Future impact of road and railway noise

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Summary

An exploratory study has been undertaken to put into perspective future impact of road and railway noise until 2050 in The Netherlands, taking into account potential economic and mobility growth, noise policy and legislation, demography and technical progress. Estimates were made of average noise levels and numbers of annoyed and sleep disturbed people for typical road and railway situations, for three mobility growth scenarios, strong, medium and low. Simplified models were used to make these estimates. The effects of policy instruments such as national noise legislation including continued application of noise abatement measures (barriers, quiet roads/tracks and dwelling insulation), European noise limits for vehicles and technical progress were assessed. It was found that the potential noise impact until 2050 shows a wide range, depending strongly on the growth scenario, policy choices and EU noise legislation. In the strongest mobility growth scenario and with continued noise legislation, an increase in numbers of annoyed and sleep disturbed people is forecast at around 25% in 2050. Significant reductions in numbers of affected people are forecast only if current regulation is continued, vehicle noise levels decrease further and mobility and population grows little. An effective noise policy at European level and widespread use of quieter vehicles and infrastructure will be required to achieve this even in the low growth scenario.

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1. Introduction

As transportation noise has a significant environmental impact and external costs, it is useful to understand how it may develop over the longer term. For this reason an exploratory study has been undertaken to put into perspective the potential future impact of road and railway noise until 2050 in the Netherlands [1], taking into account economic and mobility growth, noise policy and legislation, demography and technical progress. Information on these factors was obtained from other national studies, statistics and policy documents, which were used as background data. Estimates were made of noise emission, average noise levels at dwellings and numbers of annoyed and sleep disturbed people for typical road and railway situations, for three growth scenarios. Prognoses were made for 2013, 2020, 2030, 2040 and 2050. The approach was similar to that taken in the TNO Venoliva study in 2011 [2] for the European Commission, and outlined in [3], but applied to the Netherlands for road transport and extended with rail transport.

2. Scenarios

The three growth scenarios were high, medium and low, following those applied in transportation policy studies [4], but devised to obtain sufficient bandwidth in noise impact:

· high mobility growth combined with a limited reduction in vehicle noise emission;
· medium mobility growth combined with a reduction in vehicle noise emission following current trends;
· low mobility growth combined with a strong reduction in vehicle noise emission.

Two subscenarios were taken for each of these, for continuation or discontinuation of national noise legislation affecting further noise abatement measures such as new noise barriers, more quiet roads or tracks and dwelling insulation. The scenarios are set out in Table I. The growth scenarios correspond to Global Economy (GE, strong growth), Regional Communities (RC Slow growth) and medium growth scenarios Strong Europe (SE) and Transatlantic Market (TM). The medium scenario used here is the average of GE and RC scenarios.

Table I: Definition of Scenarios

Scenario	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**
Mobility	Strong growth	Strong growth	Medium growth	Medium growth	Low growth	Low growth
Noise emission	Small decrease	Small decrease	Continue current trends	Continue current trends	Large reduction	Large reduction
Regulation for noise abatement	Continue	Dis-continue	Continue	Dis-continue	Continue	Dis-continue
Road traffic						
Growth passenger km	GE (high)	GE (high)	Medium	Medium	RC (low)	RC (low)
Growth freight tonkm	GE (high)	GE (high)	Medium	Medium	RC (low)	RC (low)
More abatement	Yes	No	Yes	No	Yes	No
Reduction of noise emission	Moderate	Moderate	Reason-able	Reason-able	Strong	Strong
Population density	Increase	Increase	Increase	Increase	Stable	Stable
Railway traffic						
Growth passenger km	GE (high)	GE (high)	Medium	Medium	RC (low)	RC (low)
Growth freight tonkm	GE (high)	GE (high)	Medium	Medium	RC (low)	RC (low)
More abatement	Yes	No	Yes	No	Yes	No
Reduction of noise emission	Moderate	Moderate	Moderate	Moderate	Large	Moderate
Population density	Increase	Increase	Increase	Increase	Stable	Stable
Influx of quieter rolling stock	Accel-erated	Slow	Accel-erated	Slow	Accel-erated	Slow

The baseline is 2013 and growth figures are based on mobility growth data from the WLO report [4] and adjusted for slower growth during the economic crisis since 2008.

