Environmental Noise Exposure Assessment

HEI-Energy Webinar: Human Exposure Research in a Cyclical Industry Part 3: Noise from Unconventional Oil and Natural Gas Development (UOGD)

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Outline

- Overview of noise assessment history and methods
- Noise modelling and exposure assessment
- Linking health and noise data
- Health effects and pathways

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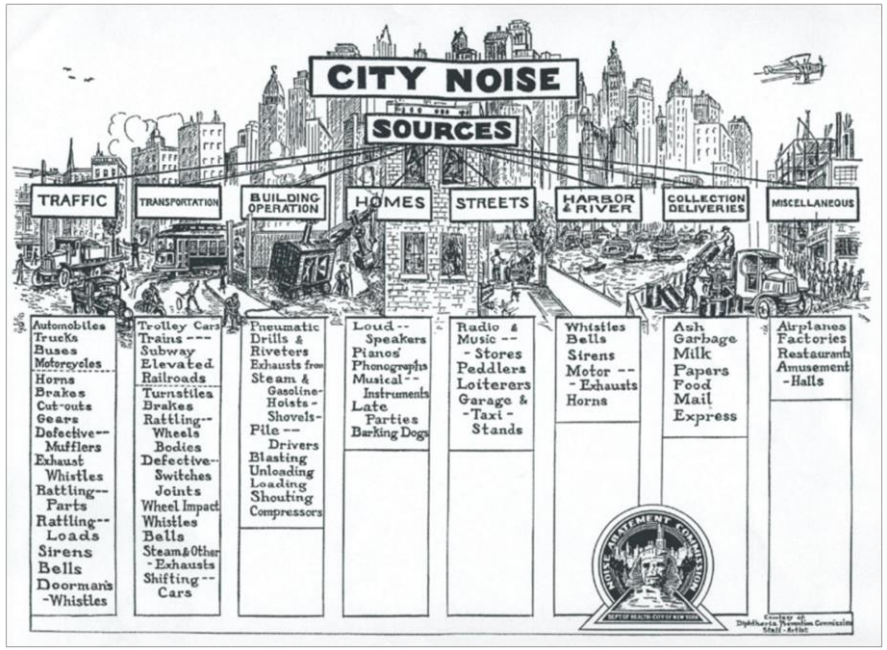
History of Noise and Health Research

- Early 1900s: Public complaints increased with motor vehicles
- 1930-1960: Increasingly sophisticated SLMs; data logging
  - Time and frequency weighting
- 1960-1980: Neighbourhood and population surveys
  - Human laboratory experiments
- 1990- Current: Noise modelling and individual exposure assessment
  - Source and definition of model standards



Photograph by *Bell Telephone Laboratories*
The noise measuring truck traveled over 500 miles in city streets, observing noise levels at 138 stations

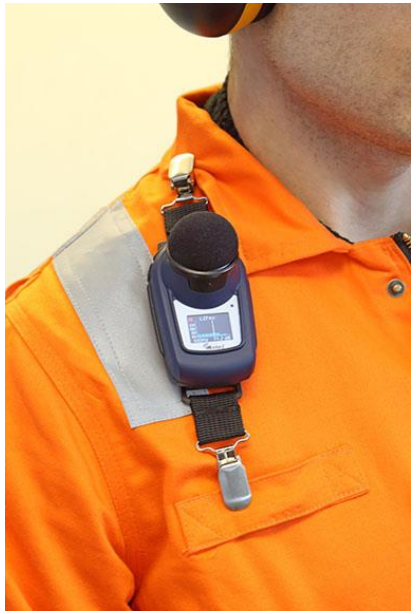
City of New York Noise Abatement Commission, 1930

