



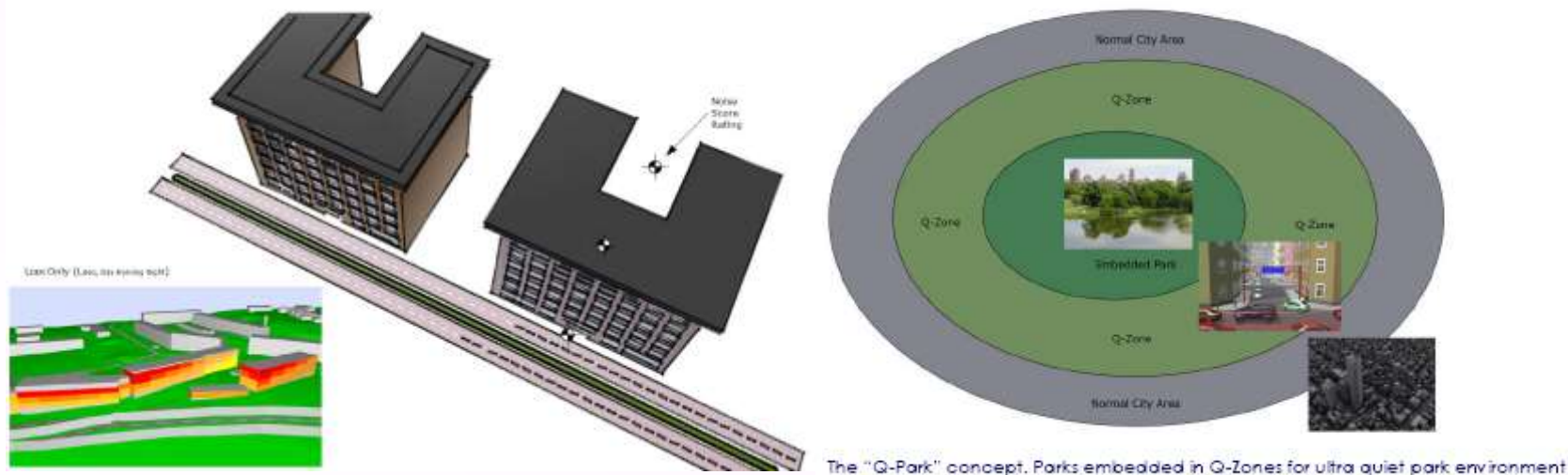
**CITYHUSH First Dissemination Seminar**  
**Reducing Transport Noise in Cities**  
**WP2: Noise Score Rating Models and Annoyance**

**Brussels, November 23, 2011**  
**Presented by Sabine Janssen, TNO**  
**(NL Organization of Applied Scientific Research)**

# WP2 Noise score rating models and annoyance

Identification of hot spots on which noise action plans are based suffers from shortcomings:

- Poor correlation between hot spots (based on equivalent noise levels only) and annoyance and complaints
- Includes only indoor noise comfort, whilst a silent outdoor environment may be very important since people live, work and recreate outdoors during many hours per day



# WP2 Noise score rating models and annoyance

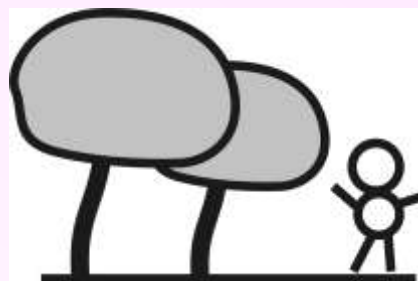
at home (WP2.2)



$L_{den}$  → % highly annoyed

insulation, spectrum  
quiet facade  
ambient noise

outdoors (WP2.1)