3. Future mobility

For the development of mobility of road and rail, volume data for road and railway usage for both passenger and freight traffic were assessed. These depend on economic growth, demography and new infrastructure planning. Data were used from various sources including [4,5,6,7,8] for growth prognoses of road and rail traffic volumes, both for passenger and freight traffic. Traffic volume estimates for roads and railways in the Netherlands are set out in figures I-IV. Infrastructure lengths are based on national statistics data [9,10].

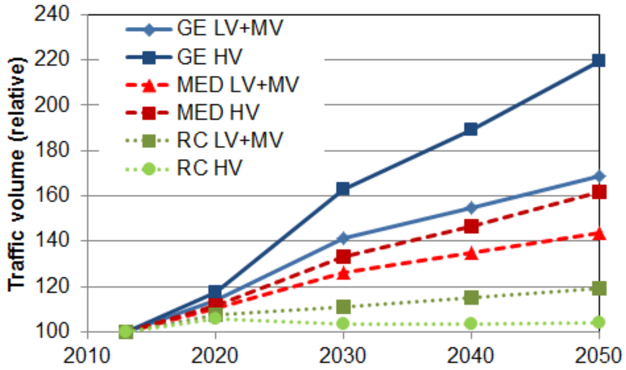

Figure I: Road traffic volume prognoses for the Netherlands, for light and medium duty vehicles and heavy vehicles, for three growth scenarios.

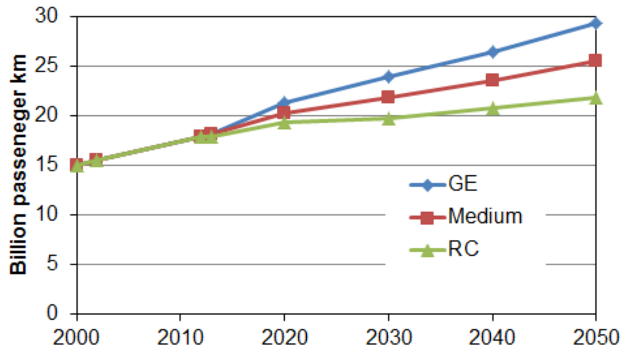

Figure II: Rail passenger volume prognoses for three scenarios, from 2000.

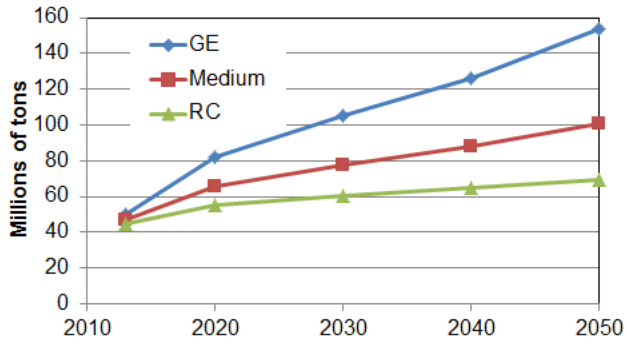

Figure III: Rail freight volume prognoses for three scenarios.

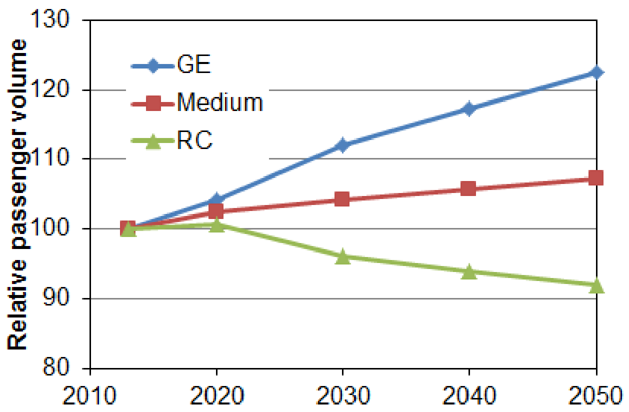

Figure IV: Metro/tram/bus passenger volume prognoses for three scenarios.

4. Future demographics

Population growth can be expected to affect traffic volume, increasing usage of either existing or new infrastructure. Estimates for population growth in the Netherlands for the three main scenarios are set out in Figure V. These are based on figures from the WLO study from 2006 [4], adjusted for more recent developments including the economic crisis. The relative growth is used here to estimate the increase in numbers of people exposed to noise for each scenario. Demographics are not used to adjust the mobility estimates, which already take these into account.