Noise Exposure Assessment for Epidemiology

Neighbourhood monitoring

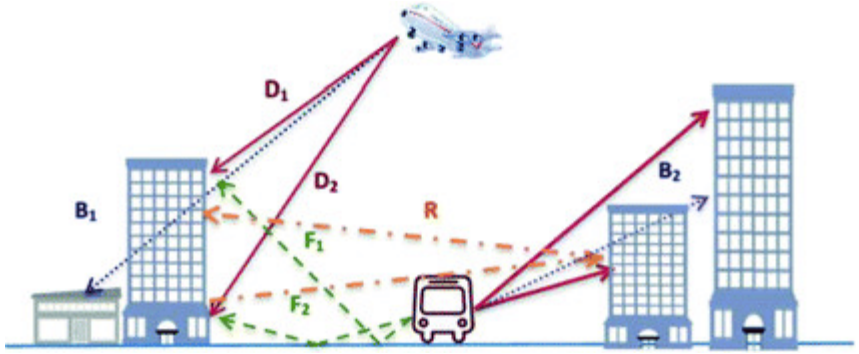
https://www.bksv.com/media/doc/bp2098.pdf

Individual monitoring



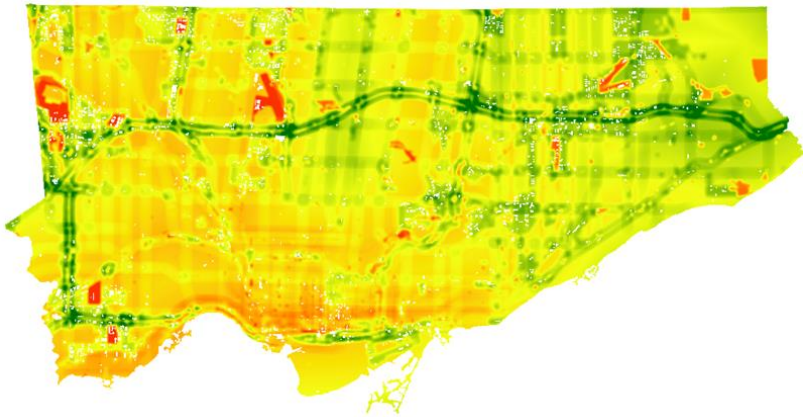
https://www.casellasolutions.com/in/en/products/dbadge2-pro.html

Source specific modelling (deterministic)



Lu et al., 2017)

Hybrid approaches (deterministic/probabilistic)



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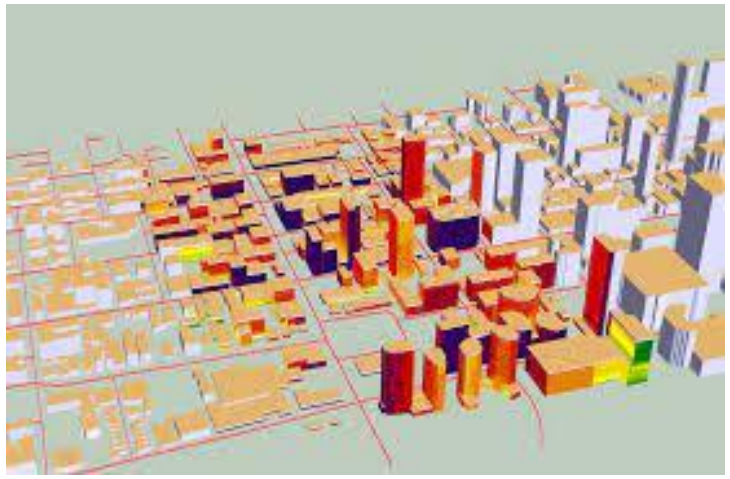
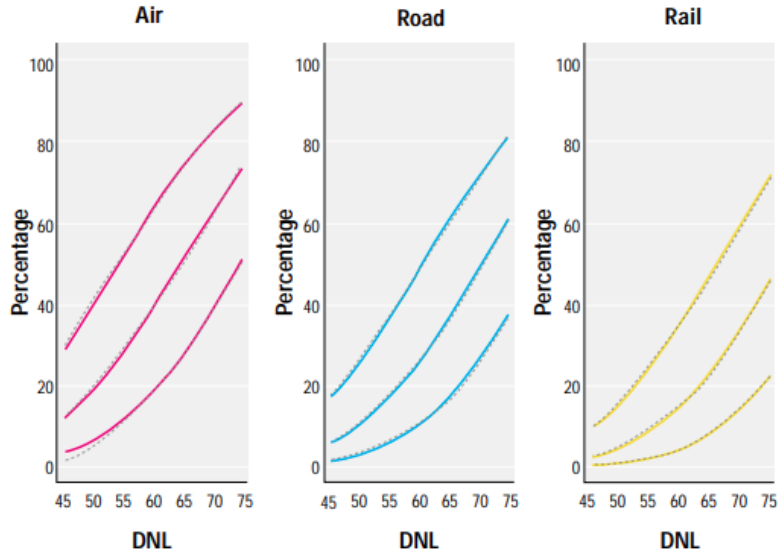
Source Specific Modelling

