MEASURING AND VISUALISING 15-MIN-AREAS FOR FAIR CO_2 BUDGET DISTRIBUTION

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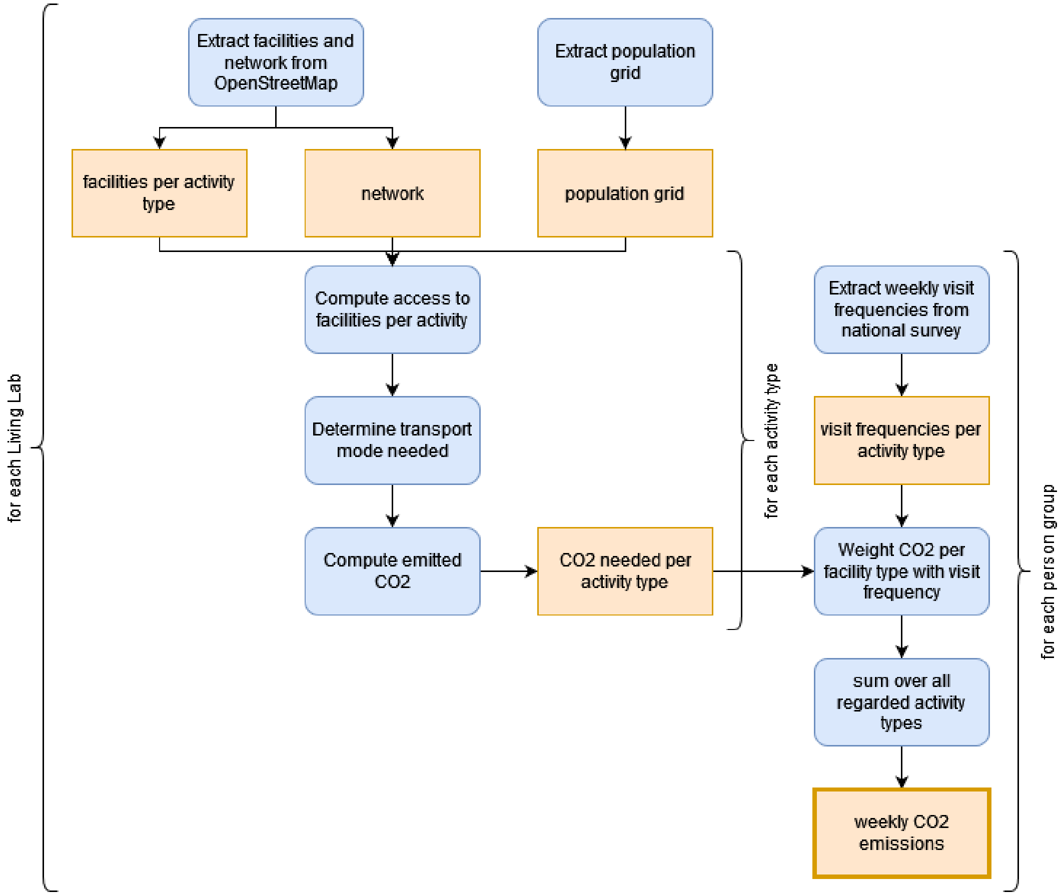
Project Context
MyFairShare – JPI Driving Urban Transition

- MyFairShare develops fair individual CO_2 mobility budgets
  - European countries are obligated to reduce their greenhouse gas emissions
  - On individual level, we do not see an adaptation
  - The importance of sufficiency for achieving sustainability is increasingly considered
- Project's assumptions
  - Assumption #1: people do not understand national greenhouse reduction targets, these targets must be broken down to the individuals
  - Assumption #2: people accept restrictions and disadvantages if they are perceived as being fair
- Herein, we describe how we've computed "needed CO_2 emissions" from which "fair, minimum CO_2 mobility budgets" will be derived

Project Context
Computing needed CO_2 emissions – Overview

- Research question: How much CO_2 emissions people cannot avoid nowadays
- Method
  - We distinguish five major activity types: education, errands, leisure, shopping, work
  - For each starting location, we compute the access times to the next places the respective activity can be performed at
  - Modes: walking, bicycling, public transport, own car
  - We determine the mode of transport needed to access these places in 15 minutes
  - We weight the obtained CO_2 emissions by the number of times the respective activity is performed in a week



Determining needed CO_2 budgets
Variance in activity places and mode selection

- We distinguish five major activity types: education, errands, leisure, shopping, work
- For each type of activity places, we need a minimum number that is accessible (not everyone works in the local bakery, e.g.)

	work	education	shopping	leisure	errands
Number of facilities to access	1000	3	2	30	10

- Access is performed using the most sustainable mode of transport as long as it does not take more than 15 minutes
  - Order: walking, bicycling, public transport, motorised individual traffic

