Noise in urban areas: How does the definition of "neighborhood" impact exposure assessment?

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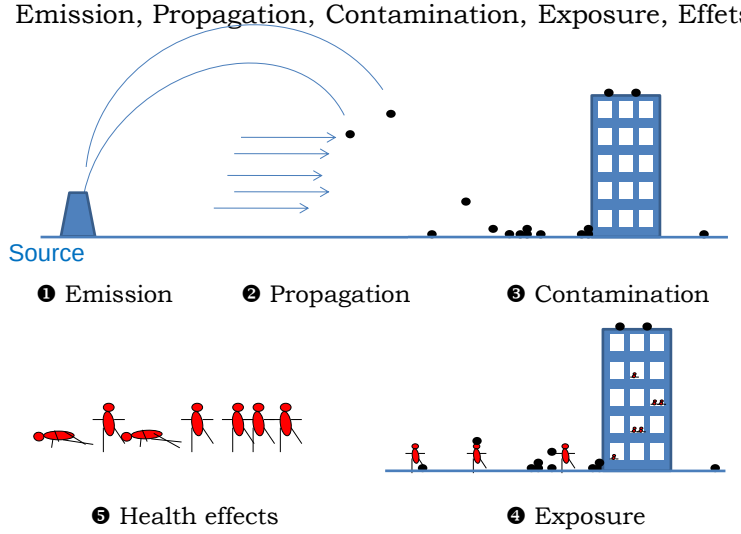
inter.noise HAMBURG 2016

Health effects: A 5-step model

Emission, Propagation, Contamination, Exposure, Effets

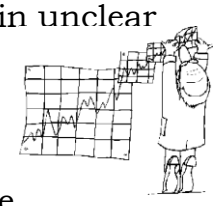


Impact on human health

- Understanding the actual exposure of urban populations is one of the biggest challenges of the next decade
- Most epidemiological studies that have focused on the effect of noise on health have been based on theoretical models
- The quality of exposure assessment depends greatly from the accuracy and scale of these models

Objective

- How the urban neighborhood is defined can vary across studies, leading to different approaches whose impacts on exposure levels remain unclear



- The aim was to explore the impact of the neighborhood's definition on environmental noise exposure estimates, and compare these results with others ubiquitous air pollutants: NO_2 and PM_{10}

Approach and Study site

- Besançon: 120,000 inhbts, 65 km²
- Main noise (and air pollution) sources:
  road and rail traffics
- Residential buildings located at least 400 m inside the city border, n=10,825
- A systematic approach conducted on environmental noise and also on air pollution
- Buildings, input data, period and definition of the exposure assessment were common

Environement prediction model

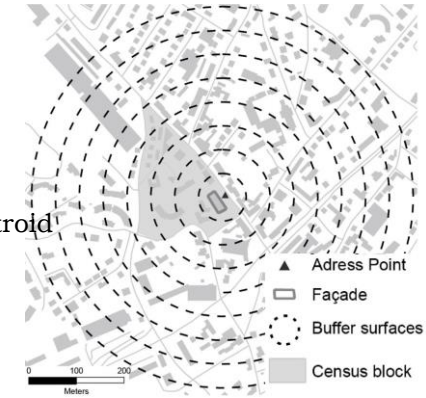
Noise model

- Software: MITHRA-SIG© (CSTB)
- Inputs:
  - topography, road and building data (BD TOPO®, IGN)
  - meteorological data (Météo France)
- Noise sources: road traffic, rail traffic, pedestrian precinct, and water fountains
- Three time periods: 06:00-18:00, 18:00-22:00, 22:00-06:00
- Validated with field campaigns *(Pujol et al. 2012)*

Noise map

- A 4 m² raster grid (arcGIS ©)
- Each pixel → a $L_{Aeq,24h}$ value

Exposure assesment

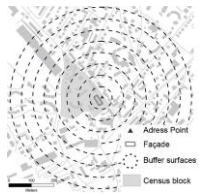


Ten noise exposures

- Address-point
- Façade
- Buffer centered on building centroid
  - 8 buffer radii (in m):
    50, 100, 150, 200, 250, 300, 350, 400

