The interrelationship between transport, land use and noise

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Changing Unsustainable Mobility Cultures

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Associated Member of the mobil.lab

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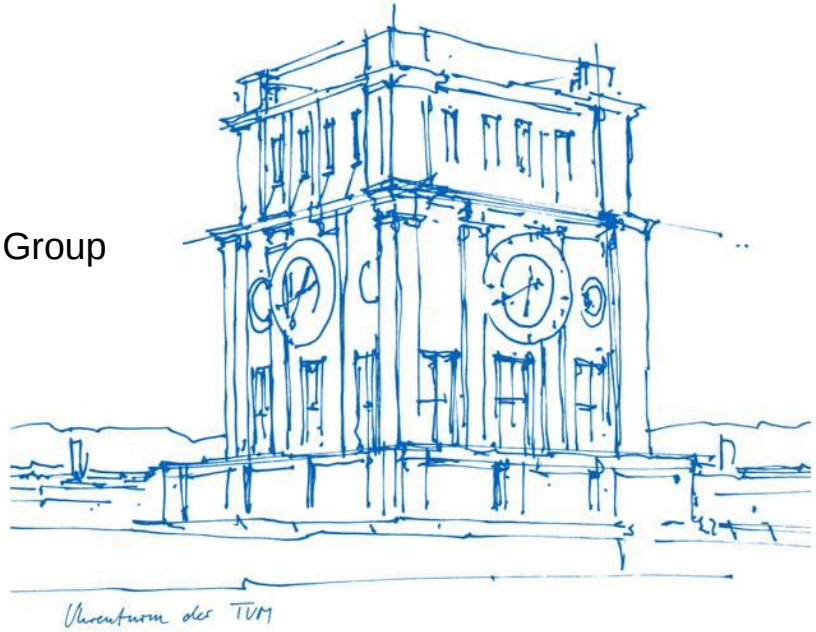
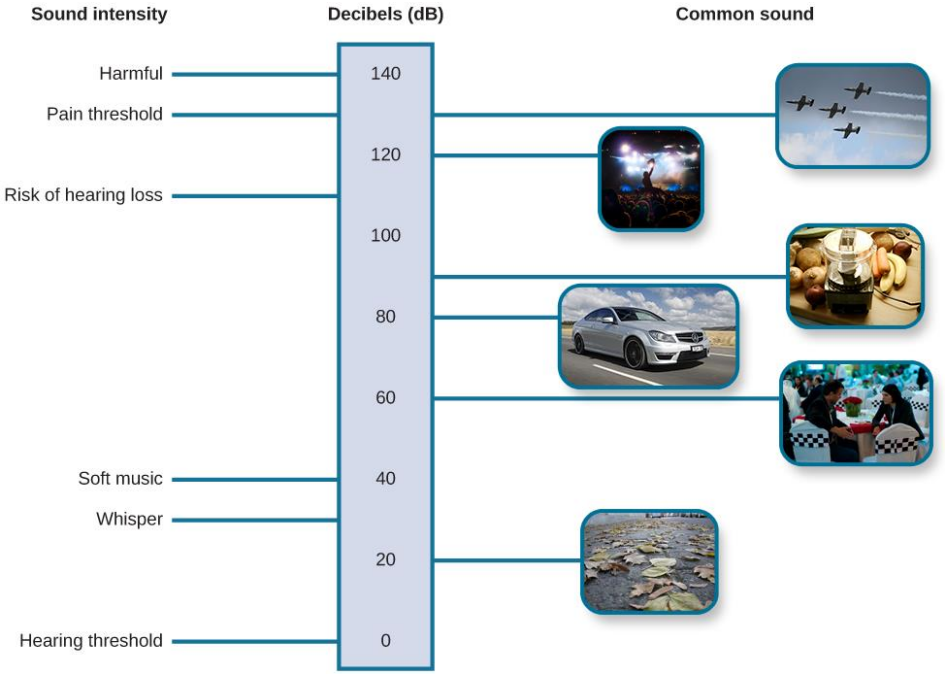


(Road) Traffic Noise – Why should we care?