preliminary model:  $L_{day}$  → % annoyed

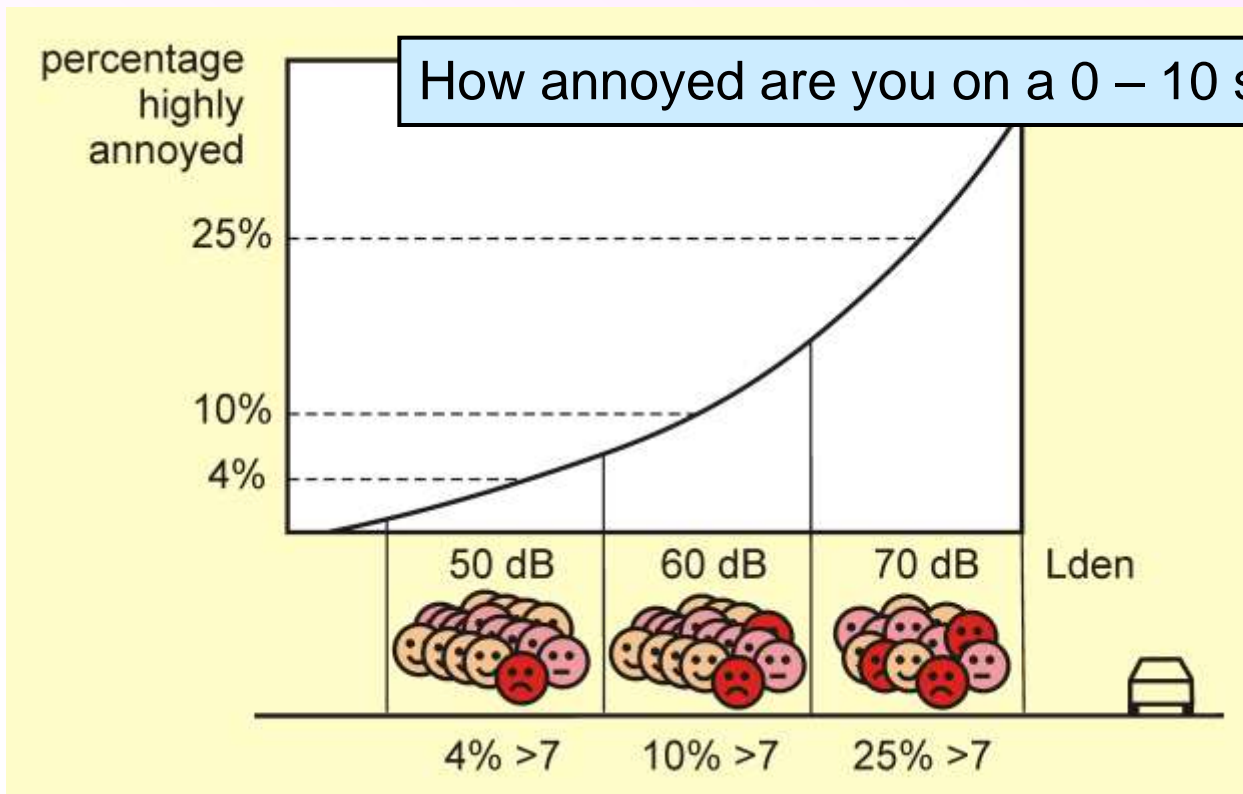
earlier findings in natural areas  
field tests (summer/autumn 2011)

# WP 2.2: Refined method for annoyance at home

## Basic method

Exposure-response function (ERF)

