Central European University
Introduction to Geospatial Data Science 2024/25 Winter

Urban Blue and Green Spaces in Vienna:

Gauging their Positive and Negative Externalities

Prepared by: Isil Oral, Tatyana Yakushina

About the project

This final project is part of a broader Master's thesis conducted in collaboration between the CEU Departments of Economics and Environmental Sciences.

It investigates the externalities of urban blue and green spaces (UBGS), with a particular focus on their influence on socio-spatial inequality and green gentrification processes in Vienna, exploring two questions:

1. What are the **social** and **economic externalities** of UBGS in **Vienna**, particularly in terms of housing prices, income-based segregation, and neighborhood demographic change?

2. Does **social segregation** increase as a result of UBGS, also referred to as **green gentrification**?

Our contribution:

- An important step towards data collection and descriptive spatial analysis that checks two main hypotheses about social segregation and green gentrification.
- In addition to urban green spaces, impact of urban blue spaces are also investigated. This is relatively less in the literature.

Analytical steps

- **Load and clean spatial data**: green spaces, blue areas, districts, buildings, and census indicators.
- **Preprocess geometries**: reproject to a common CRS, clip to Vienna, convert geometry types as needed.
- **Explore socio-economic indicators**: income, unemployment, education levels, and SSI.
- **Calculate green/blue metrics per district**: area, length, and ratios normalized by district size.
- **Run correlations and regressions**: assess links between SSI and green/blue space distribution.
- **Integrate housing price data**: visualize spatial patterns and test influence of green/blue space.
- **Assess WHO 300m rule compliance**: compute straight-line distance to green spaces; flag violations. For future work compute actual walking distances using OpenRouteService.
- **Visualize non-compliance**: with hex bins, district-level shares, and individual district maps

Data collection

Data collection process was done in 2 parts:

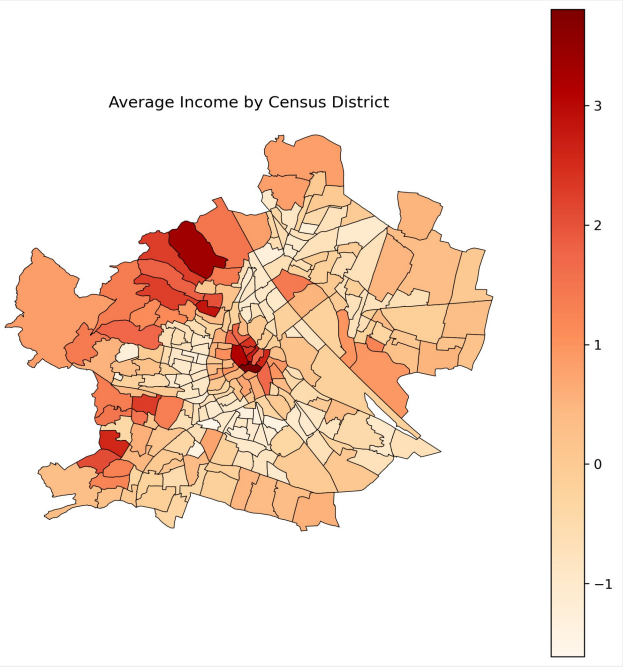
- **Riepl et al. (2025)**[1], Open Data Austria:
  The authors kindly shared both their processed data and original sources upon request.
  - *Urban green spaces data*, OEFFGRUENFLOGD.json
  - *Socioeconomic data by census district,* data_ssi.geojson

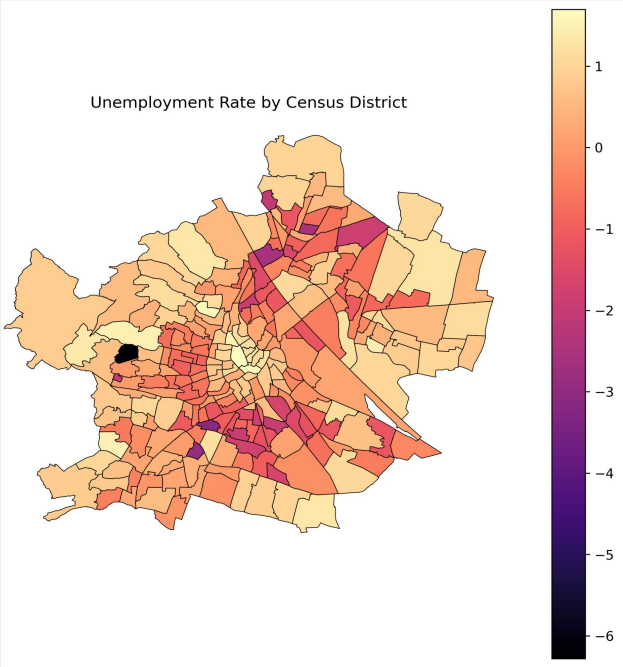
- **Additional data**:
  - *Vienna districts data:* from Homework 2 of the course
  - *Time series* of average residential building (house, apartment, social housing) prices per sq. m, from Statistics Austria