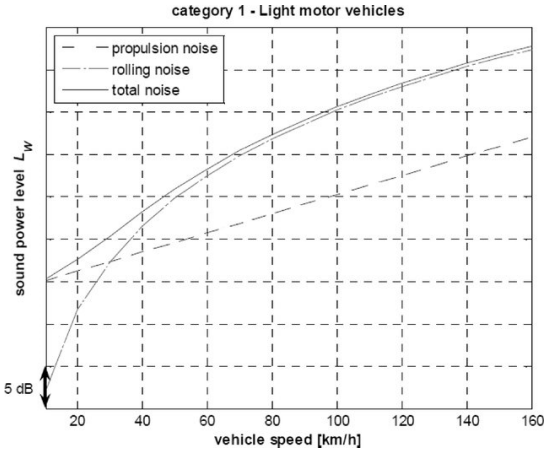
Road traffic noise

- Typically measured in decibel (dB, see figure)
- Health impacts: in Europe, more than 100 million people are exposed to noise levels harmful to their health
- Noise annoyance and reduced residential satisfaction
- Equity issues
- Auralisations: https://forcetechnology.com/en/articles/auralisation-road-noise

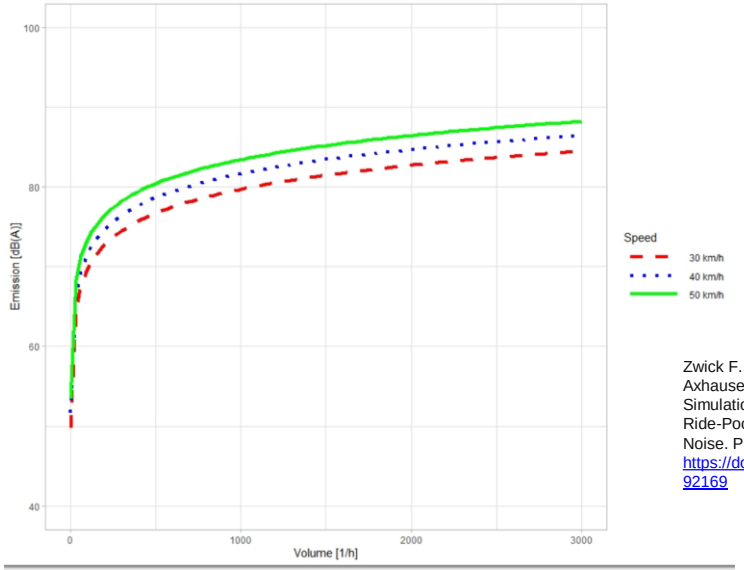


Road traffic noise

- Main contributor to noise is **rolling noise** (for speeds above 30 km/h)
- Emission of a road mostly depends on **volume** and **speed**
- Logarithmic relationship between **volume** and noise **emission**
- German noise prediction model **RLS 19** (Richtlinie für den Lärmschutz an Straßen)
- Estimates noise **emissions** and **immissions** based on traffic volumes, speeds, etc



Luigi Maffei, Massimiliano Masullo. Electric Vehicles and Urban Noise Control Policies. September 2014 Archives of Acoustics 39(3):333-341



Zwick F., Kuehnel, N., Moeckel, R., Axhausen, K.W. Agent-Based Simulation of City-Wide Autonomous Ride-Pooling and the Impact on Traffic Noise. Preprint available at https://doi.org/10.13140/RG.2.2.36064.92169

Interrelationship between transport – land use - noise

Table 3
Three most important priorities for improvement

	First	Second	Third	% mentioning
Improved road safety	25%	13%	11%	49%
Reduced local crime	13%	12%	10%	35%
More local play facilities	6%	10%	9%	25%
Improved air quality	14%	15%	9%	38%
Improved health care	4%	5%	8%	17%
Reduced noise levels	14%	16%	12%	42%
Improved neighbourhood appearance	3%	7%	7%	17%
More local shops	4%	9%	7%	20%
Improved education quality	3%	4%	7%	14%
Lower council tax	14%	9%	20%	43%

Abigail L. Bristow, M. Wardman. Using Stated Preference Methods to Value Noise from Transportation Sources. Acustica 2004 Portugal.