- Emission and propagation modelling
  - The ‘gold standard’ in large scale studies
  - Resource demanding, but high specificity (e.g., 3D)
- Possible for all types of sources
  - Primarily used for road and rail traffic
- Why individual sources?
  - Different effects of different types of noise..
  - Policy relevance
- Limitations
  - Differing standards by jurisdiction
  - Long-term changes in noise levels



Building façade assessment in Toronto (2018)



Estimated dose-response functions for percentage highly annoyed at different Day Night Levels (DNL) for air, road and rail traffic (Miedema and Oudshoorn, 2001)

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Noise exposure assessment and linkage to health assessment

- Exposure assessment summary
  - Group exposure classification
  - Individual exposure classification
  - Temporal and spatial challenges with assessment at residence

- Health assessment methods
  - Surveys
  - Linkage to population health cohorts and registries (may contain biometrics)
  - Physiological measurements and medical records
    - Blood pressure, sleep metrics, stress hormones, RNA/protein assays (e.g., inflammation markers), etc.

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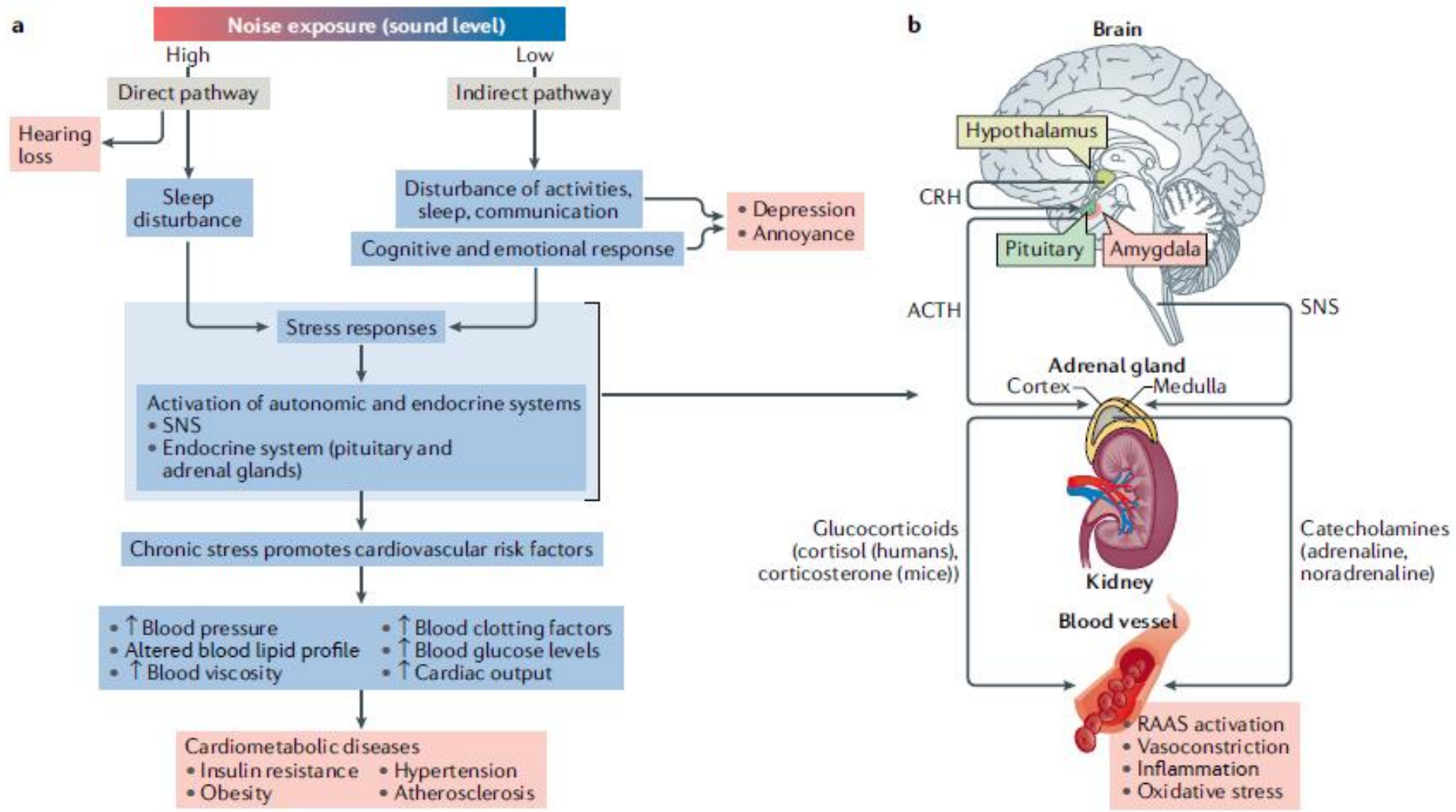
Health Effect Pathways and Outcomes