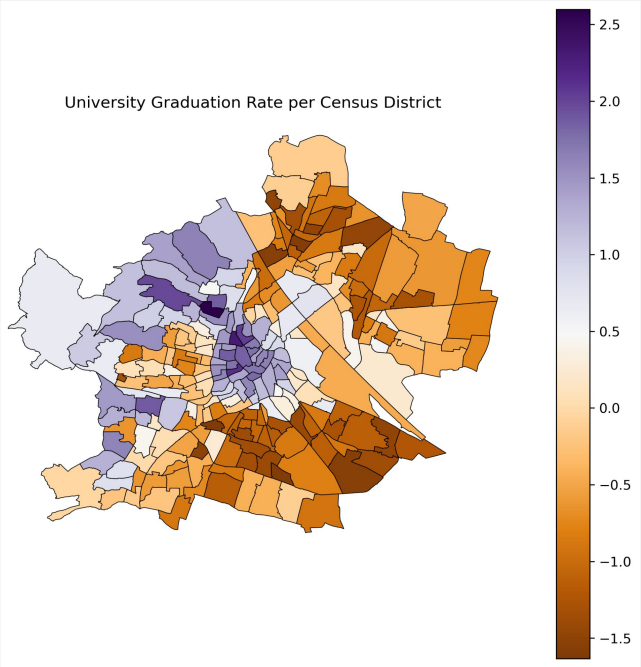
1. Riepl, T., Schaffartzik, A., Grabow, S., & Banabak, S. (2025).
Living well with the foundational economy: Assessing the spatial accessibility of foundational infrastructures in vienna and the relationship to socio-economic status. Ecological Economics, 232, 108558. https://doi.org/https://doi.org/10.1016/j.ecolecon.2025.108558

Data exploration

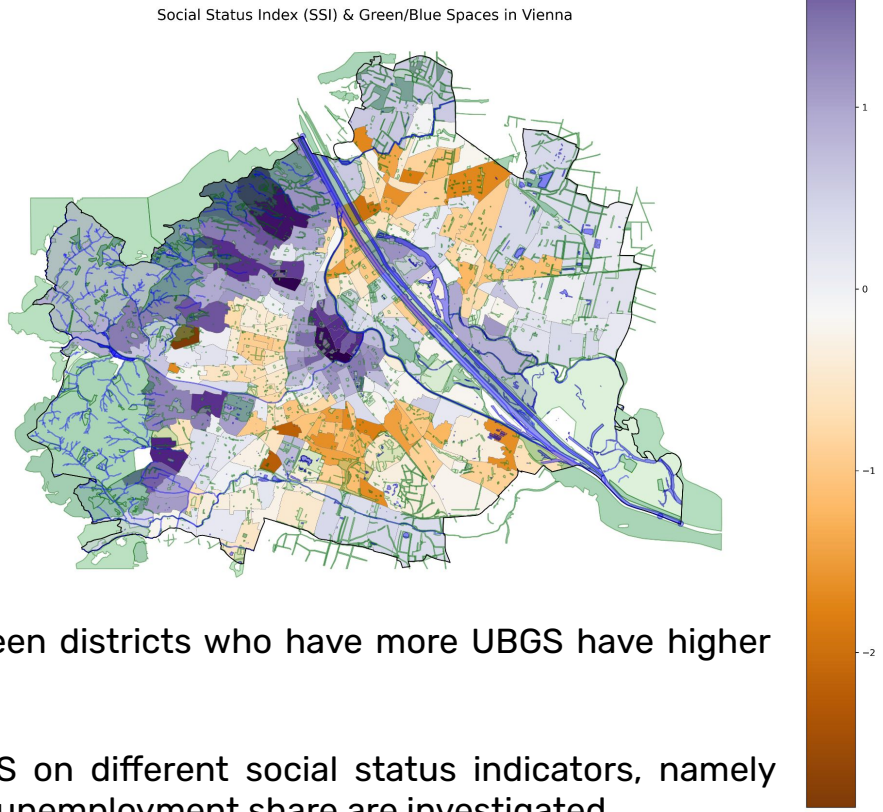
Socio-economic indicators show clear spatial patterns:
lower income and education levels are more common in outer districts,
helping contextualize green space inequalities and potential green gentrification.







