



Swiss TPH



Aefu, 28. Forum Medizin und Umwelt
«Lärm – das unterschätzte Risiko»

Health risk assessment of transportation noise

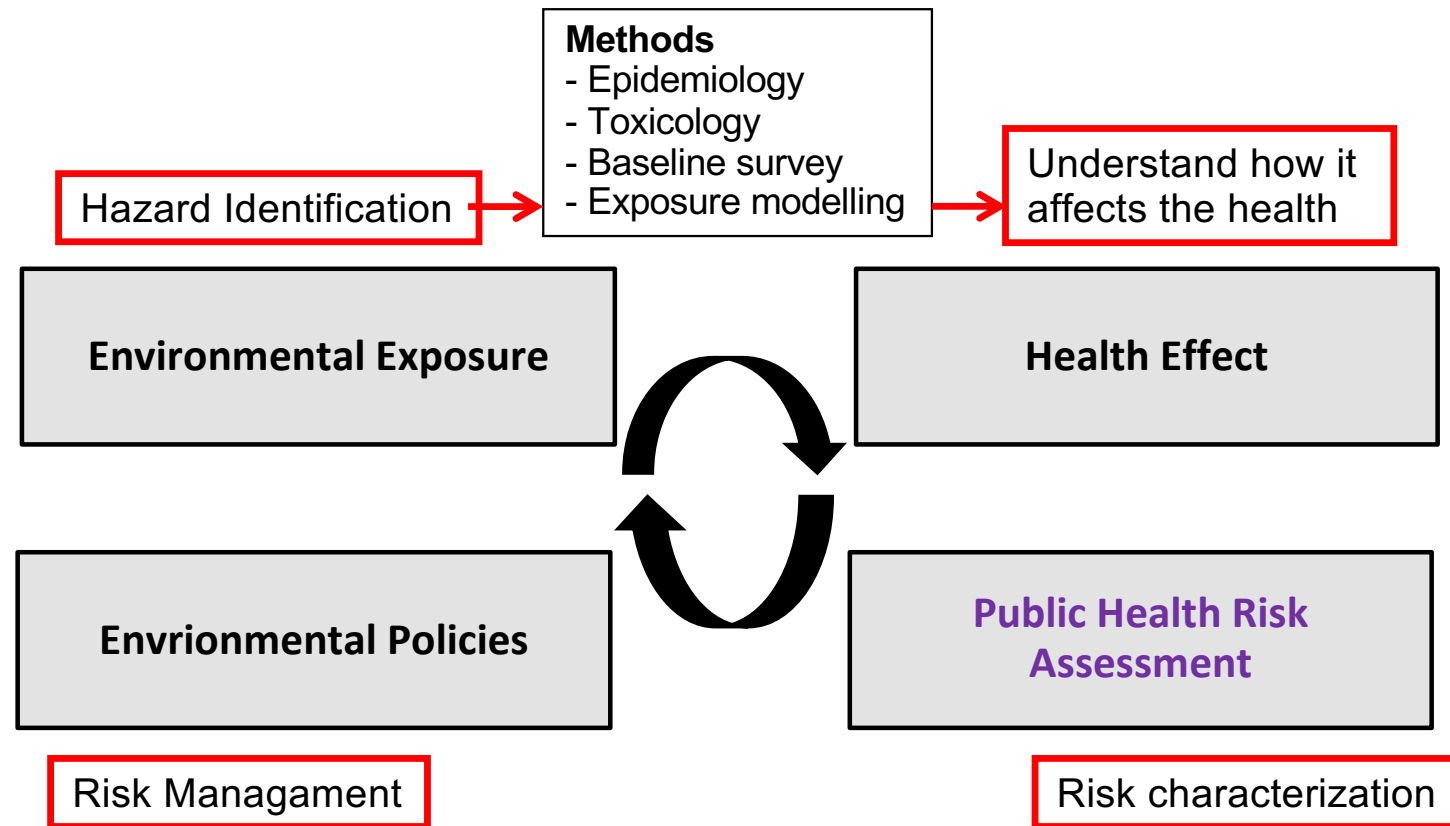
Martin Röösl, 19 May 2022

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Environmental Health Cycle: from individuals to populations



General concept health risk assessment

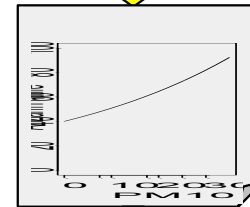
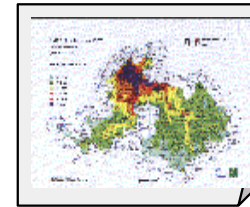
1. Hazard/scenario identification