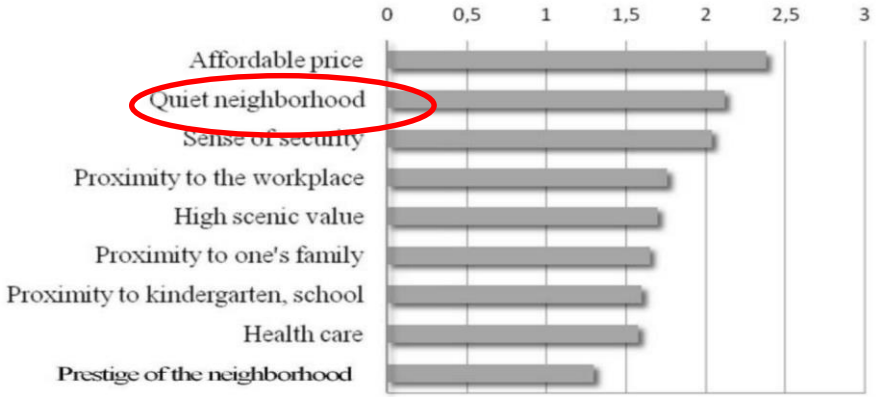
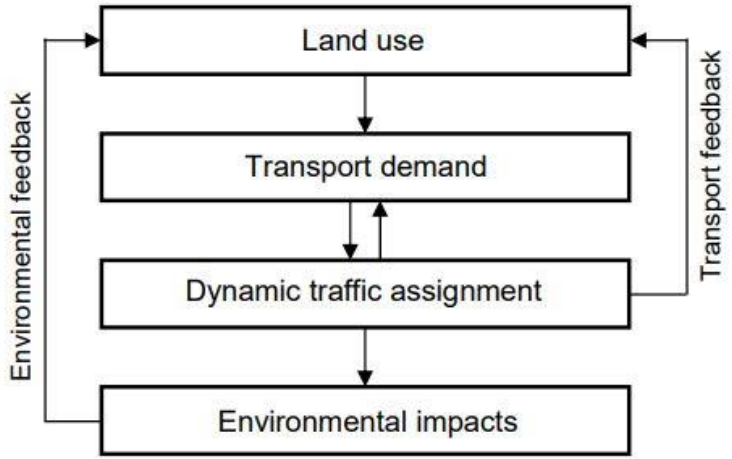


Figure 1. Key determinants of the respondents' choice of residential property
Source: own elaboration.

Sabina Źróbek, Maria Trojanek, Anna Źróbek-Sokolnik, Radosław Trojanek
"The influence of environmental factors on property buyers' choice of residential location in Poland".
Journal of International Studies, Vol. 8, No 3, 2015, pp. 164-174.
DOI: 10.14254/2071-8330.2015/8-3/13

Integrated Land Use / Transport / Environment Models

- Land use model SILO (https://github.com/msmobility/silo)
- Transport Demand Model (https://github.com/msmobility/mito)
- Transport Model MATSim (https://github.com/matsim-org/matsim-libs)
- MATSim noise extension
- Integrated for the **FABILUT** modeling suite (Fully Agent-Based Integrated Land Use Transport Model)



Moeckel, R., Spiekermann, K., Schurmann, C. and Wegener, M. (2003). Microsimulation of land use, International Journal of Urban Sciences 7(1): 14–31.
URL: http://www.tandfonline.com/doi/abs/10.1080/12265934.2003.9693520

