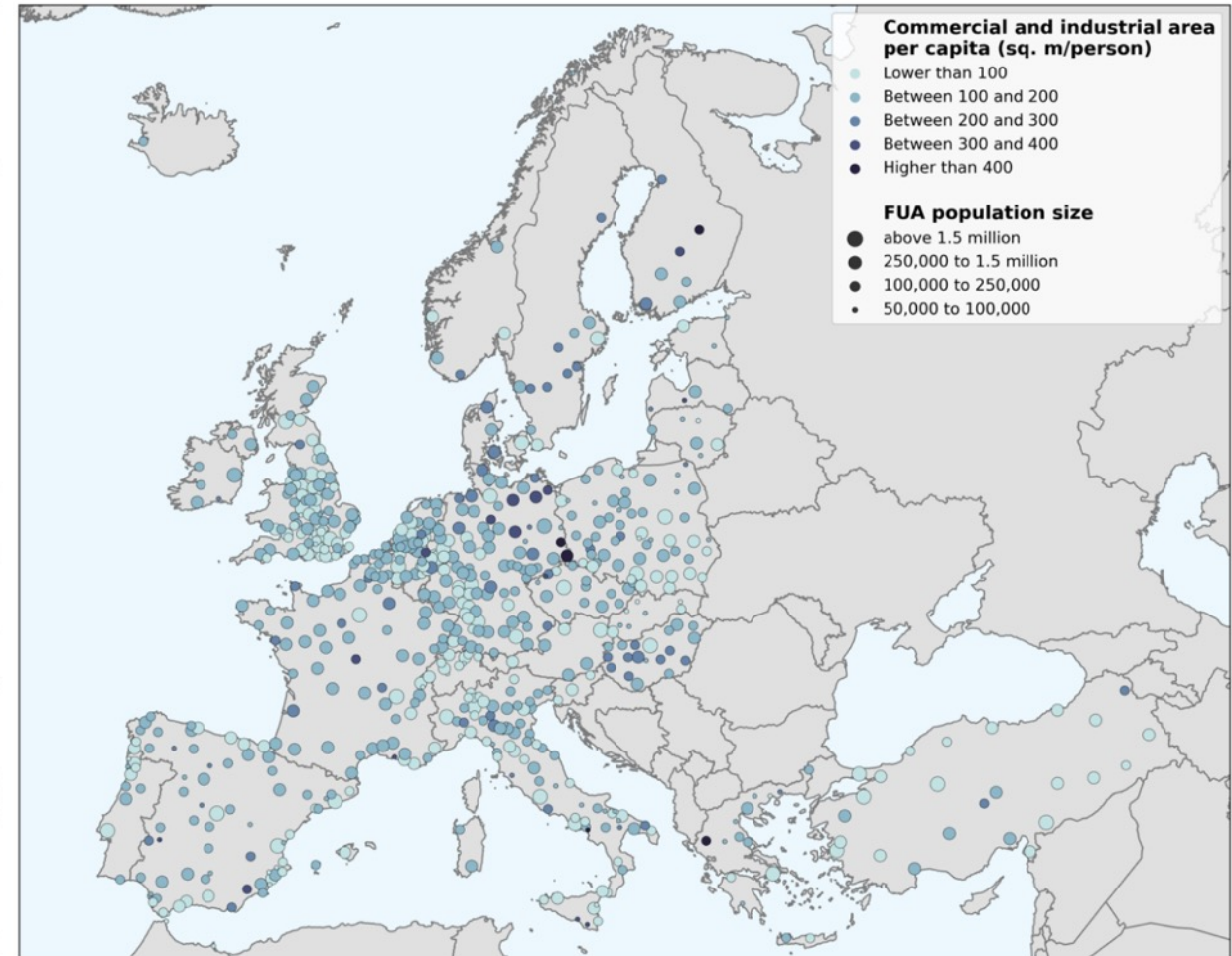