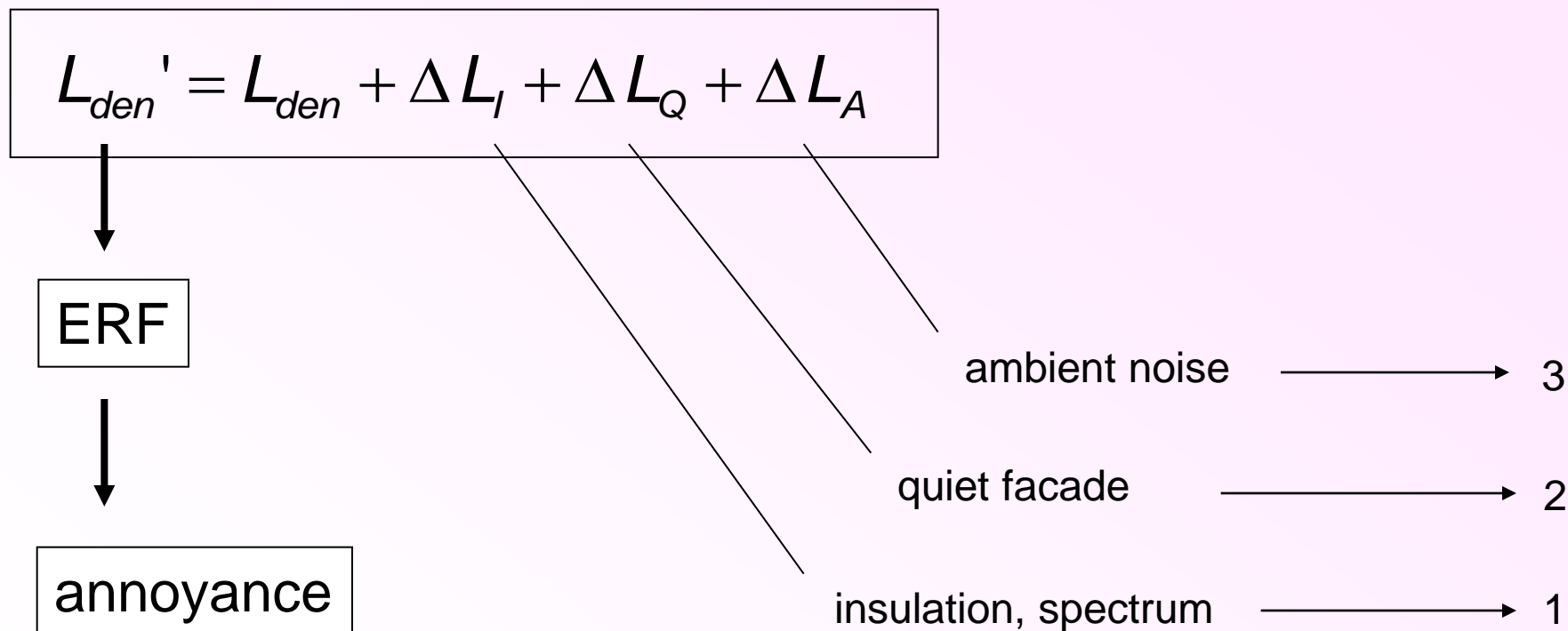
based on many noise surveys



highly annoyed:  
≥72 on 0-100 scale

## WP 2.2: Refined method for annoyance at home

### Corrections to Lden

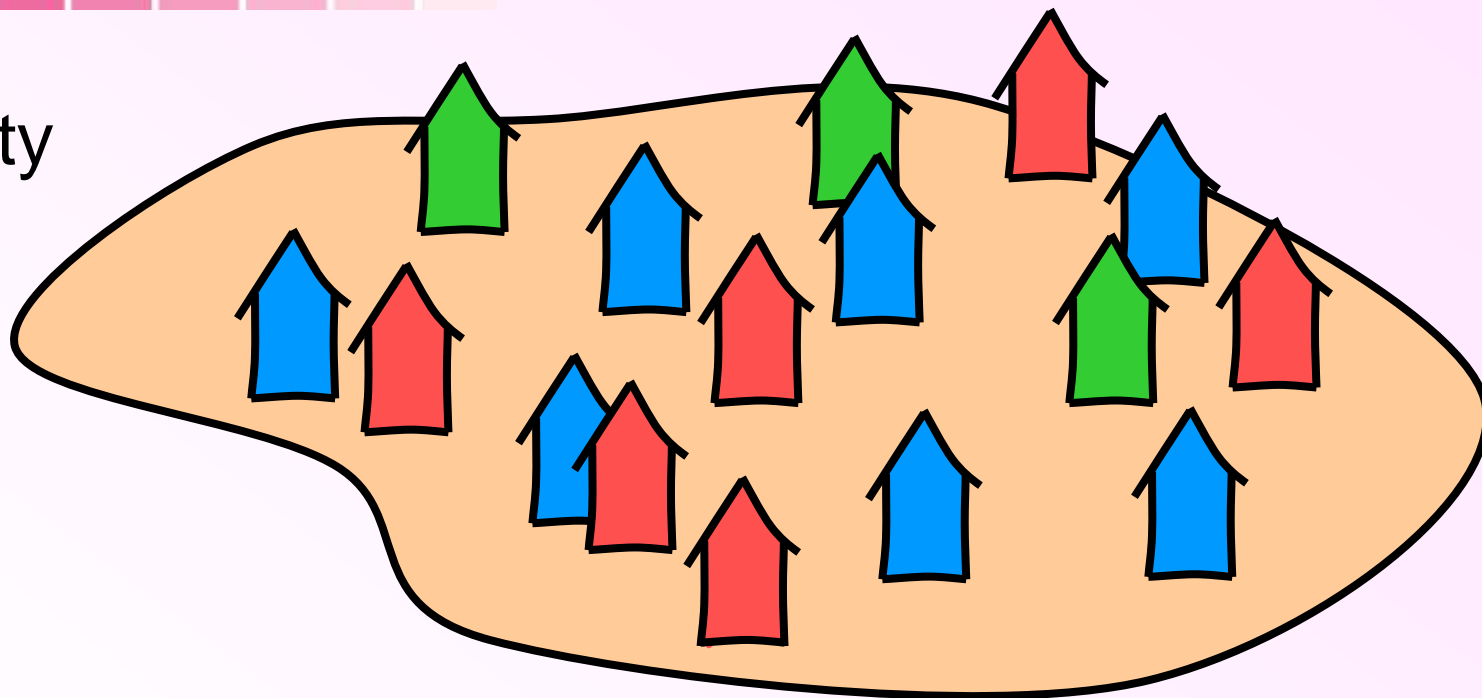


ERF = exposure-response function by Miedema and Oudshoorn (2001)

# WP 2.2: Refined method for annoyance at home

## 1. Facade insulation, noise spectrum

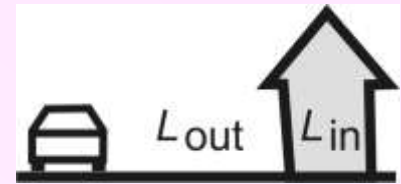
City



insulation	30 dB	20 dB	10 dB
correction	-7 dB	0 dB	+7 dB
annoyance	less	equal	more

