SPATIAL PLANNING & URBAN DESIGN

URBANISM NEXT EUROPE 2021

# Compatibility of Automated Vehicles in Street Spaces – An analysis from Vienna, Austria

Future Perspectives on Public Spaces

**Aggelos Soteropoulos**
future.lab, Institute for Transportation System Planning
Technical University of Vienna

@UrbanismNextEU #UNextEU

# Overview

1. Introduction

2. Method
   - Scenarios
   - Assessment of Compatibility

3. Results
   - Changes in Traffic Volume at peak hour
   - Changes in Compatibility

4. Conclusion

# 1. Introduction

- Most studies on impacts of Automated Vehicles (AVs) on travel behavior indicate an increase in traffic volume (vehicle miles travelled) due to AVs

- Studies were mostly conducted on city wide level → no focus on changes within different street spaces

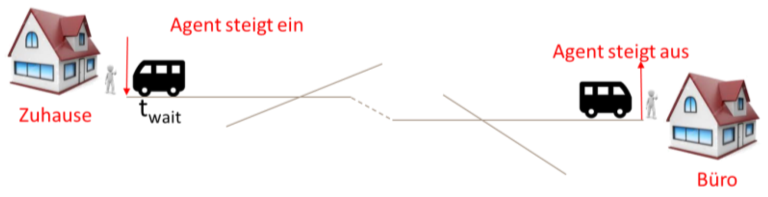
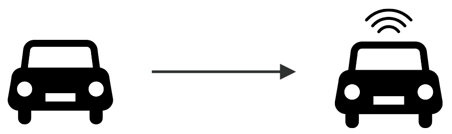
- Streets spaces
  - subject to wide range of competing usage demands
  - not only traffic function but also places for people to move, stroll, meet, sit or play
  - needs between motor vehicles and other road users only reasonable until a certain limit, above this limit no longer compatible with needs of other road users

- **How compatible are AVs in different street spaces due changes in traffic volume?**

# 2. Method: Scenarios

- Simulation of three different scenarios in MATSim
- Whole street network of Vienna, Austria

**Scenarios**

| | | | |
|---|---|---|---|
| **Reference scenario** | **Scenario 1**<br><br>Shared automated Vehicles with door-to-door service<br><br> | **Scenario 2**<br><br>Shared automated Vehicles stopping only at existing bus stops<br><br> | **Scenario 3**<br><br>Automation of all current private vehicles<br><br>+25% utility increase in MATSim<br>+40% road capacity increase<br><br> |

# Assessment of Compatibility I

**1) Determination of Maximum Compatible Traffic Volume**

- Maximum number of vehicles per hour at peak hour
- Based on Area type and age of buildlings, zoning categories and number of shops and business
- Five different area categories


| Area category | Compatible traffic volume (vehicles at peak hour) |
|---|---|
| City centre/ business district | <= 20 (well compatible)<br>>20 - **50** (compatible)<br>>50 – 150 (only just compatible)<br>>150 – 400 (not compatible)<br>>400 (completely not compatible) |
| Mixed-use with intensive commercial use | <= 50 (well compatible)<br>>50 - **150** (compatible)<br>>150 – 400 (only just compatible)<br>>400 – 600 (not compatible)<br>>600 (completely not compatible) |
| Mixed-use with medium intensive commercial use | <= 150 (well compatible)<br>>150 - **400** (compatible)<br>>400 – 600 (only just compatible)<br>>600 – 1000 (not compatible)<br>>1000 (completely not compatible) |
| Low-density residential | <= 400 (well compatible)<br>>400 - **600** (compatible)<br>>600 – 1000 (only just compatible)<br>>1000 – 1200 (not compatible)<br>>1200 (completely not compatible) |
| Industrial | <= 600 (well compatible)<br>>600 - **1000** (compatible)<br>>1000 – 1200 (only just compatible)<br>>1200 – 1500 (not compatible)<br>>1500 (completely not compatible) |

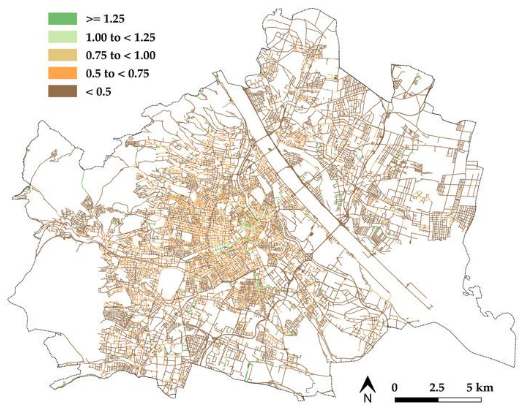
# Assessment of Compatibility II

**2) Adaptation of the Maximum Compatible Traffic Volume based on further characteristics**

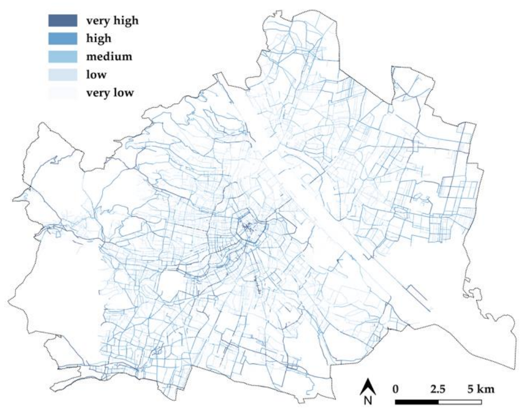
- Distribution of space
- Use by pedestrians and cyclists
- Speed
- Heavy goods vehicle traffic
- Crossing needs
- Green and design elements
- Crossability

