FACULTY OF ENGINEERING
AND ARCHITECTURE

MEET MEE MECHELEN

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The New York Times

New York Becomes the City That Never Shuts Up

Taxis at a crosswalk on the Upper East Side of Manhattan. Noise has become an increasing problem there. Justin Gilliland/The New York Times

You are not alone…

IETS DICHTER BIJ HUIS…

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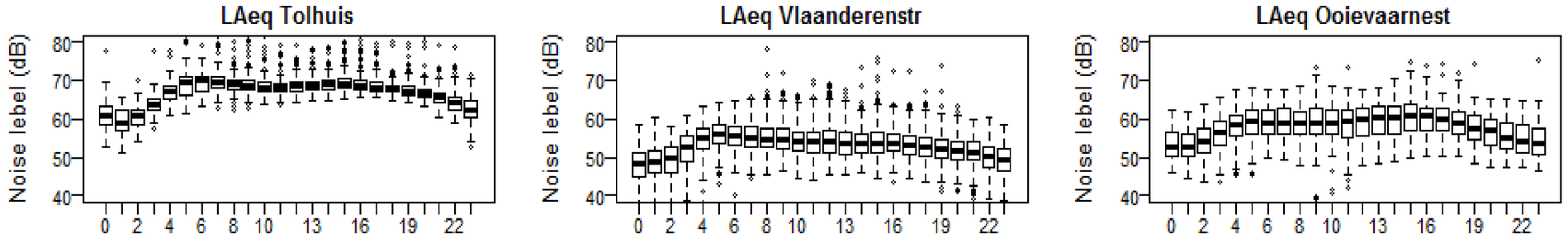
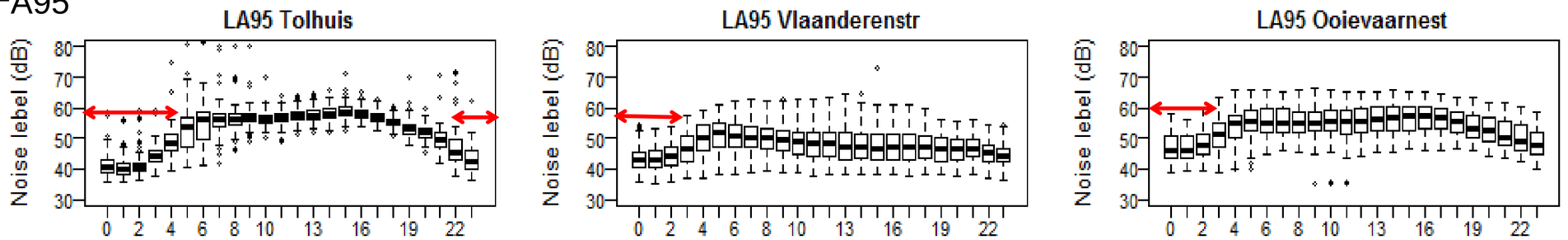
GELUID

– Snelwegen: continue geluid met korte, ondiepe nacht

L_{Aeq}



L_{A95}



Duur en grootte-orde van de ‘stille nacht’ is veel kleiner bij snelwegen

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CONTRAST MET LUCHTVERONTREINIGING (BC)

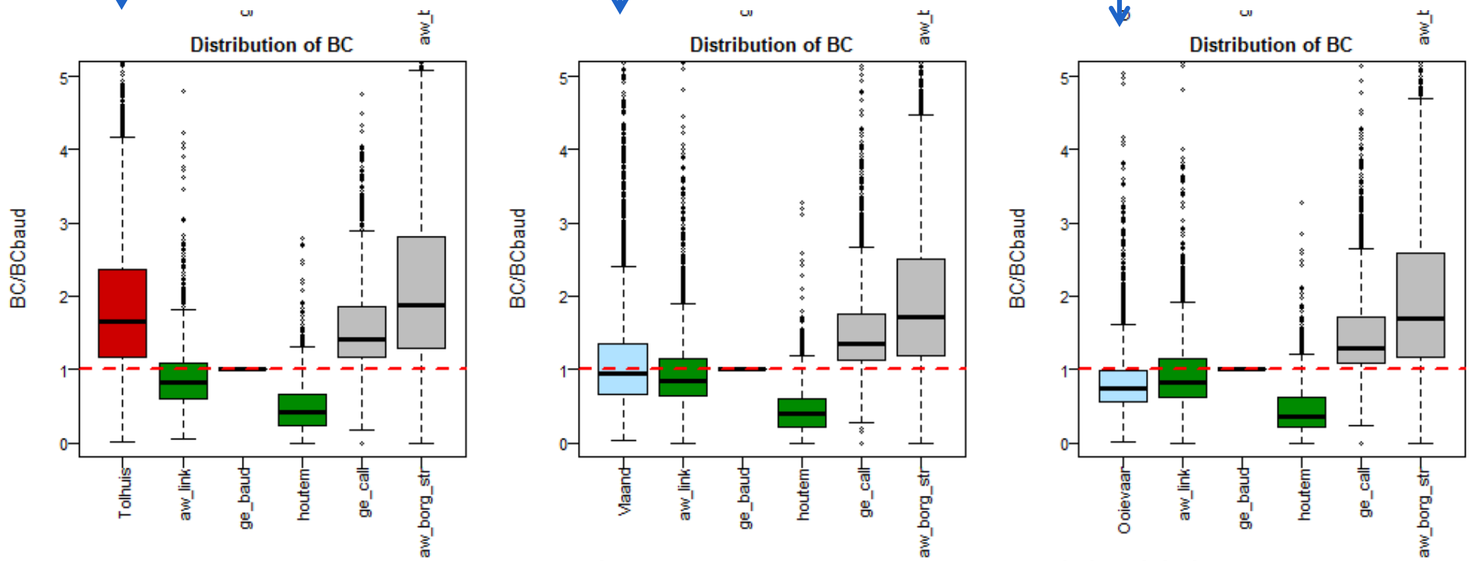
Black Carbon relative to in-city background (Baudulopark)

Mean

TER (in-city) + 90%

HW 300 m (north) + 13%

HW 300 m (south) - 23%



Exposure at TER road = 2x Exposure at 300 m of the highway

Geluid is de dominante blootstelling in de directe omgeving van snelwegen

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INHOUD

- Introductie
- Meetgrootheden: L_{day}, $L_{evening}$, L_{night}, L_{den}
- Gezondheidseffecten van geluid
- Wetgeving in Vlaanderen (?)
- Motor en rolgeluid
- Soorten maatregelen en hun potentiëel effect
- Onderzoek naar hinder…
  - Wat weten we!
  - Wat weten we nog niet!
- Take home message…