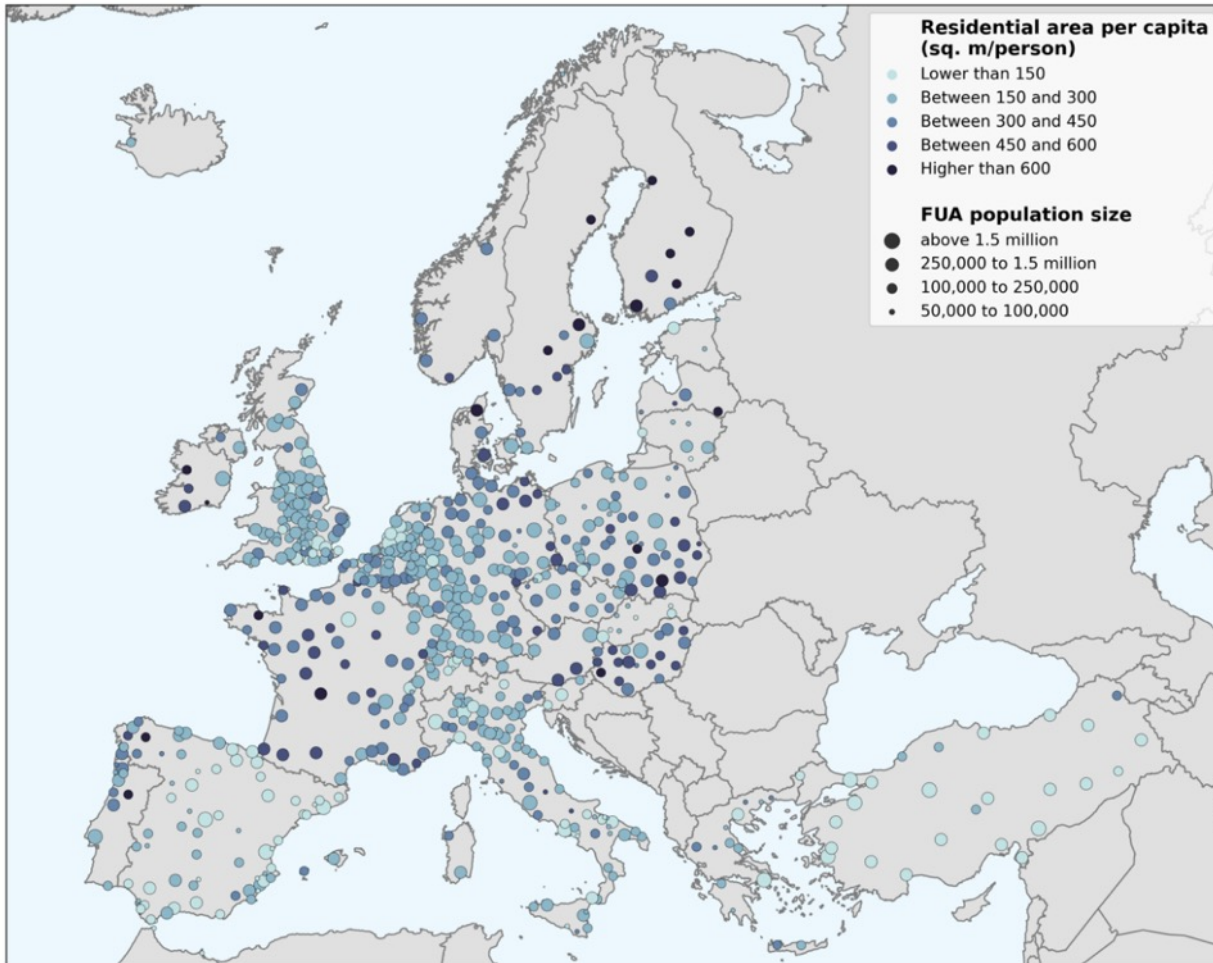


