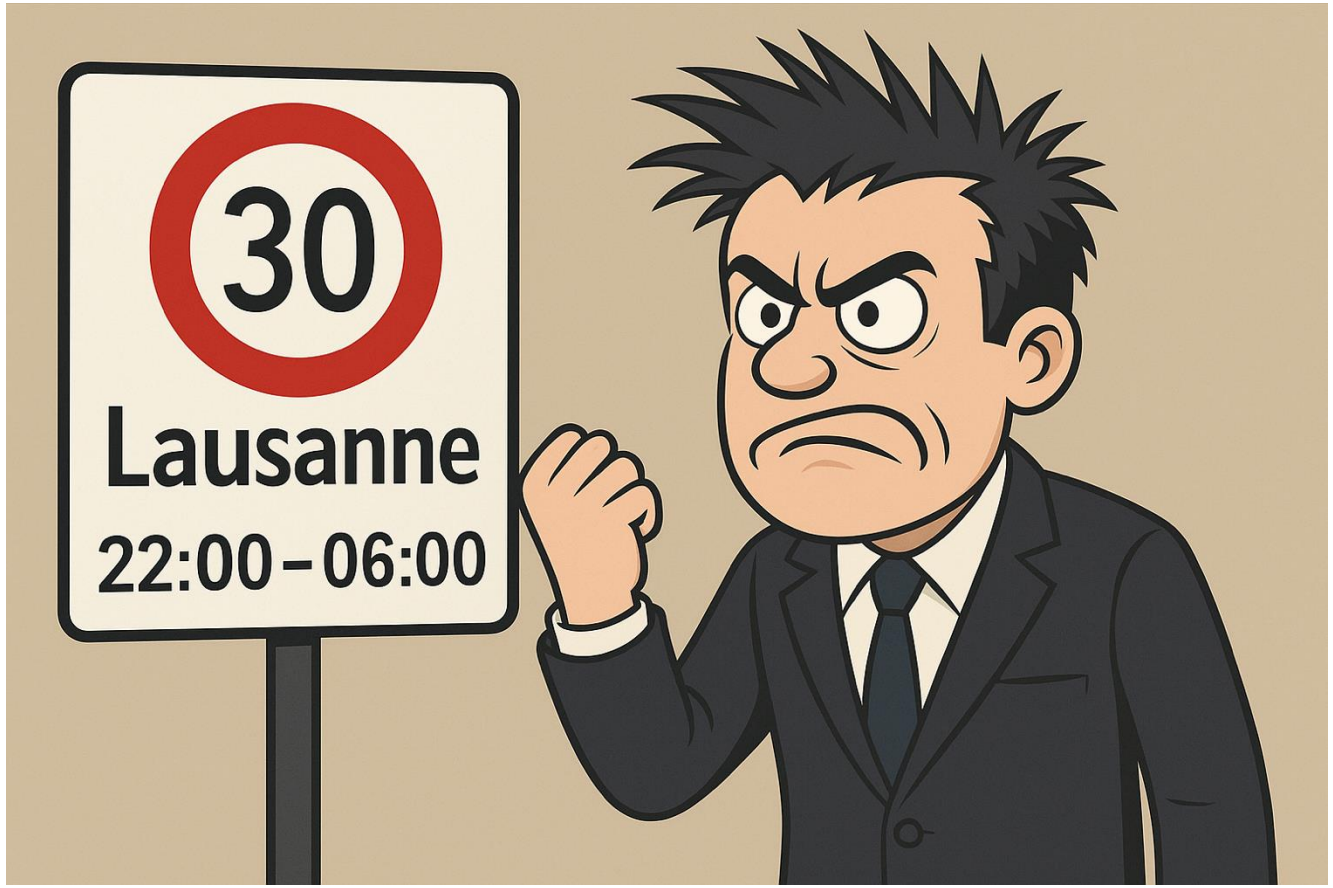
Occupational and environmental heatlh

Léan Bruttin & Jordane Provin

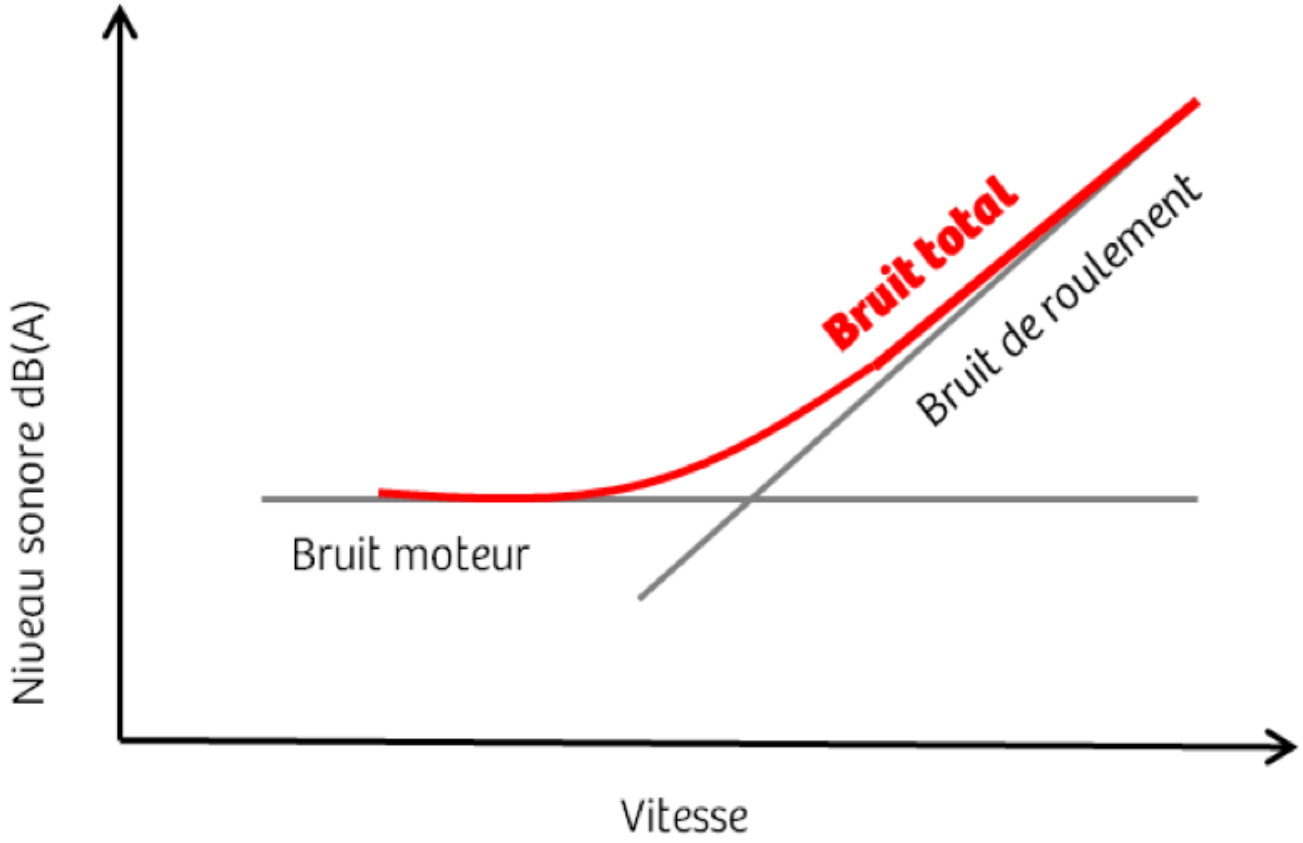
A recent preventive measure involves limiting traffic in the city at night to 30 km/h. Why this speed in particular ? What are the expected health benefits of this measure ?



Hazard Identification

- Noise : [dB[A]
- At **low speeds** (below 50 km/h), the noise mainly comes from **the engine**, acceleration, and exhaust.
- At **higher speeds** (above 50 km/h), the **tyre–road contact** dominates.

Principe d'évolution du niveau de bruit global en fonction de la vitesse



Hazard Identification

- According to the WHO Environmental Noise Guidelines (2018), road-traffic noise is one of Europe's largest environmental health burdens. It causes :
  - Sleep disturbance (strong evidence)
  - Cardiovascular effects (hypertension, heart disease)
  - Annoyance and mental stress
  - Cognitive impairment in children (moderate evidence)