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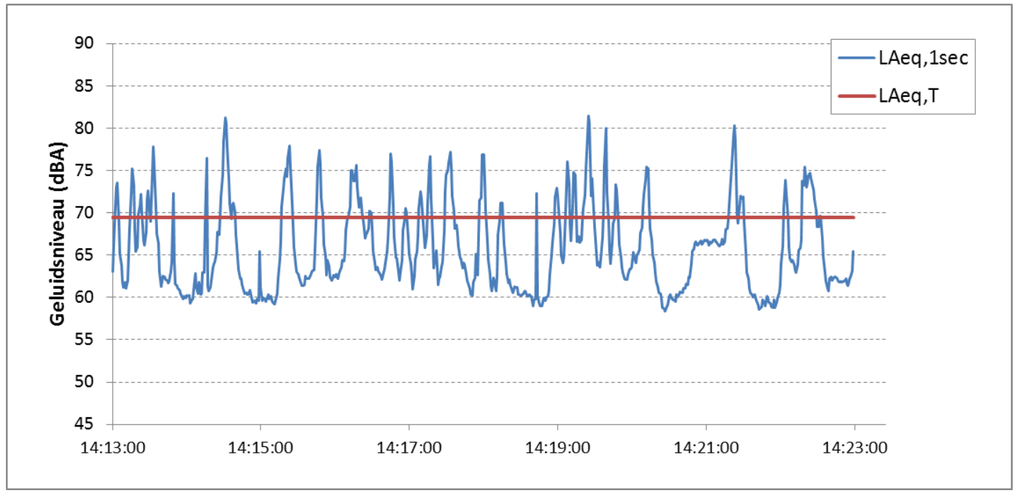
GROOTHEDEN

– L_{Aeq}: A-gewogen equivalente geluidsdrukniveaus

L_{day} , $L_{evening}$, L_{night}, L_{den}

- L_{day} 07h-19h +0 dB
- $L_{evening}$ 19h-23h +5 dB
- L_{night} 23h-07h +10 dB
- L_{den} 24h



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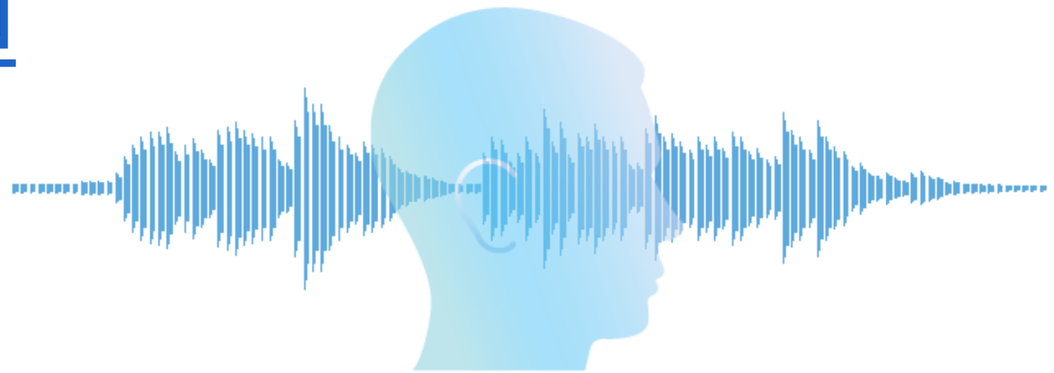
GEZONDHEIDSEFFECTEN

- WHO noise 2018
- WHO is geen wetgeving



Critical health outcome	Important health outcome
Cardiovascular disease	Adverse birth outcomes
Annoyance[7]	Quality of life, well-being and mental health
Effects on sleep	Metabolic outcomes
Cognitive impairment	
Hearing impairment and tinnitus	

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GEZONDHEIDSEFFECT IHD (HARTINFARCT)

- Relatief risico IHD: +10 dB = 8% meer voorkomen

Table 6. Average exposure levels (L_{den}) for priority health outcomes from road traffic noise

Summary of priority health outcome evidence	Benchmark level	Evidence quality
Incidence of IHD The 5% relevant risk increase occurs at a noise exposure level of 59.3 dB L_{den}. The weighted average of the lowest noise levels measured in the studies was 53 dB L_{den} and the RR increase per 10 dB is 1.08.	5% increase of RR	High quality
Incidence of hypertension One study met the inclusion criteria. There was no significant increase of risk associated with increased noise exposure in this study.	10% increase of RR	Low quality
Prevalence of highly annoyed population There was an absolute risk of 10% at a noise exposure level of 53.3 dB L_{den}.	10% absolute risk	Moderate quality
Permanent hearing impairment	No increase	No studies met the inclusion criteria
Reading skills and oral comprehension in children	One-month delay	Very low quality

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GEZONDHEIDSEFFECTEN

– WHO noise guidelines (2018)

Road traffic noise

Recommendation	Strength
For average noise exposure, the GDG strongly recommends reducing noise levels produced by road traffic below **53 decibels (dB)** L_{den}, as road traffic noise above this level is associated with adverse health effects.	Strong
For night noise exposure, the GDG strongly recommends reducing noise levels produced by road traffic during night time below **45 dB** L_{night}, as night-time road traffic noise above this level is associated with adverse effects on sleep.	Strong
To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from road traffic in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions, the GDG recommends reducing noise both at the source and on the route between the source and the affected population by changes in infrastructure.	Strong

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GEZONDHEID: INTERVENTIES

– Soort interventies

Intervention type	Intervention category	Intervention subcategory
A	Source intervention	• change in emission levels of sources • time restrictions on source operations
B	Path intervention	• change in the path between source and receiver • path control through insulation of receiver/receiver's dwelling
C	New/closed infrastructure	• opening of a new infrastructure noise source • closure of an existing one • planning controls between (new) receivers and sources
D	Other physical intervention	• change in other physical dimensions of dwelling/neighbourhood
E	Behaviour change intervention	• change in individual behaviour to reduce exposure • avoidance or duration of exposure • community education, communication

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WETGEVING IN VLAANDEREN

- Geen richtwaarden in de wetgeving
- Wel MER-richtlijnen voor wegverkeer
  - “Gedifferentiëerde referentiewaarde volgens wegindeling”

gedifferentieerde referentiewaarde vanwege weg met wegindeling	situatie	L_{den}	L_{night}	opmerkingen
hoofd- en primaire wegen	nieuwe woonont-wikkeling	55	45	-
	nieuwe wegen	60	50	-
	bestaande wegen	70	60	-