+ Weighting of Criteria

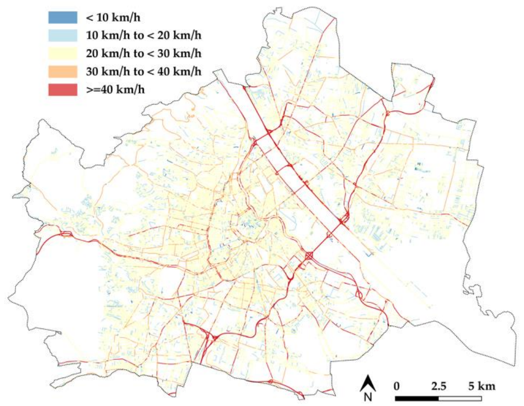
**Distribution of space**
ratio between area width for pedestrians and cyclists in comparison to area width for motorized traffic



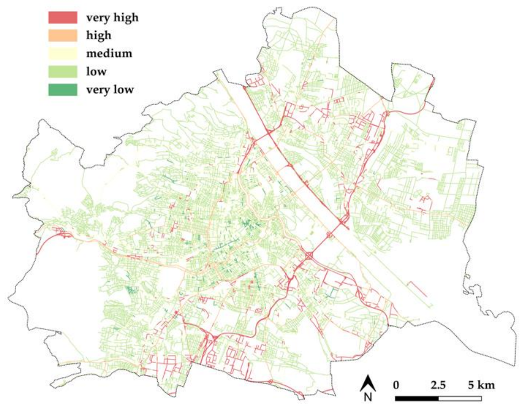

**Use by pedestrians and cyclists**




**Speed**
average speed of motor vehicles in reference scenario



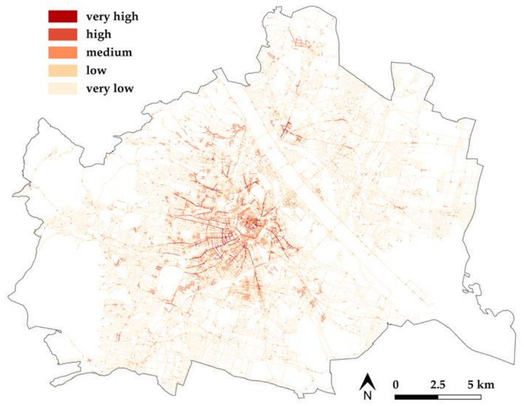

**Heavy goods vehicle traffic**
share of heavy goods traffic of the total motor vehicle traffic volume



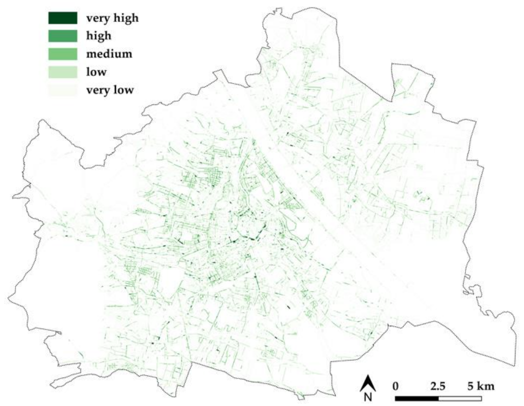

**Weighting of Criteria**

| Criterion | Weighting 1: Equal Weights of Criteria | Weighting 2: Higher Weight for C1, Lower Weight for C5 and C6 | Weighting 3: Considerable Higher Weight for C1, Lower Weights for C3 to C7 |
|---|---|---|---|
| C1: Distribution of space | 1 | 2 | **3.5** |
| C2: Use by pedestrians and cyclists | 1 | 1 | **1** |
| C3: Speed | 1 | 1 | **0.5** |
| C4: Heavy-goods vehicle traffic | 1 | 1 | **0.5** |
| C5: Crossing needs | 1 | 0.5 | **0.5** |
| C6: Green and design elements | 1 | 0.5 | **0.5** |
| C7: Crossability | 1 | 1 | **0.5** |