Determining needed CO_2 budgets
(Open) Data

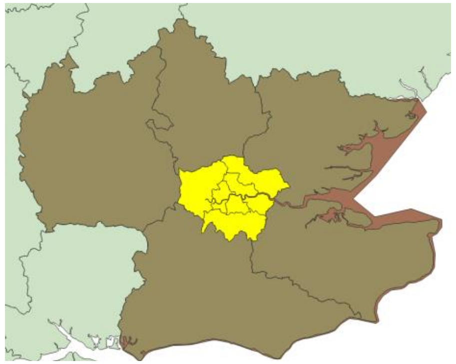
- Open Data
  - Population: from GEOSTAT (2018 version, derived from the 2011 census), 1 km × 1 km grid
  - Facilities: OpenStreetMap
  - Road networks: OpenStreetMap
  - Public transport schedule: GTFS (London had no complete dataset, we had to merge several to get a good coverage)
- Complex rules for retrieving facilities from OpenStreetMap
- Known issue: work places are the most problematic information, we use
  - Points-of-interest for leisure, errands and education facilities
  - Areas of commercial and industrial land use, divided by 400

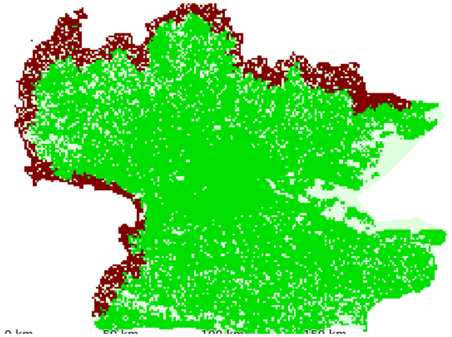
```
[node]
amenity~bank
amenity~embassy
amenity~post_office
amenity~police
amenity=townhall

amenity~dentist
amenity~clinic
amenity~doctors
amenity~hospital
amenity~pharmacy
healthcare=*

shop~beauty
shop~hairdresser
shop~massage

craft~dressmaker
craft~optician
craft~shoemaker
craft~photographer
craft~tailor
craft~watchmaker
```

Errands nodes

Determining needed CO_2 budgets
Selected areas

- We have five Living Labs in the project: Berlin (DE), London (UK), Jelgava (LV), Sarpsborg (NO), Vienna (AT)
- We selected a bigger area around each city (here: London) to
  - avoid boundary issues
  - incorporate sub-urban and rural areas
- We dismissed cells with a travel time less than 15 minutes (for all modes) to the border to avoid boundary issues