Hazard Identification

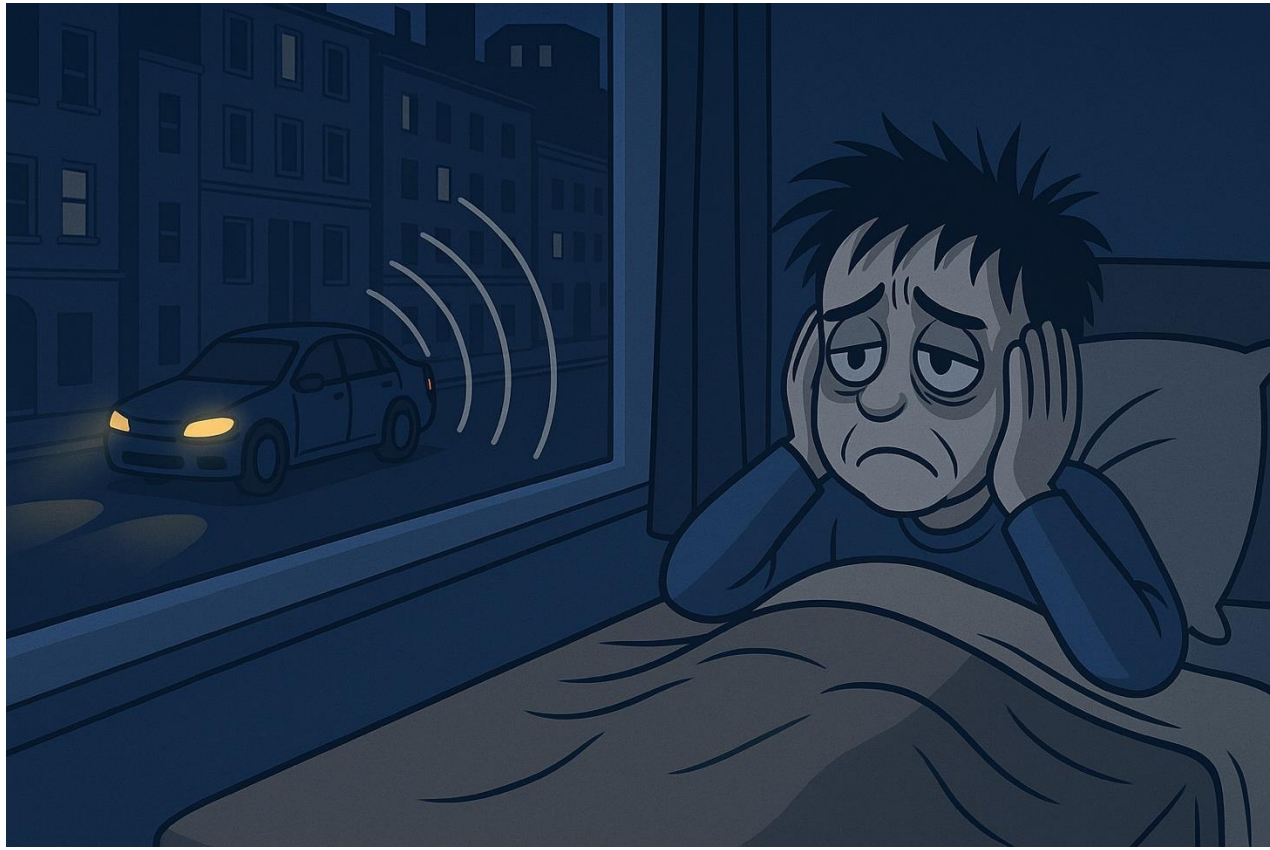
Health Outcome	Risk Estimate (per +10 dB)	Typical Exposure Level	Evidence Quality	Comments
Ischemic heart disease (IHD)	RR = 1.08 (95% CI 1.01–1.15)	≥ 53 dB	**High** (dose–response confirmed)	Clear link between traffic noise and heart disease risk
Hypertension	RR = 0.97 (95% CI 0.90–1.05)	N/A	**Low** (only 1 study)	Insufficient evidence, but trend consistent
Annoyance / Stress	OR = 3.0 (95% CI 2.6–3.6)	≥ 40 dB	**Moderate**	Strong increase in population annoyance
Cognitive effects (children)	Not estimated	N/A	**Very low**	Observed impact on reading & comprehension

https://iris.who.int/server/api/core/bitstreams/f53c45ba-11d3-4502-a424-c1cf49f5a053/content

Background and contributing factors

Why **night-time noise** matters ?

- **Background** noise is much **lower**
- Open windows at night
- Fewer cars, but each one has a stronger impact on sleep.
- Urban geometry can amplify sound reflections.
- **More people at home** at night (sleeping), fewer during the day (at work).



→ Hence the stricter Swiss OPB night limits (22:00–06:00)

Risk Assessment

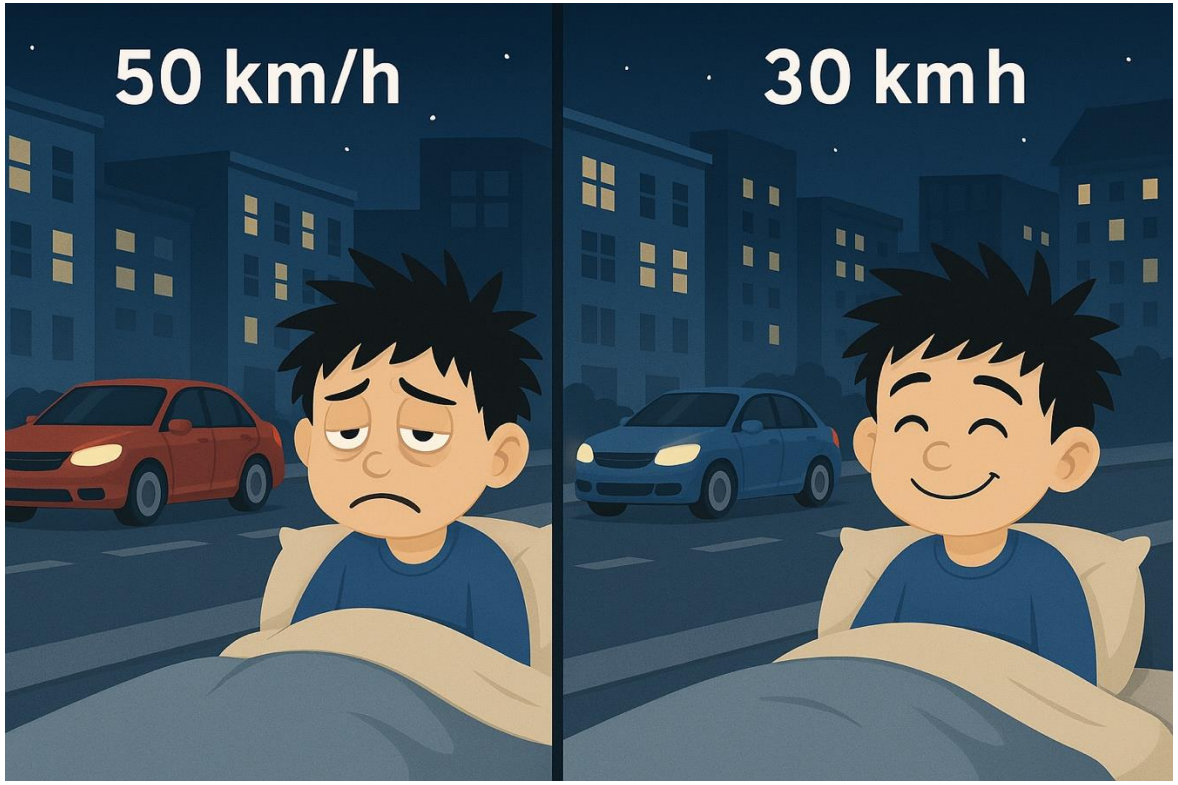
- The **OPB** Annex 3 defines maximum allowed levels for road traffic noise depending on the sensitivity degree (DS) of the zone