Bij ontwerpen van nieuwe wegen moeten de opdrachtgever hier aan te voldoen

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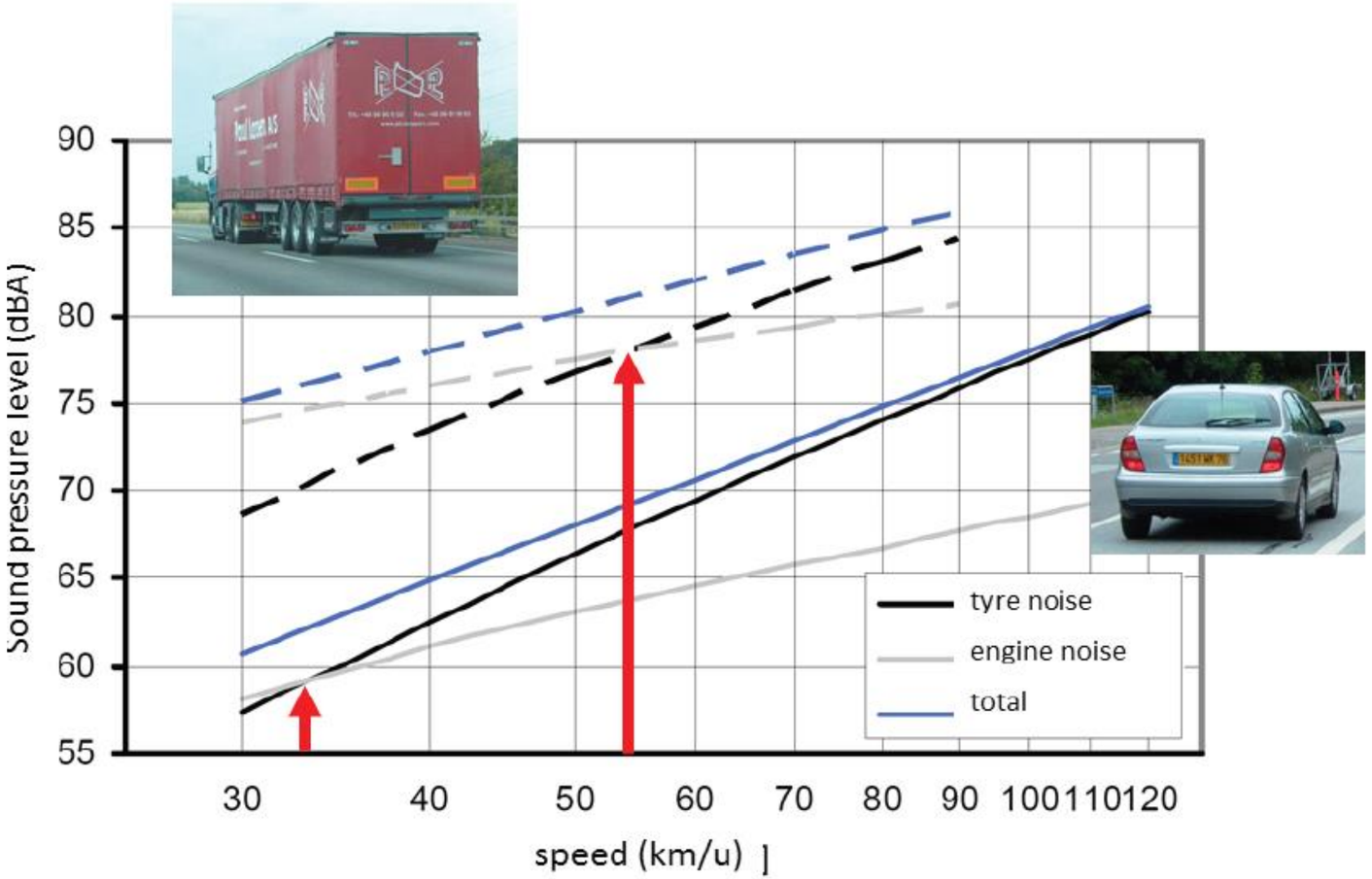
MOTORGELUID EN ROLGELUID

- Rolgeluid dominant bij auto’s vanaf 35 km/uur
- Motorgeluid nog altijd significant voor vracht bij 90 km/u



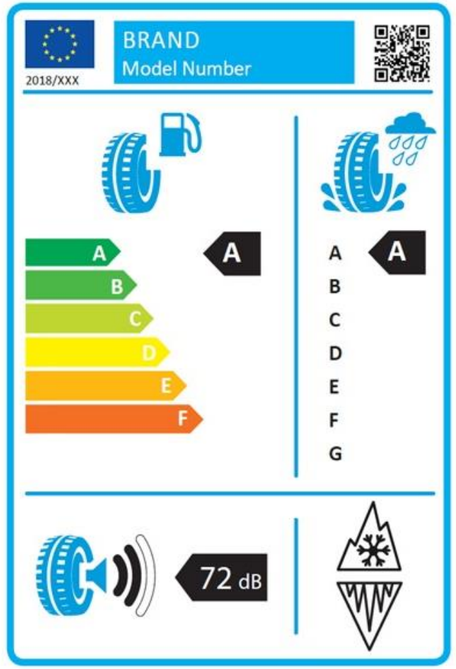
Leaflet: Low-Noise road surfaces (Eurocities, Persuade project)

SOORTEN MAATREGELEN

- **Bronmaatregelen:**
  - Productnormering: voertuigen en banden (EU)
  - Volume en samenstelling
  - Wegdek en rolgeluid
  - Snelheid
- **Pad:** hoe propageert het geluid in de omgeving?
  - Afscherming, bermen, opties en efficiëntie
  - Natuurlijke elementen en bodem
- **Ontvanger:** (end-of-pipe)
  - Kwaliteit van de woningen (nieuwe NBN-norm)
  - Stille zijde (stedelijke ontwikkelingen)
- **Structurele oplossing:** ruimtelijke ordening

PRODUCTNORMEN (EU)

- Voertuigen en banden: EU wetgeving
  - Weining stringente normen (zowel voor banden als motore
  - **Zeer beperkte reductie** te verwachten voor geluidemissie
  - 2018: Proposal for Tyre label (fuel efficiency) mainly



- Toch indirect effecten door vlootwijzigingen:
  - Hybride en elektrische voertuigen hebben stille banden
  - Diesel en SUV hebben emissie-correcties van +1 en +2 dB

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MAATREGELEN VOOR SNELWEGEN

- Verkeersintensiteit (bron)
  - Samenstelling: mix vracht en personenwagens
- Wegdek (pad)
  - Type wegdek
- Snelheid (bron)
  - Geluidsemissie stijgt met snelheid
- Schermen (pad)
  - Soorten schermen en effecten
- Bermen (pad)
  - Afschermen door natuurlijke elementen

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VOLUME EN SAMENSTELLING

- **E19:**
  - 125000 voertuigen per dag
  - 10% zware vracht (totaal)
  - **17%** zware vracht tijdens de nacht
- **Ring Mechelen**
  - 25000 voertuigen per dag
  - 3% zware vracht (totaal)
  - 5% zware vracht tijdens de nacht
- **N16 Gentse steenweg)**
  - 30000 voertuigen per dag
  - 4% zware vracht (totaal)
  - 5% zware vracht tijdens de nacht

Traffic reduction	
10 %	0.5 dB(A)
20 %	1.0 dB(A)
30 %	1.6 dB(A)
40 %	2.2 dB(A)
50 %	3.0 dB(A)
75 %	6.0 dB(A)

Verkeersvolume is een economische parameter.
Vlaanderen als een transport-hub binnen Europa…
Modal shift naar spoor en water heeft (groei)potentieel.
Effectieve reductie van de verkeersvolumes is geen prioriteit ‘an sich’.