2. Exposure assessment

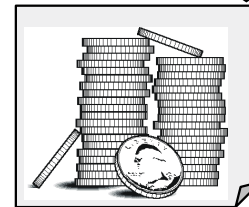
3. Exposure-outcome association

Burden of disease
Health impact

4. Risk characterization



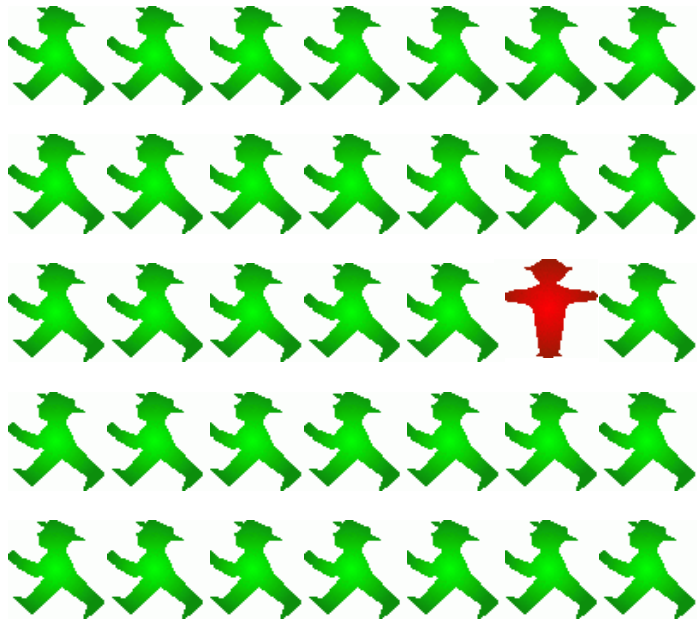
Health impact = exposure x
exposure-outcome association x disease rate



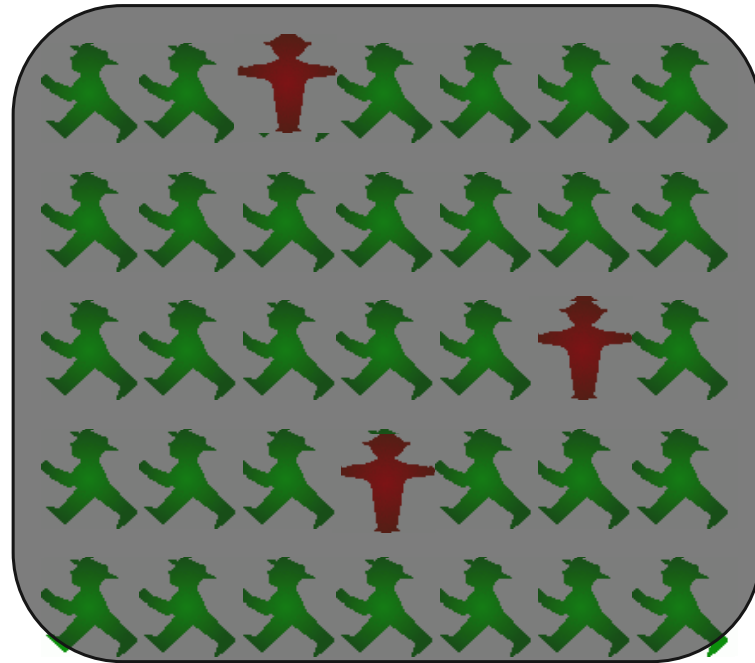
DALY: disability adjusted life years
YLD: years lived with disability
YLL: years of life lost
Attributable cases