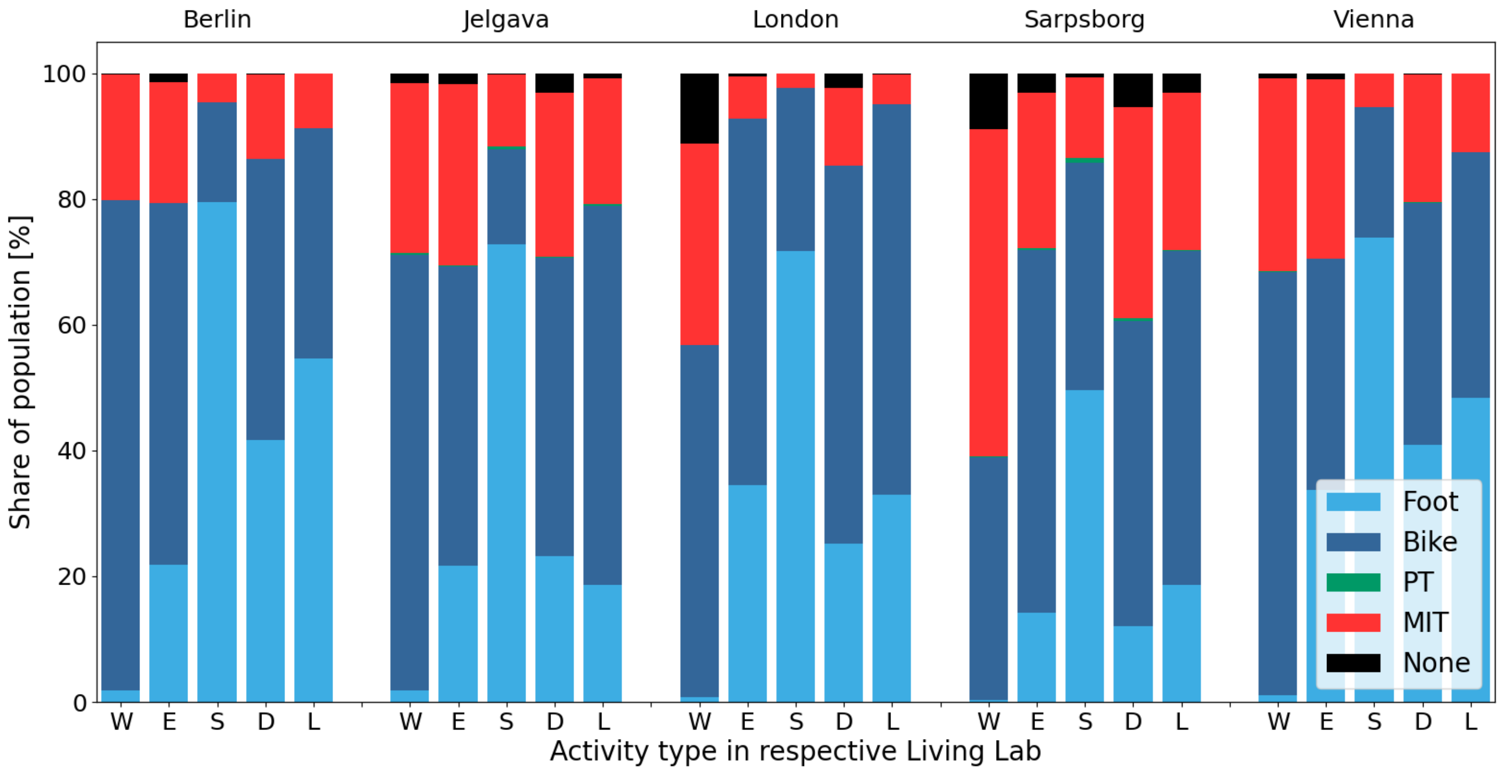




	Berlin	Jelgava	London	Sarpsborg	Vienna
City size (in km^2)	891.70	60.56	1572.03	405.61	414.82
Chosen area size (in km^2)	30546.34	21188.02	24171.72	62373.20	23576.23

Results

Modes needed to access the facilities



W: Work
E: Education
S: Shopping
D: Errands
L: Leisure

- Public transport is hardly better than using a bike for travel times ≤ 15 minutes
- In some areas, the required number of facilities cannot be accessed in 15 minutes even when using a car (“None”)
- Esp. shopping facilities can be accessed by walking in most / many areas
- Differences between rather urban and rather rural (Sarpsborg, Jelgava) areas

Results
Weighting access with visit frequency CO_2

- Given the access (travel times, CO_2) to the different facility types, we can weight it using the frequencies of visiting them
  - Derived from the Austrian mobility survey “Österreich unterwegs”[(1)]
  - Other person groups could be derived as well, as long as big enough

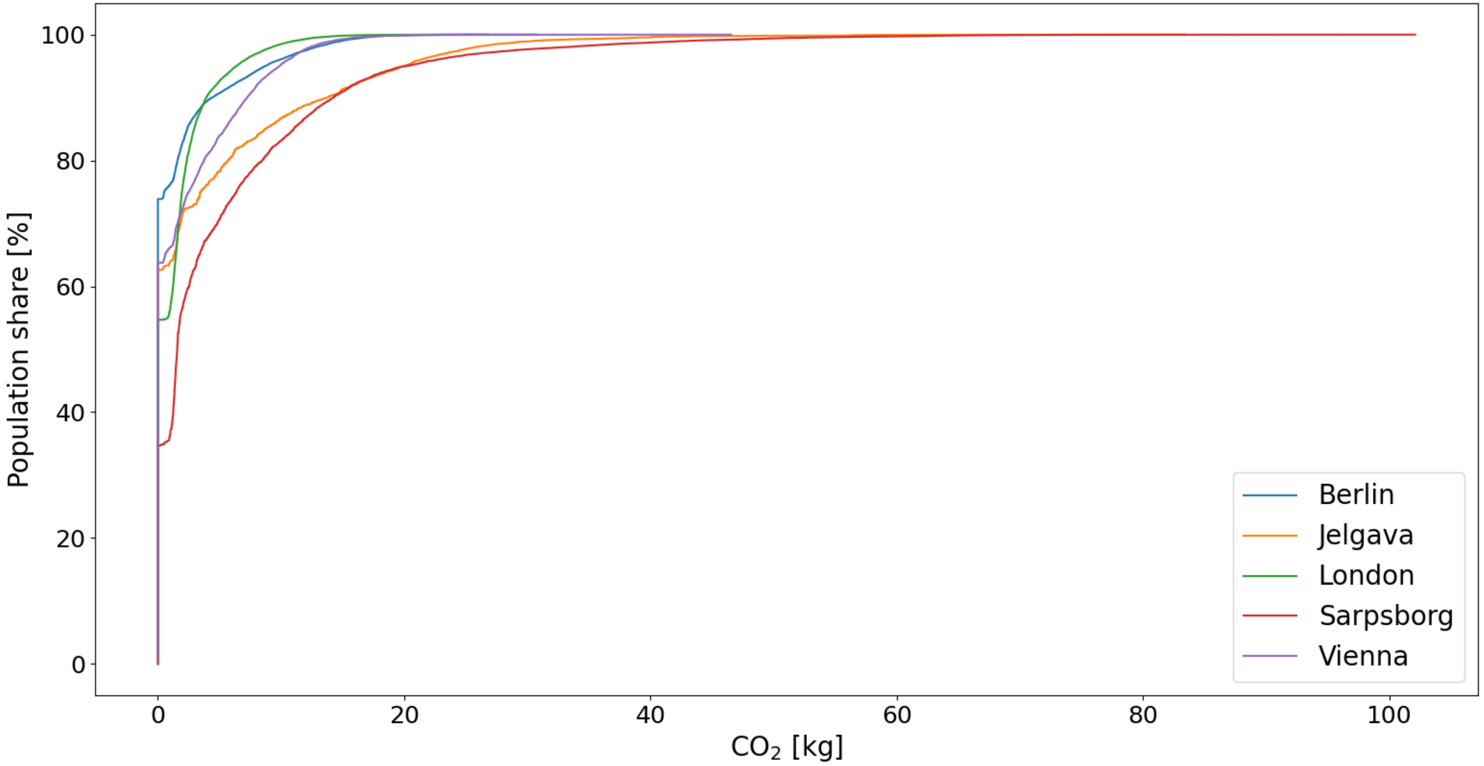
	work	education	shopping	errands	leisure
Average	2.61	0.89	2.43	1.97	3.13
Children	0.03	5.33	0.76	0.74	3.52
Elderly	0.20	0.04	3.90	3.38	3.76
Teenagers	1.02	4.15	0.84	0.86	3.16
Adults work / no children	4.93	0.10	2.00	1.65	2.75
Adults no work / no children	0.92	0.86	3.21	2.54	3.52
Adults work / children	4.03	0.18	2.98	0.53	2.80