Problem proposal: UBGS and Social Segregation



Hypothesis 1.1: There is a positive correlation between districts who have more UBGS have higher performance in Social Status Index (SSI).

- Existence of any significant impacts of UBGS on different social status indicators, namely average income, university graduate level and unemployment share are investigated.

Correlation & OLS

Contribution: Inclusion of blue spaces and investigation of their impact as well as greeneries.

Limitation of Hypothesis 1.1: Since SSI is an index designed artificially by Riepl et. al (2025) without inclusion of greeneries, there is no significant statistical effect of UBGS on SSI or vice versa.

Hypothesis 1.2: Districts with higher green or blue space areas have higher housing prices on average.

e display

OLS Regression Results

Dep. Variable:	2023	R-squared:	0.025
Model:	OLS	Adj. R-squared:	-0.129
Method:	Least Squares	F-statistic:	0.1627
Date:	Wed, 16 Apr 2025	Prob (F-statistic):	0.920
Time:	19:02:11	Log-Likelihood:	-204.08
No. Observations:	23	AIC:	416.2
Df Residuals:	19	BIC:	420.7
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	5840.7097	937.749	6.228	0.000	3877.980	7803.440
green_ratio	-5.179e-05	0.001	-0.094	0.926	-0.001	0.001
blue_area_ratio	-0.0001	0.001	-0.212	0.834	-0.001	0.001
blue_length_km	-4.9045	20.852	-0.235	0.817	-48.549	38.740

Omnibus:	37.707	Durbin-Watson:	2.123
Prob(Omnibus):	0.000	Jarque-Bera (JB):	117.194
Skew:	2.823	Prob(JB):	3.56e-26
Kurtosis:	12.508	Cond. No.	7.62e+06

Results:

- Very weak linear relationship (low R^2) between UBGS and apartment prices per sq. meter in 2023.
- Large condition number indicates severe multicollinearity which is expected as there is a strong overlap between blue and green spaces.
- No statistical significance in any of the coefficients.

Acknowledgment: These results statistically not significant at all! But due to the limited time and the scope of this project, no further research has done. This was expected since housing prices are highly affected by different variables such as room numbers, district, total sq meter, closer amenities and many more.

Problem proposal and framing: WHO 300m rule

WHO 300m rule: The World Health Organization recommends that every urban resident should live within a straight-line distance of 300 meters of accessible green space to support physical and mental well-being.

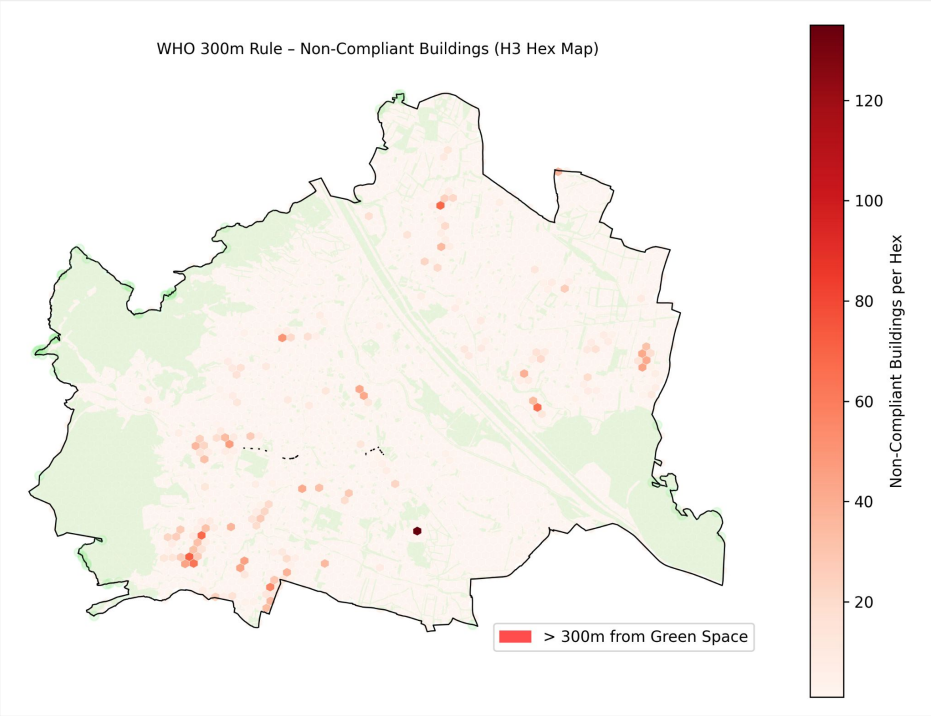
! Importance: Green spaces are essential for urban health, but their distribution may reflect or reinforce inequalities.