Concept of attributable cases

Universe 1 with Exposure C=0

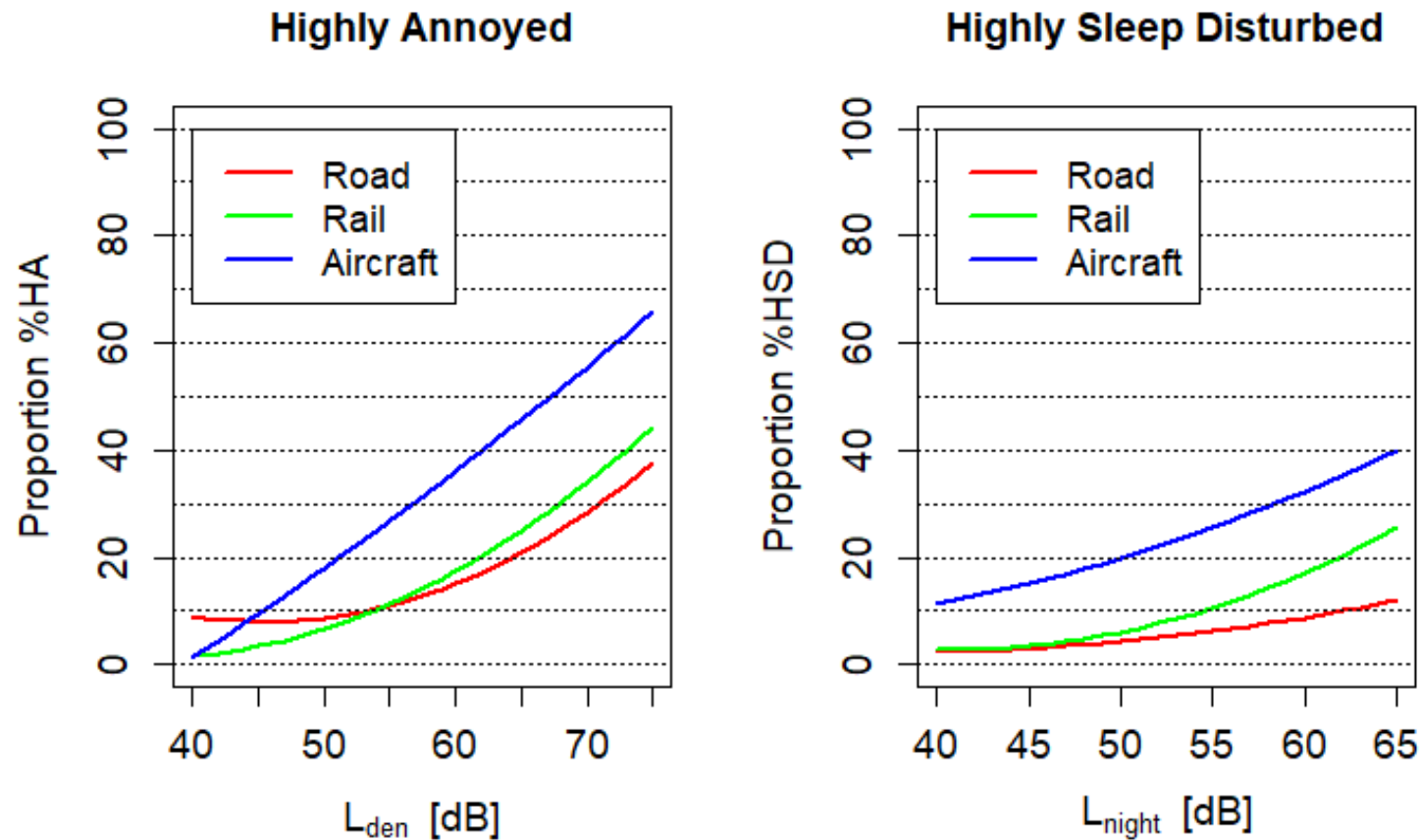


“Parallel Universe” 2 with C=1



$$\text{Relative Risk (RR)} = \frac{\text{disease rate (E)}}{\text{disease rate (nE)}} = \frac{3/35}{1/35} = 3$$

High annoyance and sleep disturbance according to WHO



Derived from
WHO, 2018

Environmental noise in Europe — 2020

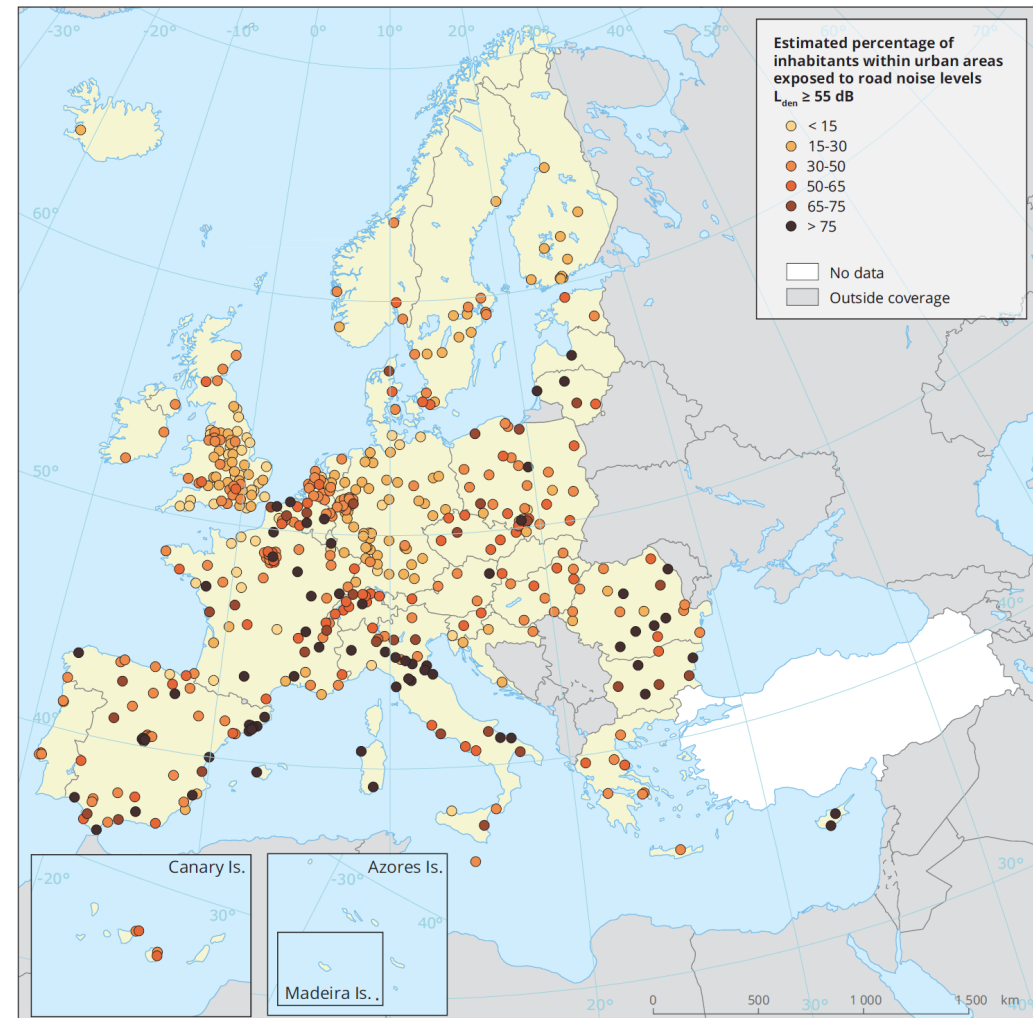
ISSN 1977-8449



25 1994-2019
European Environment Agency



Map 2.1 Estimated percentage of inhabitants within urban areas, exposed to road noise levels $L_{den} \geq 55$ dB in 2017



