The WHO Environmental Noise Guidelines and noise policy in Denmark – the case of noise from motorways

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ABSTRACT
This paper shows the consequences for urban planning and road construction, if the Danish guideline from noise from motorways is to be changed according to the WHO-guidelines from 2018. It shows comprehensive challenges for urban planning and construction of new roads. Today the Danish guideline is \( L_{\text{den}} = 58 \) dB while WHO suggest \( L_{\text{den}} = 53 \) dB. The paper shows the technical possibilities to reduce the noise according to the WHO-guidelines. The paper also shows, that the cost for noise reducing initiatives along motorways would triple, the forbidden planning zone for new housing along motorways would be doubled geographically and the profit for urban developers behind projects for new housing outside larger cities would disappear.

1. INTRODUCTION

This paper shows policy implications for Denmark if guidelines in Denmark should follow the WHO study from 2018, implying that noise limits for road traffic noise should be \( L_{\text{den}} = 53 \) dB [1]. The Danish guideline for noise from road traffic is at present set at \( L_{\text{den}} = 58 \) dB for dwellings along roads and motorways [2].

Studies from the Danish Road Directorate [3], incl. a background article for the WHO report [4] on Environmental Noise Guidelines from 2018, supports the Danish noise limit on \( L_{\text{den}} = 58 \) dB for ordinary roads (not motorways). This should correspond to approx. 10% of the population being highly annoyed by the noise.

However, studies show that motorways are more annoying at the same noise levels than other roads. The Danish investigations from the Danish Road Directorate point to \( L_{\text{den}} = 52 \) dB for 10% highly annoyed for motorways. A Swiss study suggests \( L_{\text{den}} = 51 \) dB for 10% highly annoyed [5].

The Danish guideline for noise is used by the authorities, when they are planning for urban development according to the Danish planning act [6] and for new roads, according to EU’s directive assessment of the effects of certain plans and programs [7].

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Furthermore, a report developed by the Danish consultant Ramboll [8] shows serious challenges for construction of motorways and urban planning if guidelines for noise from motorways are to be changed according to WHO report (2018).

2. PAPERS ON NOISE FROM ROADS INCLUDING MOTORWAYS

For average noise exposure, the WHO strongly recommends reducing noise levels produced by road traffic below 53 dB L_{den}, as road traffic noise above this level is associated with adverse health effects.

To reduce the health effects, WHO strongly recommends that policymakers 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 WHO recommends reducing noise both at the source and along the propagation path between the source and the affected population by changes in infrastructure.

The WHO report from 2018 recommends a limit value of L_{den} = 53 dB to keep the highly annoyance below 10%. The current Danish noise guideline is L_{den} 58 dB for all types of roads in Denmark.

2.2. Study from the Danish Road Directorate [3]
In 2014 the Danish Road Directorate carried out a large study to investigate the differences in noise annoyance from motorways and urban roads. For motorways 6. sections were chosen that affect residential areas in three large cities and affect both urban communities and rural dwellings throughout Denmark.

In total, the 6. sections represent 200 km motorway corresponding to 10% of the total Danish motorway system. The urban roads include 7. residential areas with a total of 22 road sections in the three largest cities in Denmark.

The roads in the cities are both urban roads with little traffic, shopping streets and major busy roads. The overall results are based on 6,761 respondents.

The study must be considered to be very representative of the relation between noise annoyance and noise levels from the current road types in Denmark. The study showed, that the noise annoyance is highest on motorways and that the difference increases with increasing noise levels.

The study showed good agreement with previous studies of urban roads and with the Miedema curve. Throughout the range of noise levels, from 48 to 75 dB, there is a significant difference between the urban and motorway annoyance curves:

- At 58 dB, 21.8% are highly annoyed by motorways
- At 51.8 dB, 10% are highly annoyed by motorways
- At 58 dB, 7.5% are highly annoyed by urban roads
- At 58 dB, 7.9% are highly annoyed according to the Miedema curve (EU reference)
2.3. Other surveys on noise from motorways a study from FORCE Technology presented at Euronoise in 2021[9]

Danish surveys from 2007 and 2008 [10] and [11] and 2014 [3], which include urban roads with a total of 6,188 respondents provide results that support the current limit value for ordinary roads (excluding motorways). The Swiss study with 5,364 respondents from 2014-2017 shows that 10% are highly annoyed by a noise level of \( L_{den} = \text{approx.} \ 58 \, \text{dB} \) and thus supports the Danish noise limit for ordinary roads. The here mentioned results are broadly in line with the general European annoyance curves (Miedema curves).

A few studies from before 1992 show that noise from motorways is more annoying than noise from other roads corresponding to a difference of 5 dB or more. The Danish survey of 6,761 respondents from 2014 [3] with representative Danish motorways shows that the noise from the motorways is more annoying than the noise from urban roads. The study shows that at 52 dB, 10% is highly annoyed by motorways, which is 6 dB less than for urban roads. People living along motorways are significantly more annoyed than the general EU annoyance curves (Miedema curves).