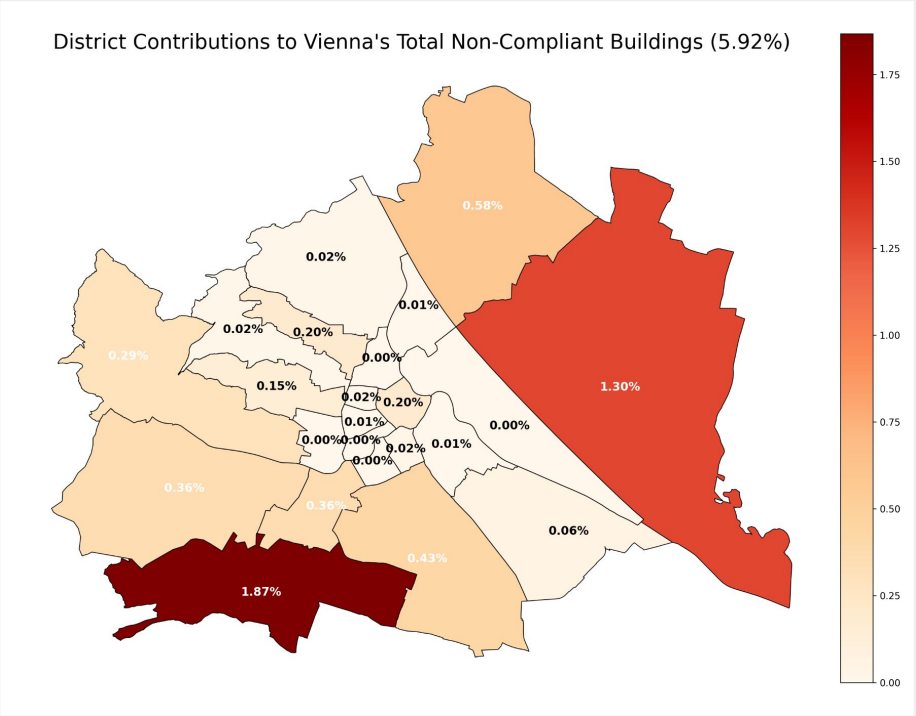
Hypothesis 2.1: Socially segregated or lower-status districts may have less access to green spaces compared to well-developed areas.

Hypothesis 2.2: Central districts may have more non-compliant buildings due to historical development patterns and limited space for green infrastructure.