[(1)] Tomschy, R., Herry, M., Sammer, G., Klementschitz, R., Riegler, S., Follmer, R., Spiegel, T. (2016). Österreich unterwegs 2013/2014. Ergebnisbericht zur österreichweiten Mobilitätserhebung.
Online at: https://www.bmk.gv.at/dam/jcr:fbe20298-a4cf-46d9-bbee-01ad771a7fda/oeu_2013-2014_Ergebnisbericht.pdf

Results

CO_2 emissions needed by an average person over a week

- Given this, we can compute the CO_2 needed per week – even when assuming a most-sustainable, yet reasonable behaviour
  - Here: cumulative CO_2 emissions for an average person per week

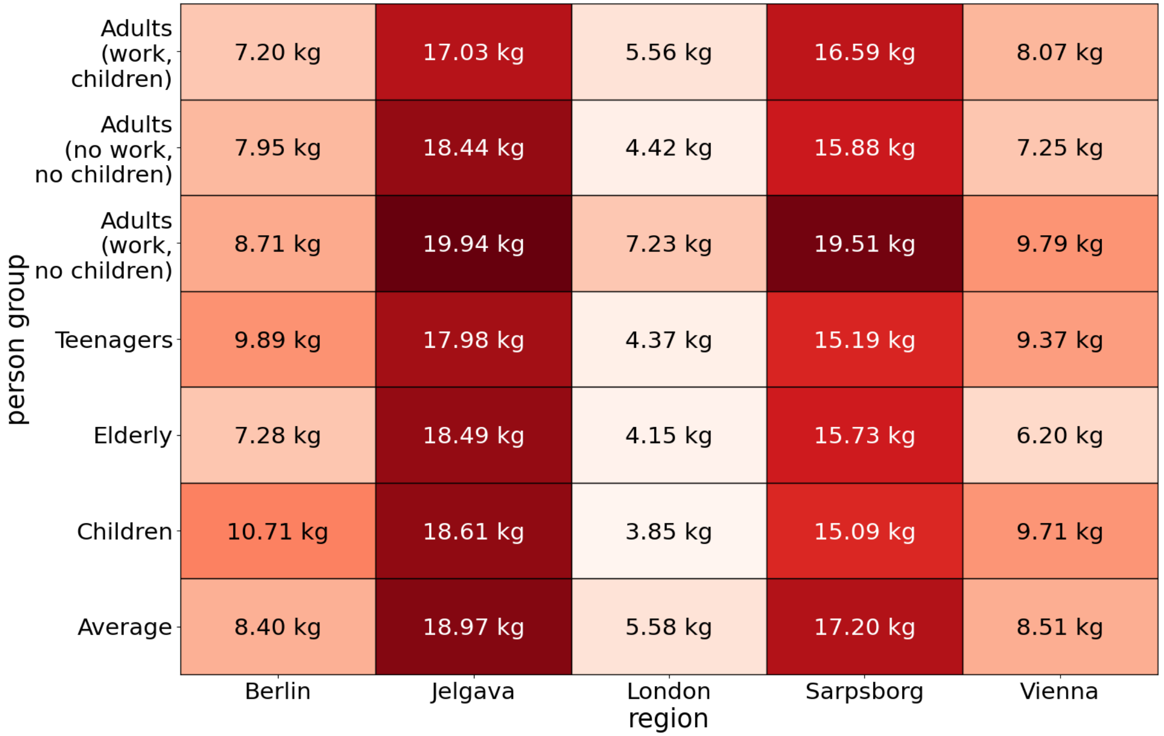


Results