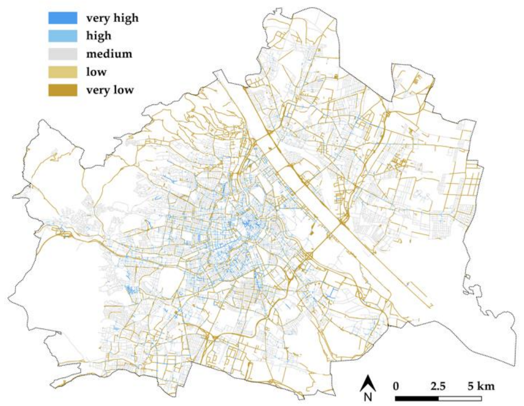
**Crossing needs**




**Green and design elements**
number of trees, bushes and design elements




**Crossability**



# Assessment of Compatibility III

**3) Comparison between actual traffic volume and adapted maximum compatible traffic volume**

- For reference scenario and all three scenarios with AVs

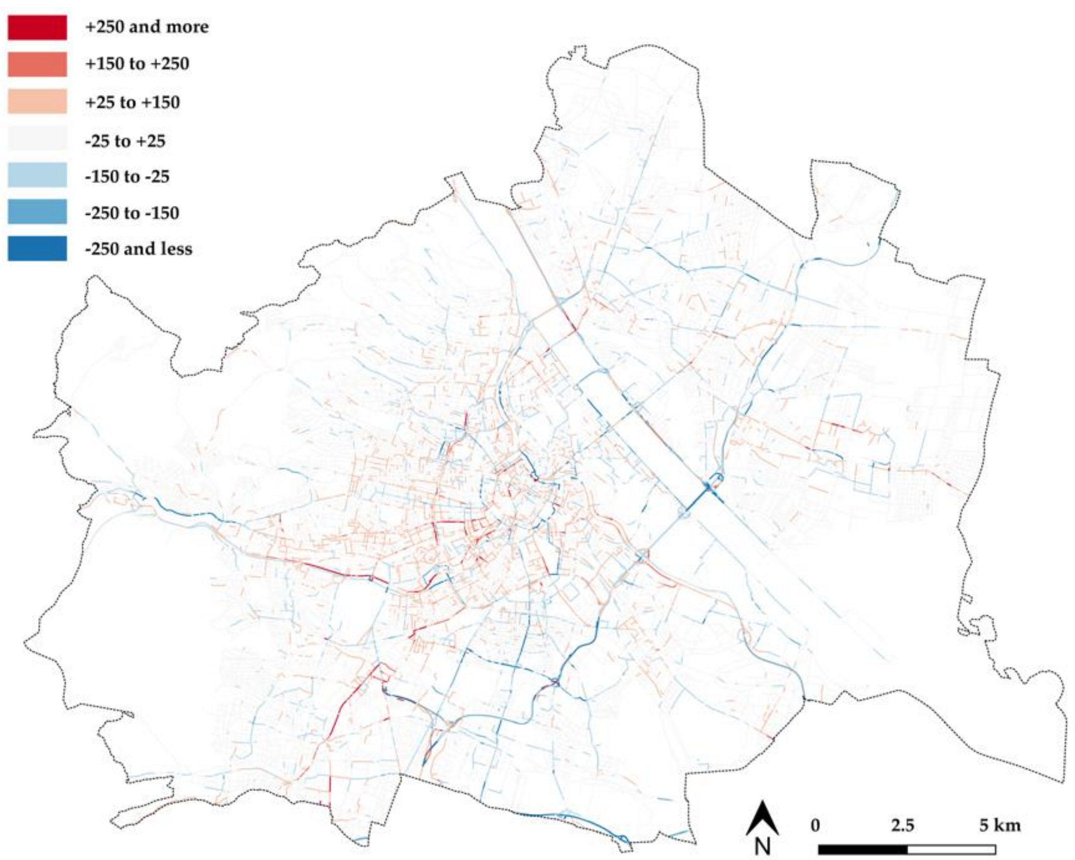
| Street Section | Maximum Compatible Traffic Volume | Adaptation of Maximum Compatible Traffic Volume | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | C1 | C2 | C3 | C4 | C5 | C6 | C7 | Total | Adapted Maximum Compatible Traffic Volume | Actual Traffic Volume | Assessment of Compatibility |
| Street section in area category “mixed-use with intensive commercial use” | 150 | +175 | −100 | −25 | −50 | ±0 | −25 | +50 | +25 | ≤75 (++)<br>>75 bis 175 (+)<br>>175 bis 425 (o)<br>>425 bis 625 (-)<br>>625 (--) | 157 | + compatible |
| | | weights | | | | | | | | | | |
| | | 3.5 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | | | | |
| | | unweighted | | | | | | | | | | |
| | | +50 | −100 | −50 | −100 | ±0 | −50 | +100 | | | | |

C1 = criterion distribution of space; C2 = criterion use by pedestrians and cyclists; C3 = criterion speed; C4 = criterion heavy-goods vehicle traffic; C5 = criterion crossing needs; C6 = criterion green and design elements; C7 = criterion crossability.

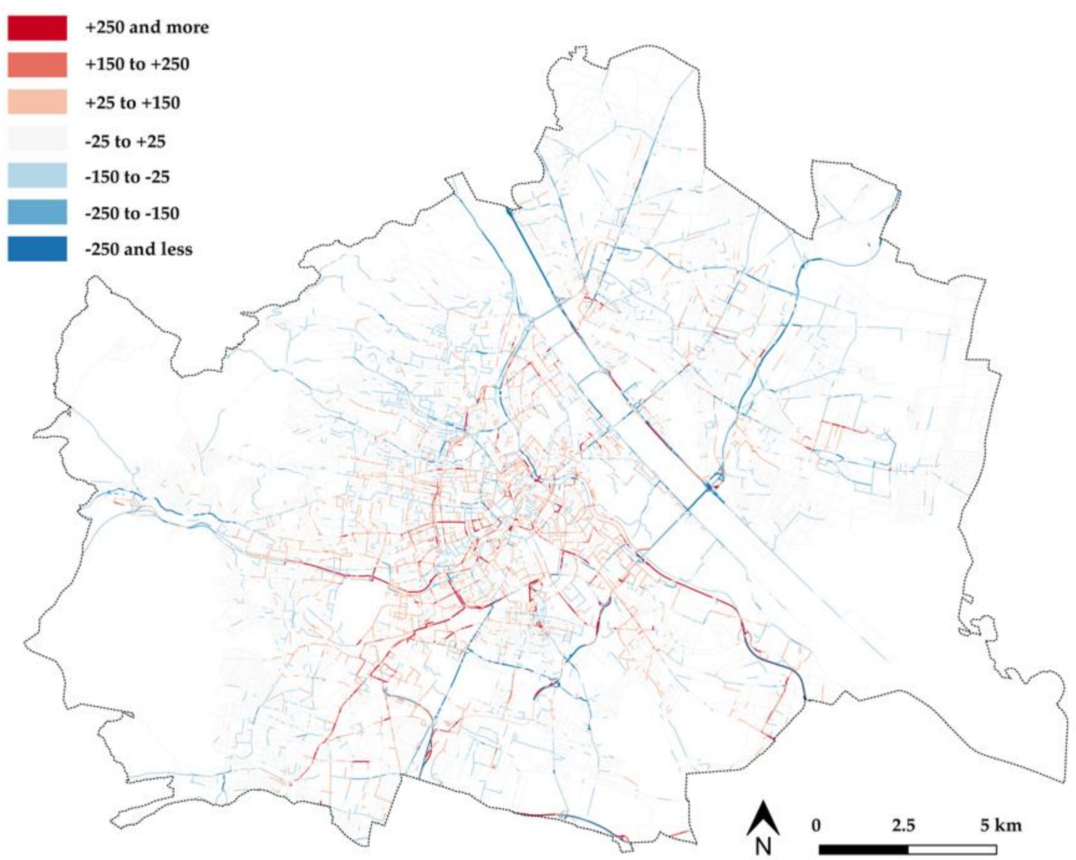
# 3. Results: Street-Level Changes in Traffic Volume at Peak Hour