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WEGDEK

- Stille wegdekken: ZOAB
  - Slijtage reduceert het effect vrij snel
  - ‘Cleaning’ nodig…

Void content	Pavement group	Noise reduction (re. SPBcars 120km/h, reference pavement SMA 11)
0 … 7 %	dense surface	0–2 dB
7 … 12 %	semi dense surface	2–4 dB
12 … 18 %	semi porous surface	4–6 dB
> 18 %	(open) porous surface	> 6 dB

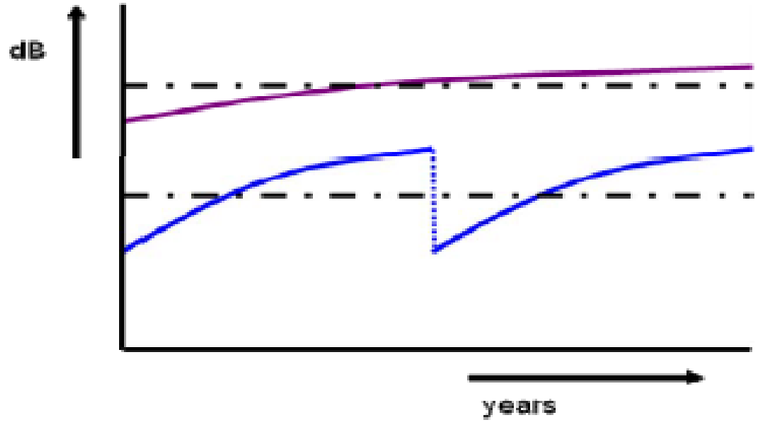

figure 3: comparison quiet asphalt and normal asphalt

- Nieuwe ontwikkelingen:
  - Veel aandacht voor stillere wegdekken (praktijk zie vorige presentatie)
  - poro-elastic surface (rubber en elastische binder), niet toepasbaar op snelwegen.

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SNELHEID

- Vooral impact op het rolgeluid, alleen voor zware vracht klein effect op motorgeluid

Table 2.2: The effect of speed reductions on noise [Andersen, 2003. p. 15 and p. 21].

Reduction in speed	Noise reduction (L_{AE}, dB) from light vehicles	Noise reduction (L_{AE}, dB) from heavy vehicles
From 130 to 120 km/h	1.0	-
From 120 to 110 km/h	1.1	-
From 110 to 100 km/h	1.2	-
From 100 to 90 km/h	1.3	1.0
From 90 to 80 km/h	1.5	1.1
From 80 to 70 km/h	1.7	1.2
From 70 to 60 km/h	1.9	1.4
From 60 to 50 km/h	2.3	1.7
From 50 to 40 km/h	2.8	2.1
From 40 to 30 km/h	3.6	2.7

- Probleem:
  - aandeel zware vracht
  - snelheidbegrenzer zware vracht op 90 km/uur
- Conclusie: marginaal effect te verwachten in L_{Aeq}/L_{den}
- Wetenschappelijk onderzoek: L_{Amax} versus L_{Aeq}

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HOE WERKT EEN SCHERM?

- the sound waves through the barrier: transmission, sound insulation of the barrier (see section 4.4.3):
  A noise barrier with a sufficient sound insulation weakens the sound waves propagating directly through the noise barrier. Their contribution to the overall sound level will thus be reduced to a minimum.

- the sound waves over the barrier: diffraction (see section 4.4.4):
  The sound waves have to bend over the noise barrier in order to reach the receiver and, in doing so, travel over a longer distance as they would in a situation without a noise barrier. This causes the sound level to reduce.

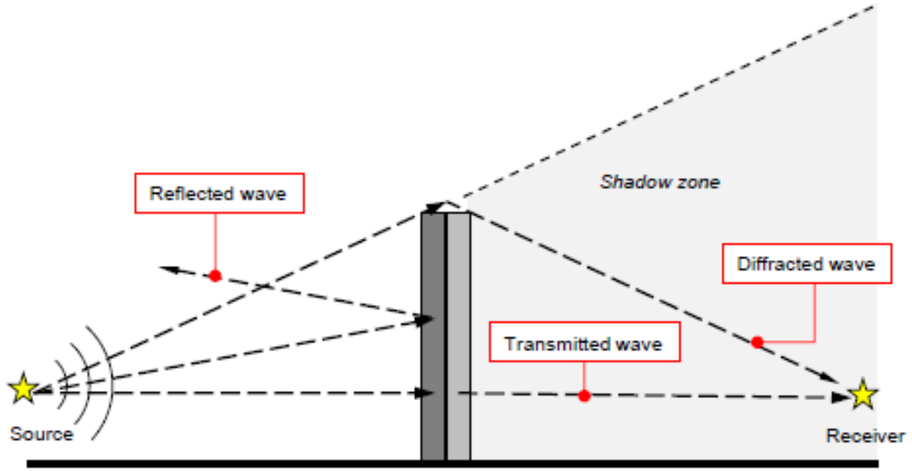

Figure 14: Mechanisms affecting noise barrier performance (Questim, 2014)

Distance between receiver and road	Expected noise reduction after installing a noise barrier	Experience by the human ear
30 m	12 dB(A)	Perceived to be 'half as loud' as before
50 m	10 dB(A)	Perceived to be 'half as loud' as before
100 m	5 dB(A)	The reduction is readily detectable, but the influence of the wind direction plays an important role
250 m	3 dB(A)	The reduction is just detectable. But because the influence of the wind direction might be greater than the noise reducing effect of the noise barrier, the receivers don't always perceive this as a reduction

Table 1: Effect of a noise barrier

4.2.5 Informing the public about the acoustic effect of a noise barrier

It is important to inform the citizens about the reducing effect of the new noise barrier to avoid misunderstandings afterwards. There are several possibilities to do this: information meetings, brochures, noise maps, audiotape, et cetera. Just to make clear that people 'behind' a new noise barriers do get (much) lower noise levels, but it will not become silent.

