ASSESS

Assessment of the contribution of the TEN and other transport policy measures to the mid-term implementation of the White Paper on the European Transport Policy for 2010

FINAL REPORT
ANNEX X NOISE IMPACT

European Commission
DG TREN
DM 28
1043 Brussels
Belgium

28 October 2005

TRANSPORT & MOBILITY LEUVEN

TRANSPORT & MOBILITY LEUVEN
VITAL DECOSTERSTRAAT 67A BUS 0001
3000 LEUVEN
BELGIË
+32 (16) 31.77.30
http:\\www.tmleuven.be

and:

TNO, Netherlands
WSP, UK
TRT, Italy
DLR, Germany
University of Gdansk, Poland
ITS Leeds, UK
SWOV, Netherlands
CAU Kiel, Germany
Istanbul Technical University, Turkey

Preface

This is ANNEX X of the final report for *'Assessment of the contribution of the TEN and other transport policy measures to the mid-term implementation of the White Paper on the European Transport Policy for 2010'*.

Project title: ASSESS

Client: European Commission, Directorate-General for Transport and Energy, Unit B1.

Contract: TREN/04/ADM/S07.38796

Project contractor: Transport & Mobility Leuven

Authors:

Jeroen Borst, TNO, the Netherlands
Merijn Martens, TNO, the Netherlands

Version:
Final Version.

Date:
28 October 2005.

Reference:
Borst H..C., Martens M., (2005), Noise impact, Annex X of ASSESS Final Report, DG TREN, European Commission.

Scope

<u>**Scope of the ASSESS project**</u>

The ASSESS study is about the ***"Assessment of the contribution of the TEN and other transport policy measures to the mid-term implementation of the White Paper on the European Transport Policy for 2010"***.

The European Commission's White Paper of 12.9.2001 "European transport policy for 2010: time to decide" aims to promote a sustainable transport policy. The White Paper proposes to achieve sustainability by gradually breaking the link between transport growth and economic growth, principally in three ways: changing the modal split in the long term, clearing infrastructure bottlenecks and placing safety and quality at the heart of the transport policy.

As foreseen, the White Paper on Transport undergoes in 2005 an overall ***assessment concerning the implementation of the measures it advocates and to check whether its targets*** - for example, on modal split or road safety - ***and objectives are being attained or whether adjustments are needed.***

ASSESS provides technical support to the Commission services for the above mid-term assessment of the White Paper.

The analysis accounts for the economic, social and environmental consequences of the proposed measures and their contribution to sustainable development objectives. It provides also a detailed analysis of those effects of enlargement likely to affect the structure and performance of the EU transport system.

The study takes a three pillar approach based on the use of analysis, indicators and models. National transport policies are reviewed for compatibility and coherence with the White Paper objectives. The models used allow a detailed analysis of the freight market, the passenger market and their infrastructure networks under a number of scenarios.

<u>**Scope of this Annex**</u>

The measures formulated in the White paper will have consequences for the volumes of different modes of transport. Changing traffic volumes will cause changes in noise levels, noise exposure and noise annoyance. This annex takes into consideration the noise impacts of the four policy scenarios defined in ASSESS. On basis of the estimated changes in the transport sector, most importantly changes in traffic volumes, an estimate is made of the impacts on noise nuisance.

Index

Tables

Figures

ANNEX X Noise impact

Authors:
Jeroen Borst, TNO, the Netherlands
Merijn Martens, TNO, the Netherlands

X.1. Introduction

Noise annoyance due to transportation is widespread in the industrialized countries and in urban areas in the developing countries. New legislation EU requires an assessment of the noise situation as well as the formulation of action plans for the reduction of the number of people harmfully affected by environmental noise.

The measures formulated in the White paper will have consequences for the volumes of different modes of transport. Changing traffic volumes will cause changes in noise levels, noise exposure and noise annoyance. Therefore it is useful to assess changes in noise annoyance due to the changes in traffic volumes caused by the measures described in the White Paper.

Beside changes in traffic volumes, the White Paper sets out targets for noise reduction in the field of air transport. It says 'the aim is to compensate for the increase in air traffic by reducing aircraft noise by 10 dB in order to cut the perceived noise level by 50 %. Research will focus on aircraft technology, low-drag aerodynamics and flight operating procedures'. The effect of aircraft noise reductions on noise annoyance is also assessed in this paper.