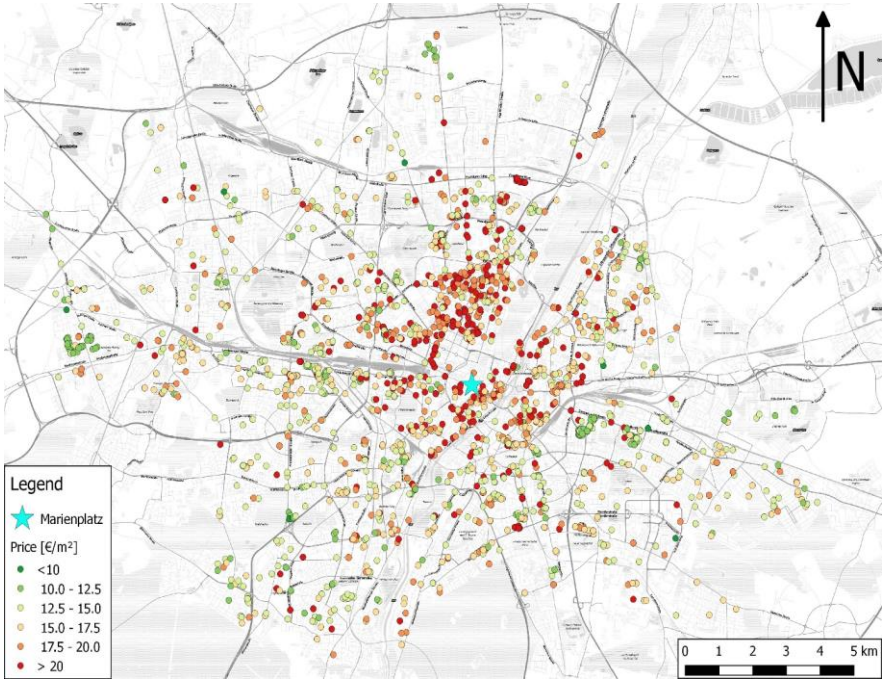
Traffic Noise and Rent Prices

Traffic Noise and Rent Prices

- Data taken from immobilienscout24.com
- ~3500 geo-coded apartments from advertisements
- Average rent ~18€/m²
- NSDI (Noise Sensitivity Depreciation Index) as a common indicator

$$NSDI = \frac{percentage\ change\ of\ housing\ price}{increase\ of\ noise}$$

- Existing studies find values between 0.08% and 2.22% with an average of 0.4%



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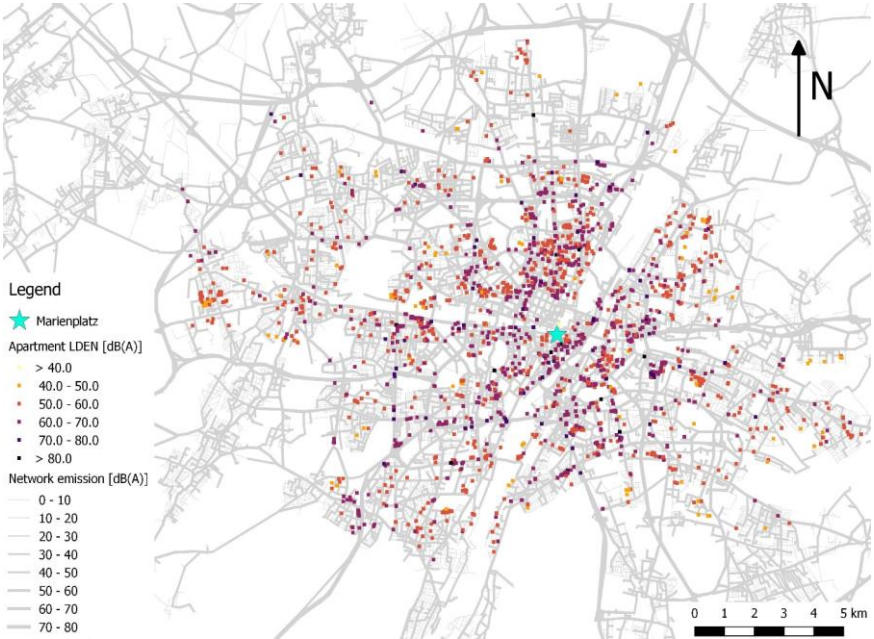
Traffic Noise and Rent Prices

- Traffic noise is estimated using traffic volumes from the transport simulation MATSim and its noise extension based on the RLS 90