Munzel et al., 2021

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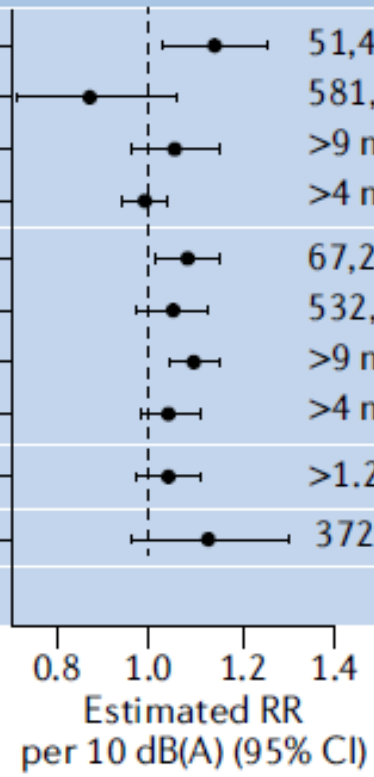
Health Effect Pathways and Outcomes

Chronic noise exposure	Adverse health effects	Noise source	Association	Participants (*n*)	Events (*n*)	Quality level of evidence
L_{den} >45 dB(A) for aircraft noise L_{den} >54 dB(A) for road and railway noise	Stroke	Road	Incidence	51,485	1,881	+++
			Mortality	581,517	2,634	+++
		Aircraft	Incidence	>9 million	97,949	+
			Mortality	>4 million	25,231	+++
	Coronary artery disease	Road	Incidence	67,224	7,033	++++
			Mortality	532,268	6,884	+++
		Aircraft	Incidence	>9 million	158,977	+
			Mortality	>4 million	15,532	++
	Depression	Road	Incidence	>1.2 million	–	+++
	Anxiety	Road	Incidence	372,079	–	+++
L_{night} >40–42 dB(A)	Sleep disturbance					