# WP 2.2: Refined method for annoyance at home

## 1. Facade insulation, noise spectrum



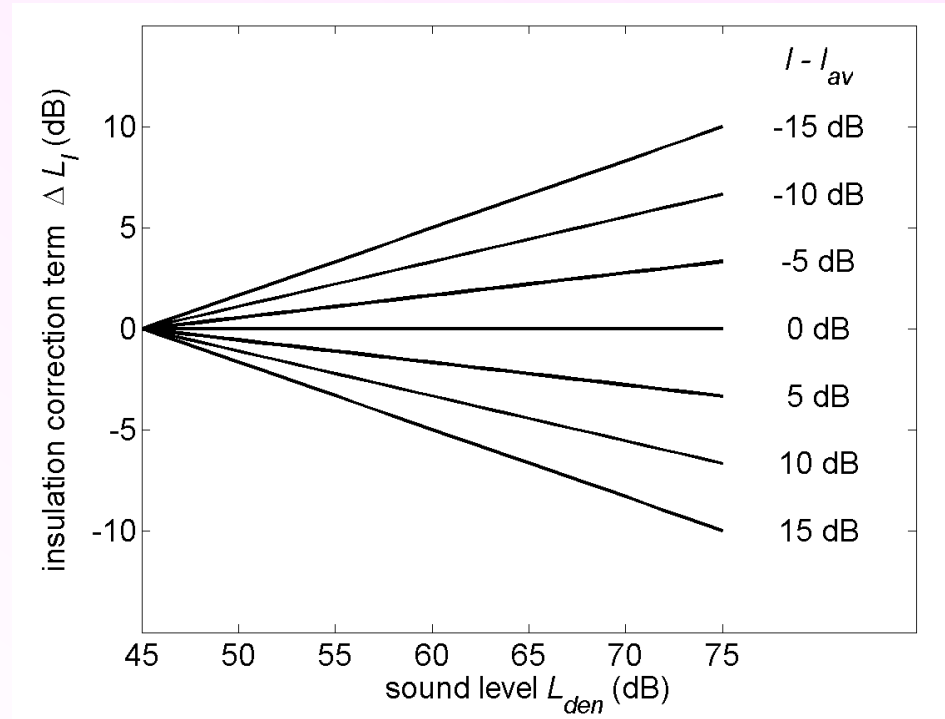
$$\Delta L_f = a(I - I_{av})L_{den} + b(I - I_{av})$$

$I$  = façade insulation

QCity	-0.0222	1
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Norwegian facade insulation study:  
OK, but further work needed

Value of  $I_{av}$  ?  
ERF population  
21 dB Night noise guidelines



# WP 2.2: Refined method for annoyance at home

## 1. Facade insulation, noise spectrum



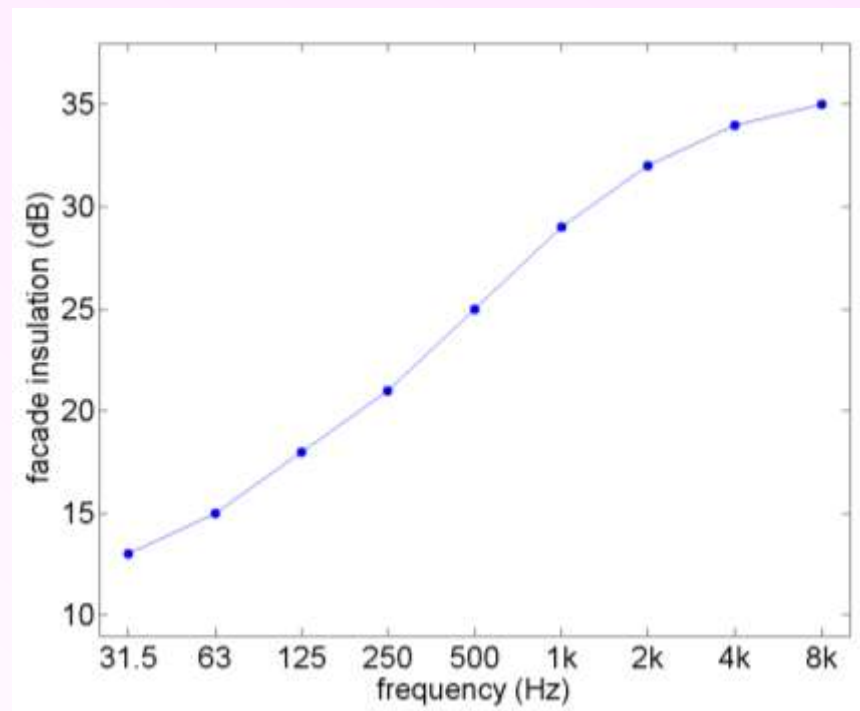
$$I = \sum_j L_j - \sum_j (L_j - I_j)$$

noise  
spectrum

facade  
insulation  
spectrum

Variations façade insulation

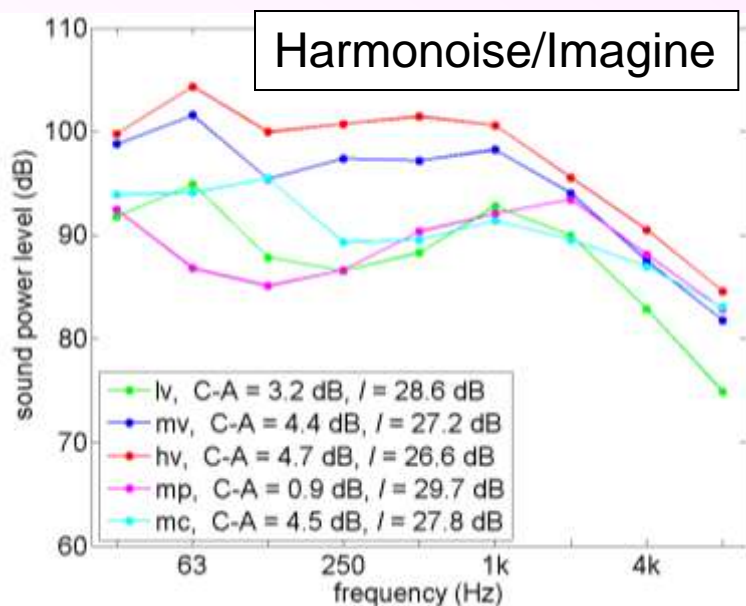
- Construction of dwellings
- Noise spectrum