- Increase of vehicles at peak hour in the inner parts of the city for both scenarios with SAVs
- Decrease of vehicles at peak hour in outskirts, especially for Scenario 2
- Increase of vehicles at peak hour at higher-level street network for private AVs

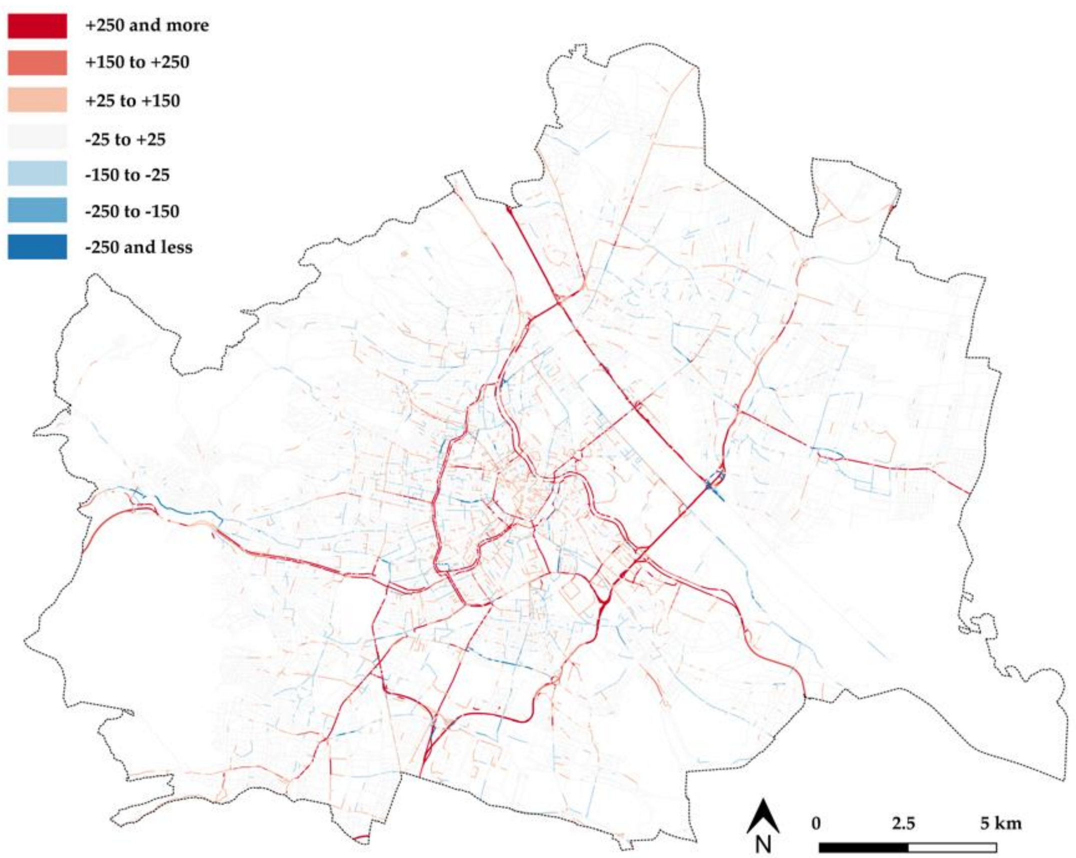
Scenario 1 in comparison to reference scenario