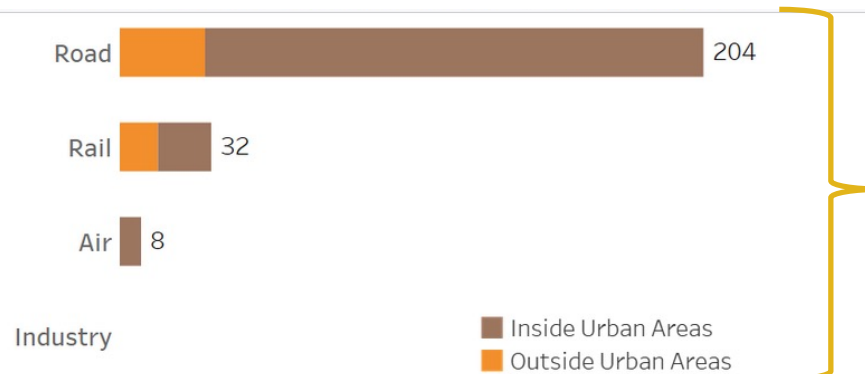
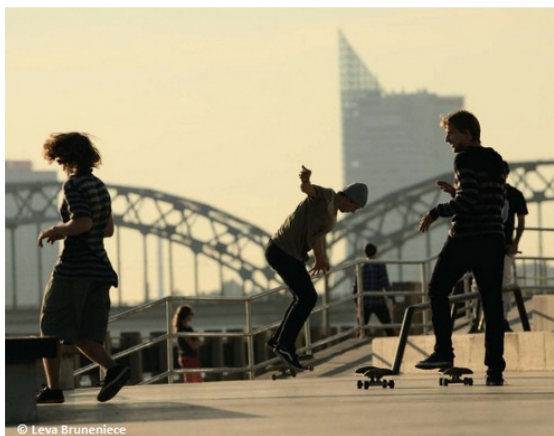
Health Impact in Europe (EEA)

Table 3.5 Estimated number of people suffering from various health outcomes due to environmental noise in 2017, EEA-33 (Turkey not included)

		High annoyance	High sleep disturbance	Ischaemic heart disease	Premature mortality (a)	Cognitive impairment in children
Inside urban areas	Road	12 525 000	3 242 400	29 500	7 600	
	Rail	1 694 700	795 500	3 100	800	
	Air	848 300	168 500	700	200	9 500
	Industry	87 200	23 400	200	50	
Outside urban areas	Road	4 625 500	1 201 000	10 900	2 500	
	Rail	1 802 400	962 900	3 400	900	
	Air	285 400	82 900	200	50	2 900
Total (b)		21 868 500	6 476 600	48 000	12 100	12 400

At least 20 % of the EU population live in areas where traffic noise levels are harmful to health. These significant health impacts are most likely to be underestimated, with new WHO evidence

EEA health risk estimates for noise in Switzerland (2021)



Deaths attributable to transportation noise

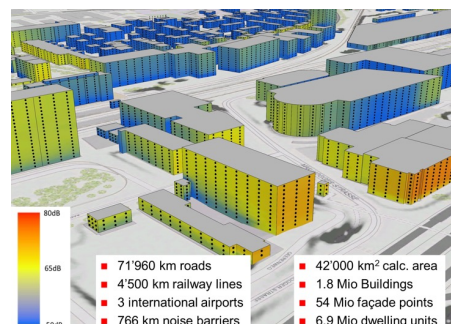
	YLD/yr	YLL/yr	DALYs/yr	DALYs/yr per 100000 inhabitants
Road	17,471	2,058	19,529	232
Rail	5,015	321	5,336	63
Air	1,424	78	1,502	18
Industry				

Years of life lost (YLL), years lived with disability (YLD) and disability adjusted life years (DALYs) attributable to noise exposure. The disability weights used here are described in the WHO Environmental Noise Guidelines for the European Region (2018).

<https://www.eea.europa.eu/themes/human/noise/noise-fact-sheets/noise-country-fact-sheets-2021/switzerland-noise-fact-sheet-2018>

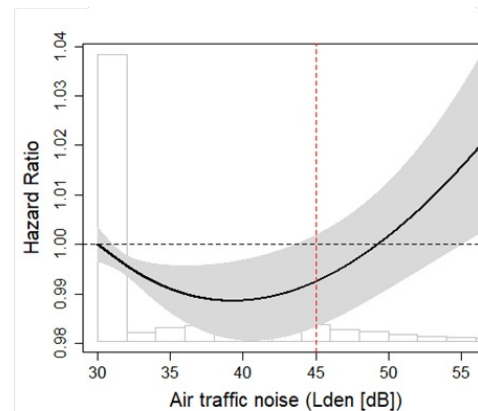
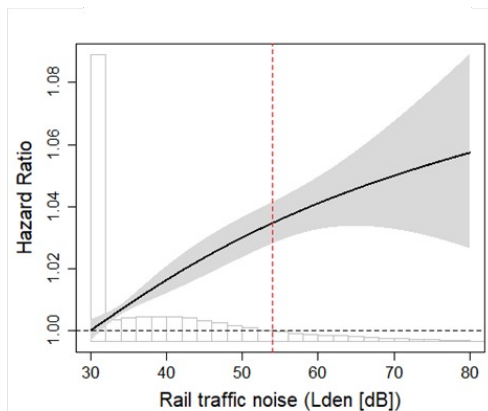
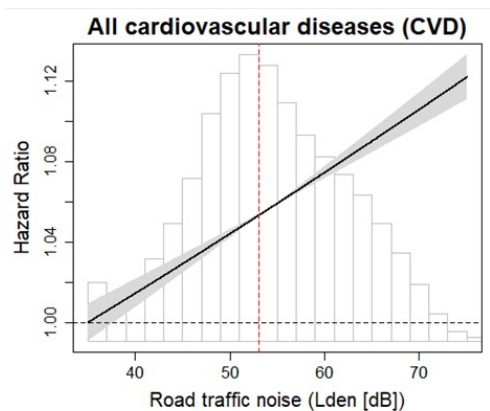
Swiss National Cohort (2000-2015)