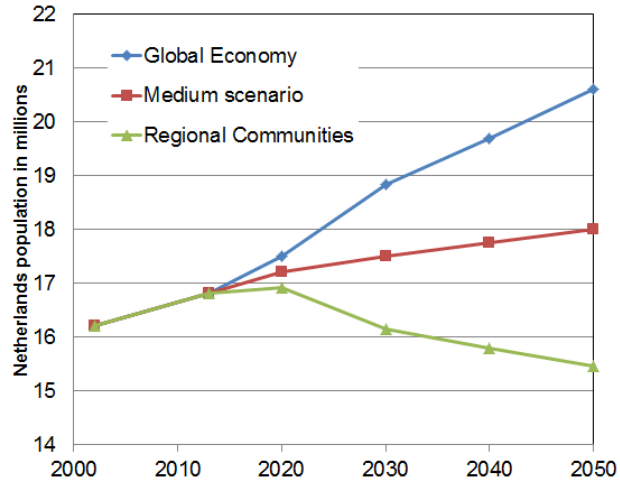

Figure V: Population prognosis for the Netherlands until 2050 for three growth scenarios.

Shift of population from rural areas towards urban areas is ongoing and could imply increase in local population density, causing both higher traffic volumes and more people affected by noise. However, this is not deemed to be a dominant effect as population increase in urban areas is often accompanied by new roads and housing estates, and not always higher density of dwellings. Whether inside or outside urban areas, dwellings will mostly be close to roads.

5. Evolution of noise emission, noise limits and technical progress

The noise emission from vehicles and infrastructure can be expected to decrease over time following stricter European vehicle noise limits [13] together with quieter infrastructure. These impact overall traffic noise levels once the whole fleet is fully replaced or refitted. For powertrain noise from road vehicles this takes approximately 13 years after new limits come into force, which is the typical life span for cars. Hybrid and electric vehicles may contribute to traffic noise reduction, mainly powertrain noise, but not for many years at the current low growth rate of these vehicles. For tyre noise, stricter noise limits may take effect around four years after introduction of new limits. But here also the type of road surface plays a role, so the extent and quality of quiet road surfaces also must be taken into account.

For railway noise, vehicle noise limits (TSI) [14] and the penetration of freight rolling stock with low noise braking systems are key factors for future railway noise emission. In addition, track design and maintenance play a significant role. After the reduction in wheel/rail roughness an improvement in track design is to be expected to achieve further noise reduction at source. Further on, stricter noise limits may also reduce other noise sources such as traction and aerodynamic noise.

6. Noise abatement on infrastructure

Noise abatement on the road and railway infrastructure consists mainly of quiet road surfaces, smooth tracks, quieter track design including rail dampers and shielding, noise barriers and insulation of dwellings. The future increase in the amount of such noise abatement measures depends on continued application of current national legislation. For this study, the effect of continuing or discontinuing such legislation is included as subscenarios A and B. Discontinuation (B) implies that no further noise abatement is implemented, but existing measures are maintained. This is modelled by taking total length of new noise barriers, quiet road surfaces, rail dampers and numbers of newly insulated dwellings into account. Such data was based on the national action plans for road and railway noise abatement [15,16].

7. Prognoses of noise levels and affected people

Road traffic noise emission levels were calculated for 6 characteristic road types (residential, main and arterial roads, urban and rural motorways, rural main roads), average traffic volumes, vehicle emission levels (light/medium and heavy vehicles) and driving conditions (intermittent or free flowing traffic). Traffic flow rates were based on typical average flow rates found for the various road types. The noise levels are adjusted for quieter road surfaces. Evolution of European vehicle and tyre noise limits were taken into account including the time required for replacement of the fleet (around 13 years lifetime for cars). Introduction of electric and hybrid vehicles is also taken into account although this mainly affects intermittent traffic at lower speeds.

For railways, six railway line types were defined, each with particular traffic mix and speeds:
- mixed traffic lines with dynamic/variable speeds;
- mixed traffic main line with constant speeds;
- local lines;
- light rail (trams and metro);
- freight lines;
- high speed lines.

L_{DEN} levels were calculated using the Dutch railway noise calculation method [12], based on characteristic railway noise emission levels, average traffic volumes, and typical speeds.