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Hedonic pricing regression

- $y = \alpha + \beta_1 * x_1 + \beta_2 * x_2 + \ ... + \ \beta_n * x_n + \varepsilon$
- Independent variable is price (composite good)
- Semi-log model is used:
- $\ln(y) = \ \alpha + \beta_1 * x_1 + \beta_2 * x_2 + \ ... + \ \beta_n * x_n + \ \varepsilon$
- In this case NSDI is simply:
- $NSDI = \ \beta_{noise} * 100$

$$NSDI = \frac{percentage\ change\ of\ housing\ price}{increase\ of\ noise}$$

Variable	Unit	Min	Max	Mean	n (N=3,540)	Used in model
Area	m²	14.00	278.00	70.10		all (log transformed)
Noise (L_{DEN})	dB(A)	37.97	88.09	57.24		1
Low noise	Dummy				1,202	2 (baseline category)
Moderate noise	Dummy				2,149	2
Loud Noise	Dummy				199	2
Microscopic accessibility	-	6.54	8.52	7.91		all
Average dwelling quality	Dummy				1,063	all
Superior dwelling quality	Dummy				2,178	all (baseline category)
Luxury dwelling quality	Dummy				289	all

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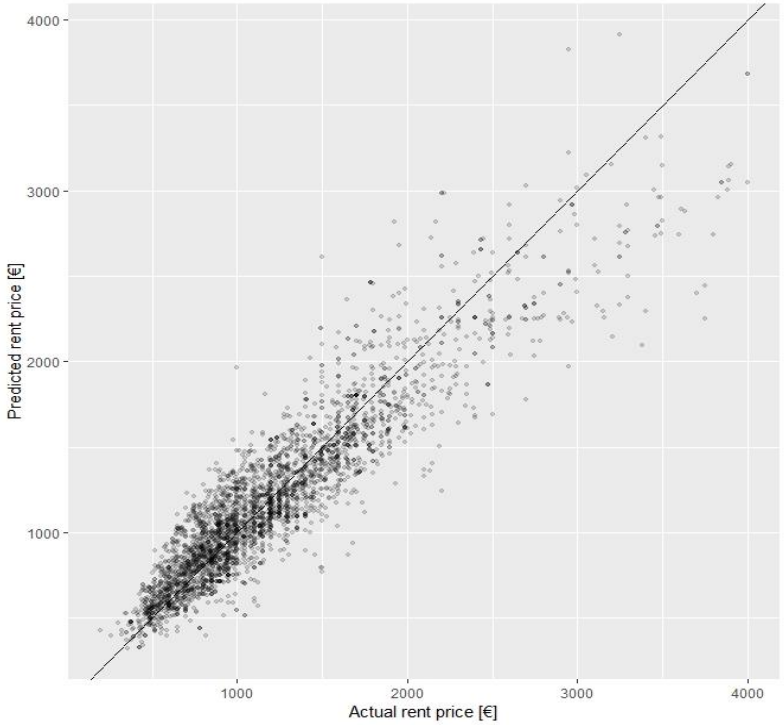
	Dependent variable:	
	log(rent)	
	Model (1)	Model (2)
log(area)	0.769***	0.778***
	(0.0066)	(0.0066)
noise	-0.004***	
	(0.0006)	
low noise		0 (Base)
moderate noise		-0.058***
		(0.0068)
loud noise		-0.096***
		(0.0138)
microscopic accessibilities	0.204***	0.210***
	(0.0085)	(0.0081)
Luxury dwelling quality	0.213***	0.211***
	(0.0112)	(0.0110)
Superior dwelling quality	0 (Base)	0 (Base)
Average dwelling quality	-0.197***	-0.197***
	(0.0067)	(0.0066)
constant	2.433***	2.196***
	(0.0718)	(0.0738)
Observations	3,540	3,540
Adjusted R^2	0.838	0.842
Residual Std. Error	0.1783	0.1757
F Statistic	3,657	3,147
Note:	Signif. codes: '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 robust SE in (brackets)	