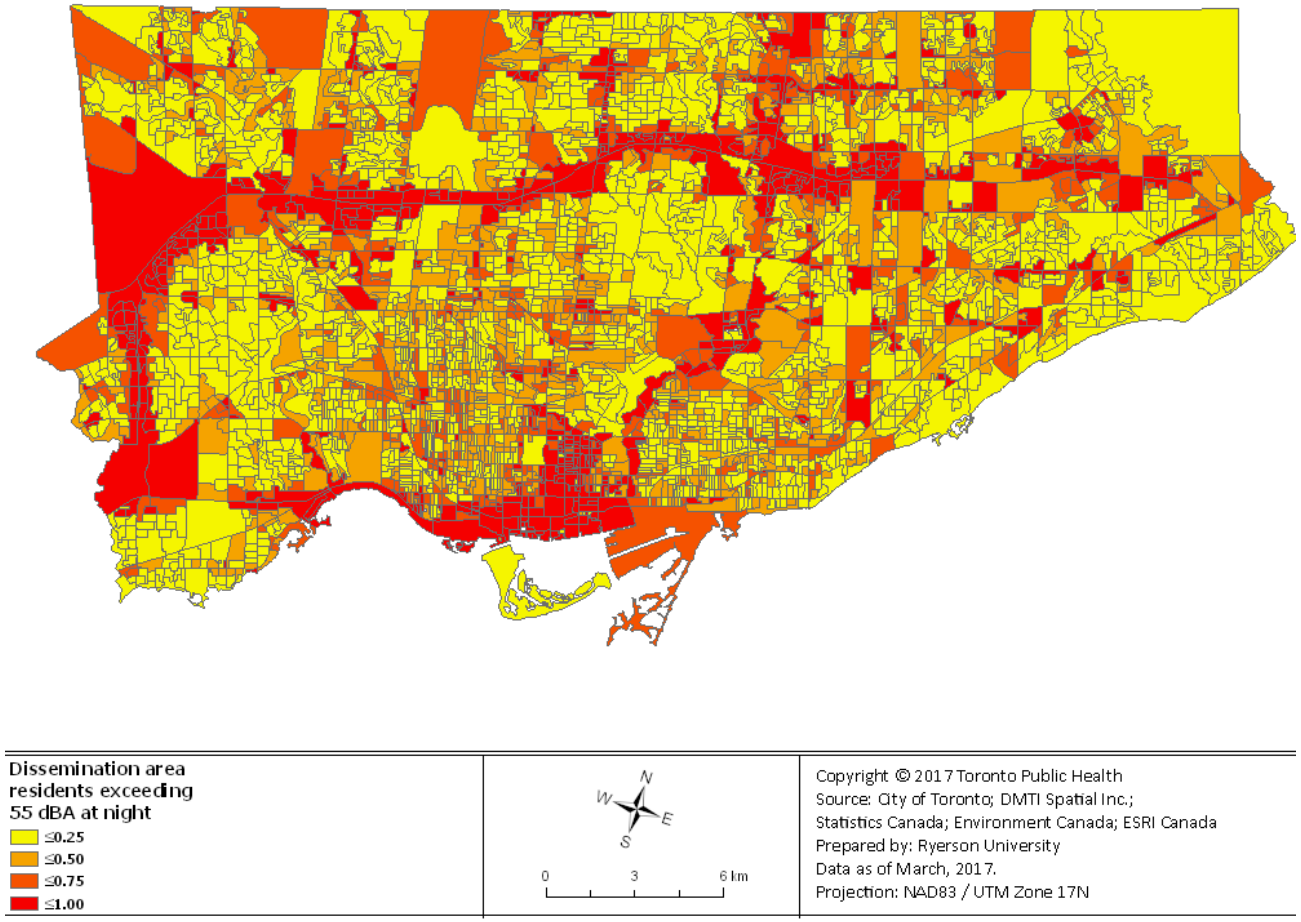


2018 WHO Environmental Noise Guidelines; Munzel et al., 2021

Strategic Noise Mapping

- Contour or Grid maps
  - Worst-case scenarios
  - Day and nighttime averages

- Population exposure assessment for use with performance metrics
  - Proportion of population at high risk
  - Proportion of population above threshold levels (e.g., WHO)



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References

- Lu, Lu & Adolphi, Thomas & Löwner, Marc-Oliver. (2017). 3D Complete Traffic Noise Analysis Based on CityGML. 10.1007/978-3-319-25691-7_15.
- Miedema, H. M., & Oudshoorn, C. G. (2001). Annoyance from transportation noise: relationships with exposure metrics DNL and DENL and their confidence intervals. *Environmental health perspectives*, *109*(4), 409-416.
- Münzel, T., Sørensen, M., & Daiber, A. (2021). Transportation noise pollution and cardiovascular disease. *Nature Reviews Cardiology*, 1-18.

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