Bron: Technical Report 2017-02 State of the art in managing road traffic noise:noise barriers

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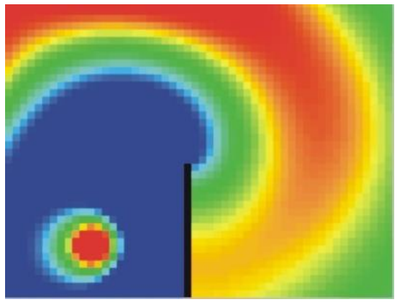
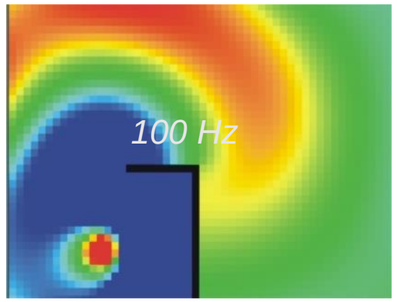
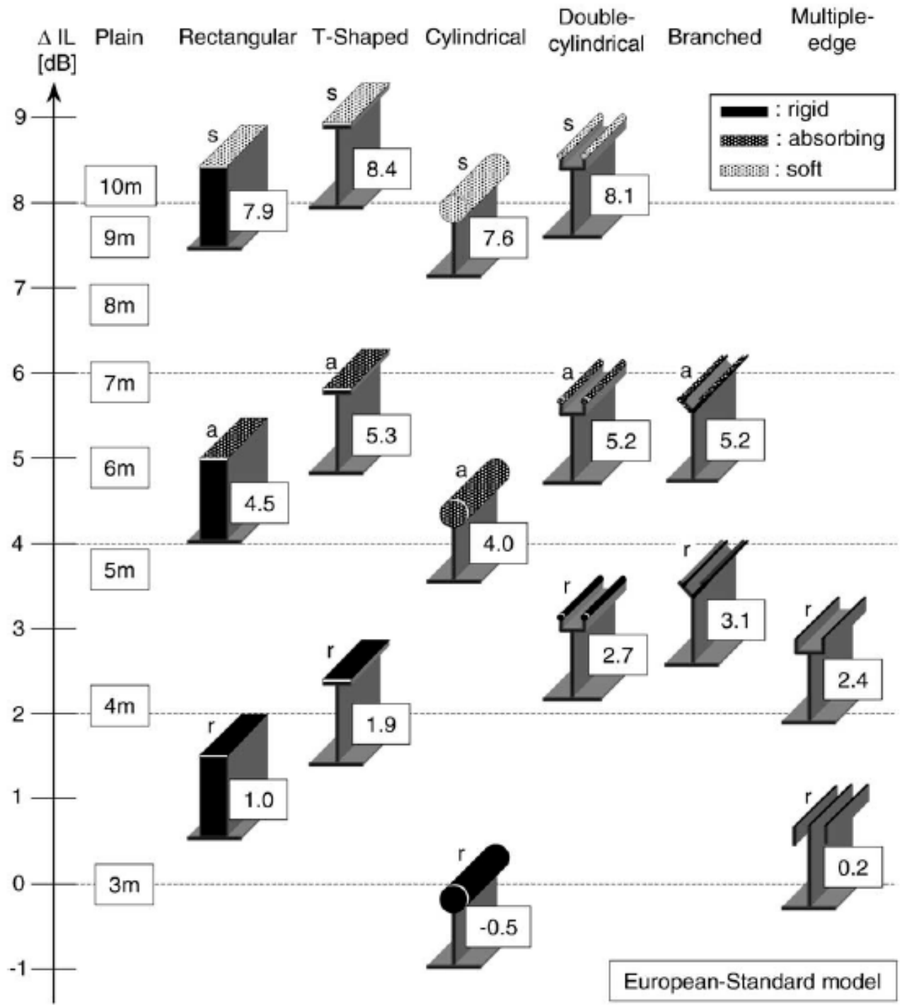
SCHERMTOPPEN EN ABSORPTIE

- Noise barriers
  - Screen tops
    - Multiple diffraction points
    - Important increase in shielding (by using absorption)





Ishizuka et al., Applied Acoustics, 2004



SCHERMEN - VOORBEELDEN

Figure 11: Sound diffraction measurement (source: http://www.akustikforschung.de/en/leistungen/umweltakustik/strassenlarm/larmschutzwand-schallschirm/)

Figure 35: Noise barrier is blending with the landscape

Figure 34: Noise barrier dominating the landscape

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GROENE SCHERMEN, PV

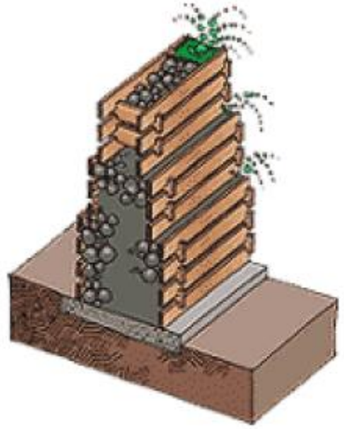

Figure 65 - Bio barrier with wooden structure

Figure 66 - Bio barrier with concrete structure (after the construction and after fully vegetated)

Figure 73: Example of noise barrier with photovoltaic modules

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BERMEN (1)

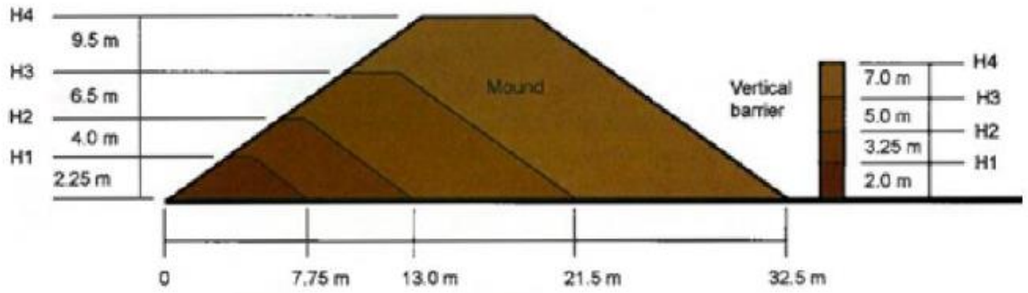
5.6.1 Earth mounds

An earth mound is an obvious solution to noise pollution in rural areas, because it fits (better) into the landscape more naturally than any vertical structure, especially as it supports planting which improves its appearance in rural contexts.

Earth berms can be a clever way to reduce noise. Berms appear environmentally friendly and may be designed aesthetically pleasant. Applying earth berms makes sense in rural areas where they fit well with the surroundings. They have advantages compared to conventional screens:

1. They have a natural appearance and they may not be perceived as noise barriers.
2. They create an more open area feeling compares to noise barriers.
3. They do not require extra security fence.
4. Costs are lower for construction and maintenance.
5. They have a higher perceived effectiveness.
6. They usually have an unlimited lifespan.

Figure 61 shows a comparison between vertical noise barriers a earth berm corresponds, acoustically speaking, to a 3.25 m high



Comparison of heights in metres

	H1	H2	H3	H4
Vertical barrier	2.0	3.25	5.0	7.0
Mound	2.25	4.0	6.0	9.5

NOTE: The dimensions will vary as berm widths and slope angles depend on the structural stability of different soils and fill materials

Not to scale

Figure 61: Comparison of the acoustic performance of a vertical noise barrier and an earth berm. A 4 m high earth berm is equivalent, acoustically speaking, to a 3.25 m high screen (H2).