All inhabitants in Switzerland (4.41 million people aged >30 years)



Vienneau et al, Env Int, 2022

<https://doi.org/10.1016/j.envint.2021.106974>



Source	Excess risk per 10 dB (%)
L_{den} Road	2.9 (2.4-3.4)
L_{den} Railway	1.3 (1.0-1.7)
L_{den} Aircraft	0.3 (-0.4-1.0)

600 deaths per year attributable to transportation noise

	Road	Railway	Aircraft	Remarks
Counterfactual («no exposure»)	45	45	45	Fig. 1 in Vienneau et al, 2022
Mean exposure (Lden) above threshold	56*	54**	51***	2011 assessment from Tab. 1 in Vienneau et al, 2022
Excess relative risk per 10 dB	2.9%	1.3%	0.3%	Tab. 2 in Vienneau et al, 2022
Excess relative risk per Δ noise	3.23%	1.21%	0.19%	$ERR_{10dB} \cdot \frac{\Delta noise}{10dB}$
Population attributable fraction (PAF)	2.73%	0.36%	0.03%	$\frac{p_{ex} \cdot ERR}{p_{ex} \cdot ERR + 1}$
Observed number of CV death*	20,000	20,000	20,000	https://www.bfs.admin.ch/bfs/de/home/statistiken/gesundheit/gesundheitszustand/krankheiten/herz-kreislauf-erkrankungen.html
Attributable death to noise	546	73	6	Total: ca. 600 deaths

*mean=56dB for 87% exposed >45 dB; **mean=54 dB for 30% exposed >45 dB; ***mean=51 dB for 16% exposed >45 dB

Choice of threshold is critical (or substantial deaths <limit)

Using WHO guidelines as threshold for calculation

	Road	Railway	Aircraft	Remarks
Counterfactual («no exposure»)	53	54	45	Fig. 1 in Vienneau et al, 2022
Mean exposure (Lden) above threshold	60*	60**	51***	2011 assessment from Tab. 1 in Vienneau et al, 2022
Excess relative risk per 10 dB	2.9%	1.3%	0.3%	Tab. 2 in Vienneau et al, 2022
Excess relative risk per Δ noise	2.04%	0.72%	0.18%	$ERR_{10dB} \cdot \frac{\Delta noise}{10dB}$
Population attributable fraction (PAF)	1.11%	0.10%	0.03%	$\frac{p_{ex} \cdot ERR}{p_{ex} \cdot ERR + 1}$
Observed number of CV death*	20,000	20,000	20,000	https://www.bfs.admin.ch/bfs/de/home/statistiken/gesundheit/gesundheitszustand/krankheiten/herz-kreislauf-erkrankungen.html
Attributable death to noise	222	20	6	Total: ca. 250 deaths

*mean=60 dB for 55% exposed >53 dB; **mean=60 dB for 14% exposed >54 dB; ***mean=51 dB for 16% exposed >45 dB

Externe Effekte des Verkehrs 2010

Monetarisierung von Umwelt-, Unfall- und Gesundheitseffekten

Schlussbericht Phase II

16. April 2014

zuhanden des Bundesamts für Raumentwicklung



ECOPLAN Forschung und Beratung
in Wirtschaft und Politik

INFRAS Forschung und Beratung

Methods report:

http://www.ecoplan.ch/download/ekv10_sb_de.pdf

GRUNDLAGEN

Externe Kosten und Nutzen des Verkehrs in der Schweiz

Strassen-, Schienen-, Luft- und Schiffsverkehr 2018

 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

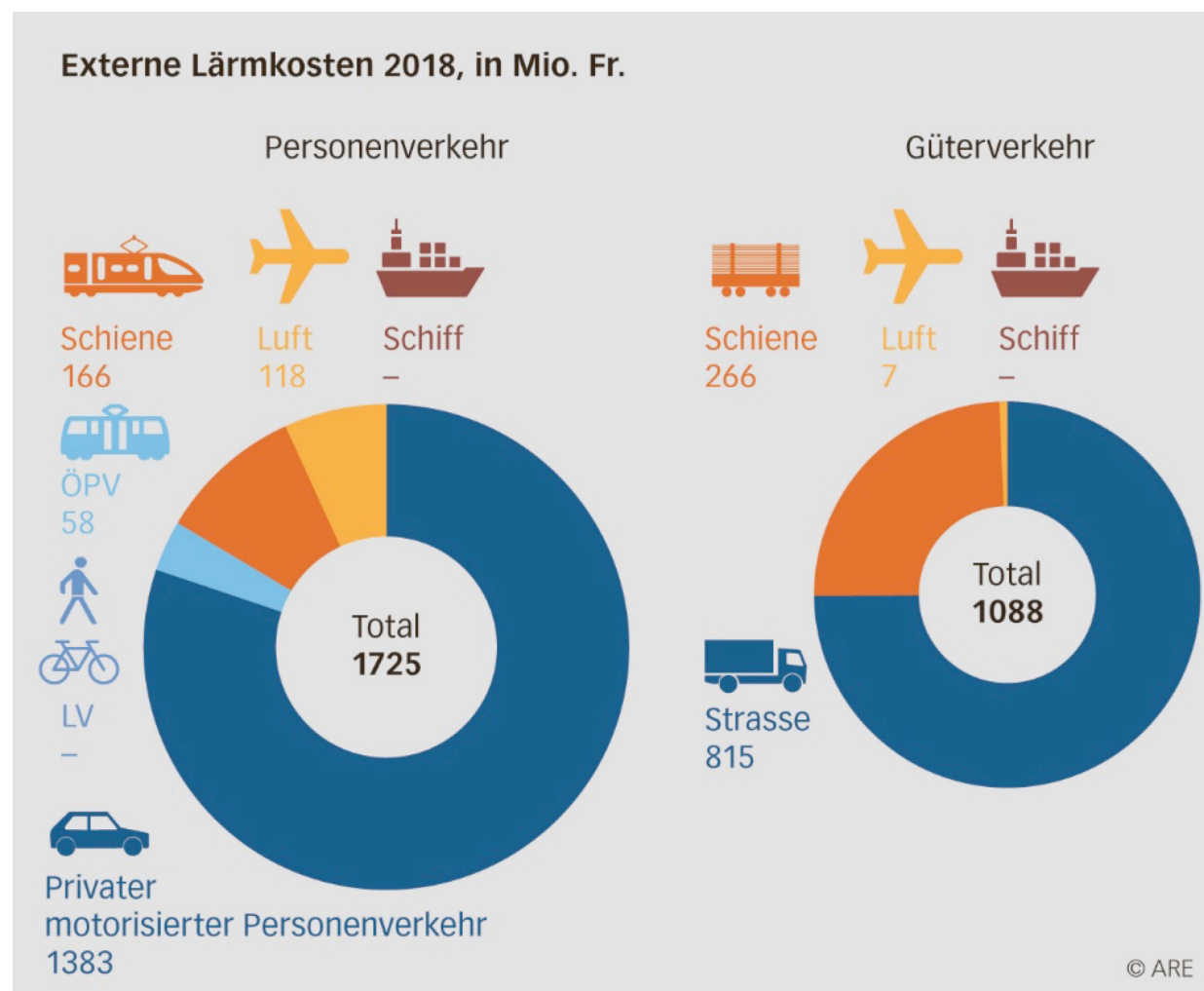
Bundesamt für Raumentwicklung ARE
Office fédéral du développement territorial ARE
Ufficio federale dello sviluppo territoriale ARE
Uffiz federal da svilup dal territori ARE

Annual updates:

<https://www.are.admin.ch/are/en/home/mobility/data/costs-and-benefits-of-transport.html>

External costs of noise (CH in Mio CHF)

<https://www.are.admin.ch/are/de/home/medien-und-publikationen/publikationen/verkehr/externe-kosten-und-nutzen-des-verkehrs-in-der-schweiz.html>



Total external costs (2018, in Mio CHF)

Externe Kosten und Nutzen des Verkehrs 2018 nach Schadens- und Nutzenkategorien in Mio. Fr.							
	Strasse			Schiene	Luft- verkehr	Schiff	Total
	Priv. mot. PV u. GV	LV	ÖPV				
Luftverschmutzung	3461		134	431	52	74	4151
Lärm	2198		58	432	125		2813
Klima	1643		40	4	1106	12	2805
Natur und Landschaft	1001	30	14	129	7	5	1187
Vor- und nachgelagerte Prozesse	1050	62	24	63	182	3	1384
Unfälle	714	960	4	6	4	<1	1688
Weitere	184		8	67			259
Abzug LSVA-Anteil	-553						-553
Total	9698	1052	283	1132	1475	95	13 735
Gesundheitsnutzen Langsamverkehr (Fuss- und Veloverkehr)		1368					1368

<https://www.are.admin.ch/are/de/home/verkehr-und-infrastruktur/grundlagen-und-daten/kosten-und-nutzen-des-verkehrs.html>

Costs of annoyance: derived from market study Zürich Cantonal Bank

Decrease of apartment costs per dB:

Verkehr	Lärmklassen	Miet- wohnungen	Stockwerk- eigentum	Einfami- lienhaus	Durchschnitt Eigentumswohnung	Durchschnitt alle Wohnungen
Strassenverkehr	Nachtlärm > 40 dB(A) / Tageslärm > 50 dB(A)	0.21%	0.59%	n.a.	0.59%	0.25%
Schienenverkehr	Nachtlärm > 40 dB(A) / Tageslärm > 50 dB(A)	0.24%	0.47%	n.a. Ecoplan & Infrac, 2104	0.47%	0.27%
Luftverkehr	Tageslärm > 50 dB(A)	0.45%	1.20%	0.87%	1.04%	0.52%

Berechneter Wert.