Scenario 2 in comparison to reference scenario



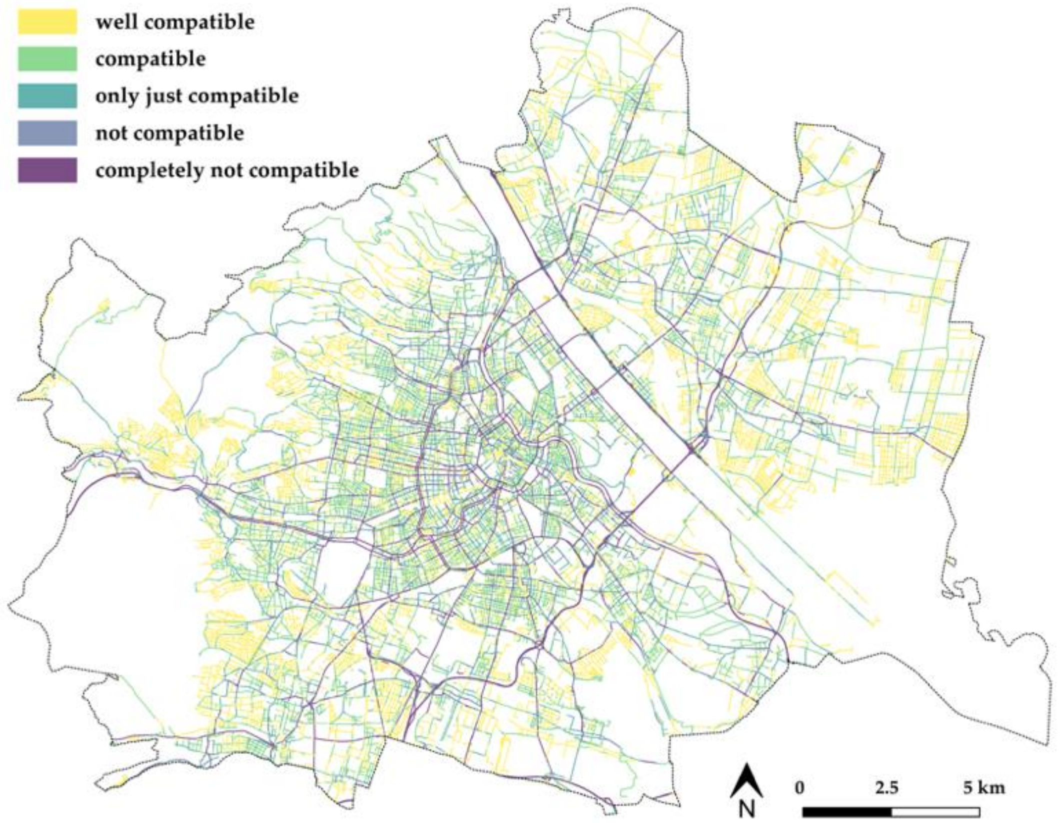

Scenario 3 in comparison to reference scenario



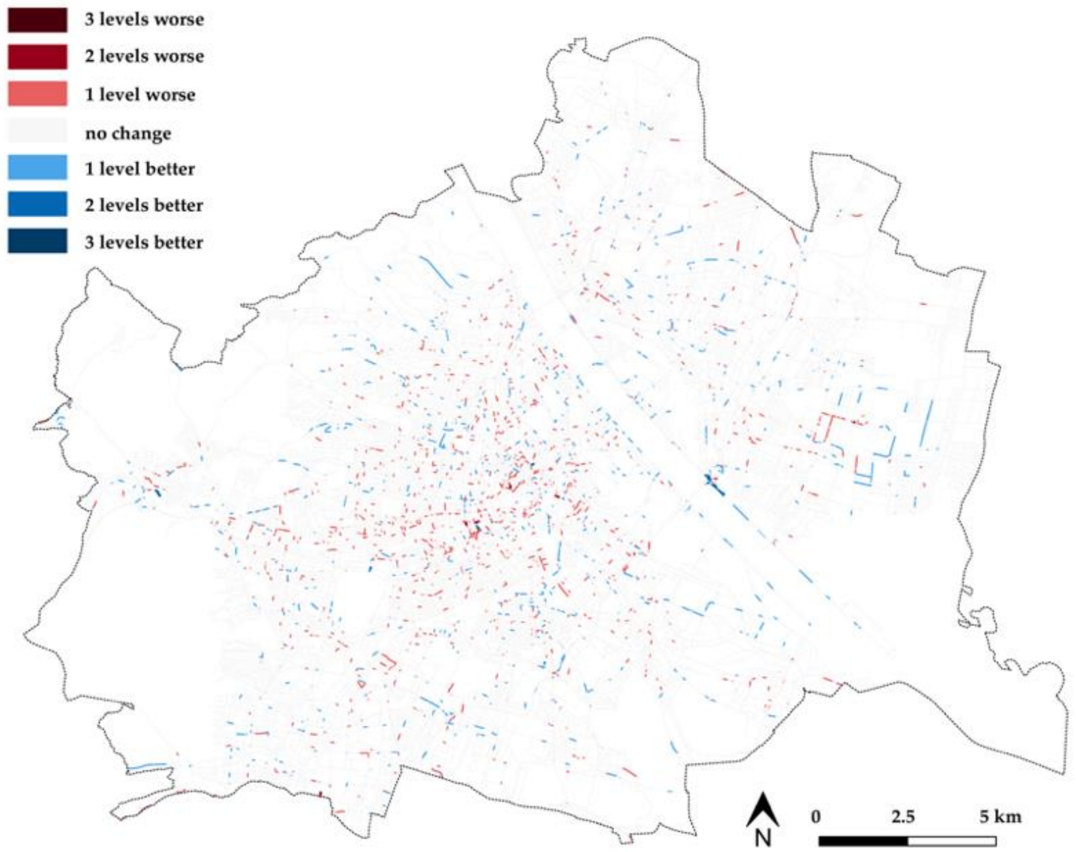
# Changes in the Compatibility of Street Spaces

- Actual traffic volume in the reference scenario is mostly not compatible with the needs of the surrounding uses and users in the higher-level street network and in several streets in the lower-level street network in the inner parts of the city
- All scenarios with AVs show lower levels of compatibility in comparison to the reference scenario, especially in the inner parts of the city
- Improvement in compatibility along streets in the outskirts, especially for Scenario 2