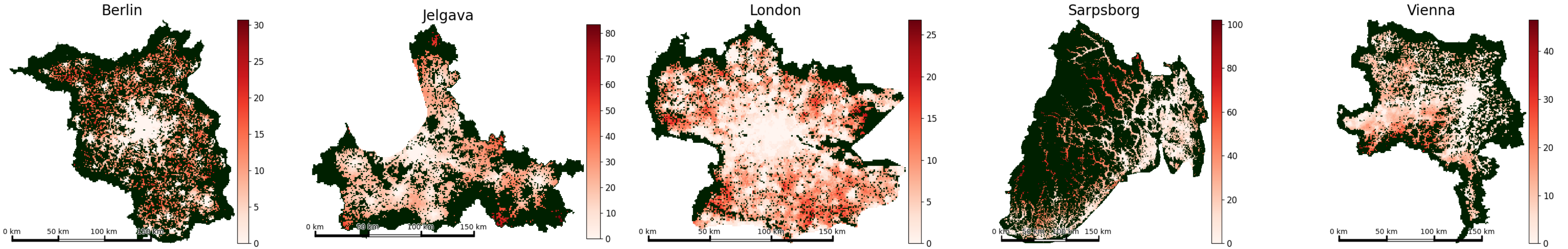
CO_2 emissions needed by different population groups

DLR

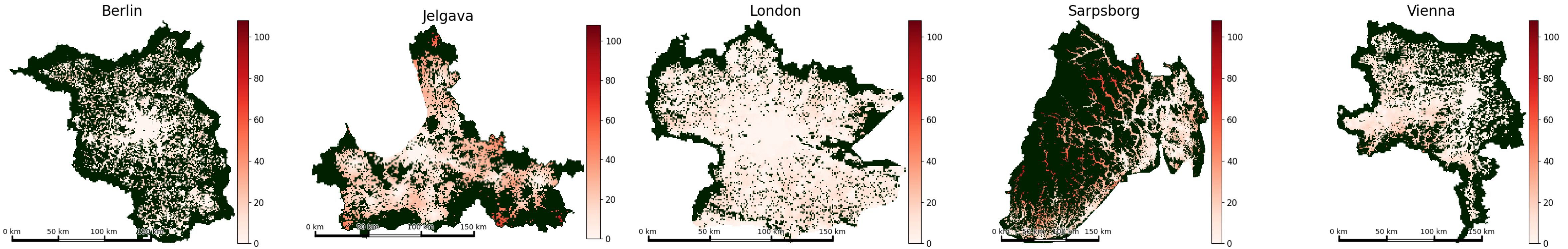
- Shown here: medians
- Differences between Living Labs higher than between person groups
- Children need much due to a high number of leisure activities
- Working adults with no children need more due to the highest number of work place visits
- But: high spread, esp. for rural areas in greater distance to the cities



Results
CO_2 emissions needed by an average person



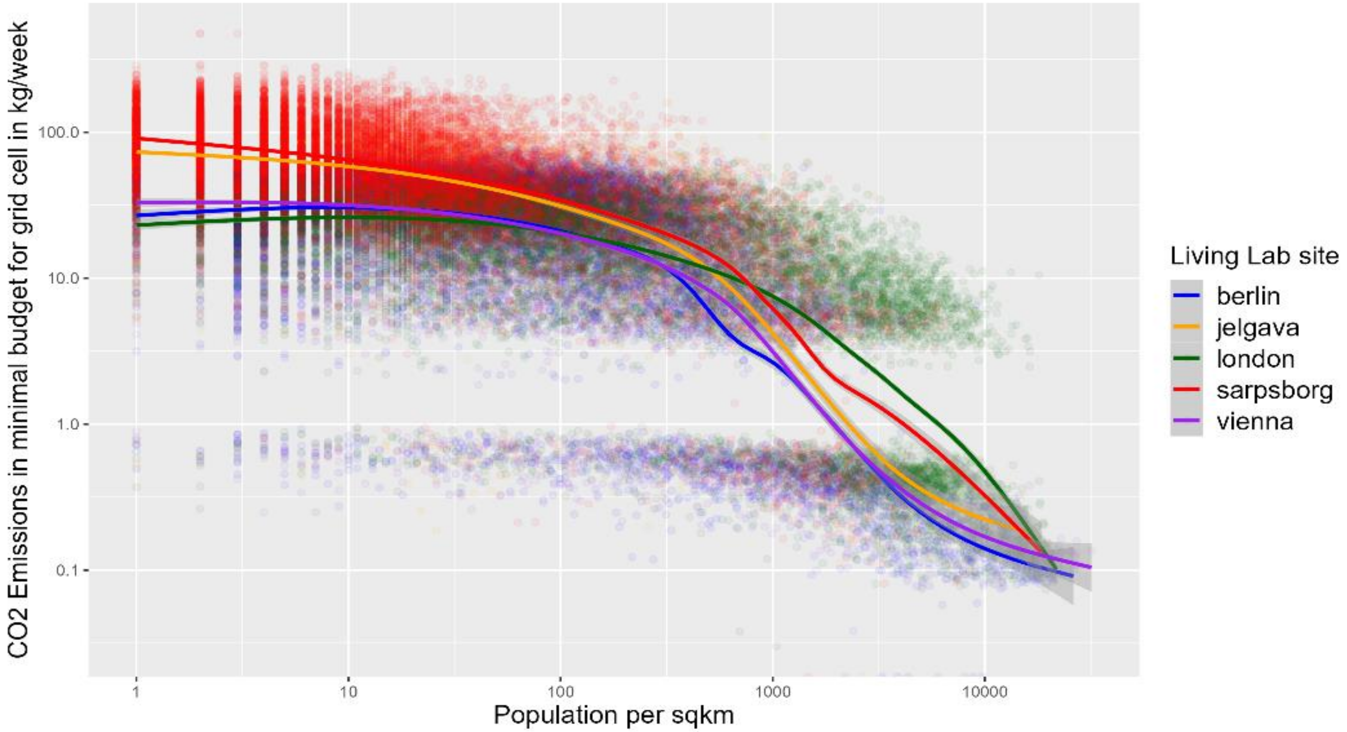
CO_2 needed by an average person per week [kg]



