Abstracts of five articles about QSIDE work in peer-reviewed scientific journals.

1) T. Van Renterghem and D. Botteldooren.
"Focused Study on the Quiet Side Effect in Dwellings Highly Exposed to Road Traffic Noise." *Int. J. Environ. Res. Public Health* **2012**, *9*, 4292-4310

2) Y. De Kluizenaar, S.A. Janssen, H. Vos, E.M. Salomons, H. Zhou, F. Van den Berg,
"Road traffic noise and annoyance: A quantification of the effect of quiet side exposure at dwellings."
Int. J. Environ. Res. Public Health **2013**, *10*, 2258-2270

3) M. Hornikx, J. Forssén, D. Botteldooren, T. Van Renterghem, W. Wei, M. Ögren, E. Salomons, "Urban background noise mapping: the multiple-reflection correction term", accepted for publication in Acta Acustica.

4) W. Wei, D. Botteldooren, T. Van Renterghem, M. Hornikx, J. Forssén, E. Salomons, M. Ögren, "Urban background noise mapping: the general model", submitted for publication in Acta Acustica

5) J. Forssén, M. Hornikx, D. Botteldooren, W. Wei, T. Van Renterghem, M. Ögren, "Urban background noise mapping: the turbulence scattering model",
Acta Acustica **5** (2014) 810-815.

T. Van Renterghem and D. Botteldooren.
"Focused Study on the Quiet Side Effect in Dwellings Highly Exposed to Road Traffic Noise."
Int. J. Environ. Res. Public Health **2012**, *9*, 4292-4310

Abstract: This study provides additional evidence for the positive effect of the presence of a quiet façade at a dwelling and aims at unraveling potential mechanisms. Locations with dominant road traffic noise and high L_{den}-levels at the most exposed façade were selected. Dwellings both with and without a quiet façade were deliberately sought out. Face-to-face questionnaires (N = 100) were taken to study the influence of the presence of a quiet side in relation to noise annoyance and sleep disturbance. As a direct effect, the absence of a quiet façade in the dwelling (approached as a front-back façade noise level difference smaller than 10 dBA) leads to an important increase of at least moderately annoyed people (odds-ratio adjusted for noise sensitivity equals 3.3). In an indirect way, a bedroom located at the quiet side leads to an even stronger reduction of the self-reported noise annoyance (odds-ratio equal to 10.6 when adjusted for noise sensitivity and front façade L_{den}). The quiet side effect seems to be especially applicable for noise sensitive persons. A bedroom located at the quiet side also reduces noise-induced sleep disturbances. On a loud side, bedroom windows are more often closed, however, conflicting with the preference of dwellers.

Y. De Kluizenaar, S.A. Janssen, H. Vos, E.M. Salomons, H. Zhou, F. Van den Berg,
"Road traffic noise and annoyance: A quantification of the effect of quiet side exposure at dwellings."
Int. J. Environ. Res. Public Health **2013**, *10*, 2258-2270

Abstract: Previous studies indicate that residents may benefit from a "quiet side" to their dwellings. The influence of the level of road traffic noise exposure at the least exposed side on road traffic noise annoyance was studied in Amsterdam, The Netherlands. Road traffic noise exposure was assessed at the most and least exposed façade ($L_{den,most}$ and $L_{den,least}$ respectively) of dwellings for subjects in a population based survey (N = 1,967). It was investigated if and to what extent *relative quietness* at the least exposed façade affected the level of road traffic noise annoyance by comparing two groups: (1) The subgroup with a relatively quiet façade; (2) the subgroup without a relatively quiet façade (large *versus* small difference in exposure between most and least exposed façade; DIF ≥ 10 dB and DIF < 10 dB respectively). In addition, it was investigated if and to what extent $L_{den,least}$ affected the level of road traffic noise annoyance. Results indicate a significantly lower road traffic noise annoyance score at a given $L_{den,most}$, in the subgroup with DIF ≥ 10 dB *versus* DIF < 10 dB. Furthermore, results suggest an effect of $L_{den,least}$ independent of $L_{den,most}$. The estimated size of the effect expressed in an equivalent change in $L_{den,most}$ approximated 5 dB for both the difference between the two subgroups (DIF ≥ 10 dB and DIF < 10 dB), and for a 10 dB change in $L_{den,least}$.