Summary of WHO 300m rule: City-wide

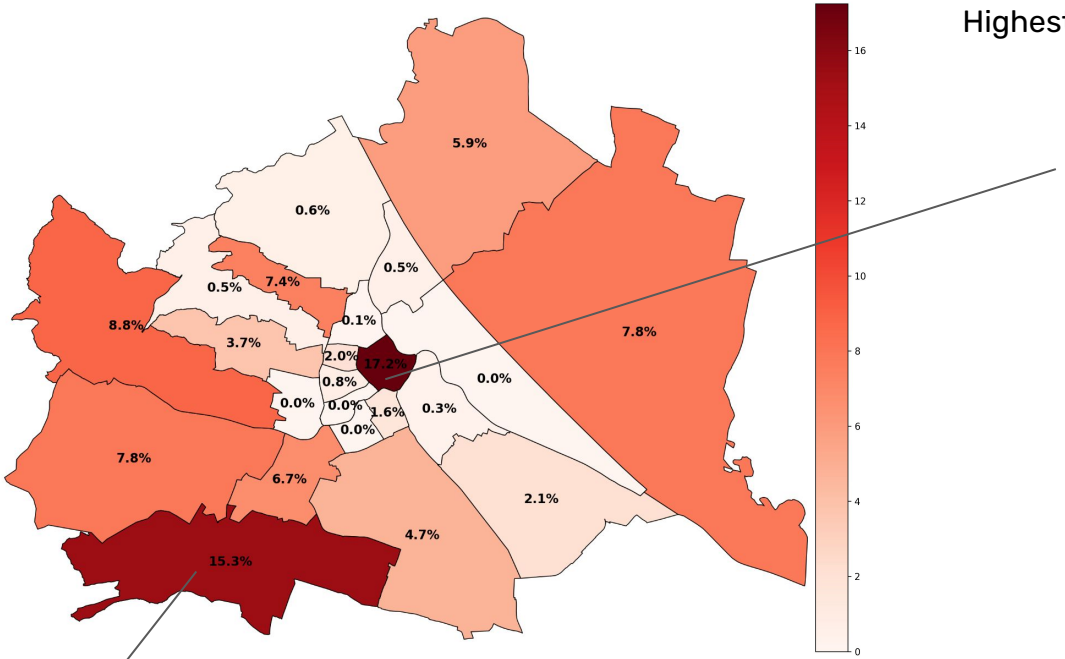
Non-compliance is concentrated in outer districts that tend to have *lower socio-economic status*, suggesting that socially segregated or less affluent areas may face reduced access to green spaces.





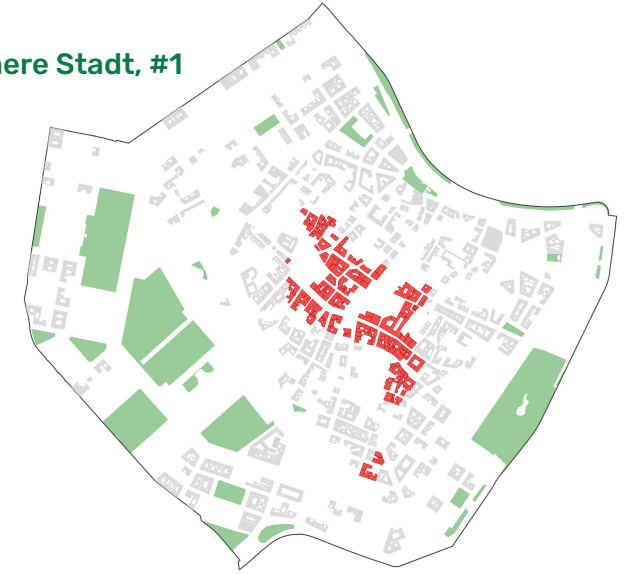
Note: Values near the city border may be underestimated, as green spaces beyond Vienna's boundaries are not considered.

WHO 300m Green Space Non-Compliance (%) by District (Vienna)

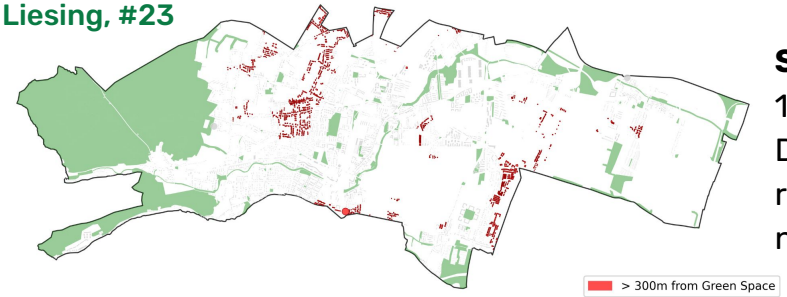


Supports Hypothesis 2.2.
Highest non-compliance rate, due to its dense historic layout and limited space for green infrastructure.

Innere Stadt, #1



Liesing, #23



Supports Hypothesis 2.2: District 23 has the non-compliance rate of 15.3% and contributes most to total non-compliant buildings (1.87%). Despite its green space, large residential pockets in lower-income areas remain underserved, suggesting socio-spatial inequalities limit access to nearby nature.

Thank you!

For any questions or further information, please contact us.

Link to Github repository with code and data.

Isil Oral
Oral_Isil@student.ceu.edu
CEU, MA Economics (Year 2)

Tatyana Yakushina
Yakushina_Tatyana@student.ceu.edu
CEU, MA Economics (Year 2)

We chose to work in pairs to combine different strengths and perspectives,
and to meaningfully contribute both to the course and to a real-world research project.

Note: our presentation includes more than the required 6 slides (as for individual work) to reflect our joint contribution.