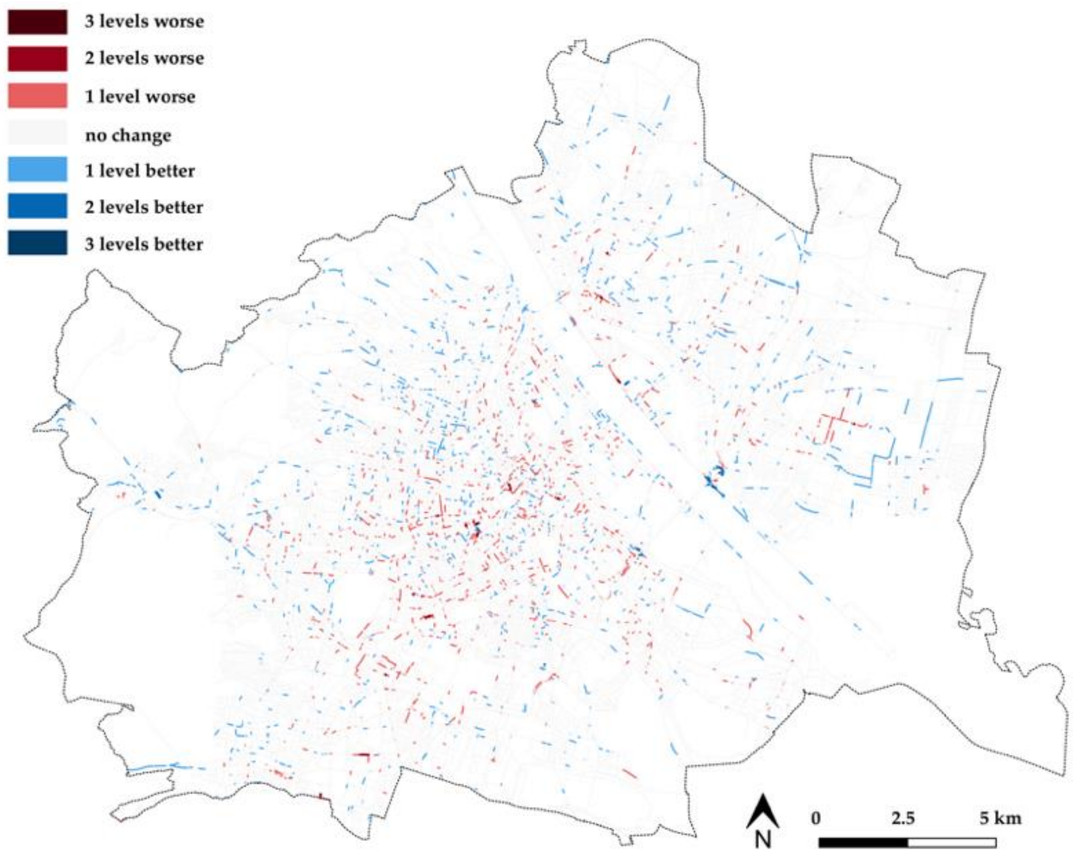
**Reference scenario**



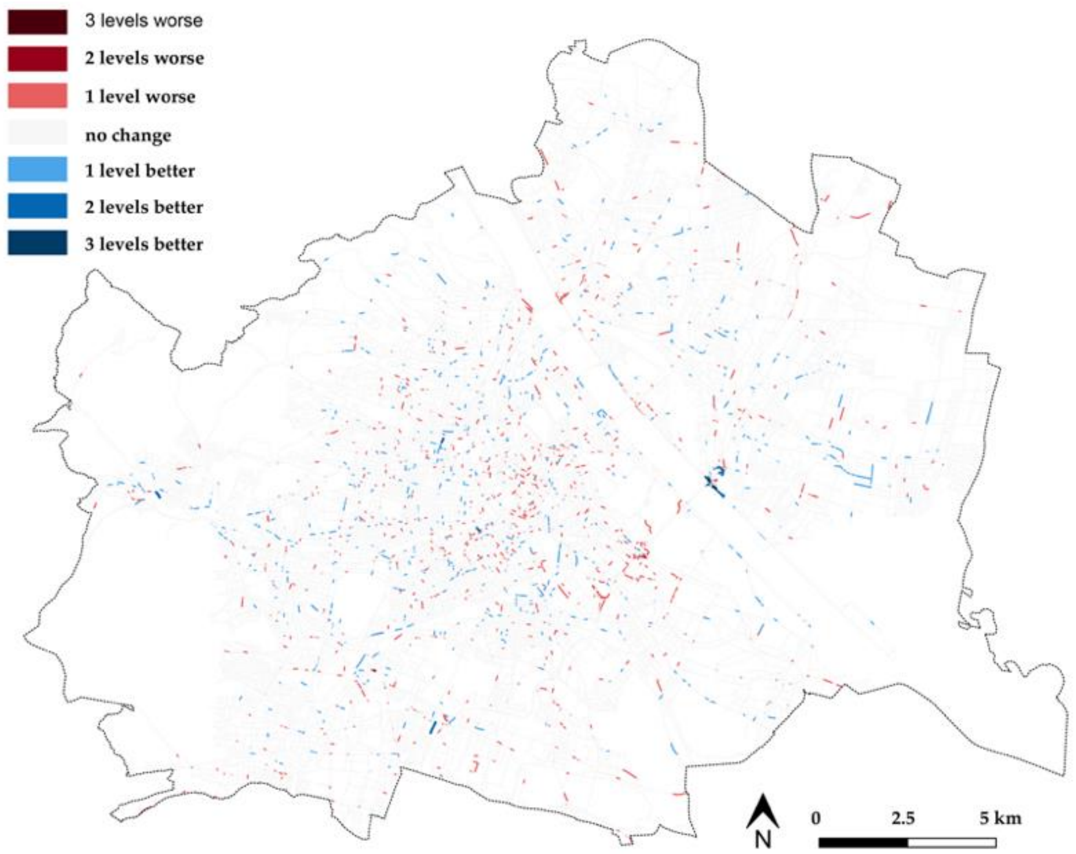

**Scenario 1 in comparison to reference scenario**




**Scenario 2 in comparison to reference scenario**




**Scenario 3 in comparison to reference scenario**

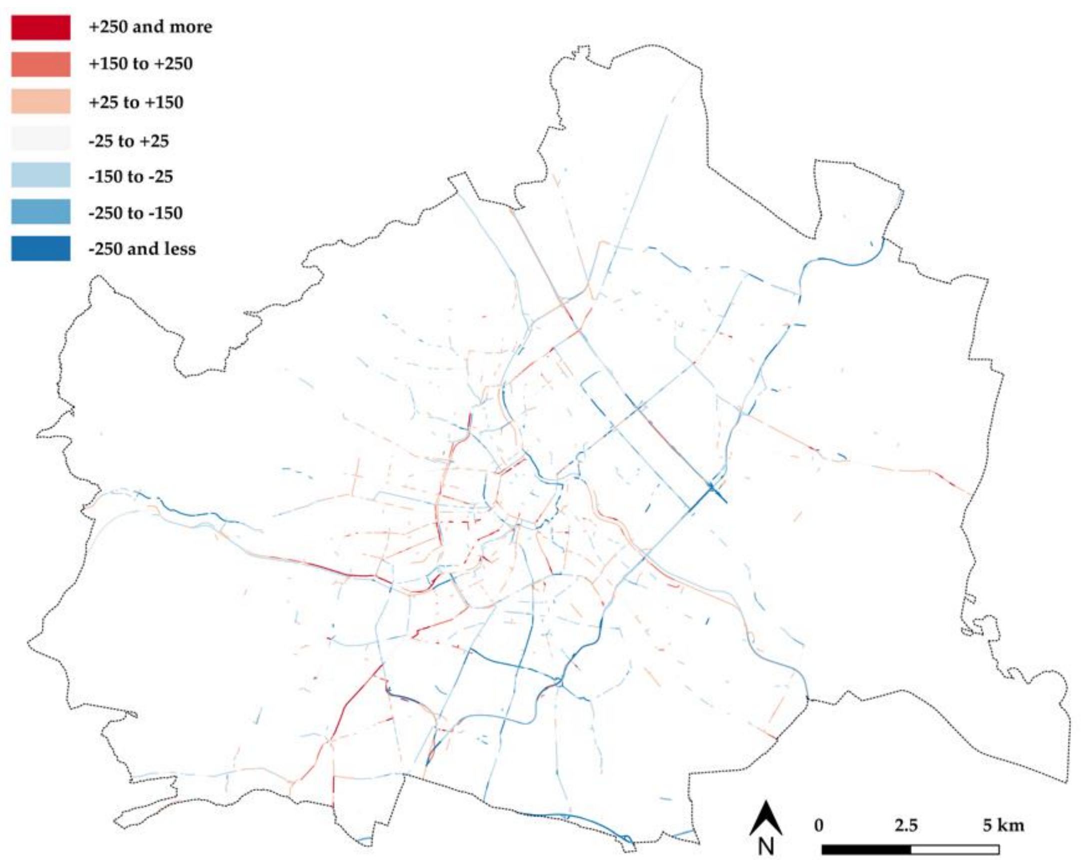