NSDI = 0.4

Moderate Noise = 5.8% discount
Loud Noise = 9.6% discount



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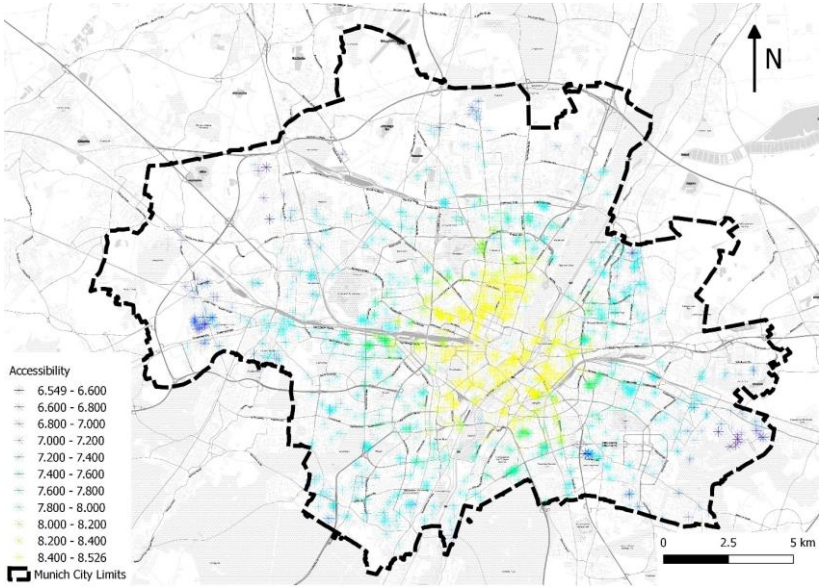
Accessibility as a Confounding Variable

- Econometric accessibility indicator:

$$A_i := \frac{1}{\mu} \sum_j e^{\mu V_{ij}^{trav}}$$

- Can be computed for different times of day, with and without congestion, for diff. modes
- Solely based on OpenStreetMap data
- See:

Ziemke, D.; Joubert, J. W.; Nagel, K. (2017). Accessibility in a Post-Apartheid City: Comparison of Two Approaches for Accessibility Computations. Networks and Spatial Economics, 18(2), 241–271.



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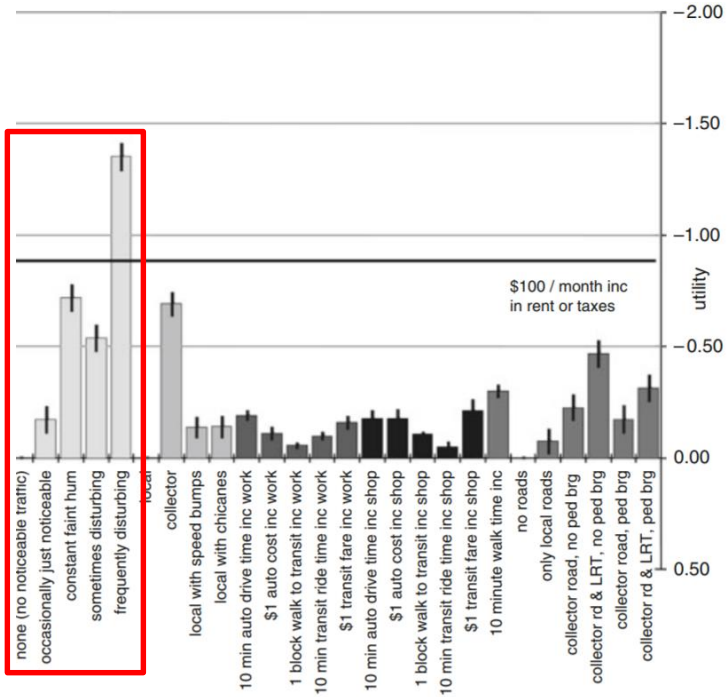
Integrated Model

