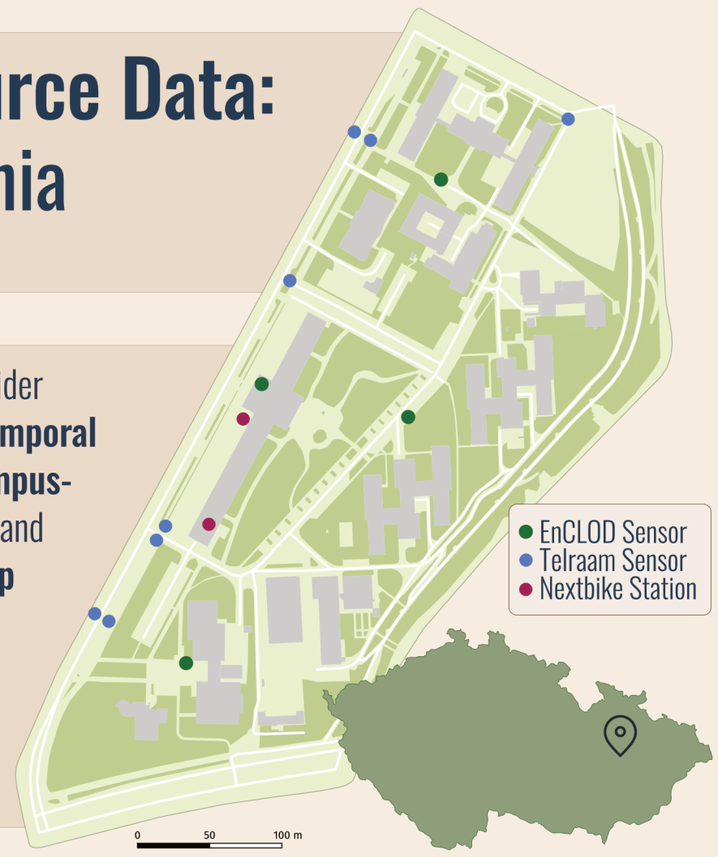
Geovisualisation of Mobility Patterns Using Multisource Data: A Case Study at Envelopa Campus, Olomouc, Czechia

- DIPLOMA THESIS -



Introduction

Mobility within UPOL's Envelopa Campus is shaped by university activity, local residents, commuters and wider urban movement. Although several mobility datasets cover the area, they differ in **spatial coverage, temporal resolution, transport modes and uncertainty**. This thesis uses Telraam, EnCLOD, Nextbike and CHMI weather data to **assess campus-scale mobility patterns.** The analysis focuses on spatial and temporal variation, weather sensitivity, academic-period effects and disagreement between sensors with overlapping coverage. Findings are presented through the written thesis and an interactive **web map dashboard**. The study aims to answer the overarching research question:

"How can heterogeneous mobility data sources be utilised to assess movement patterns within a specified AOI effectively?"

Methodology

0 - Initial steps

- Define AOI and research questions
-Review multisource moblility methods
-Select suitable datasets

1 - Data Acquisition

- EnCLOD and CHMI acquired through APIs
- Telraam downloaded from online interface
- Nextbike OD records provided directly from the company
- Main study period: May 2025 - May 2026, source-specific coverage

Telraam | EnCLOD | nextbike | Czech Hydrometeorological Institute

Multimodal sensor | Motor-vehicle sensors | OD bike share records | Weather records

2 - Preprocessing

- Clean IDs, timestamps and count fields
- Filter Nextbike to AOI-relevant trips and remove OD pairs within 30m, then journey production from least-cost path analysis using NetAScore cycling index
- Aggregate all dataset by day, week, month, weekday-in-month and academic terms

Excel: Quality control of datasets

Python: processing and analysis

ArcGIS Pro: creation of spatial layers

3 - Statistical Analytics

- Calculate KPIs: mean and maximum counts, AM/PM peaks, daily deviations, 24-hour profiles and term-level trends
- Test weather sensitivity using Spearmann and GLM
- Compare Telraam and EnCLOD using symetric percentage differences

4 - Application development

- Interactive maps, charts and filters using HTML, CSS, JavaScript and Leaflet
- Main visualisation: EnCLOD as road segments, Telraam as doughnut markers and Nextbike as estimated route intensity

Leaflet | JS | HTML | CSS

5 - Web hosting

- Static web dashboard deployed on GitHub Pages; requires no specialist software or user installation

Access the interactive dashboard via the **QR code**, or at **mariaannaa.github.io/envelopa_dashboard/**

Results

Overall Mobility Trends

Mobility patterns varied across the AOI and academic calendar. Šmeralova appeared more **sensitive** to university routines, while 17. Listopadu remained active during non-teaching periods, suggesting a **wider urban corridor** function.

Average daily motor-vehicle counts at 17. Listopadu were around **1/3 higher** during the Winter Semester than during the Summer Exam Period.

5,120 AOI-relevant trips

After filtering, **13%** of the original Nextbike records remained. These trips were visualised as **estimated likely routes,** not observed trajectories.

PM peaks were more stable

Most afternoon peaks occurred around **15:00-16:00,** while morning peaks **varied more** by sensor, location and academic period.

Weather and Event Trends

Daily mobility counts were joined with CHMI weather data to test whether **active modes were more weather-sensitive** than motor vehicles, and whether **academic terms** explained variation after accounting for weather and weekday effects.

Mean absolute Spearman correlation was **highest for cyclists** at **0.305**, followed by pedestrians at **0.296** and motor vehicles at **0.117.**

Rainy days were associated with a median cycling **decrease of 13%,** although this effect was less consistent than the cold-day effect.

Cyclists most sensitive

Cycling volumes showed a median **decrease** of **26.82%** on cold days, with statistically significant effects in all cyclist tests.

Academic-term controls improved GLM performance in **100%** of pedestrian and cyclist tests, and **90%** of motor-vehicle tests.

Variability in Sensor Values

Telraam and EnCLOD were compared where both datasets covered the same road segments. Neither dataset was treated as ground truth, so symmetric percentage differences were used to assess **bias and disagreement.**

38% and 88% improvement

Weighted adjustment of Telraam nighttime counts **reduced extreme disagreement** by 38% at the front location and 88% at the side location.

High count disagreements

Median disagreement was **low at the side location**, ranging from 8.1% to 10.9%, but **remained high** at the front location, ranging from 32.8% to 36.8%.

EnCLOD values were **higher in nearly all front-location comparisons** and in most side-location comparisons. Disagreement was **not consistently explained** by traffic volume alone.

Conclusions

Heterogeneous mobility data can reveal campus-scale movement **patterns that no single dataset can explain alone.** In the Envelopa Campus AOI, mobility was shaped by academic periods, street function, weather conditions and sensor characteristics. The results show that multisource mobility data should be **harmonised and compared carefully rather than directly fused.** Telraam, EnCLOD, Nextbike and CHMI each provide useful information, but each also contains different uncertainties, coverage limitations and measurement assumptions. The interactive dashboard communicates findings through maps, charts and KPI cards using a reproducible static-web structure, providing an accessible tool for exploring mobility patterns, while making clear that the values should be **interpreted as indicators of mobility trends rather than exact measurements.**

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