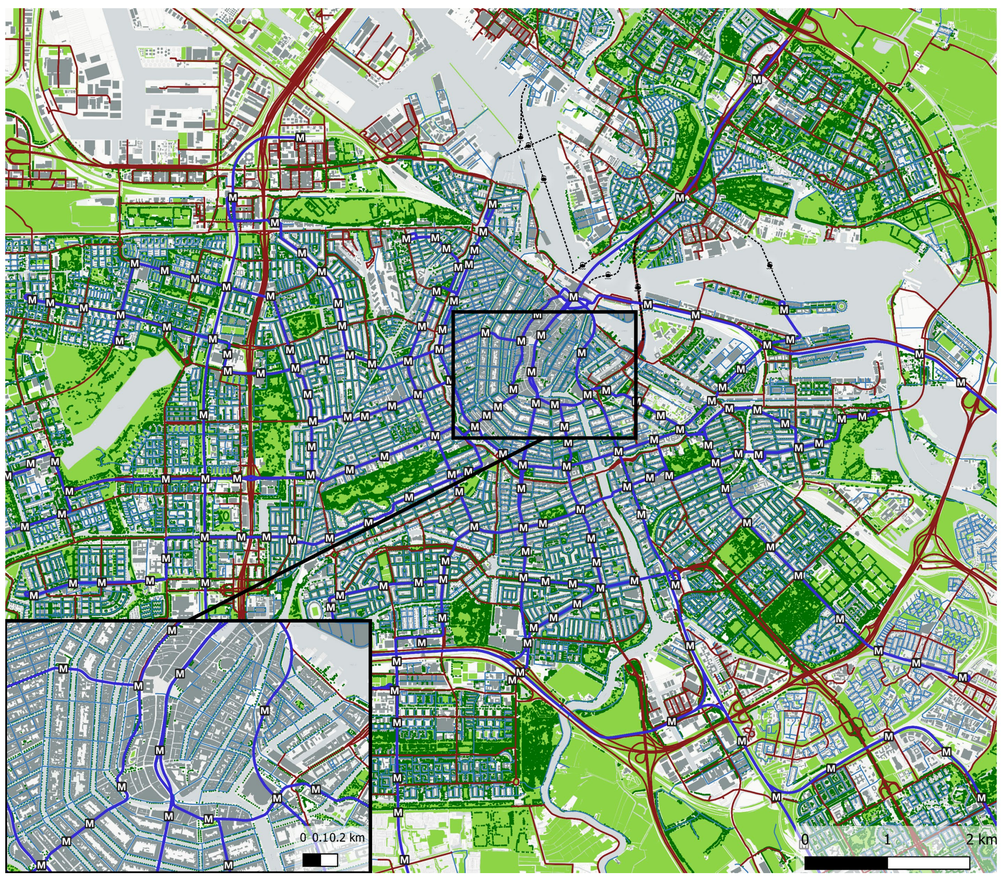
Scenarios of Healthier Urban Transport Regimes

Tabea Sonnenschein, Simon Scheider, Ardine de Wit , James Woodcock, Roel Vermeulen

AGENT-BASED MODEL OF AMSTERDAM

Multi-dimensional Environment: Built, Physical-Chemical, Social



Map Legend

Built Environment

- Tram & Metro Stations
- Tram & Metro Lines
- Ferries
- Urban Highways
- Roads
- Trees
- Green Spaces
- Buildings

Carto Light

Perceivable Environment

Raster with aggregate metrics:

population density, amenity density, green coverage, road intersection density, nr traffic accidents, nr trees, mean traffic volume, highway length, nr pedestrian accidents, pedestrian street width, pedestrian street length, length bike routes, distance CBD, amenity diversity, mean speed limit, max speed limit, nr streetlights, crime incidence, max daytime noise, fraction of open space, perc. migration background, perc. welfare dependency , sum traffic volume, public transport density, max nighttime noise, min speed limit, parking prices

Other Spatial Data

Activity-specific Destinations

- Residential Buildings
- Schools
- Universities
- Arts & Entertainment
- Sports Buildings
- Supermarkets
- Offices & Prof. Spaces
- Shops & Services
- Recreation Facilities
- Nightlife
- Restaurants & Cafés
- Kindergardens

Spatial Dispersion Moderators

- Building Height
- Nr Trees
- Fraction of Green Space
- Fraction of Open Space
- Topography