Prognoses of L_{den} and L_{night} façade levels were made for each road or railway type, typical façade distances and propagation conditions. The characteristic noise levels were compared with current published levels along the road and rail infrastructure [17,18]. Selected results for L_{den} façade levels are shown in figures VI-IX for scenarios 1B and 3A, illustrating the greatest potential increase or decrease of noise levels over time. L_{night} noise levels show very similar trends.

Numbers of (highly) annoyed and (highly) sleep disturbed people were then derived from the numbers of exposed people along roads and railways and established dose-effect relationships. The numbers of exposed people were based on population density along each road/railway type and the effective length with dwellings. Corrections were then made for roads and railways with noise barriers, quiet road surfaces, and dwellings with sound insulation provided due to legislation. The input parameters for the reference year 2013 were chosen to correlate with annoyance survey results from 2003 [20].

Selected results for numbers of annoyed people are shown in Figure X for roads, Figure XI for highly annoyed people near the major road network and in Figure XII annoyed numbers for railways.

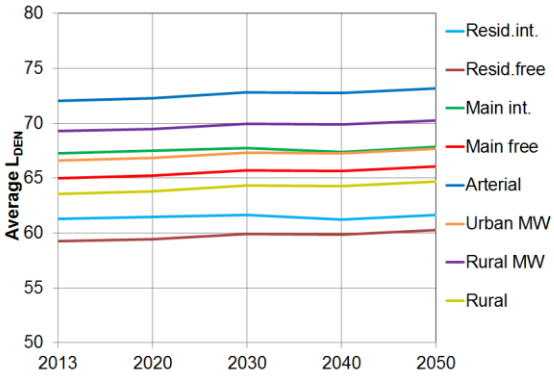

Figure VI: L_{DEN} road noise for scenario 1B for 8 road types.

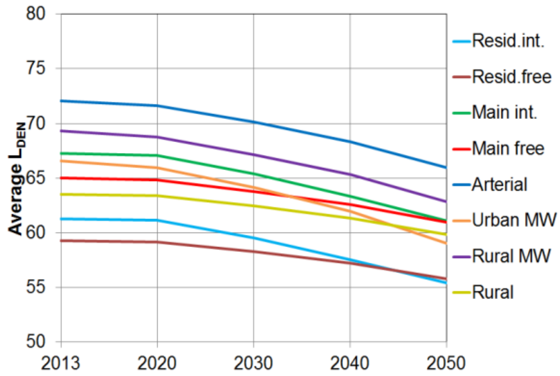

Figure VII: L_{DEN} road noise for scenario 3A for 8 road types.

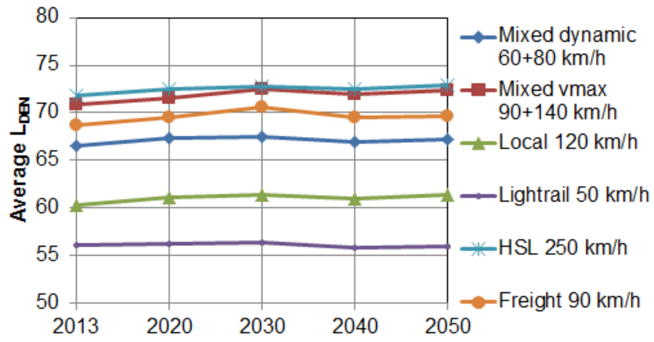

Figure VIII: L_{DEN} railway noise for scenario 1B for 6 railway traffic types.

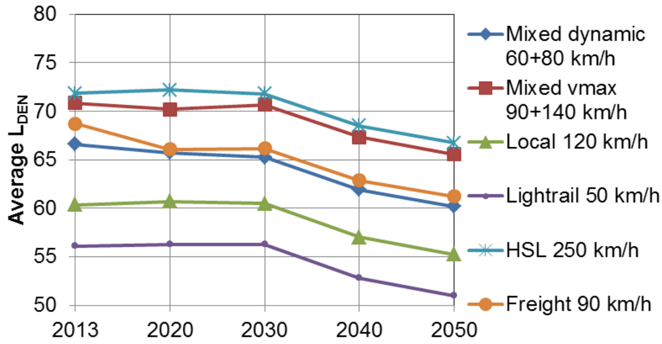

Figure IX: L_{DEN} railway noise for scenario 3A for 6 railway traffic types.