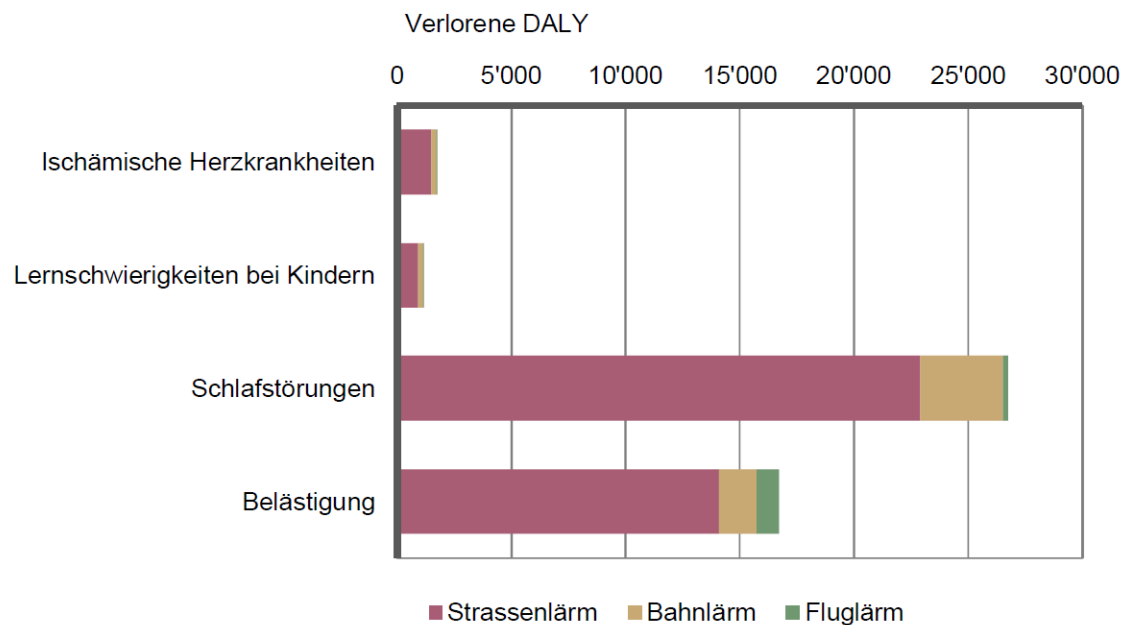
Quelle: ZKB (2012), Wie Lage und Umweltqualität die Eigenheimpreise bestimmen, S. 9 bzw. Luftverkehr ZKB (2005), MIFLU.

External costs from noise annoyance and sleep disturbances estimated from loss of renting and housing costs. (People pay less for noisier apartments.)

DALY transportation noise

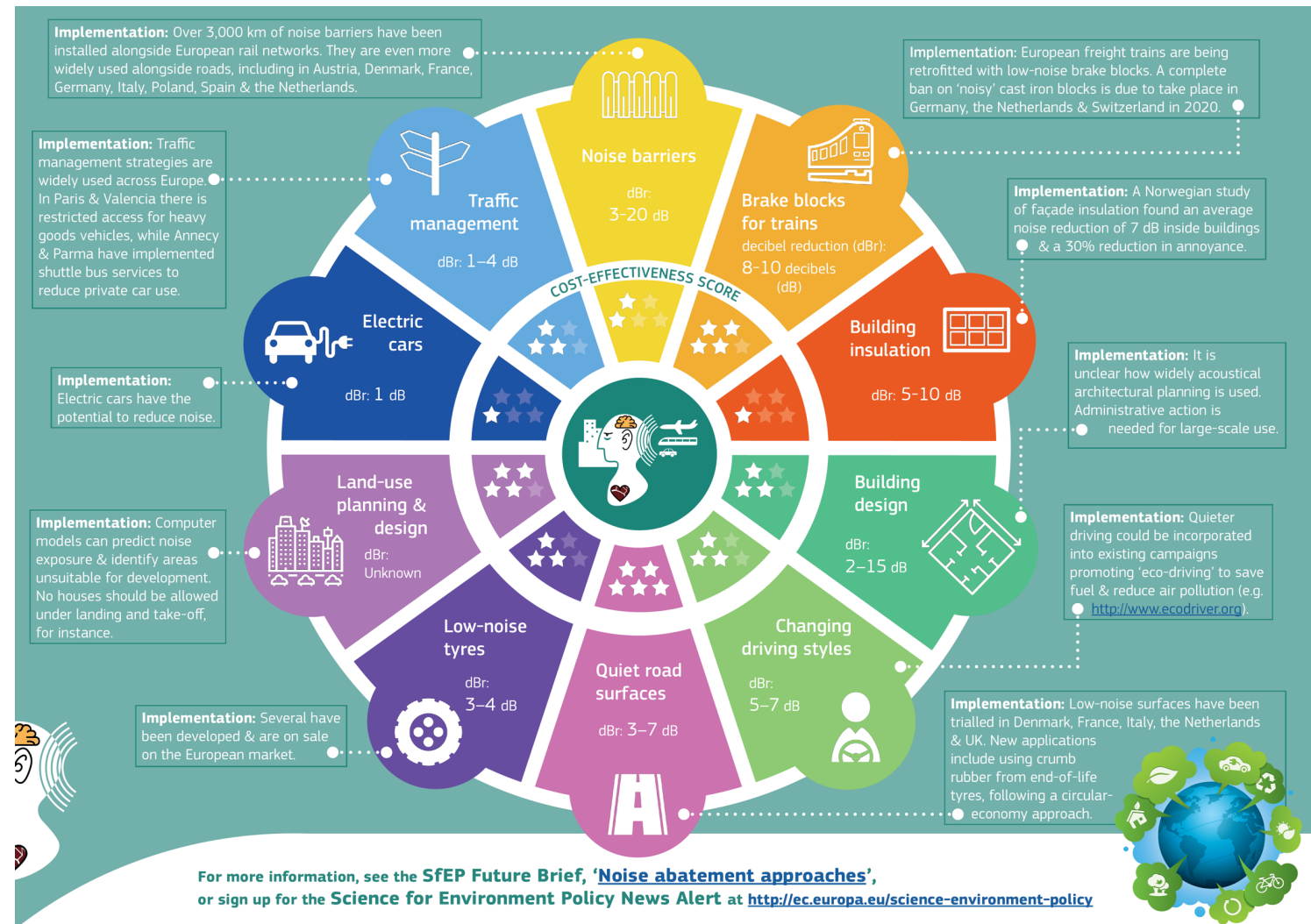
- Estimates based on Swiss external cost study (2010): 46,400 DALYs (Uncertainty range: 25,400 und 141,600).
- Road: 85%, Rail: 12% Aircraft:3%