CO_2 needed by an average person per week [kg]
(normed over all Living Labs)

Results

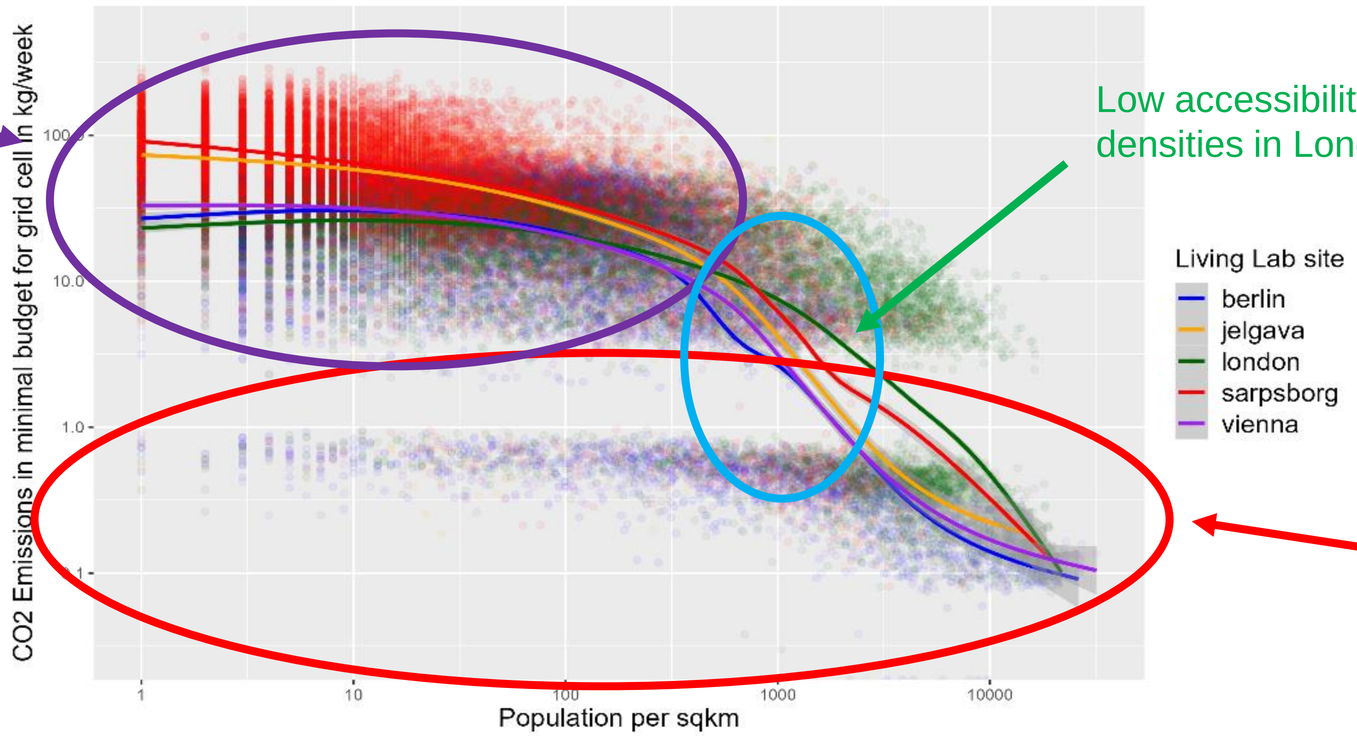
Dependency between population density and CO_2



- Both, the population per square-kilometre and the minimum CO_2 budget per cell are given in logarithmic scales
- Sarpsborg / Jelgava: higher emissions in sparsely populated areas indicate the lack of opportunities
- At about 1000 persons / km^2, Jelgava is similar to Berlin and Vienna
- Accessibility is worse in London at high densities, indicating a low land-use mix