In order to quantify the impact of the White Paper on the noise annoyance in Europe, a case study is performed on the city of Amsterdam in the Netherlands. On the basis of detailed noise maps, the noise exposure of dwellings is assessed for the base year (2005) and for the four ASSESS policy scenarios in 2010 and 2020. In order to complement this detailed local assessment with broader overviews (which are only available in less detail), also national data on noise exposure in the Netherlands were used.

For the scenarios, traffic volumes for different transportation modes were provided by TREMOVE. The method section describes how the TREMOVE data were used in order to assess noise.

X.2. Method

X.2.1. Road and rail transport noise

This assessment of noise annoyance does focus on the impacts of traffic volume differences that are the result of White Paper policies. The differences in traffic volumes per policy scenario are deduced from the SCENES-TREMOVE model combination. From the TREMOVE output, the differences in road and rail traffic volume compared to the base year (2005) are calculated. For trains, the total growth in traffic volume of passenger trains and freight trains was used.

A case study approach

It is difficult to assess noise impacts at a European level. Estimating the noise impact by only multiplying traffic volumes with an emission factor, a method correctly applied in case of other environmental impact categories like CO_2, produces incorrect estimations in case of noise annoyance. It is needed to assess to what extent the increase in noise does result in an increase in noise annoyance since emission of noise becomes only a problem when the noise is produced in vicinity of people. This can only be done at a low geographical scale level, preferable the street level. Currently there is no instrument that can estimates changes in noise annoyance at street level in all European countries. Therefore a case study approach is applied for the purpose of assessing the noise impacts of the White Paper.

The city of Amsterdam (the Netherlands) was used as a case to assess the noise impacts of the different scenarios that are defined in the ASSESS project. Amsterdam has 733 392 inhabitants on an area of 219 km2. For the city of Amsterdam, detailed noise maps have been made with the noise model Urbis (Borst & Miedema, 2005). Although one case study can never represent all of Europe, Amsterdam can be considered to be a typical European city with a historical and high density central city.

With Urbis, noise emissions of roads are calculated on the basis of traffic volumes, traffic speeds and road surface type. Noise propagation is calculated on the basis of information on noise barriers, surface type and shielding objects. This way, the noise exposure of dwellings due to road traffic can be calculated. Rail and air traffic noise is calculated in a similar way. In Amsterdam, noise exposure occurs due to road traffic on highways, road traffic on urban roads, rail traffic on different railway lines surrounding the city and air traffic to and from to Amsterdam Airport Schiphol (AAS).

For every dwelling in Amsterdam, the noise exposure on the most exposed facade caused by the following traffic categories is calculated:

- passenger cars on motorways;
- passenger cars on urban roads;
- light duty vehicles on motorways;
- light duty vehicles cars on urban roads;
- heavy duty vehicles on motorways;
- heavy duty vehicles cars on urban roads;
- trains.

On the basis of the growth of traffic volume per traffic category, the increase of noise exposure per traffic category for every dwelling in Amsterdam is calculated. On the basis of these noise exposures, the percentage Highly Annoyed is calculated using exposure-response relations (Miedema & Oudshoorn, 2001). The definition and calculation of the percentage Highly Annoyed has become a standardized practice in Europe.

Estimating national impacts

To enable an assessment of noise impacts at a higher, and not solely urban, geographical scale an estimate of the noise impact at the National level was made. The Dutch National Institute for Public Health and the Environment (RIVM) assesses the noise situation in the Netherlands with EMPARA – module NOISTOOL. This system has been developed to map the effects of traffic noise on a national scale. The information from EMPARA is less detailed than the data from Urbis. This holds for the geographic detail as well as for the traffic types. Due to its limited geographic resolution, EMPARA is not very accurate in urban areas. It was also not possible to discriminate the different types of road traffic. However, because EMPARA covers the whole of the Netherlands, analysis of the EMPARA data is complementing to the detailed but specific case study Amsterdam. From the EMPARA data, distributions of the noise exposure due to road traffic, rail traffic and air traffic were used to calculate the expected noise annoyance. On the basis of the TREMOVE data, an overall change of the noise from road and rail traffic was estimated.

X.2.2. Aircraft noise

The method described in the previous sections can not be used to assess changes in aircraft noise. TREMOVE only produced estimates of passenger kilometres in air transport and these cannot be used to assess changes in noise impact due to air traffic. Aircrafts only cause noise annoyance when taking off and landing, and growth in passenger kilometres is not a good measure for growth in the number of take-offs and landings for the following reasons. Since the average aircraft size and occupancy rates are growing, the growth in the number of take-offs and landings will be considerably lower than the growth in the number of passengers. This is illustrated by table 1, which shows that take offs and landings are decreasing while passenger and freight transport is growing for Dutch airports.