Synthetic Population

872749 individuals = Amsterdam Population

Attributes
age, sex, migration background, single HH, is child, Nr of children, HH size, current education level, absolved education level, BMI, employment status, car ownership /access, biking habit, driving habit, transit habit

Method
Synthetic Reconstruction + Deterministic Reweighting

Census Data (CBS)
1. Marginal street block distributions (479)
2. Stratefied multi-variable joint distributions

Activity Schedules
10min step activity schedules for 7 days. Activities: sleep/rest, eating, work, school/university, at home, cooking, gardening, walking the dog, shopping/services, social life, entertainment / culture

Method
Most common activity per timestep per age group, sex, income, education level

Eurostat
Harmonised European Time Use Survey

Mode of Transport Choice

For each agent for each trip in their schedule

Random Forest model

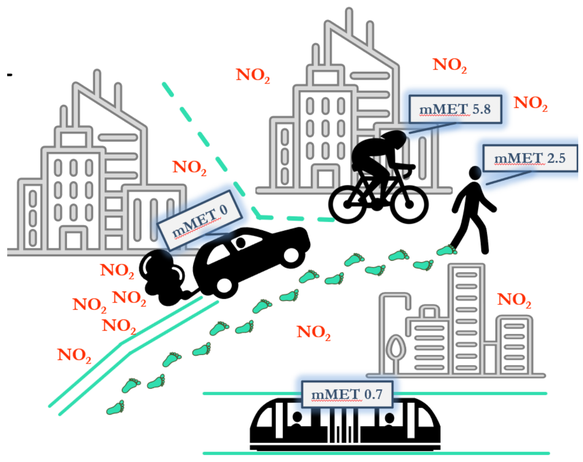
Data: Perceivable environment along route, individual attributes, weather, trip attributes (length, purpose)

F1-score: 0.78

Exposure Model

Hourly personal exposure

1. to traffic dependent hourly NO2 along spatial tracks and activity location
2. to mobility Metabolic Equivalent of Task (MET)



NO2 Hybrid Model

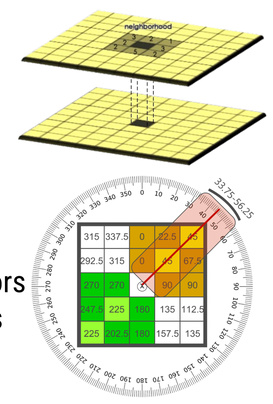
Land Use Regression

generates: baseline NO2, traffic NO2 coefficient

&

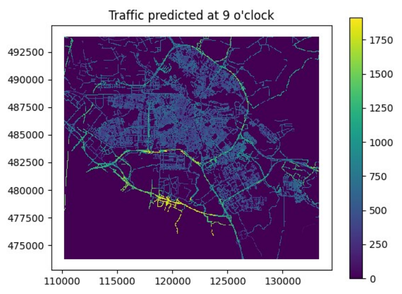
Cellular Automata Model

includes: Spatial Dispersion moderators (see above), Meteorology (determines moving window (see right))