Results
Dependency between population density and CO_2

Lack of opportunities in areas with a low population density



Low accessibility at high densities in London

Accessible by active modes

- Both, the population per square-kilometre and the minimum CO_2 budget per cell are given in logarithmic scales
- Sarpsborg / Jelgava: higher emissions in sparsely populated areas indicate the lack of opportunities
- At about 1000 persons / km^2, Jelgava is similar to Berlin and Vienna
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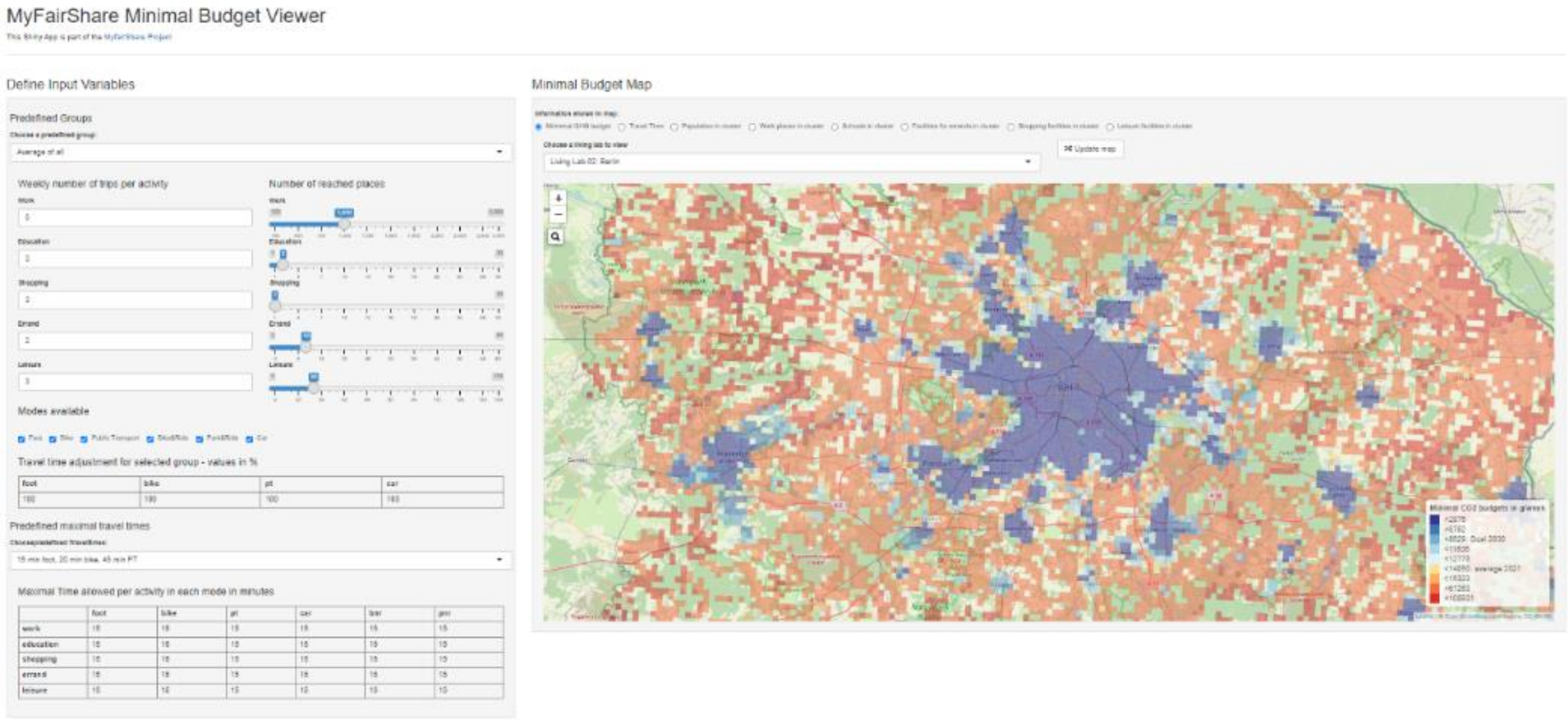
MyFairShare
Viewer

- Besides the computation, a viewer was developed
- Available at https://mytrips.ait.ac.at/myfairshare/