Table 1: Growth Dutch Airports

Airport	Indicators	2001	2004	Change
Amsterdam Airport	Take-offs and landings (sum)	432 056	418 612	-3,11%
	Passengers	39 309 441	42 425 392	7,93%
	Freight (ton)	1 183 208	1 421 115	20,11%
All Dutch airports*	Take-offs and landings (sum)	662 312	573 950	-13,34%
	Passengers	40 789 564	44 575 911	9,28%
	Freight (ton)	1 217 433	1 466 058	20,42%

* Airports of Amsterdam, Rotterdam, Maastricht, Eindhoven and Groningen
Source: CBS, The Netherlands.

Due to different developments, the average length of a flight will change. High speed trains will substitute airlines on shorter routes. On the other hand, Low Cost Carriers will probably increase the number of flights on shorter routes. Therefore, the growth in passenger kilometres is a poor predictor for changes in numbers of take-offs and landings and the change in noise impact.

Instead the assessment of noise from air transport is focused on the development of aircraft noise abatement technology. The impact of this development is likely to have a higher impact on noise emission that changes in traffic volumes. Moreover, aircraft noise abatement technology is one of the targets of the White Paper.

The assessment of aircraft noise abatement technology makes use of existing European research projects that aim to reduce exposure to air traffic noise. First of all, X-noise is a cluster of research projects involving 32 organizations in nine European countries, aiming to develop technologies to reduce turbo machinery, exhaust and airframe noise. Secondly, the SOURDINE project will define and assess new approach and take-off procedures for all European airports supported by adequate validated simulation tools. The automation tools required to assist the end-users (pilots and controllers) in the utilisation of the new procedures will also be defined.

In order to reduce annoyance from air transport, the EU adopted in 1992 a directive to ban the noisiest aircraft from European airports, defined in Chapter 2 of Annex 16 to the Convention on International Civil Aviation ("Chicago Convention"). These aircrafts were no longer allowed to operate in the European Union after April 2002. In 2002, a directive on the establishment of rules and procedures with respect to the introduction of noise related operating restrictions at Community airports (2002/30/EC) was adopted. This Directive enables Member States' competent authorities to prohibit or restrict the operation of aircraft which comply only 'marginally' with ICAO noise standards, i.e. which meet the standards in force by a margin of no more than 5 decibels.

The effects of implementation of measures developed in the two projects on aircraft noise exposure are estimated on the basis of the description of the projects: 6 dB. This yields an overall reduction of exposure levels of 6 dB if all other factors (fleet, frequency, procedures) are left unchanged. The effect of the estimated change in noise exposure on noise annoyance is assessed by taking the present distribution of the Dutch population over exposure levels as starting point. Although the introduction of noise reducing technologies will take time to be fully implemented, the effect of the full emission reduction is assessed.

X.3. Results for road and rail traffic

X.3.1. Traffic volumes

From the TREMOVE runs, the growth of road and rail traffic volume is calculated with 2005 as base year, and the results are presented in table 2. To enable the calculation of noise impacts the changes in traffic volumes are computed for passenger cars, light duty trucks and heavy duty trucks and for motorways, urban roads and rail.

Table 2: Growth in traffic volume (vehicle kilometres) for scenarios (base year 2005 = 100)

Traffic Type	Network	2010N	2010P	2010F	2010E	20210N	2020P	2020F	2020E
passenger cars	motorways	108.8%	108.8%	110.5%	110.6%	122.5%	122.4%	124.0%	117.6%
passenger cars	urban	108.3%	108.3%	109.6%	109.8%	125.6%	125.6%	126.8%	118.8%
light duty	motorways	105.2%	104.9%	105.9%	104.5%	113.0%	112.5%	111.6%	105.5%
light duty	urban	105.8%	105.9%	106.7%	107.4%	119.9%	120.0%	120.7%	116.4%
heavy duty	motorways	117.5%	116.9%	115.1%	113.3%	137.0%	135.6%	129.8%	123.9%
heavy duty	urban	89.9%	89.9%	88.4%	88.6%	88.1%	87.7%	85.3%	83.9%
trains	rail	107.2%	108.3%	108.4%	108.4%	116.7%	119.4%	120.0%	127.5%

X.3.2. Noise exposure in the Amsterdam case study

The increased traffic volumes produces higher noise levels and using the GIS-based URBIS tool it is computed how many people in the city of Amsterdam will be highly annoyed. In table 3, the expected percentage of highly annoyed (*%HA*) due to road traffic and rail traffic in the different scenarios is shown. Also the annoyance relative to the base year 2005 is shown.

