inter.noise HAMBURG 2016

Empa Materials Science and Technology

Parameter study on IR, a metric reflecting short-term temporal variations of transportation noise exposure

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Session: Noise indicators and exposure assessment for health impact studies

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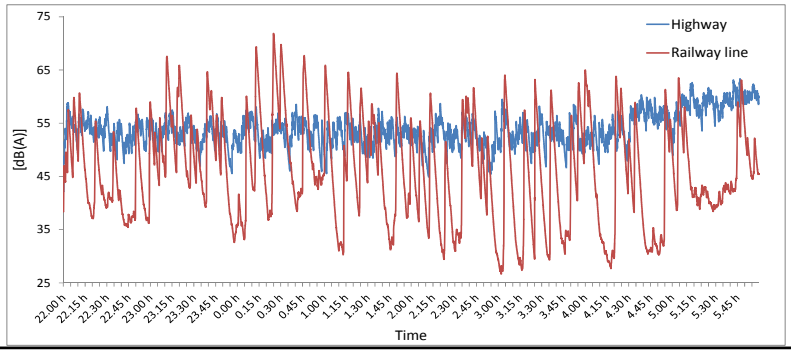
Content

Introduction

- SiRENE (Short and Long Term Effects of Transportation Noise Exposure)
  - Interdisciplinary research project (Epidemiology, Chronobiology, Socio-Acoustics)
  - Task: Sound exposure modeling for the whole Swiss population
  - Acoustic descriptors?



Introduction (2)

- How to describe short-term level variations? Potential descriptors:
  - Max level (distribution)
  - Event duration
  - Slope of rise
  - Number of events
  - Emergence (from background noise)
  - Structure / sequence of events
- How to define an integral descriptor to express the eventfulness of an exposure situation over a longer period of time?
- Restriction: Calculation must be possible based on the information at hand.

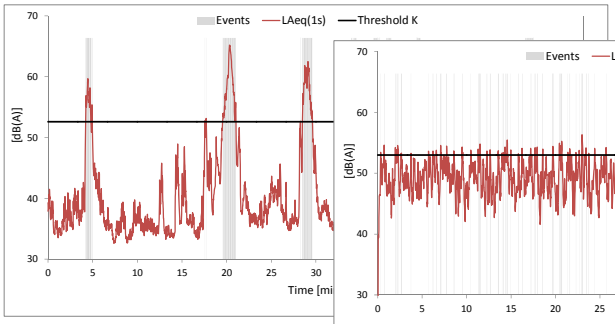
➔ Journal of Exposure Science and Environmental Epidemiology (2015), 1-11

Intermittency Ratio: Definition

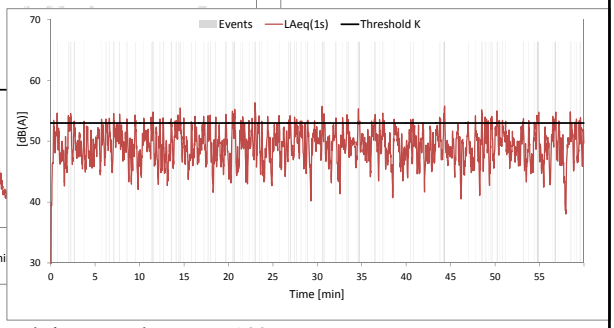
- We define the Intermittency Ratio *IR* as the ratio of the event-based sound energy to the overall sound energy

$$IR \equiv \frac{10^{0.1L_{eq,T,Events}}}{10^{0.1L_{eq,T,tot}}} \cdot 100 = 10^{0.1\left(L_{\mathrm{eq,T,Events}} - L_{\mathrm{eq,T,tot}}\right)} \cdot 100[\%]$$