Area Type	Day [dB(A)]	Night [dB(A)]
Hospital, sanatoria	55	45
Residential	60	50
Mixed use	65	55
Industrial	70	60

Risk Assessment

- Example : **Residential street**
  - Measured night level: 52 dB(A)
  - Limit: 50 dB(A) → **slightly exceeded**

- Effect of speed reduction (50 → 30 km/h)
  - Typical noise reduction: ≈ **–3 dB(A)**
  - ≈ 50% less sound energy
  - ≈ 20% quieter for human perception
  - In our example : 52 – 3 = 49 dB(A) → in the limit



Risk Assessment

- $\Delta L = 10 * log_{10}(I)$
  - Where :
    - ΔL : change in decibel
    - I : ratio of energy
- $I = 10^{\Delta L/10} = 10^{-3/10} = 0.5$
- → **50 %** less **sound energy**

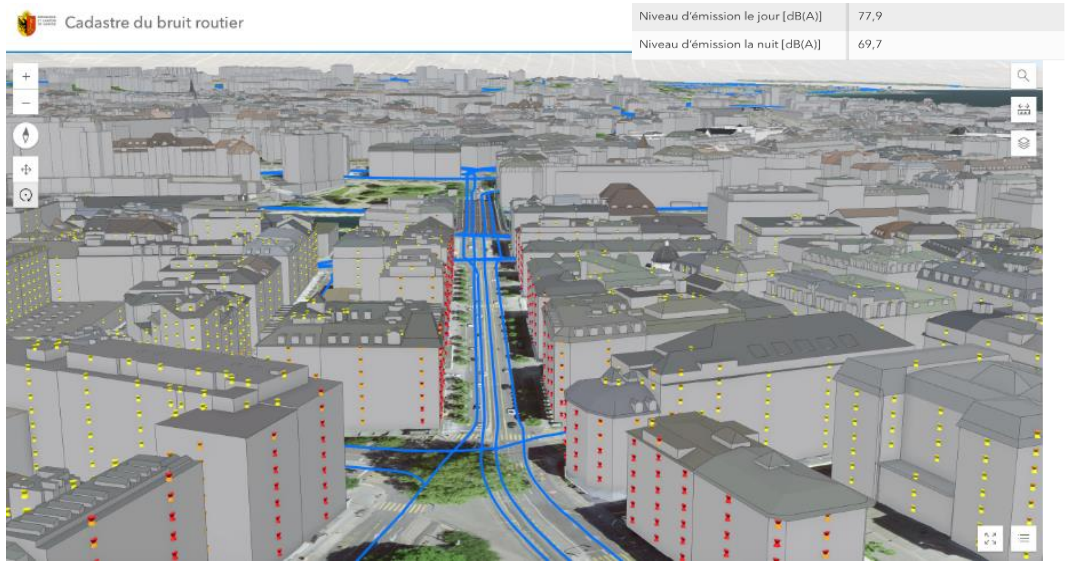
- $Loudness = 2^{\frac{Phon - 40}{10}}$
  - Where :
    - Loudness : perceived loudness of a sound
    - Phon : A phon measures loudness compared to a 1 kHz tone.
- $Loudness_{52} = 2^{\frac{52 - 40}{10}} = 2.297$
- $Loudness_{49} = 2^{\frac{49 - 40}{10}} = 1.866$