# Changes in traffic volume in already not compatible street spaces in the reference scenario

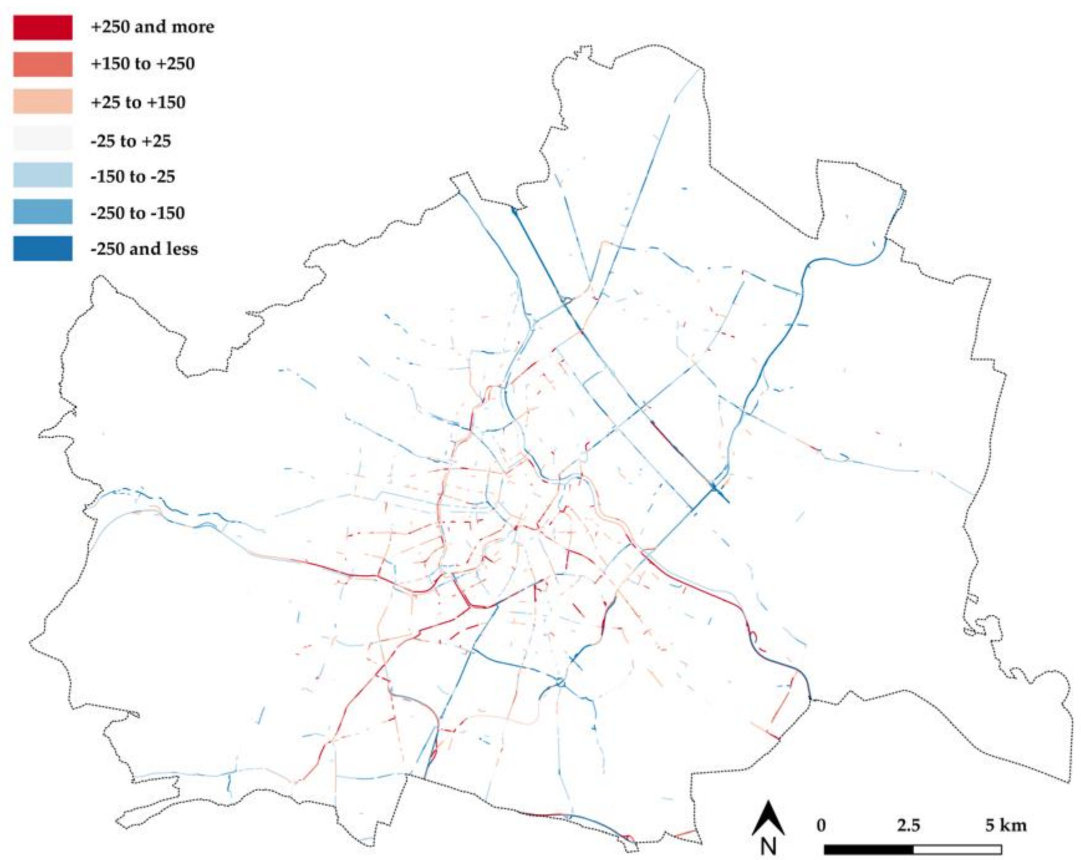
- For scenarios with SAVs increases of vehicles at peak hour in completely non-compatible street spaces are observable only in the eastern and southern part of Vienna