$$K \equiv L_{\mathrm{eq,T,tot}} + C[\mathrm{dB}]$$



Railway noise: IR = 87%



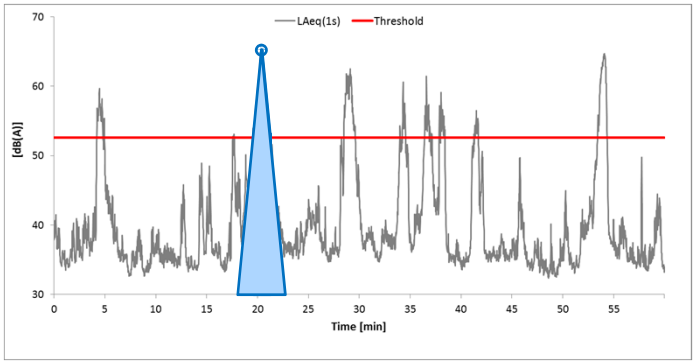
Highway noise: IR = 19%

Intermittency Ratio: Calculation

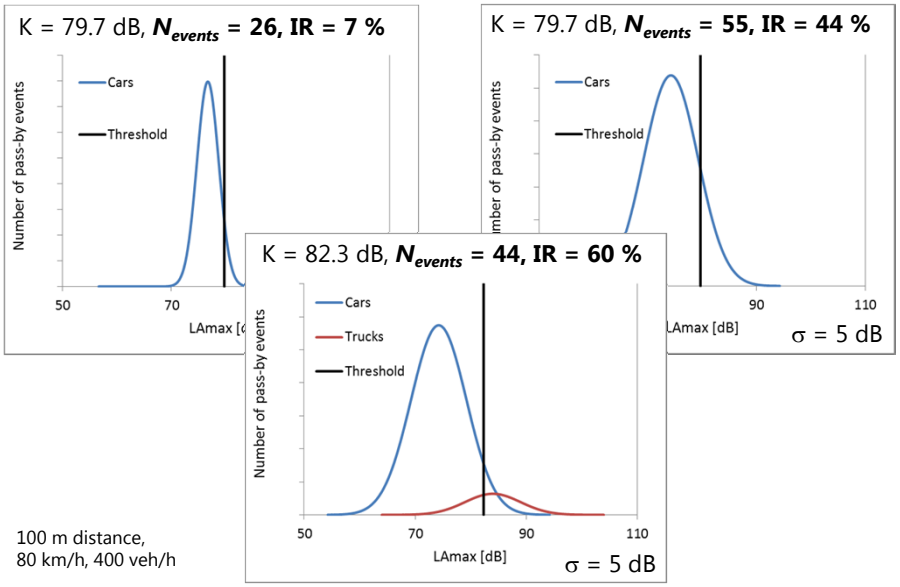
(1) Get the total L_{eq} of all traffic sources and derive threshold K

(2) Estimate the **maximum sound pressure level L_{Fmax}** per pass-by
L_{Fmax} = f($L_{eq,1veh/h}$, d, ϕ, v)

(3) Only account for the part of the event above threshold



Distribution of maximum level

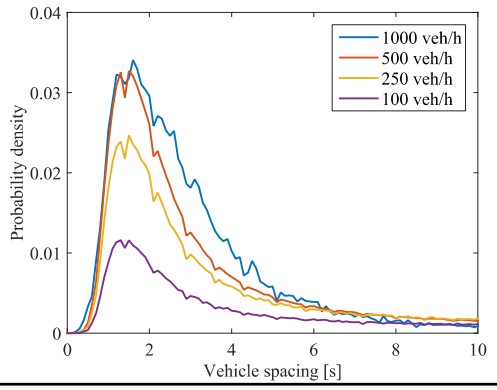


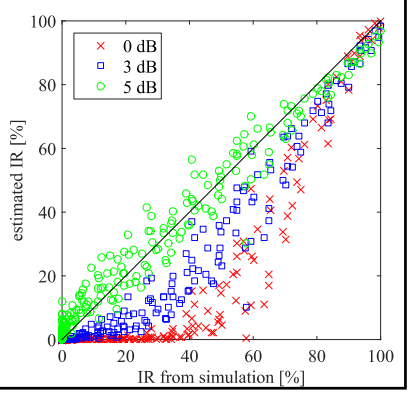
100 m distance,
80 km/h, 400 veh/h

Accounting for overlapping events in road traffic noise

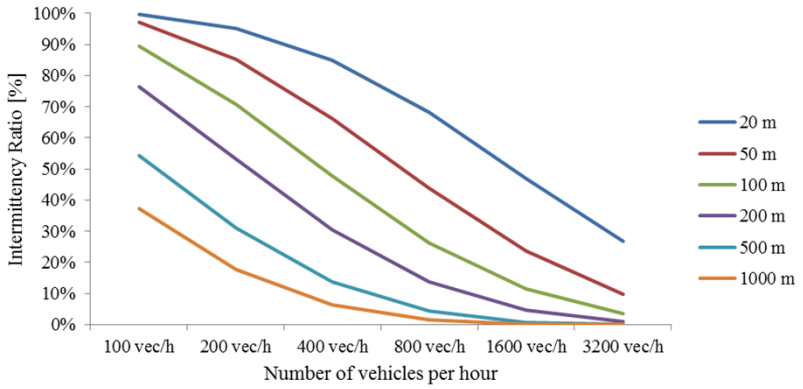
Distribution of maximum level $h(L_{\max}) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(L_{Fmax}-\bar{L}_{Fmax})^2}{2\sigma^2}}$

$\sigma = \sqrt{\sigma_0^2 + \sigma_{OL}^2}$ ➔ Variation of source level + temporary overlap