Abbildung 1: Verlorene DALY aufgrund lärmbedingter Krankheitsbilder nach Verkehrsträger



Ecoplan, 2014

Mitigation: measure at the source have priority





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Environment International

journal homepage: www.elsevier.com/locate/envint



Estimating the health benefits associated with a speed limit reduction to thirty kilometres per hour: A health impact assessment of noise and road traffic crashes for the Swiss city of Lausanne

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Scenario definitions and exposure assessment

- City of Lausanne (136'077 inhabitants)
- No speed reduction as reference in comparison to:
 1. Current situation (2017)
 2. Whole city speed 30 km/h (without main road) (-1.5 dB on average)
 3. All roads speed 30 km/h (-1.7 dB on average)
- National SonBase noise model
- Exposure reduction assumed for persons living within 25 m from a speed reduction road.

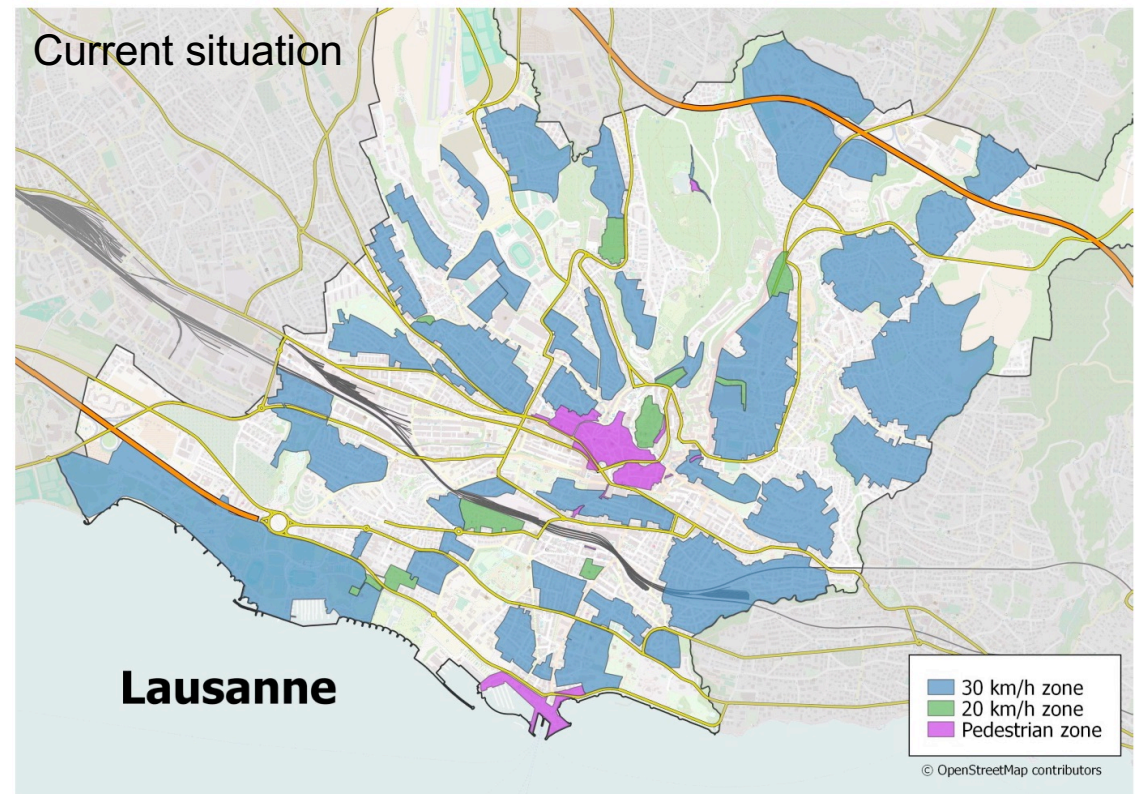


Figure S1 Lausanne 30 km/h, 20 km/h and pedestrian zones in 2017 (motorways are represented in orange, cantonal roads in yellow, railway lines in black, green areas in green)

Health benefits of whole city speed 30 km/h

Number of prevented cases

Exposure	Health effects (per year)	Attributable cases without main road
Noise	Cardiovascular deaths	2.0 (1.4 - 2.5)
	Cardiovascular hospital days	153 (111 - 195)
	New cases of diabetes	36 (11 - 58)
	Number of highly annoyed	2577
	Number of highly sleep disturbed	1977
Crashes	Deaths	0.0 (0.0 - 0.0)
	Severe injuries	8.2 (5.5 - 10.8)
	Minor injuries	38 (25 - 50)

Rossi, Env Int, 2020

Conclusions

- In Europe, noise is the 2. most relevant environmental health burden after air pollution.
- Estimated DALYs due to transportation noise in CH: 25,000-50,000
- Deaths attributable to transportation noise in CH: 250-600
- Annual external costs in CH: 2.8 Billion CHF
- From all transportation modes, road traffic is more relevant for health impact and external costs.
- Current estimates for health risk of noise substantially underestimate the impact:
 - New evidence for lower threshold (e.g. 55 dB)
 - Emerging outcomes are missing
- Health risk assessment for noise needs to be updated and included in the Global Burden of Disease study.