Integrated Model

- Residents in the land use model SILO now **react to noise** when evaluating current and possible dwellings for relocation
- Loud dwellings sell for less
- High income households are more sensitive to noise and less sensitive to price -> **on average, move to more quiet dwellings**
- Low income households are more sensitive to price and are less picky about noise -> **on average, move to more noisy dwellings, take advantage of price discounts**



Based on: Hunt J.D. (2010) Stated Preference Examination of Factors Influencing Residential Attraction. In: Pagliara F., Preston J., Simmonds D. (eds) Residential Location Choice. Advances in Spatial Science (The Regional Science Series). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-12788-5_2

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	Study Area	Munich
∅ income, noisy (>65 dB(A))	EUR 24,570	EUR 24,177
∅ income, quiet (<35 dB(A))	EUR 27,805	EUR 26,758
∅ noise, high inc. (>EUR 68,000)	48.42 dB(A)	53.76 dB(A)
∅ noise, low inc. (<EUR 15,000)	50.56 dB(A)	55.54 dB(A)

Nico Kuehnel, Dominik Ziemke, Rolf Moeckel. Traffic Noise Feedback in Agent-Based Integrated Land-Use/Transport Models. Journal of Transport and Land Use (forthcoming).

Integrated Model

- Predicted noise levels in the study area after 30 simulation years

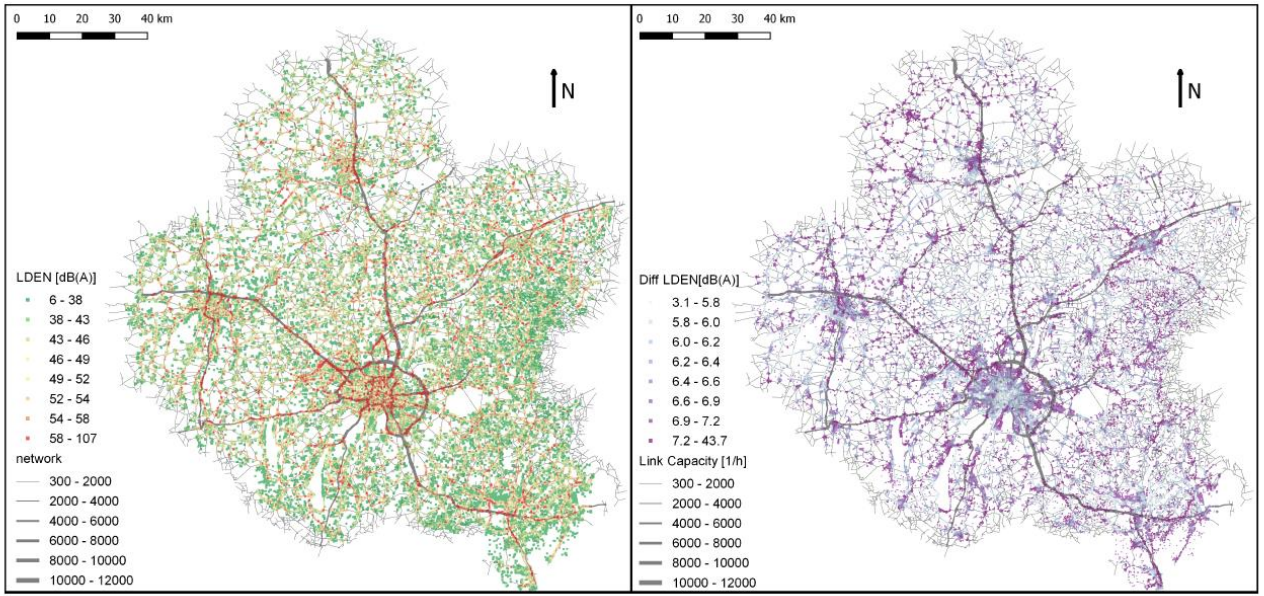

Figure 5: Noise levels in 2011 (left) and increase of noise between 2011 and 2030 (right) as well as link capacities per hour. Noise level ranges based on quantiles.

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Tackling Traffic Noise: Ridepooling?