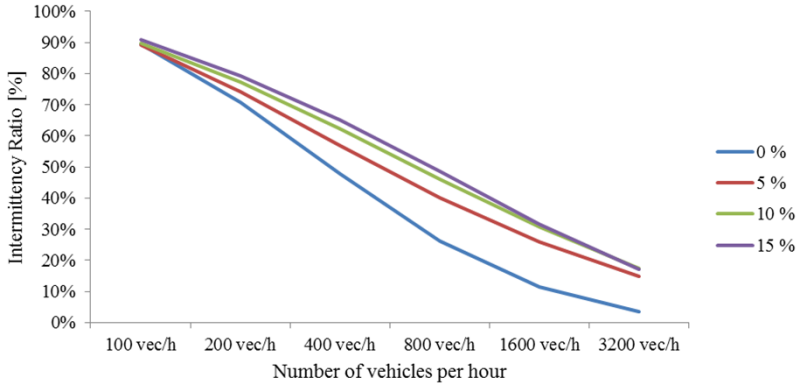
Dependence of IR on traffic volume and propagation distance



➔ IR decreases with increasing distance and traffic volume

Speed 80 km/h, single vehicle category with σ_{OL} = 5 dB

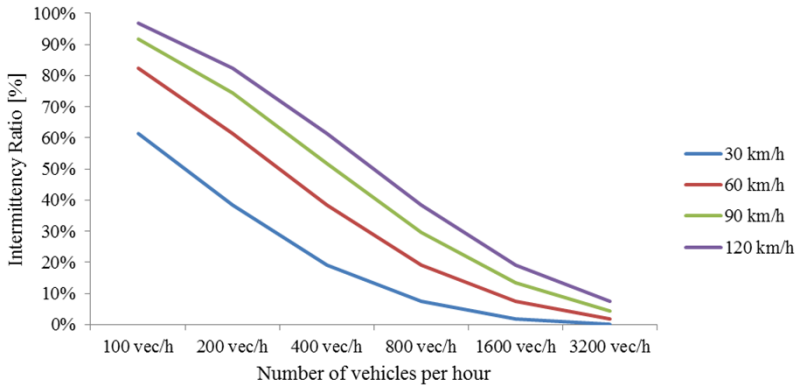
Dependence of IR on traffic volume and the percentage of heavy traffic



➔ IR increases with increasing percentage of heavy traffic

Distance 100 m, speed 80 km/h, single vehicle category with σ_{OL} = 5 dB

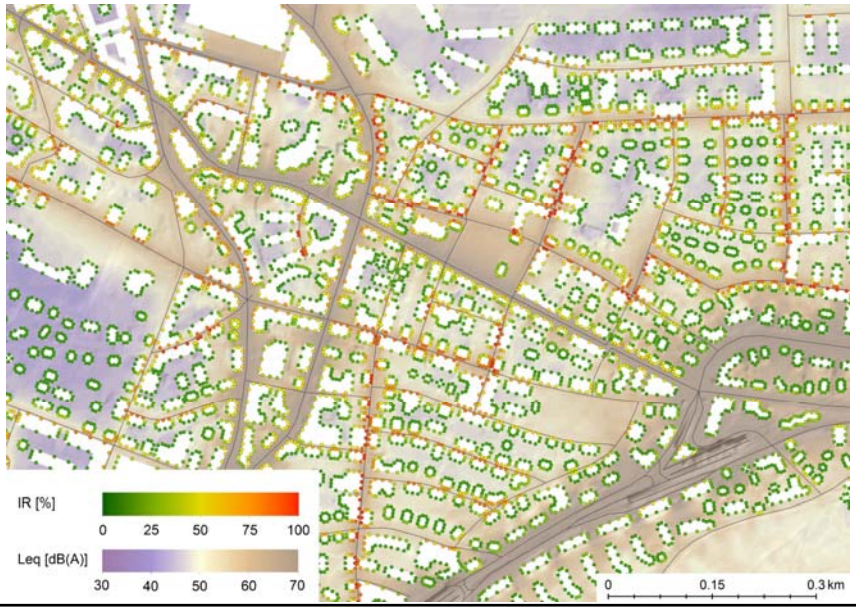
Dependence of *IR* on traffic volume and travelling speed



➔ IR increases with increasing travelling speed

Distance 100 m, single vehicle category with σ_{OL} = 5 dB

Noise maps including IR – Road traffic



Summary & Conclusions

- IR is not a replacement but rather a refinement of the L_{eq}. It is intended to characterize the temporal pattern of sound.
- Intuitively IR shows the intended behaviour.
- IR is derived from energy proportional quantities (Event-L_{eq} and Total-L_{eq}). Nevertheless it is widely uncorrelated to the L_{eq}, which is mandatory to carry additional information.
- IR can be measured as well as calculated. Calculations can be performed based on input data, which is available by common noise mapping tools.
- The latter requires several simplifications and assumptions – there are more subtle approaches (Heimann, de Coensel), which however are difficult to apply to noise mapping.
- We hope for a higher explanatory power in socio-acoustic and epidemiological studies – in combination with other quantities based on the concept of energetic dose.