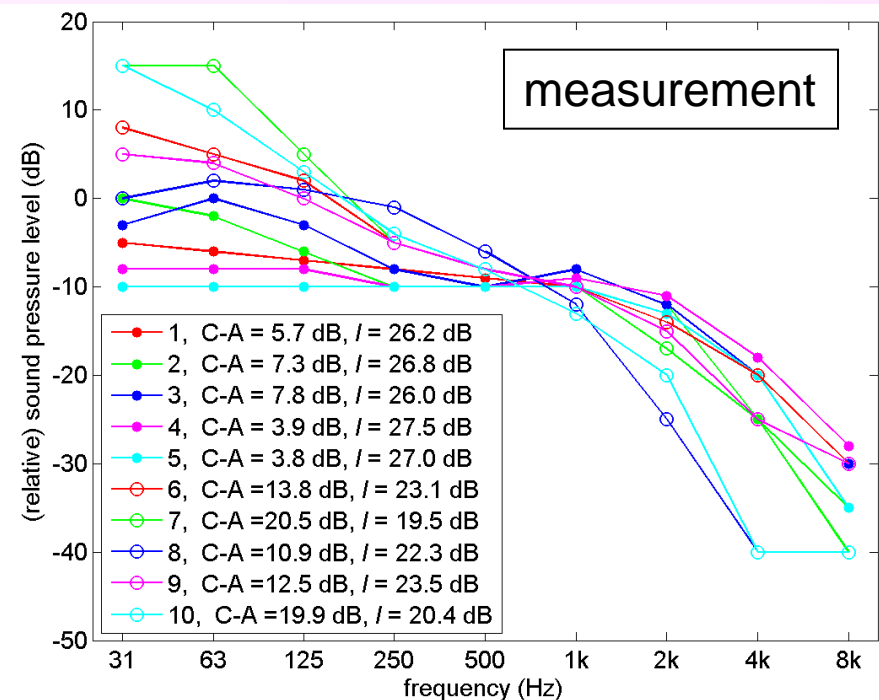
# WP 2.2: Refined method for annoyance at home

## 1. Facade insulation, noise spectrum



lv = light vehicle  
 mv = medium-heavy vehicle  
 hv = heavy vehicle  
 mp = moped  
 mc = motor cycle

$I = 26 - 30$  dB



1-4 road, 5 rail, 6-7 ship. 8 aircraft, 9-10 industry

$I = 19 - 28$  dB

# WP 2.2: Refined method for annoyance at home

## 1. Facade insulation, noise spectrum

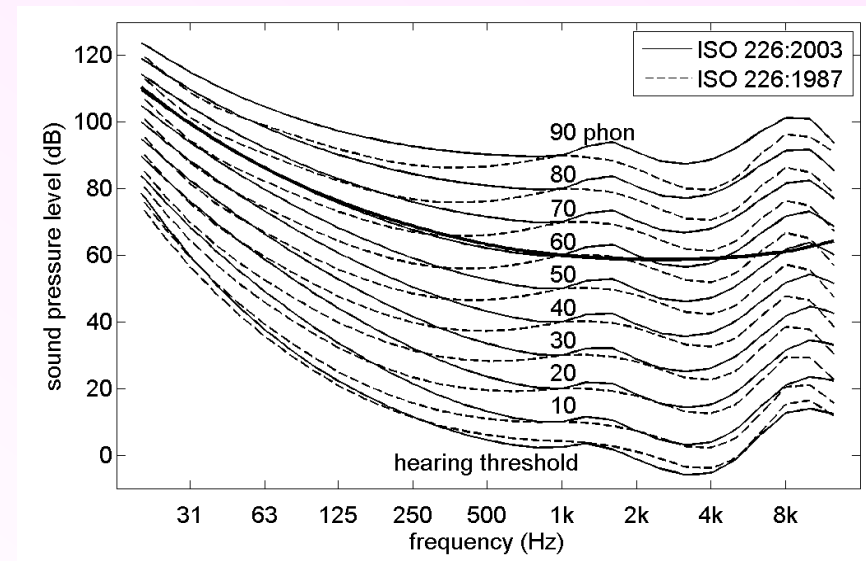
Do we also need a direct penalty for low-frequency noise?