The Swiss study [5] shows that roads with a motorway-like noise character, i.e. a relatively constant noise without pauses is approx. 7 dB more annoying than roads with scattered traffic and pauses at the same noise levels. This should be taken into account when determining guidelines for road noise.

3. DANISH REGULATION – URBAN PLANNING AND CONSTRUCTION OF NEW MOTORWAYS

According to the Danish planning act [6] municipalities cannot plan for new housing developments if the noise limit is exceeded. It would mean that planners have to comply with a change from 58 dB \( L_{den} \) to 52 dB \( L_{den} \).

According to planning of and construction of new motorways, the Danish Road Directorate is responsible authority. For construction, the limits are only guidelines, but the authorities will in any case try to approach noise levels close to the limit value [7].

4. CONSEQUENCES IF NOISE LIMITS WOULD BE CHANGED IN DENMARK [8]

The table below shows the number of noise exposed dwellings along the motorways in Denmark with three different indicative limit values.

<table>
<thead>
<tr>
<th>Noise from traffic on motorways</th>
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<tbody>
<tr>
<td>Guidelines ( L_{den} )</td>
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<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>58 dB</td>
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<tr>
<td>55 dB</td>
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<tr>
<td>52 dB</td>
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</tbody>
</table>
As it is seen, the number of noise exposed dwellings would be tripped, if the guideline is changed fra 58 dB to 53 dB.

Figure 1: Suburban area in Copenhagen – forbidden zone for new dwellings according to Danish planning act.

The above figure shows that the forbidden planning zone would more than double, if guideline is to be changes to 53 dB.

5. SOLUTIONS TO REDUCE NOISE

The consultant Ramboll [8] has for the Danish Environmental Protection Agency outlines the possibilities for reducing noise:

- Reduced speed can give 2 dB if the speed is reduced from approx. 110 km/h to 90 km/h and approx. 3 dB if reduced to 80 km/h.

- Less noisy tires and vehicles can give approx. 2-4 dB reduction.

- Noise-reducing road surfaces can cause a reduction in traffic noise of up to app 4 dB on average over the life of the pavement.

- Noise barriers or berms can give approx. 5-7 dB reduction.
The areas that become noise exposed with a limit value of 52 dB – according to figure 1 - can in most cases be brought back to a non-noise exposed status by using the solutions mentioned above. That is, the use of noise barriers or noise berms, possibly in combination with drainage asphalt. If it is appropriate for the sake of traffic flow, etc. reduced speed can in some cases also be part of an overall solution. Drainage asphalt and reduced speed can in combination reduce the noise by 5-6 dB and therefore almost compensate for a 6 dB lower limit value.

6. ECONOMIC CONSEQUENCES FOR URBAN DEVELOPMENT [8]

When planning for a new residential area in noise-exposed areas, noise barriers must be established, to comply with the noise limits within the entire residential area, including the noise levels at all facades. This can lead to massive costs for the establishment of noise barriers along the motorway or within the local planning area. If the urban development areas are large enough, it is the assessment that the establishment of noise barriers is economically viable in the larger cities.

In situations where there is a need for the establishment of noise barriers, they must often have an extent of 1-3 km, corresponding to an establishment cost of €2.5-8 million. Alternatively, noise berms can be used if surplus soil is available. In that case, the cost may be significantly lower.

Ramboll has estimated, that for planning for new residential areas in smaller cities in Denmark, projects may not be sustainable economically along motorways.

6.1 Economic consequences for construction of new motorways at a limit at 52 dB [8]

When planning motorways and motorway extensions, lower limit values will mean that the Danish Road Directorate must include significantly larger areas in the assessment of needs and possibilities for noise reduction measures. To illustrate the consequences, an actual motorway project has been selected, namely the expansion of the E45 Østjyske Motorway between cities of Vejle and Skanderborg from four lanes to six lanes. It is a stretch of 37.5 km.

A change in the noise limit to 52 dB Lden will mean that noise barriers on several sections must be included in a more detailed analysis. It is estimated that the total length of potential noise barriers would increase to 28 km, corresponding to 4 times the length included in the project mentioned above. With an establishment cost of €2500 per meter of noise barrier (6 m high), this means a relative increase in the construction costs for noise barriers from approx. €17 million to €68 million. The construction estimate for the entire expansion project without additional noise barriers is €484 million.

7. CONCLUSIONS FOR POLICY MAKING IN DENMARK

- In a short perspective, change in noise limits will not have any impact for the people already exposed by noise.
- No matter what the noise limit is, noise reduction measures should in any case be made for the people most exposed by noise.
- We need more knowledge about the reason why people seems more annoyed from noise from motorways than other roads (is it because of the motorway or is it because of different types of dwellings along the motorway)
- We need more knowledge of the link between noise and health (savings on health care costs versus noise reduction costs)
- Cost benefit analyses of combining all solutions for noise reduction.

8. ACKNOWLEDGEMENTS

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