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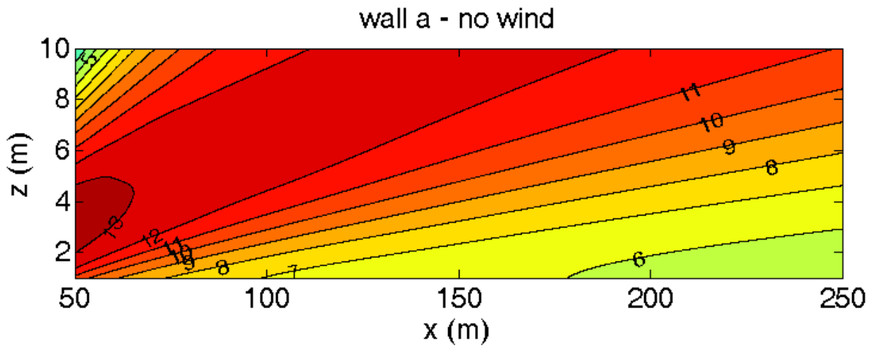
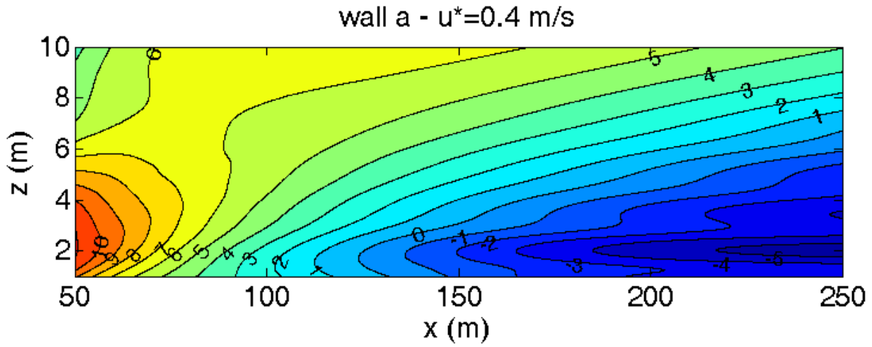
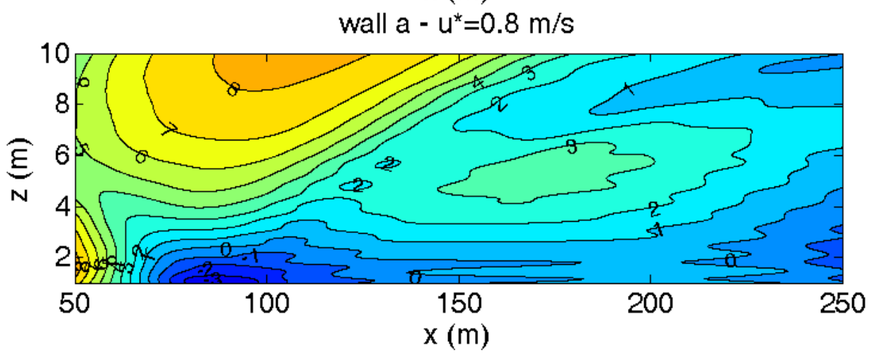
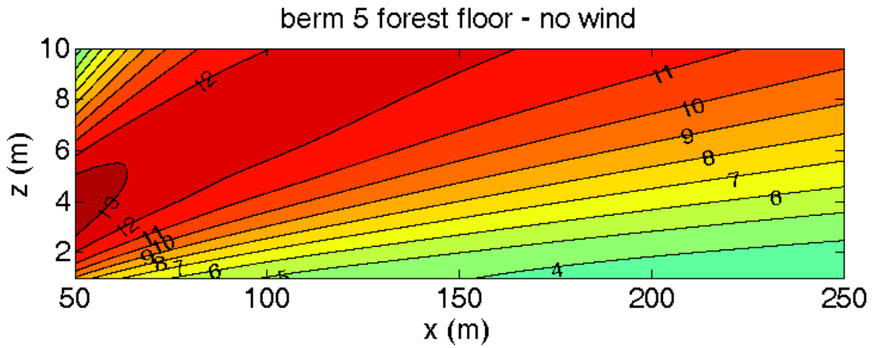
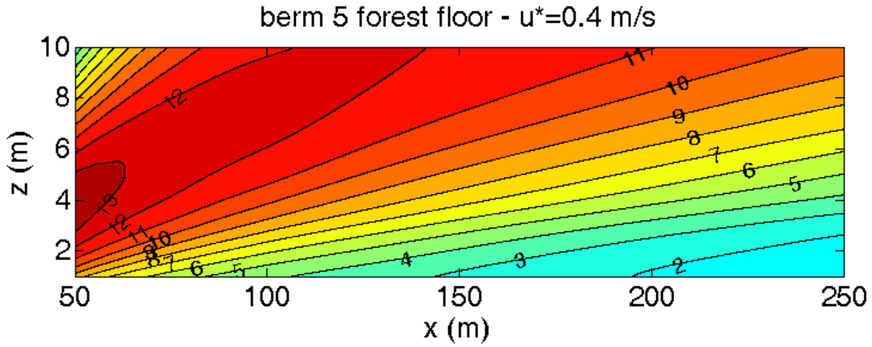
WINDEFFECTEN

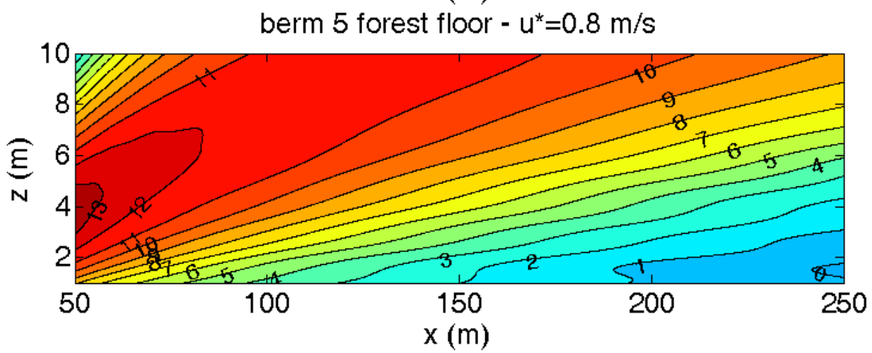




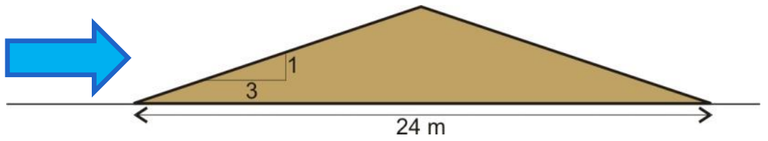








Van Renterghem et al., *Landscape and urban planning*, 2012



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COMBINATIE – GEBRUIK VAN RUIMTE