Vos et al (TNO): no

Leventhall, Berglund: yes

A-weighting  
underestimates LF loudness

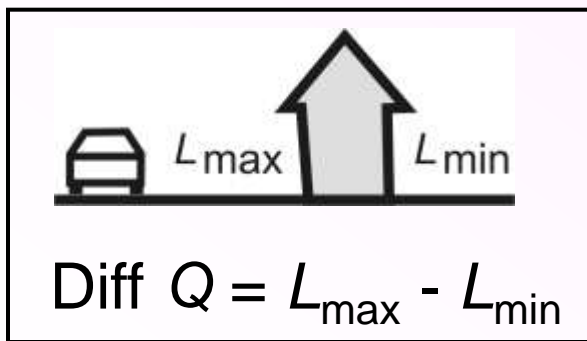
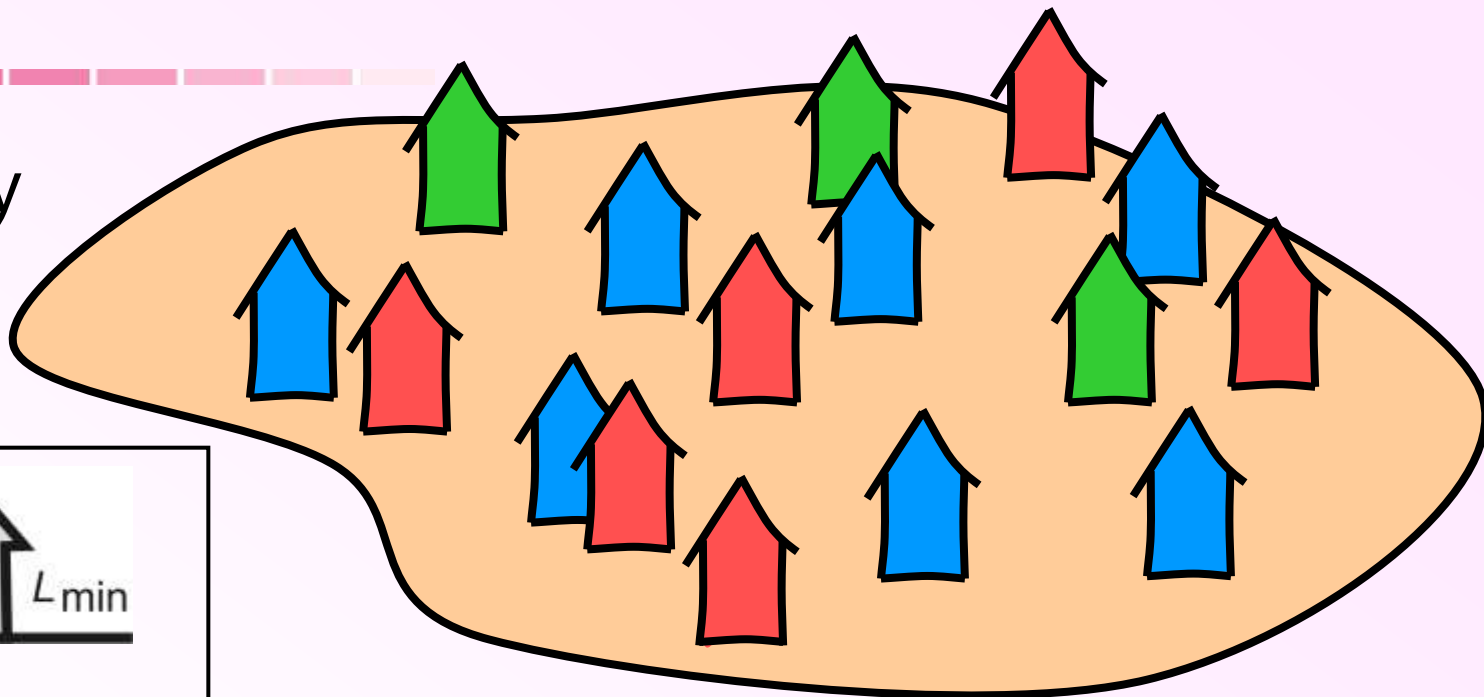
Salomons & Janssen  
Int. J. Env. Res. and Public Health 2011