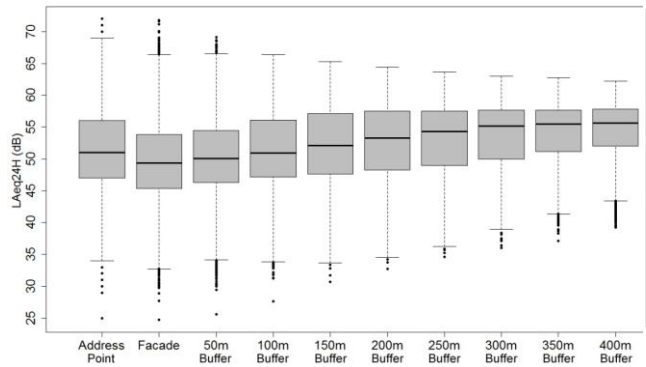
Scale effect analysis

- mean/variance of assessments
- For each building, $\Delta_{400\text{-}50} = L_{aeq,24h\text{-}400m} - L_{aeq,24h\text{-}50m}$



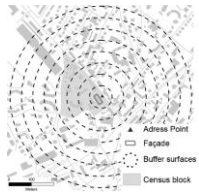
Results

Noise exposure distribution

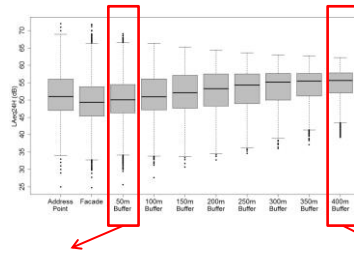


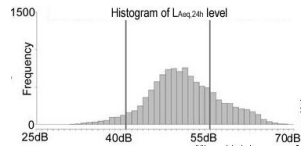
The means increased: 49.6 dB ➔ 54.2 dB
The SD decreased: 7.1 ➔ 4.9 dB

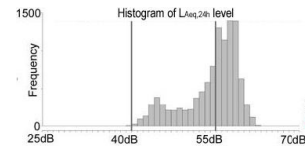
Ténailleau et al., Jesee 2015.



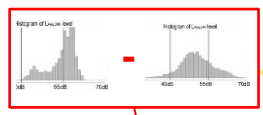
Noise exposure distribution



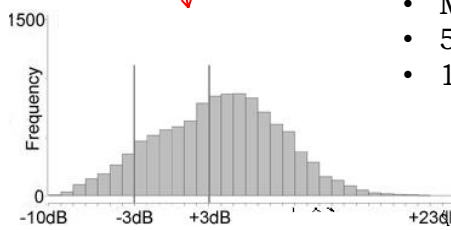




Tenailleau et al., Jesee 2015.



The $\Delta_{400\text{-}50}$ $L_{Aeq,24h}$ (1)



- Between -9.4 dB and +22.3 dB
- Mean variation: +3.9 dB
- 57% over +3 dB
- 10% under -3 dB

$L_{Aeq,24h\text{-}400m} - L_{Aeq,24h\text{-}50m}$

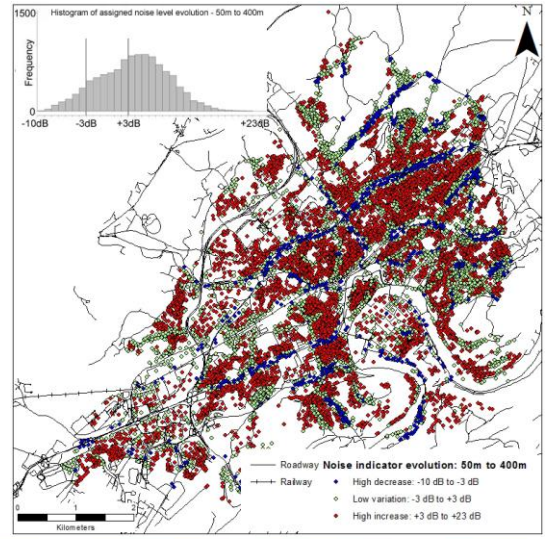
The $\Delta_{400\text{-}50}$ $L_{Aeq,24h}$ (2)