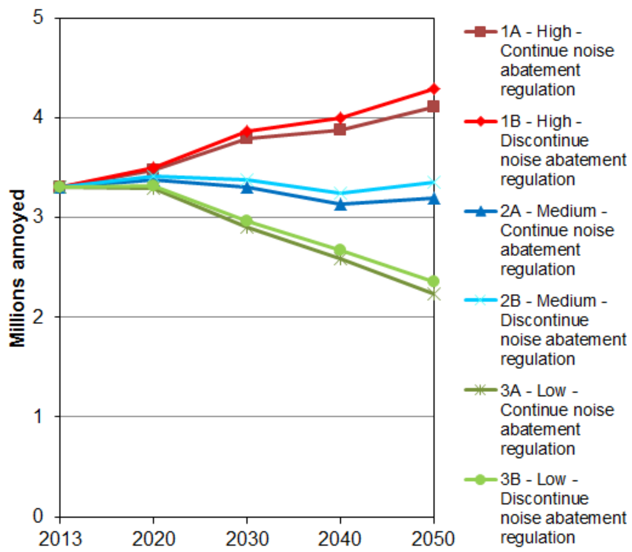

Figure X: Roads: Evolution in annoyance for the whole road network for 6 scenarios.

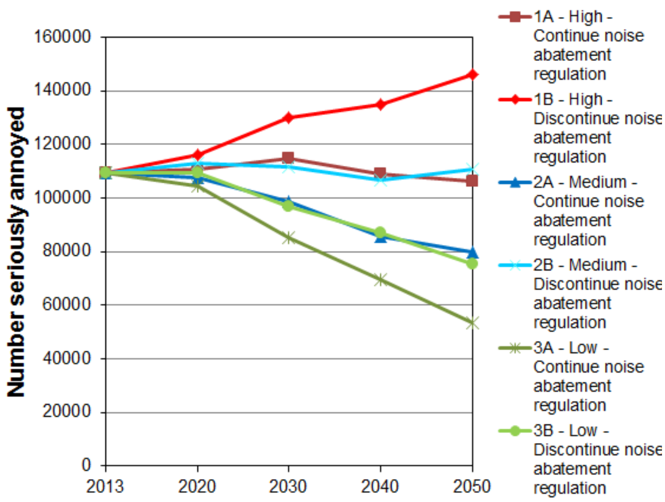

Figure XI: Roads: Evolution in serious annoyance for only the major road network for 6 scenarios.

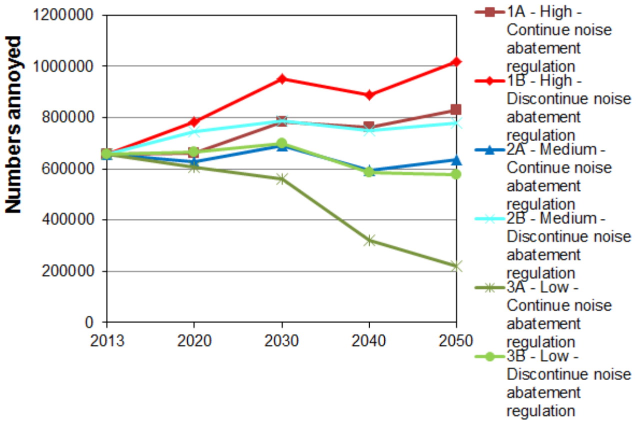

Figure XII: Railways: Evolution in annoyance numbers for 6 scenarios.

Similarly to the trends in noise levels, these results show that the mobility growth scenarios strongly affect future noise levels and annoyance, and that national legislation on noise abatement also has a significant effect.

8. Conclusions

The potential noise impact until 2050 strongly depends on the growth scenario, policy choices and EU noise legislation. In the strongest mobility growth scenario and with continued national legislation on noise abatement, an increase in numbers of annoyed and sleep disturbed people is forecast at around 25% in 2050. Significant reductions in numbers of affected people are forecast only if current national regulation on noise abatement is continued, vehicle noise levels decrease further and mobility and population grows little. An effective noise policy at European level and widespread application of quieter vehicles and infrastructure will be required to achieve this even in the low growth scenario.

Acknowledgement

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