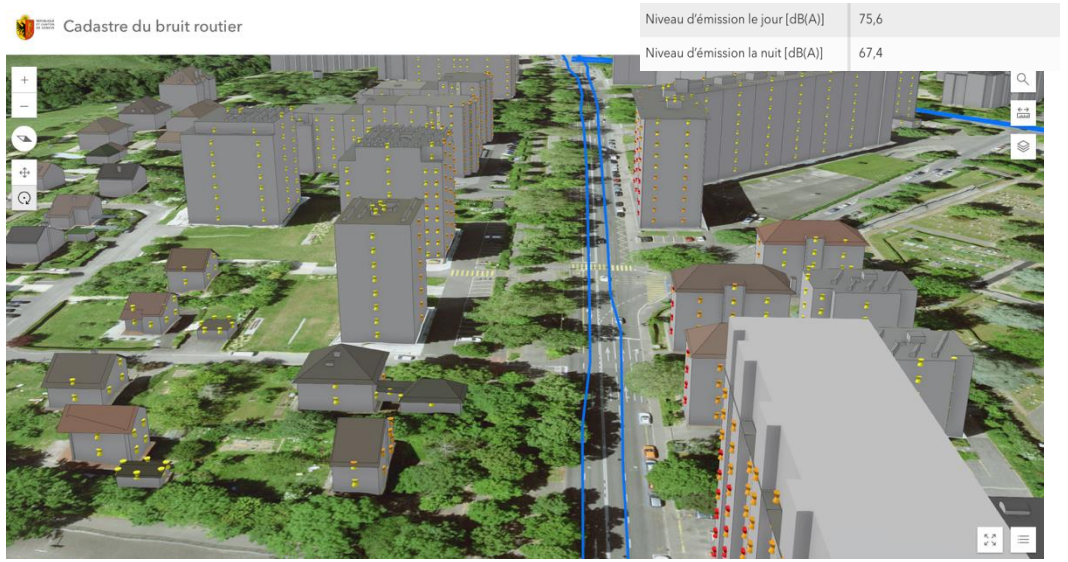
- → **19%** decrease in **loudness**

Risk Assessment - Why Speed Limit Alone Is Not Enough ?

- Reducing from 50 → 30 km/h gives **about –3 dB even with many car**
  - We could **reduce the number of cars** in the cities :
    - Park-and-ride at the city edge
    - Less transit traffic through residential streets
    - Better public transport and active mobility (walking, cycling)

- **Urban geometry** strongly impact noise
  - Narrow, high streets are much noisier than wide, low streets
  - Studies have shown :
    - **Adding sound-absorbing materials** can reduce levels by ≈ 4–5 dB
    - Combining absorption with optimised geometry can reach ≈ 9–10 dB reduction





Risk Assessment - Why Speed Limit Alone Is Not Enough ?

- Swiss study (Locher et al.): typical outdoor → indoor reductions for road traffic noise
  - Open window ≈ 10 dB(A)
  - Tilted window ≈ 16 dB(A)
  - Closed window ≈ 28 dB(A)
- Better ventilation systems (no need to open the window) and better wall insulation can therefore strongly reduce indoor exposure
- Impact of the road surface
  - 0.9 dB(A) diff between standart and quiet
  - 1.4 dB(A) diff between noisy and quiet
    - → could change road surface for quiet