The $\Delta_{400\text{-}50}$:

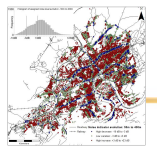
- **-10 dB to -3 dB**
- **-3 dB to +3 dB**
- **+3 dB to +23 dB**

A positive link with:

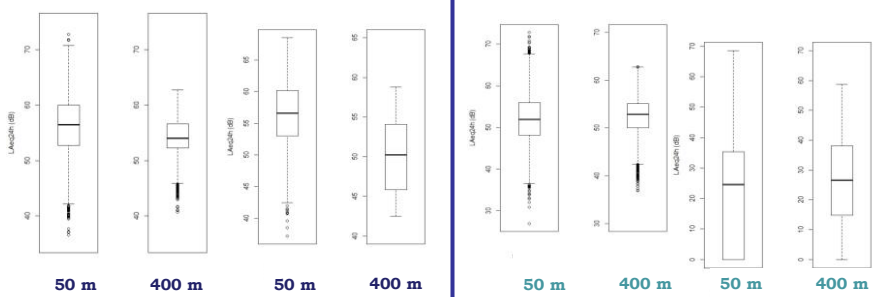
- Distance to the road
- Urban type
- Population density



Tenailleau et al., Jesee 2015.



Road and rail, separately

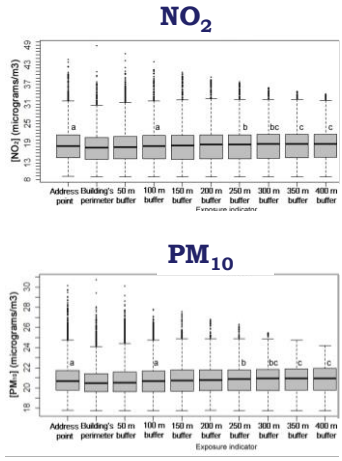


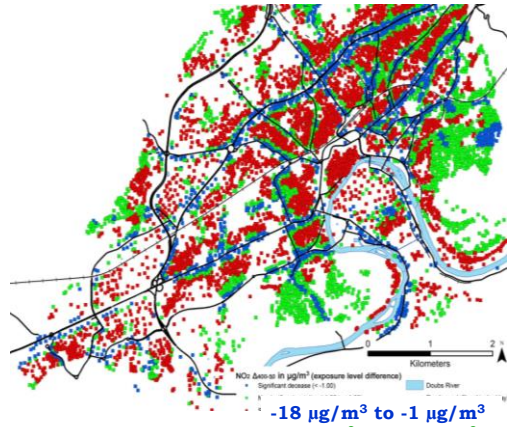
Vinicity of major transport infrastructures

All buildings

Air pollution

nitrogen dioxide (NO_2) and particulate matter (PM_{10})





The NO_2 Δ_{400-50} values: **-18 µg/m³ to -1 µg/m³**
-1 µg/m³ to +1 µg/m³
+1 µg/m³ to +8 µg/m³

Tenailleau et al., Env Poll. 2015

Circul'Air (COPERT4) and ADMS-Urban© softwares by ATMO Franche-Comté

Discussion

- A real influence of the definition of the neighborhood on the noise and air pollution exposure assessment
- This influence applies differentially and depends of the spatial position of assessments
- Impact for Exposure science, Epidemiology and Health risk assessment

Conclusion

A medium-sized European city

- 100,000-500,000 inhbts
- highly represented in terms of demography
  - near 45% of the European population
- but less studied than the bigger cities

Considering the effort to reduce pollution in major cities, this could makes today's medium-sized cities good places for studying the future of major cities

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