Ride-pooling

- Studies have shown that large-scale applications of ride-pooling can reduce vehicle kilometers travelled and traffic emissions

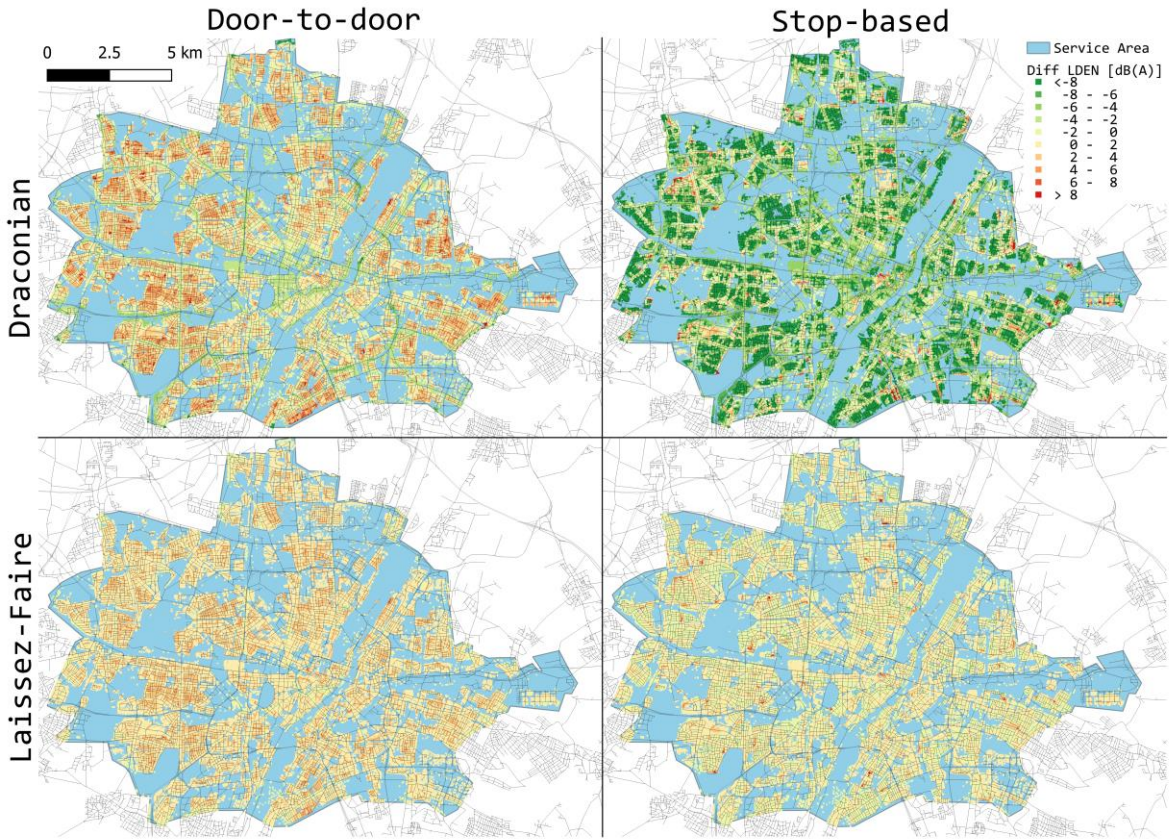
- Previously no systematic investigations of ride-pooling and traffic noise impacts

- Benefits in traffic noise unclear:
  1. Reductions in noise on major roads might not be substantial as long as there still is noteable traffic
  2. Additional detours/empty rides may increase noise significantly in previously quiet residential areas

- A stop-based pooling service should be better than a door-to-door service in terms of noise exposure

Ride-pooling

- Impacts on noise largely depend on the service design (stop-based vs door-to-door)
- In addition, a radical scenario replacing _all_ provate car traffic with ride-pooling vehicles results in clearer patterns



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Conclusions

Conclusion

- Noise as a negative external effect of (road) traffic
- Transport, land use and the environment interact with each other
- Noise can explain significant variations in rent prices
- Proof of concept of a microscopic integration in a model
- Noise cannot be tackled easily

Thanks!