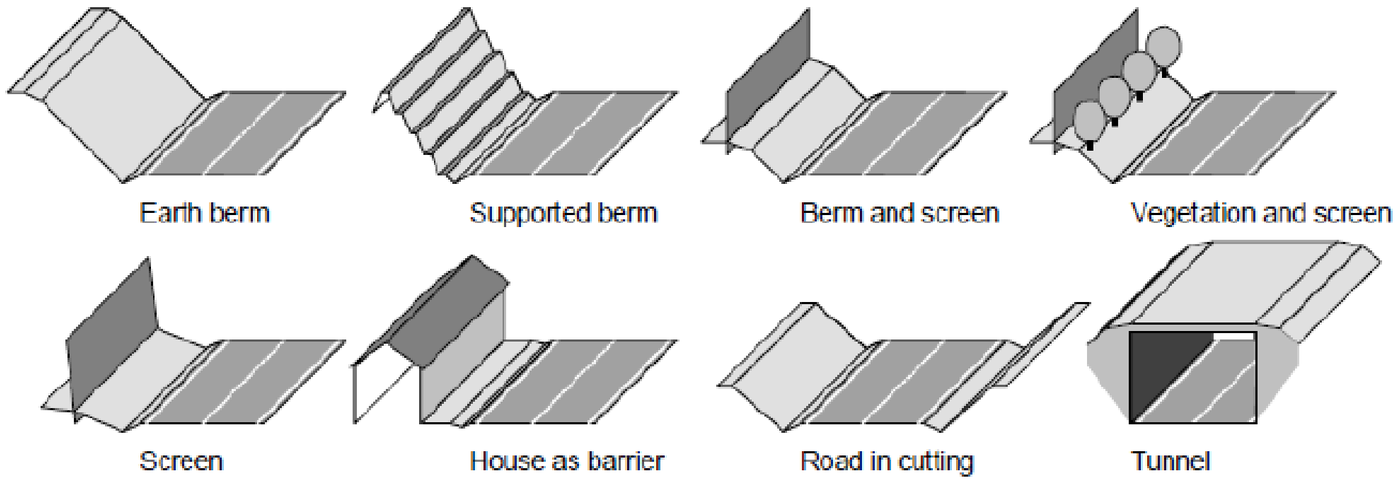

Figure 37 – Different types of barrier

- Embankments and earth mounds which may be used in combination with a conventional barrier.
- Vegetative barriers: barriers made partly or entirely from vegetation, which is rooted in a retained soil mound. The mound can be retained by various means, e.g. woven willow branches.
- Screening can also be realized with a combination of a building and a barrier.
- Covering barriers: for example as a grid set over a road in a cutting or as a complete cover on both sides of and above the road. Such complete covers are quite expensive, but offer very significant noise reduction.

NOISE SCREENING	LOCAL EFFECT, dB(A)
Barriers (Screen)	0-15
Depressed roads	0-5
Buildings as noise barriers	0-20
Tunnels	0-30
Vegetation	0-1

Table 2: Effect of noise screening

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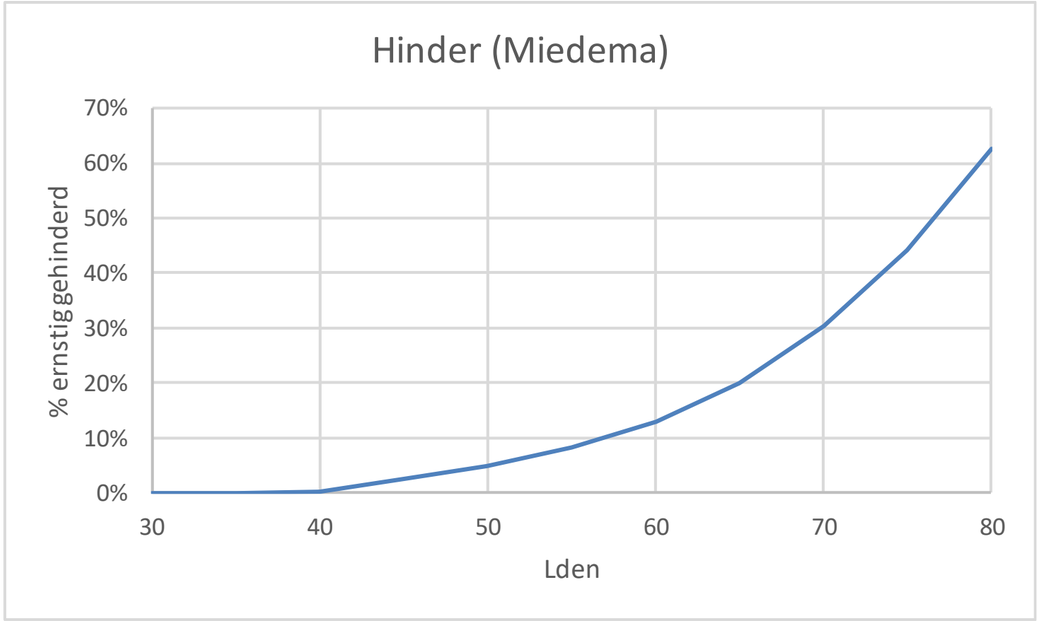
HINDER: WAT WETEN WE?

- Op basis van gerapporteerde hinder
  - Aantal mensen die ‘ernstig gehinderd’ aankruisen in een gestandaardiseerde enquête.
  - Internationale functies, opgenomen in EU, BE en Vlaamse wetgeving
- Geluidskaart omzetten naar potentiële hinder



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HINDER: WAT WETEN WE NIET!

- Probleem: L_{den} is zeer ongevoelig als indicator
- Effect van events?
  - Zwitserland: IR ‘intermittency ratio’
    - een correctie op L_{den} die rekening houdt met events en stille periodes.
- Variatie in dagpatronen!

- Persoonlijk parameters beïnvloeden hinderrespons (gevoeligheid voor geluid).

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VERKLAART L_{DEN} ALLE VARIATIE IN DE HINDER?