M. Hornikx, J. Forssén, D. Botteldooren, T. Van Renterghem, W. Wei, M. Ögren, E. Salomons, “Urban background noise mapping: the multiple-reflection correction term”, accepted for publication in Acta Acustica.

Abstract

Mapping of road traffic noise in urban areas according to standardized engineering calculation methods systematically results in an underestimation of noise levels at areas shielded from direct exposure to noise, such as inner yards. In most engineering methods, road traffic lanes are represented by point sources and noise levels are computed utilizing point-to-point propagation paths. For a better prediction of noise levels in shielded urban areas, an extension of the engineering method by an attenuation term A_can describing these propagation paths has been proposed, including geometrical aspects of the urban environment both in the source and in the receiver area. In the present work, it is shown by numerical calculations that for distances exceeding twice the street width, A_can may be divided into independent source and receiver environment terms, A_s and A_r. the terms may moreover be treated as being independent of the source-to-receiver-distance. Also, A_s and A_r may be split into a distance independent part and a distance dependent part based on an analytical equivalent free field analogy. Further, the validity of treating the propagation path in a 2D plane rather than in 3D is investigated. A simple model is put together to compute that the 3D term A_can using 2D calculations, where adjustments are made for the different distance dependence as well as for the urban configuration characteristics. For the latter, a street with and without cross streets and a courtyard have been examined.

W. Wei, D. Botteldooren, T. Van Renterghem, M. Hornikx, J. Forssén, E. Salomons, M. Ögren, “Urban background noise mapping: the general model”, submitted for publication in Acta Acustica

Surveys show that inhabitants of dwellings exposed to high noise levels benefit from having access to a quiet side. However, current practice in noise prediction often underestimates the noise levels at a shielded facade. Multiple reflections between facades in street canyons and inner yards are commonly neglected and facades are approximated as perfectly at surfaces yielding only specular reflection. In addition, sources at distances much larger than normally taken into account in noise maps might still contribute significantly. Since one of the main reasons for this is computational burden, an efficient engineering model for the diffraction of the sound over the roof tops is proposed, which considers multiple reflections, variation in building height, canyon width, facade roughness and different roof shapes. The model is fitted on an extensive set of full-wave numerical calculations of canyon-to-canyon sound propagation with configurations matching the distribution of streets and building geometries in a typical historically grown European city. This model allows calculating the background noise in the shielded areas of a city, which could then efficiently be used to improve existing noise mapping calculations. The model was validated by comparison to long-term measurements at 9 building facades whereof 3 were at inner yards in the city of Ghent, Belgium. At shielded facades, a strong improvement in prediction accuracy is obtained.

J. Forssén, M. Hornikx, D. Botteldooren, W. Wei, T. Van Renterghem, M. Ögren, “Urban background noise mapping: the turbulence scattering model”,
Acta Acustica **5** (2014) 810-815.

Abstract.
Sound scattering due to atmospheric turbulence limits the noise reduction in shielded areas. An engineering model is presented, aimed to predict the scattered level for general noise mapping purposes including sound propagation between urban canyons. Energy based single scattering for homogeneous and isotropic turbulence following the Kolmogorov model is assumed as a starting point and a saturation based on the von Kármán model is used as a first-order multiple scattering approximation. For a single shielding obstacle the scattering model is used to calculate a large dataset as function of the effective height of the shielding obstacle and its distances to source and receiver. A parameterisation of the dataset is used when calculating the influence of single or double canyons, including standardised air attenuation rates as well as façade absorption and Fresnel weighting of the multiple façade reflections. Assuming a single point source, an averaging over three receiver positions and that each ground reflection causes energy doubling, the final engineering model is formulated as a scattered level for a shielding building without canyon plus a correction term for the effect of a single or a double canyon, assuming a flat rooftop of the shielding building. Input parameters are, in addition to geometry and sound frequency, the strengths of velocity and temperature turbulence.