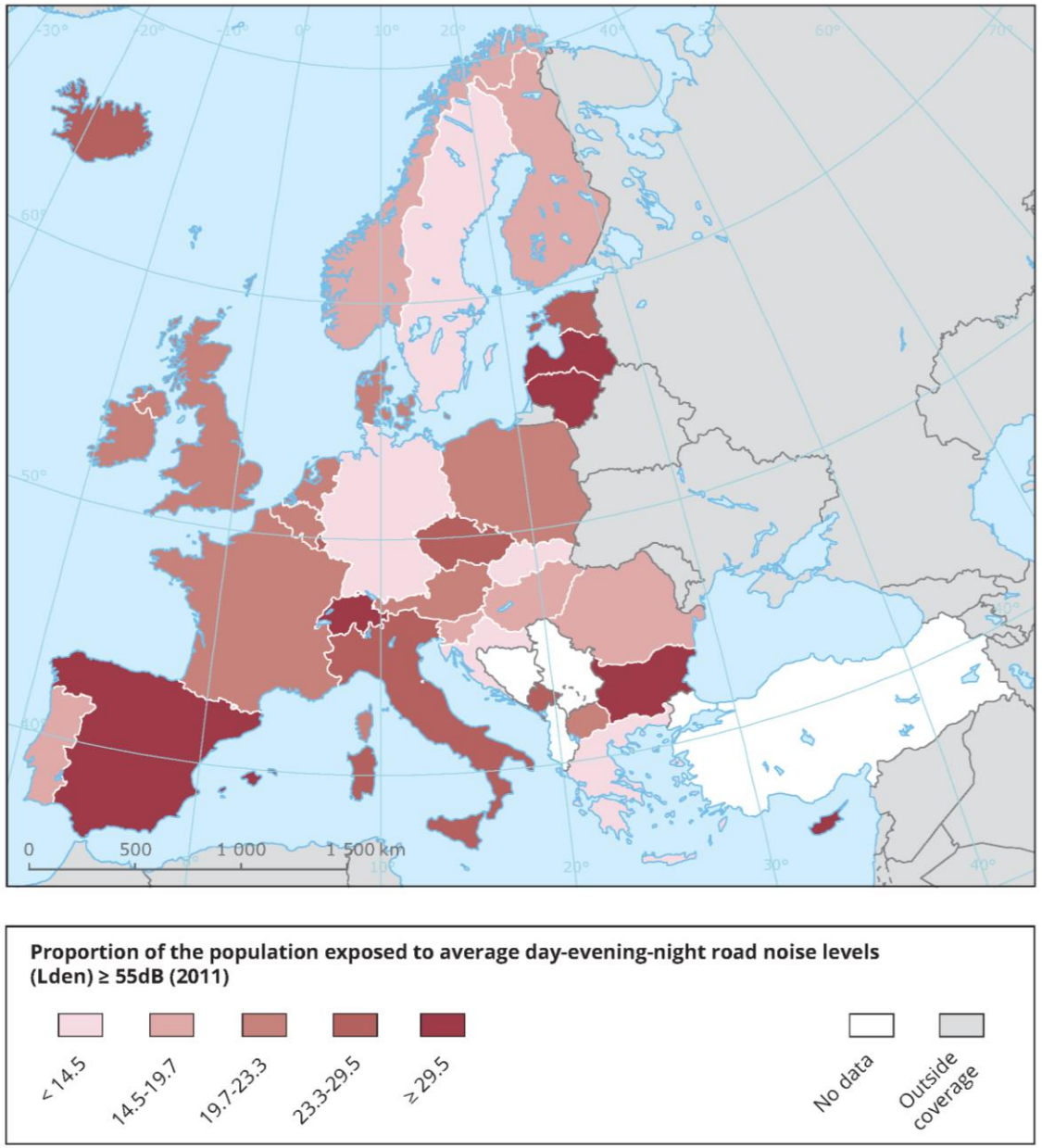
Réduction de la vitesse	Revête-ment peu bruyant	Revê-tement standard	Revê-tement bruyant
50 à 30 km/h	- 2.5 dB(A)	- 3.4 dB(A)	- 3.9 dB(A)
70 à 50 km/h	- 2.3 dB(A)	- 2.6 dB(A)	- 2.8 dB(A)
90 à 70 km/h	- 1.9 dB(A)	- 2.1 dB(A)	- 2.2 dB(A)
110 à 90 km/h	- 1.6 dB(A)	- 1.7 dB(A)	- 1.8 dB(A)
130 à 110 km/h	- 1.4 dB(A)	- 1.4 dB(A)	- 1.5 dB(A)

Risk Assessment

According to the European Environment Agency **(EEA)** (2023):

- **100 millions** people in the EU exposed to **> 55 dB(A)**
- **48 millions** exposed to **> 50 dB(A)** at night
  - → ≈ 12 000 premature deaths
  - → ≈ 50 000 heart-disease

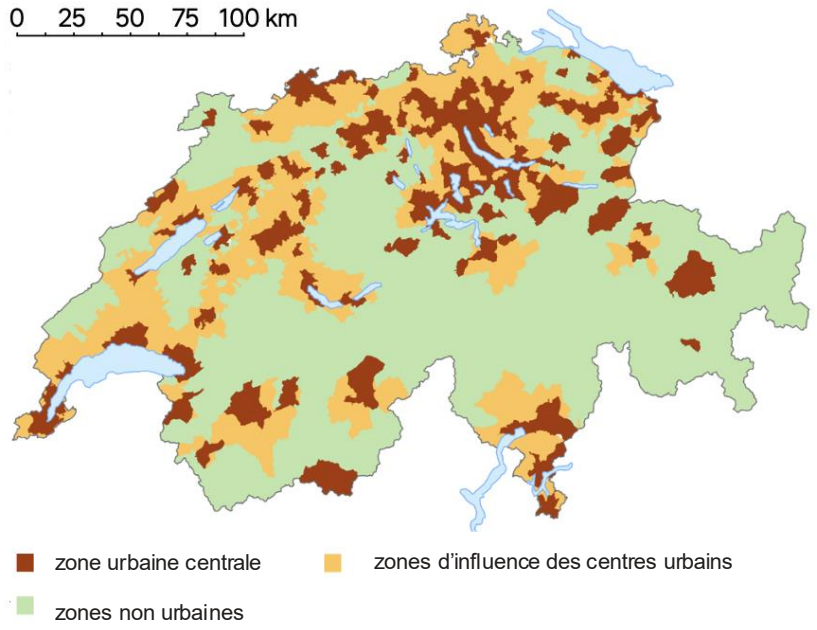
- A simple 2–3 dB reduction is a real public-health gain.