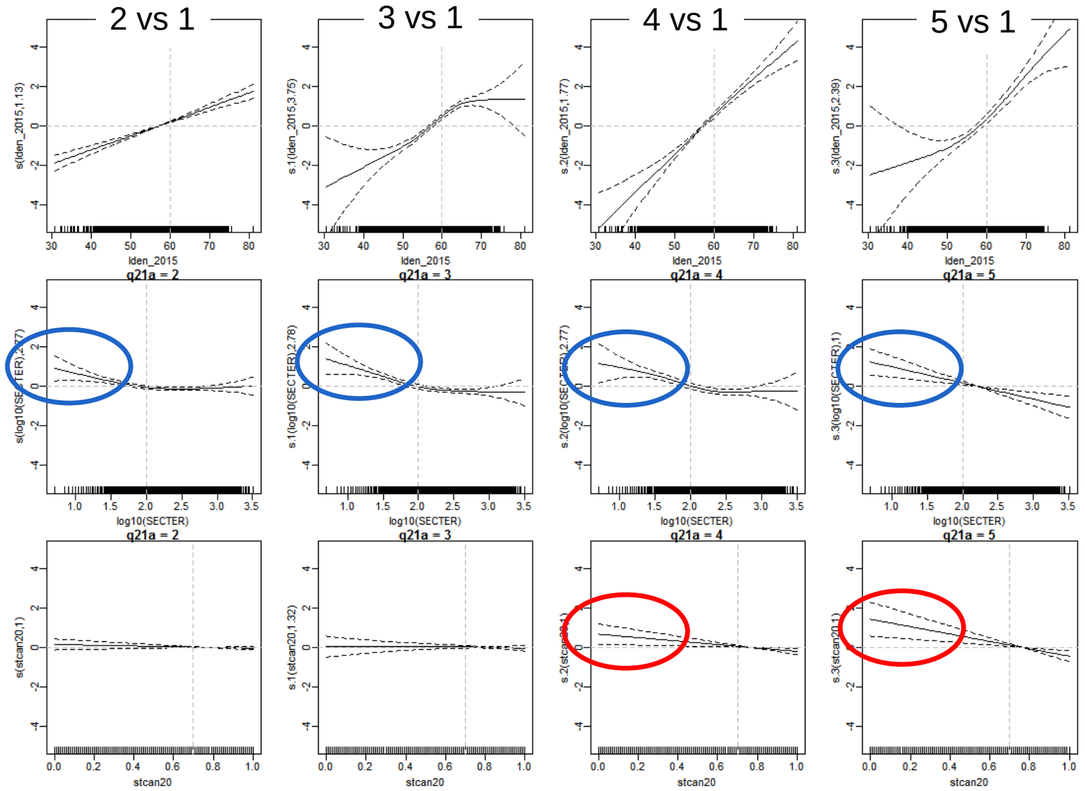
– Multinomial Generalized Additive Model on QoL (SLO3 in Flanders)
  - 1: not annoyed - 5 extremely annoyed

L_{den}

Distance to secondary road

StreetCanyon

+ factor(in_city)



Odds ratio relative to ‘not annoyed’

Higher response when close to sec/ter road

Higher response In open area

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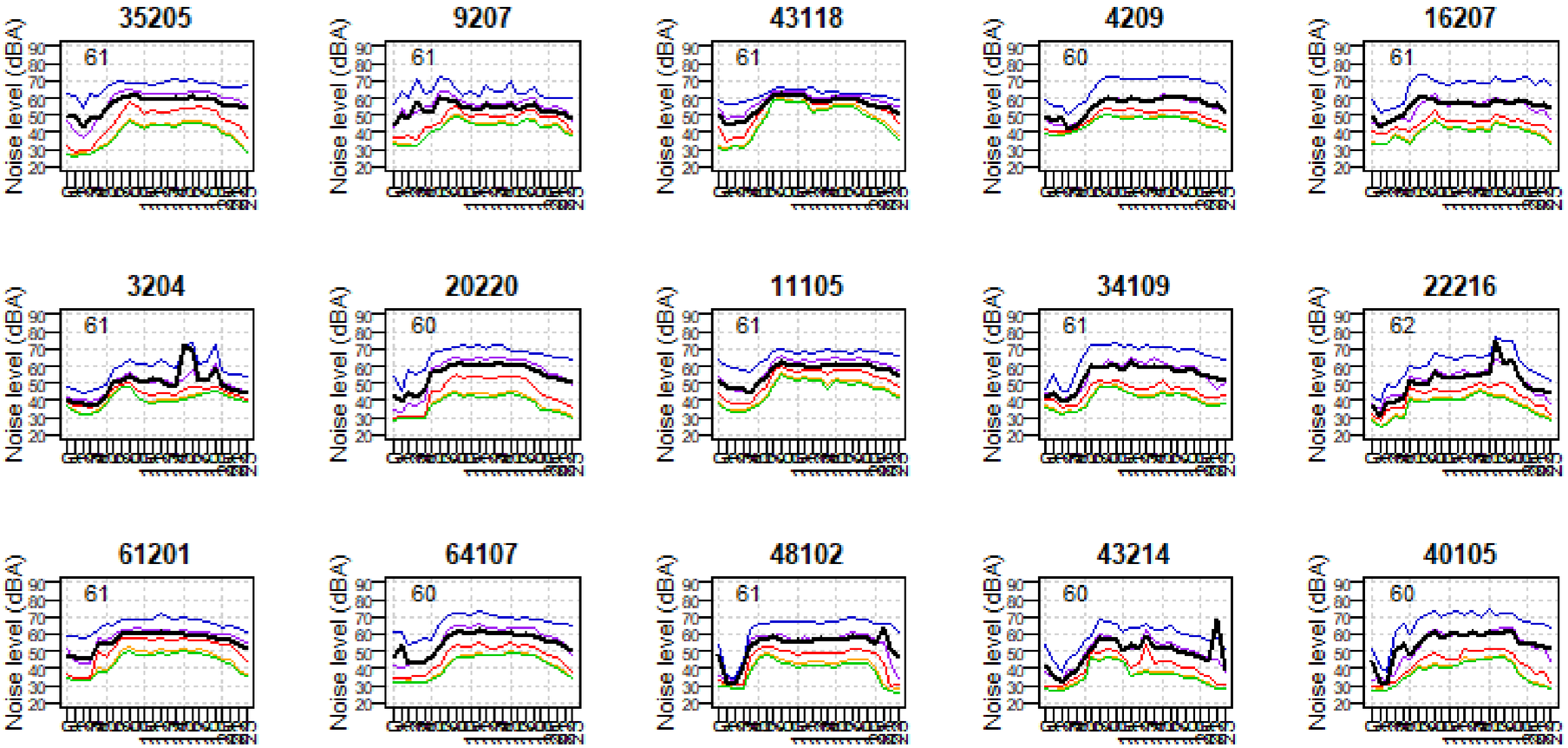
IDENTIEKE L_{DEN}, ANDER DAGPATROON EN EVENTS

L_{den} between 60 and 62



Source: UK noise incidence study (1160 locations)

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CITIZEN SCIENCE

- We (wetenschappers) hebben meer metingen nodig!
- Betere modellen betekent sterker bewijsmateriaal
- Meer bewijsmateriaal meer politiek gewicht
- Meer politiek gewicht betekent meer budget voor interventies en betere (meer stringente) wetgeving.
- Jullie bijdrage is welkom !

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BESLUIT

- Jullie bezorgdheid is gegrond.
- De (beschikbare) interventies zijn niet zaligmakend alleen (gedeeltelijk) remediërend.
- De financiële middelen zijn beperkt.
- Subsidiariteit…
- Prioriteit op politieke agenda is relatief laag maar krijgt meer en meer momentum…
- De stem van de burger kan het momentum versterken.