Traffic Model

Individual mobility assigned to aggregate Traffic Volume



POLICY SCENARIOS ACROSS SOCIAL STRATA, TIME & SPACE

Intervention Impacts

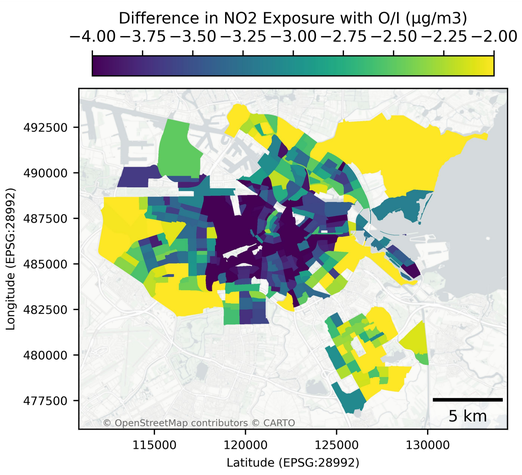
Scenarios	Personal NO2	Personal NO2 w. I/O Filter	Personal Transport MET	Time spent indoors	NO2	Traffic NO2	Mean Travel Time	Driving Share	Biking Share	Walking Share	Transit Share	NO2-based LYG	MET-based LYG
	µg/m3/h	*µg/m3/h*	*MET/h*	*min/h*	*µg/m3/h*	*µg/m3/h*	*min/h*	*%trips/h*	*%trips/h*	*%trips/h*	*%trips/h*	*LYG/ 100.000*	*LYG/ 100.000*
Status Quo	24.35	13.17	21.10	53.06	20.86	3.56	10.52	16.50%	33.40%	41.00%	9.11%		
Scenario Difference (Percentage Change)													
Parking Price Increase 2019	-0.13 (-0.55%)	-0.07 (-0.54%)	0.2 (0.97%)	-0.01 (-0.01%)	-0.05 (-0.22%)	0.05 (-1.3%)	0.03 (0.27%)	**-0.44% (-2.66%)**	0.31% (0.94%)	-0.01% (-0.01%)	0.13% (1.44%)	122.88	1148.76
No Emission Zone 2025	**-4.36 (-17.91%)**	**-2.36 (-17.93%)**	0.0 (0.0%)	0.0 (0.01%)	-1.76 (-8.45%)	-1.76 (-49.54%)	0.01 (0.07%)	0.01% (0.03%)	-0.02% (-0.07%)	0.03% (0.07%)	-0.01% (-0.13%)	6908.1	0
No Emission Zone 2030	**-6.47 (-26.56%)**	**-3.49 (-26.46%)**	**5.42 (25.67%)**	-0.19 (-0.35%)	-3.56 (-17.05%)	-3.56 (-100.0%)	**0.89 (8.51%)**	**-7.52% (-45.6%)**	**5.87% (17.56%)**	**0.03% (0.07%)**	**1.63% (17.93%)**	**10245.5**	**22367.5**
15 Min City (version 1)	-0.07 (-0.30%)	-0.03 (-0.26%)	0.02 (0.01%)	-0.02 (-0.03%)	0.0 (0.02%)	0.0 (0.09%)	0.11 (1.00%)	**0.01% (0.07%)**	-0.94% (-2.81%)	0.94% (2.3%)	-0.01% (-0.15%)	122.89	329.02
15 Min City (version 2)	-0.59 (-2.41%)	-0.54 (-4.13%)	**-9.65 (-45.73%)**	0.82 (1.55%)	-0.24 (-1.13%)	-0.24 (-6.61%)	**-4.29 (-40.79%)**	**-8.49% (-51.47%)**	**0.16% (0.49%)**	**16.02% (39.08%)**	**-7.69% (-84.47%)**	923.92	29422.1

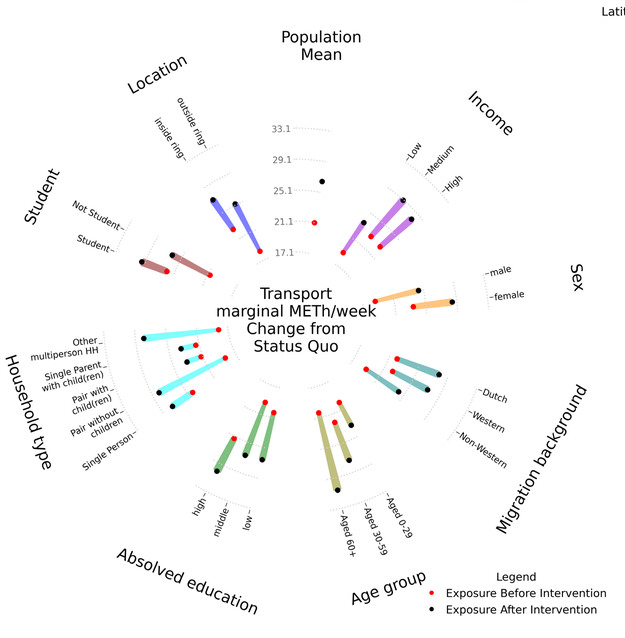
ABM's for urban environmental health intervention scenarios can…

- ❖ be empirically grounded and structurally validated
- ❖ predict intervention impacts measured in natural experiments accurately
- ❖ perform different types of scenario analyses, including projections, predictions and retrodictions
- ❖ inform about policy relevant social, spatial and temporal heterogeneities in effects
- ❖ capture unintended and negative side effects of interventions

Full city No Emission Zone (2030)

Everyone benefits from NO2 exposure reduction





While biking is healthy…

Unequal travel time burden for less affluent households living in the outskirts

Tabea Sonnenschein
t.s.sonnenschein@uu.nl

Sonnenschein, T., Scheider, S., de Wit, A.G., Woodcock, J., Vermeulen, R., (2025) Discovering environmental health effects of transport scenarios through agent -based simulations. (under review in Environment International)

Utrecht University · EXPANSE · exposomeNL