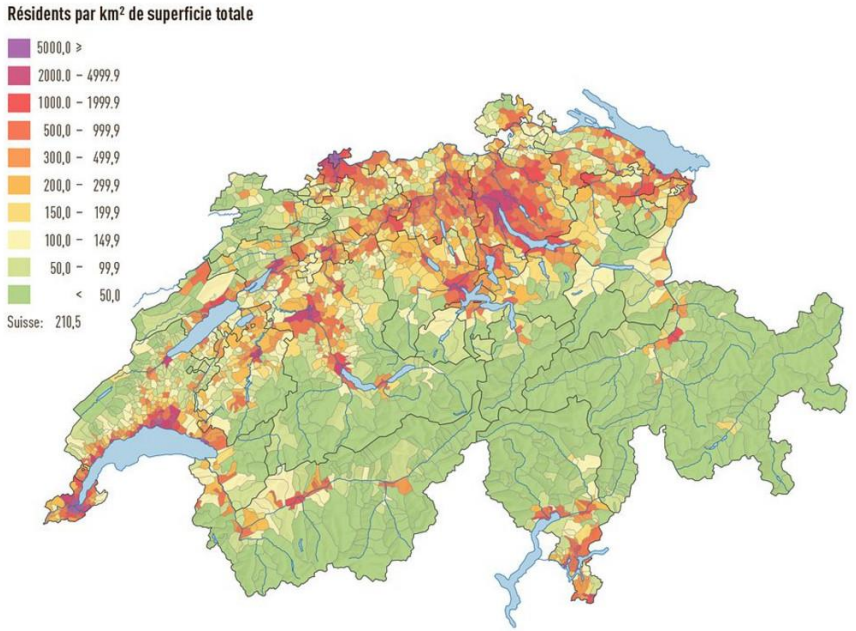


Risk Assessment

Closer look at Swirtzerland

- Switzerland is **highly urbanised** along the **Plateau** (Geneva → Lausanne → Bern → Zurich → St. Gallen).
- Urban areas are characterised by:
  - High population density
  - Buildings close to roads
  - Heavy road traffic volumes
- Topography (valleys, “urban canyons”) can amplify noise propagation.





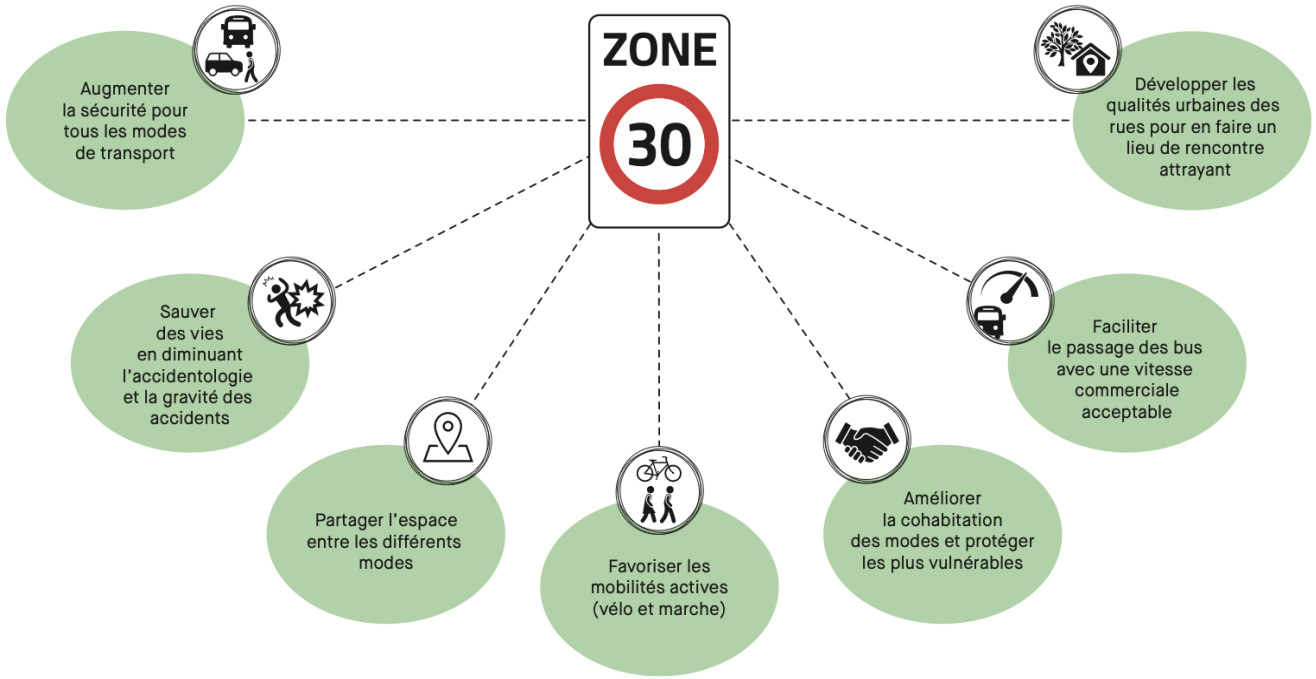
Regulation and legal framework

Switzerland has one of the strickest noise frameworks

Federal Law	Ordinance	Cantonal Directive	Technical Tools
LPE (Federal Environmental Protection Act)	**OPB** (Ordonnance sur la protection contre le bruit, RS 814.41)	**DGMR** Directive OZ30 (Vaud, 2021)	sonROAD18 + ISO 9613-2
Art. 11–13 : “limit noise at the source first”	Defines limit (VLI), planning (VP)and alarm (VA) values by sensitivity and time (day/night)	Authorizes 30 km/h zones for noise reasons if OPB limits exceeded	Models for noise emission and propagation (official tools)