# WP 2.2: Refined method for annoyance at home

## 2. Quiet facade

City



Diff	15 dB	10 dB	5 dB
correction	-3 dB	0 dB	+3 dB
annoyance	less	equal	more

# WP 2.2: Refined method for annoyance at home

## 2. Quiet facade

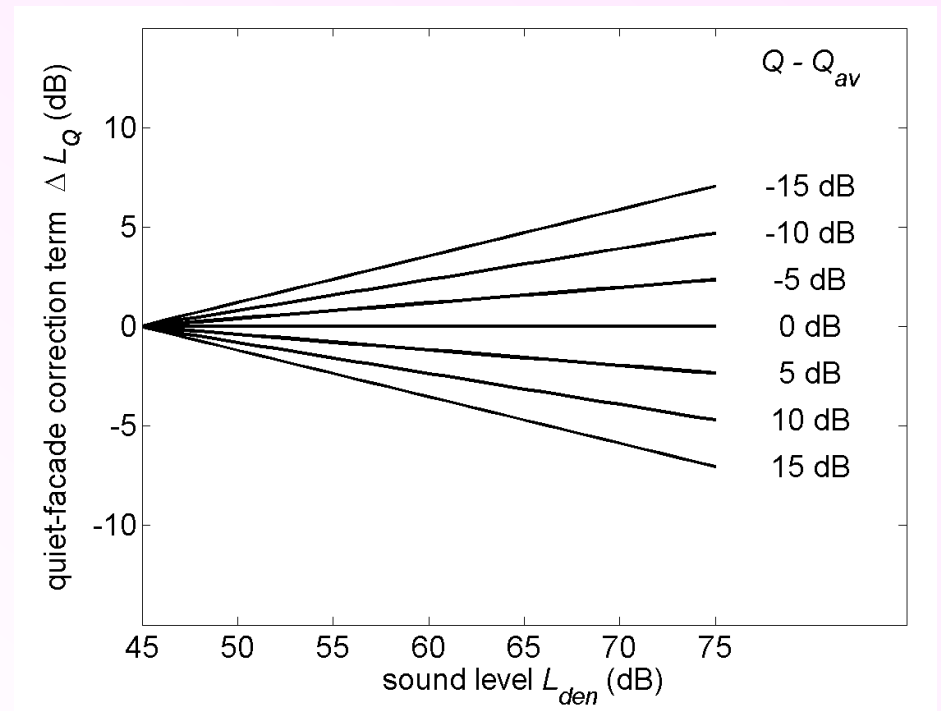


$$\Delta L_Q = a(Q - Q_{av})L_{den} + b(Q - Q_{av})$$

$$Q = L_{max} - L_{min}$$

Observed effects between 2-6 dB  
(Gothenburg, Norway, TNO)  
Further work needed (QSIDE)

De Kluizenaar, Salomons, Janssen et al.  
J Acoust Soc Am Oct 2011



# WP 2.2: Refined method for annoyance at home

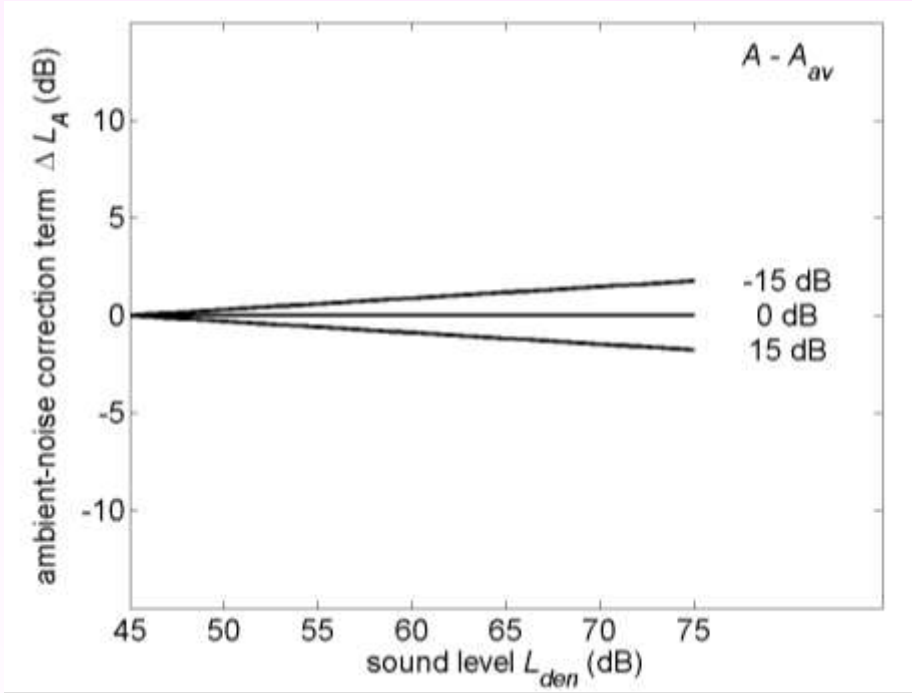
## 3. Ambient noise



$$\Delta L_A = a(A - A_{av})L_{den} + b(A - A_{av})$$

$$A = \langle L \rangle_{0-200m}$$

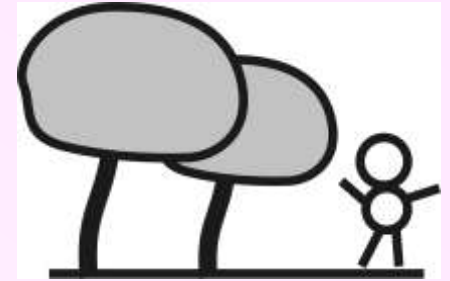
Gothenburg: nearby green areas  
 Norwegian study: ambient noise  
 Gent: focus on routes  
 Further work needed (QSIDE)



## WP 2.1: Noise score rating model for the outdoors

### Aim:

- Develop preliminary outdoor noise score rating model based on current knowledge
- Incorporate the following parameters if possible:
  - Function of the area
  - Number of people visiting/living in a certain radius of the area
  - Equivalent noise levels during the day (and evening?) period
  - Rate of occurrence of individual events (% of the time heard)
  - Source characteristics (low frequency noise, motorcycles)
- Gather additional data on response to noise outdoors in a field study
- Use results to evaluate and improve outdoor noise score rating model



$L_{day} \rightarrow$  annoyance

# WP 2.1: Noise score rating model for the outdoors

Preliminary outdoor noise model for aircraft noise based on relationship observed by Krog & Engdahl (2004), equal to EU-aircraft - 5dB, for road traffic noise EU-road - 5 dB.