## Distribution in built-up land use, 2021





# Built-up area per capita varies substantially across cities

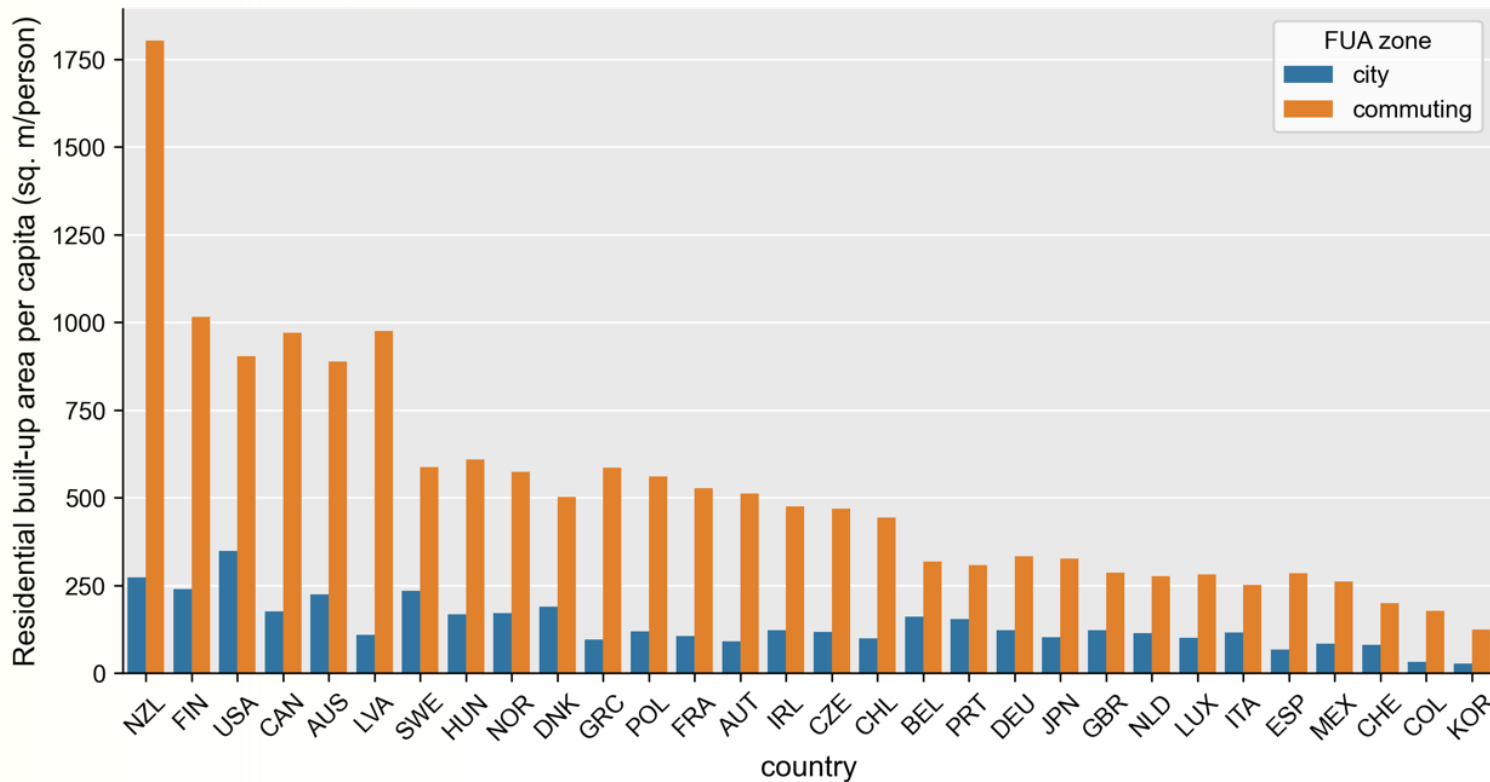






# Built-up area per capita varies substantially between cities and commuting zones

Residential built-up area per capita in cities and their commuting zones, 2021





**Illustration: detecting  
land-use changes**



# Example on the city of Naas (FUA of Dublin)

2018





# Example on the city of Naas (FUA of Dublin)

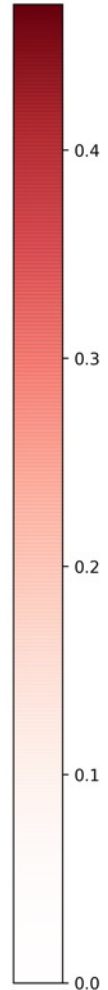
2021