Why 30 km/h ? - Noise and health benefits

- **1. Acoustic justification**
  - 50 → 30 km/h = –3 dB(A) (≈ half the sound energy)
  - Reduction is largest in this speed range
  - Below 20 km/h → reduction plateaus (engine load ↑)
- **2. Health benefits (WHO 2018)**
  - Better sleep: fewer awakenings
  - Lower cardiovascular risk (IHD, hypertension)
  - Reduced annoyance & stress
  - Improved cognitive outcomes (children)
- **3. Co-benefits**
  - Safer streets
  - Less air pollution (NO_2, PM)
  - Calmer, more livable neighbourhoods



Conclusion

Why 30 km/h at night matters ?

- Traffic noise = proven public-health hazard
- 30 km/h → **–3 dB(A)** (≈ **50% less sound energy**)
- Enough to bring many façades below **OPB night limits**
- Measures aligned with **LPE**, **OPB**, and **DGMR OZ30**
- Evidence-based, source-level, low-cost intervention
- Supports safer, quieter, more livable neighbourhoods

“Prevention at the source protects both people and the environment.”

Reference

Regulatory & Legal Frameworks

Swiss OPB (Ordonnance sur la protection contre le bruit, RS 814.41), Annex 3 – Noise limit values by sensitivity degree (DS I–IV).

DGMR Vaud (2021) – Directive OZ30: Implementation criteria for 30 km/h night speed limits.

LPE (Federal Environmental Protection Act, Articles 11–13) – Pollution prevention at the source.

Acoustic Models & Technical Standards

OFEV/BAFU (2019) – sonROAD18: Swiss road traffic noise emission model (valid from 20 km/h).

ISO 9613-2 – Sound propagation calculation standard.

OFEV (2022) – Frases Pilot Study: Measured −3 dB(A) reduction from 50→30 km/h.

Cadastre de bruit : https://app2.ge.ch/tergeoportal/apps/instant/3dviewer/index.html?appid=a24f2d33815d4effa73024b886d03af5

Reference

Health & Epidemiological Evidence

WHO (2018) – Environmental Noise Guidelines for Europe: Sleep disturbance, cardiovascular risks, and annoyance thresholds (Lnight ≤ 40 dB(A) recommended).

European Environment Agency (2023) – Transport Noise Health Impacts: 12,000 premature deaths/year in the EU linked to noise.

EPFL OEH Course 4.1 (2025) – Physical Hazards: Noise & Vibrations: Leq, dB(A), and dose-response relationships.

OFEV sonROAD18; Frasses pilot 2022; WHO Environmental Noise Guidelines 2018; EPFL OEH 4.1.

Local & Practical Context

SITG Geneva (2023) – Façade noise exposure mapping (Lr_day/night).

Cercle Bruit – Urban noise mitigation strategies (quiet pavements, traffic smoothing).

VD Cantonal Mobility Office – 30 km/h night limits in Lausanne (2021).

Annex – 30 km

- Vertical signage (30 km/h signs + installation): typically on the order of a few hundred francs per location.
- Road markings: also a few hundred CHF per site (order of magnitude based on 30 km/h planning documents).
- Studies + communication + police enforcement: lump-sum (campaign + controls).

→ ≈ 0.5–1 million CHF for the Lausanne network.

Annex – Park-and-ride (P+R)

- Fribourg study: surface P+R ≈ CHF 5,000–8,000 per space.
- Example for Lausanne: +1,000 spaces ≈ CHF 5–8 million
- Public transport & active modes
- Upgrading or adding a well-served bus/tram line costs a few million CHF/year in operation, plus targeted walking/cycling infrastructure.

→ Really expensive millions of CHF !

Annex – Building isolation

- **Building Insulation & Ventilation Upgrades**
  - Façade / acoustic insulation upgrade: ≈ 150–300 CHF/m²
  - Moderate renovation: +3–10% of total building renovation cost when adding acoustic measures
  - Costs vary by existing building condition, façade type, windows, and ventilation system
- Better ventilation reduces need to open windows → large reduction of indoor noise exposure

https://www.movu.ch/ratgeber/en/noisy-apartment-guide/

https://www.ecoacoustique.ch/wp-content/uploads/2019/01/VD-2004-Full-review-of-swiss-stardard-SIA-181.pdf

https://en.houzy.ch/post/house-renovation-costs-switzerland

Annex – Urban geometry

- Acoustic effect (order of magnitude)
- Sound-absorbing façade cladding in street canyons: ≈ 4–5 dB reduction at façades.
- Absorption + optimised geometry (balconies, slight façade rotation): up to ≈ 9–10 dB in simulations.
- Trees / green & living walls: mainly small physical effect (≈ 1–3 dB) but clear perceived noise relief and visual comfort.

→ Really complicated to implement