Next to LAeq, % of time events are heard and background level (L95 or L50) are relevant

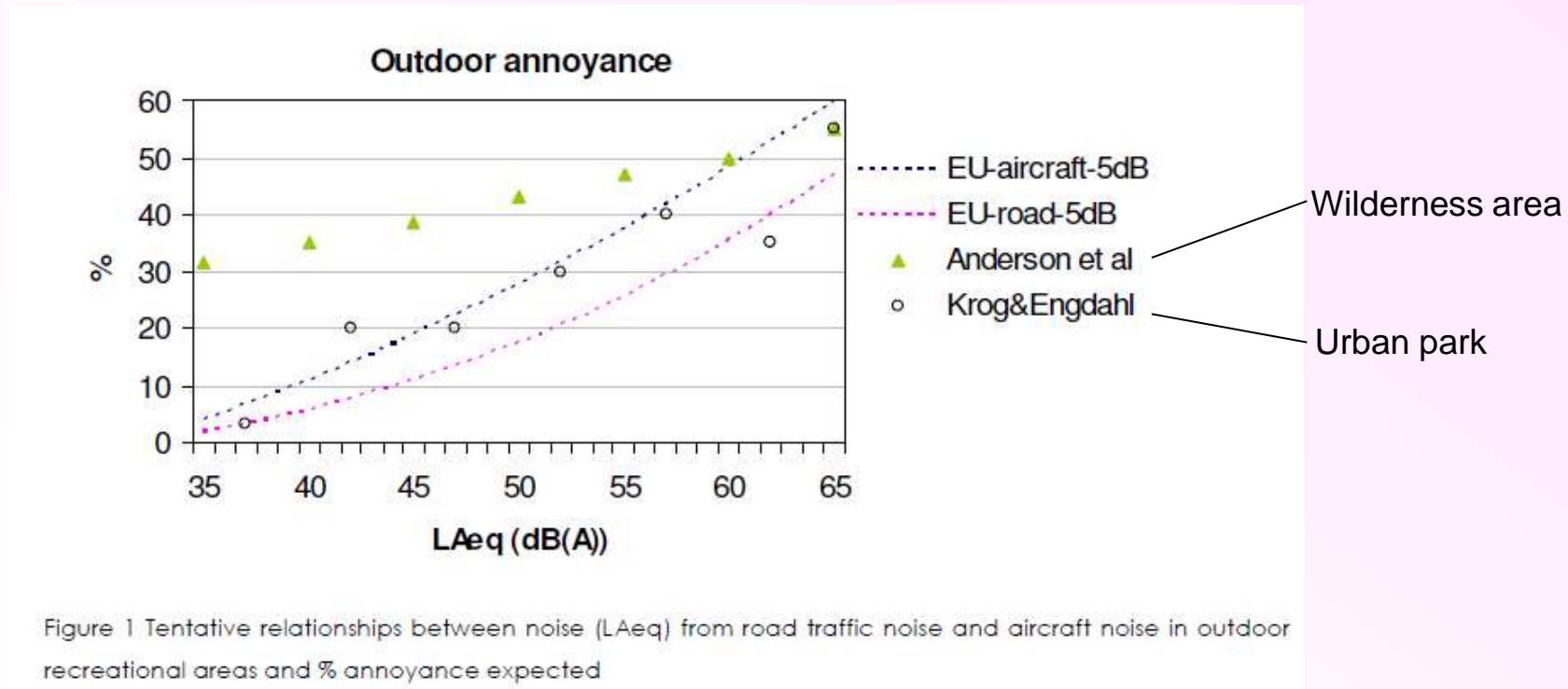


Figure 1 Tentative relationships between noise (LAeq) from road traffic noise and aircraft noise in outdoor recreational areas and % annoyance expected

## WP 2.1: Noise score rating model for the outdoors

Validation by field study on the impact of outdoor noise on park visitors

Subjects (N=52) walking in both noisy and relatively quiet natural urban area

Measurements include:

- Mood/ Perceived restoration
- Evaluation of the acoustic situation
- Annoyance from several noise sources
- Need for restoration (stress-related symptoms)
- Heart rate and heart rate variability (continuous)
- Blood pressure (intermittently)
- Individual noise exposure measurements



Field study has been conducted in the summer/autumn of 2011

First results will be available end 2011



# WP 2 Noise score rating model at home and outdoors

## Conclusions

	Included	Further work needed
Façade insulation, noise spectrum	Yes	+
Quiet façade	Yes	+
Ambient noise	Yes	++
Temporal fluctuations	No	+++
Mopeds, motorcycles, ...	No	+++
Outdoors: Lday	Yes	+++