# Example on the city of Naas (FUA of Dublin)

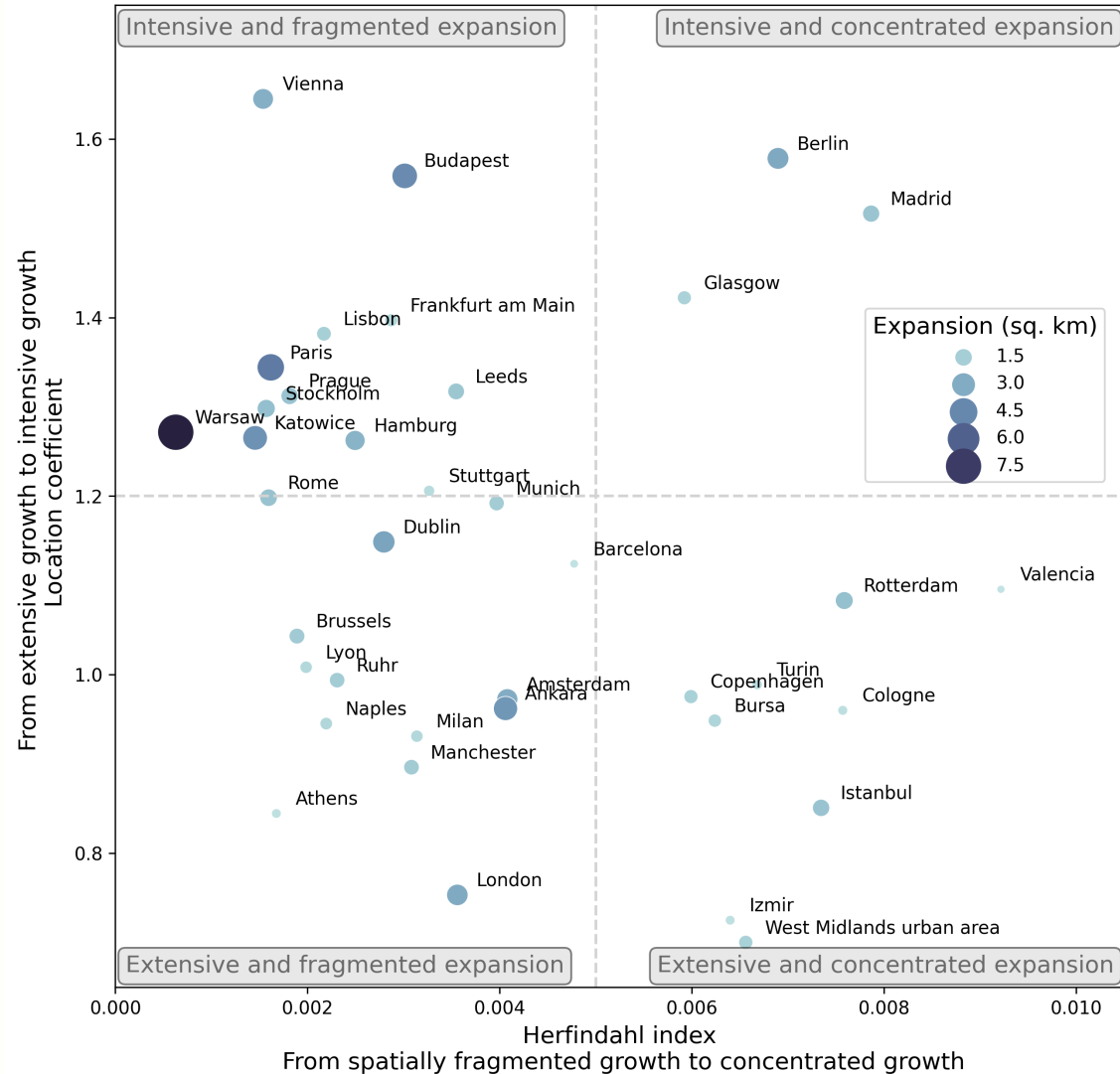
Residential expansion




Commercial & industrial expansion



# Speed and shape of urban expansion





# Conclusion

- **Model enabling to track land use in OECD cities:**
  - Validation on European FUAs
  - Validation still necessary on non-European FUAs and for change detection
  - Working paper coming soon
- **Challenges in the deployment of EO data in the public sector:**
  - Important IT resources required
  - Various technical skills

# Thank you!



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