- In Scenario 3 traffic volume at peak hour highly increases in most of the already completely non-compatible streets → even higher non-compatibility and further increasing separating or barrier effect of such streets

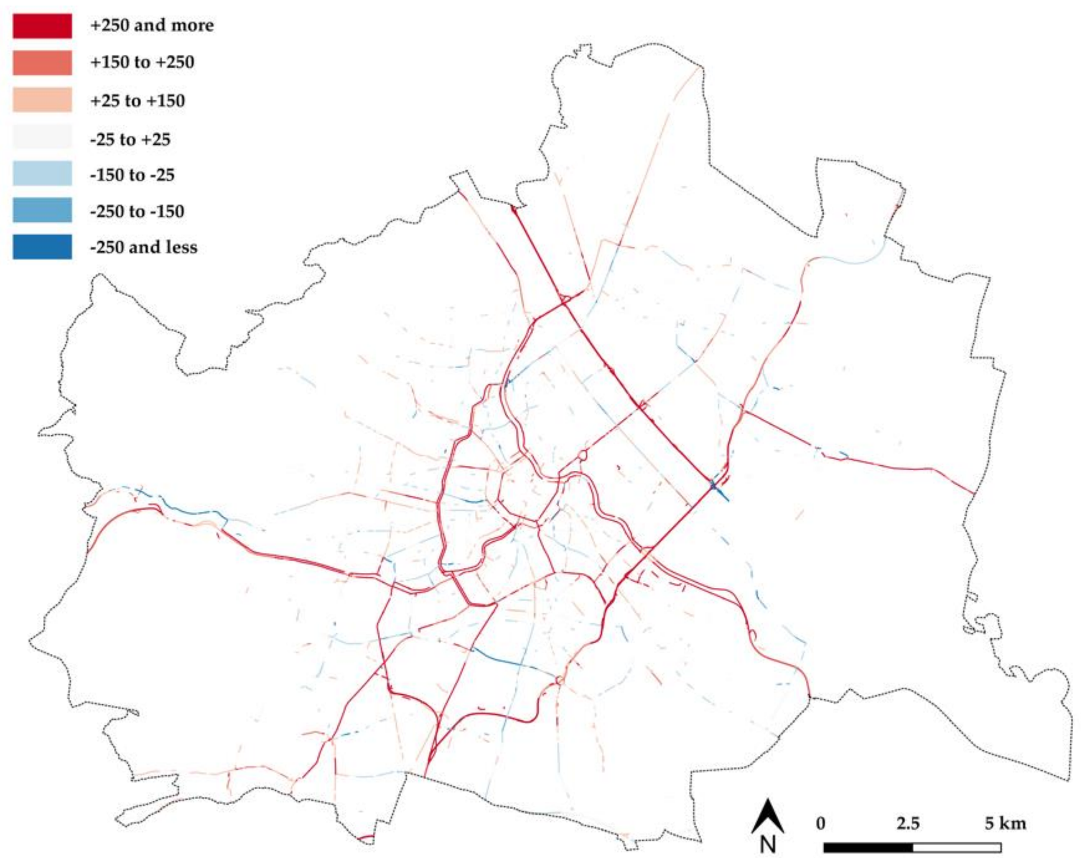
Scenario 1 in comparison to reference scenario




Scenario 2 in comparison to reference scenario




Scenario 3 in comparison to reference scenario



# 4. Conclusion

- **Spatially different strategies for the implementation of AVs are needed in the future!**

- **Street spaces in areas in the outskirts**
  - Sensibility towards a further increase of vehicles due to AVs is lower and conflicts less with other needs of uses and users than in the inner parts of the city
  - Implementing SAVs in addition to public transport may decrease traffic in these areas and thus might be interesting for cities to consider

- **Street spaces in which the current traffic volume at peak hour is already not compatible with the usage demands and especially in inner-city areas**
  - AVs could induce traffic volumes
  - Street spaces should be designed to be more compatible with the needs of pedestrians and cyclists e.g., by implementing walking and cycling infrastructure, speed reduction, or additional crossing aids or the implementation of AVs should be linked to these measures.
  - conversion of parking spaces in favor of such design elements and space for pedestrians and cyclists seems important and could become an appropriate and (more accepted) measure with regard to future concepts with AVs, as parking needs—especially in the case of SAVs – could be reduced

- **Analyses that take into account the spatial heterogeneity in cities are important! → not only with regard to compatibility but also with regard to the technical-infrastructural suitability of street spaces for AVs (e.g. different complexity for automated driving systems)**

# Further information

**Soteropoulos, A., Berger, M., Mitteregger, M. (2021). Compatibility of Automated Vehicles in Street Spaces: Considerations for a Sustainable Implementation. Sustainability, 13(5), 2732.**
**https://www.mdpi.com/2071-1050/13/5/2732**

# Thank you!

Do you have any question?

Ask Aggelos Soteropoulos, aggelos.soteropoulos@tuwien.ac.at