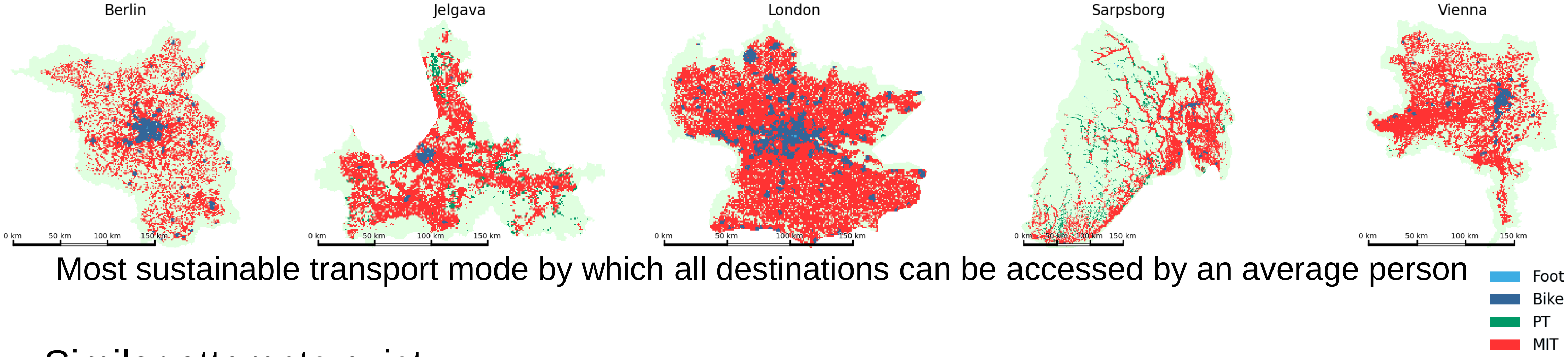


MyFairShare
Discussion

- It was an exploratory attempt…
  - Using a grid of 1 km × 1 km yields in artefacts, should be replaced by a finer resolution (per-building, e.g.)
  - Population data is probably outdated
  - Original computation of all travel times is not necessary (results in reduction from some 10 GB to some 100 MB)
  - Currently, the quality of walking / bicycling infrastructure is not regarded
  - The values of location to “see” should be put on a better empirical base
- Nonetheless
  - Method to determine the amount of CO_2 emissions that cannot be avoided
  - Using data that is, besides GTFS data, available for the whole Europe

MyFairShare
And what about the city of 15 minutes?

- Of course, we can use this to benchmark whether an area is an "area of 15 minutes"
  - Taking only walking, bicycling, and public transport into account



Most sustainable transport mode by which all destinations can be accessed by an average person

- Similar attempts exist
  - We extend them by considering the visit frequencies by different person groups
  - We support a complete description about computing it using open data and tools
  - We can compute the additional CO_2 needed

Thank you!

Impressum

Thema: **Measuring and visualising 15-min-areas for fair CO_2 budget distribution**

Datum: 16.04.2024

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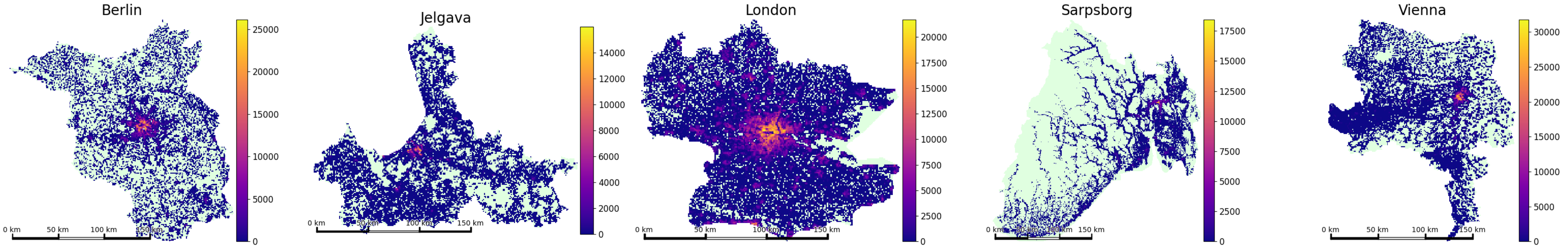
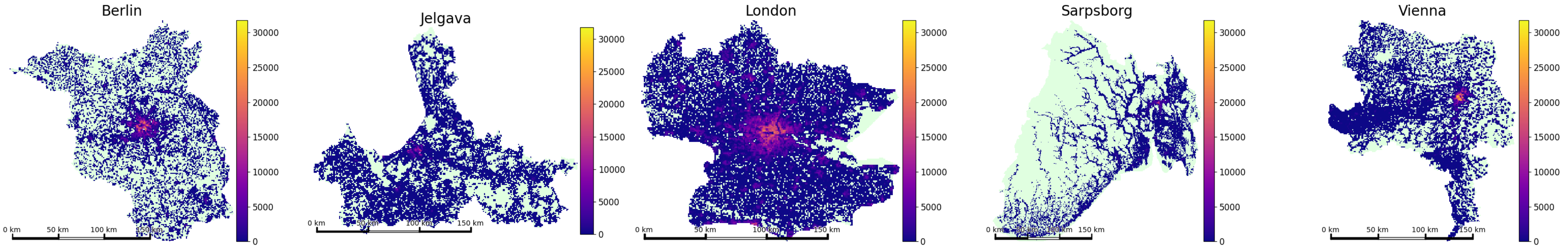
Bildcredits: DLR, AIT

Supplementary material
Population density in the Living Labs



Population density (persons / $1km^2$)



Population density (persons / $1km^2$)
(normed over all Living Labs)