Table 3: Expected percentage of highly annoyed (%HA) due to road traffic and rail traffic in the different scenarios in the population of Amsterdam.

	%HA Road	*relative to 2005*	*%HA Rail*	*relative to 2005*
2005N	5.95%	100%	0.53%	100%
2010N	6.13%	103%	0.55%	105%
2010P	6.13%	103%	0.56%	106%
2010F	6.16%	104%	0.56%	106%
2010R	6.16%	104%	0.56%	106%
2020N	6.52%	110%	0.59%	111%
2020P	6.52%	110%	0.60%	113%
2020F	6.54%	110%	0.60%	113%
2020R	6.36%	107%	0.62%	118%

The table shows that noise annoyance due to road traffic as well as rail traffic will increase in all scenarios. The number of people being highly annoyed due to road traffic will be increase by 10% in 2020 due to volume growth according to all scenarios except the extended scenario, for which the increase is 7%. For rail traffic, the number of people being highly annoyed will increase up to 18% in to the extended scenario. The extended scenario, being a scenario in which rail transport is growing faster than car transport as a result of the introduction of infrastructure pricing for passengers, is the only scenario where noise annoyance around roads is lower than in the partial (P) or the reference scenario (N) while at the same time the annoyance around rail is higher. If we summarise noise annoyance from road and rail the extended scenario scores best since the decline in highly annoyed people around roads is much higher than the relatively small growth of highly annoyed people around rail.

These conclusions are also illustrated by figure 1 and figure 2, which show the development of the noise annoyance in Amsterdam due to traffic volume growth. figure 1 shows the development of noise annoyance due to road traffic. All scenarios, except for the extended scenario, virtually coincide. The increase of noise annoyance according to the extended scenario is less. Figure 2 shows that noise annoyance due to rail traffic increases the most in the extended scenario.

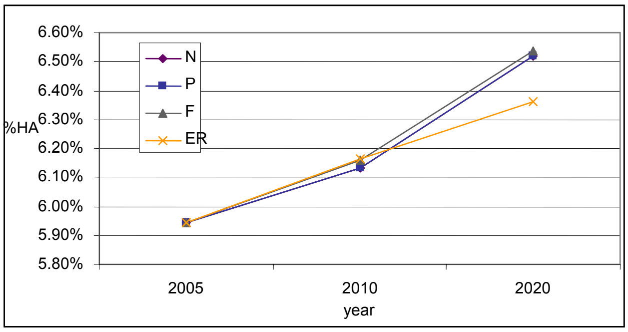

Figure 1: Development of percentage highly annoyed (%HA) due to road traffic noise in Amsterdam.

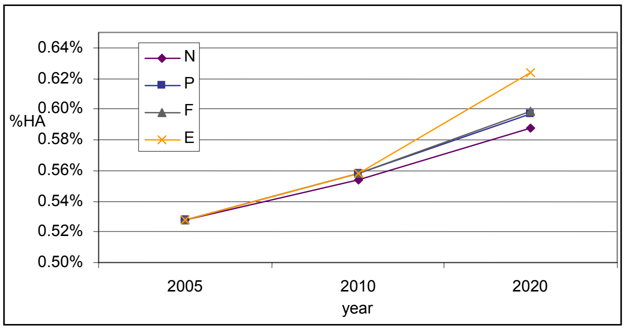

Figure 2: Development of percentage highly annoyed (%HA) due to rail traffic noise in Amsterdam

Please note that the scales of both figures differ. The percentage of people being highly annoyed by rail traffic is much lower than the percentage highly annoyed by road traffic. Taking both road traffic noise and rail traffic noise into account, overall the extended scenario gives the lowest increase in the number of people being highly annoyed.

X.3.3. Noise exposure at the national level

To estimate to what extent the results of the Amsterdam case study are also valid for larger areas that consist out of both urban and non-urban areas, a second noise-model is used to estimate the noise impacts of increasing traffic volumes for the entire Dutch road and rail network. Figure 3 shows the distribution of the Dutch population over the noise exposure categories. This distribution is calculated by the Dutch National Institute for Public Health and the Environment (RIVM). On the basis of these distributions, the expected percentage of highly annoyed in the population was calculated. The present situation was used as base year (2005). The current percentage of the Dutch population being highly annoyed is 4.49% for road traffic noise, 0.51% for rail traffic noise and 0.48% for air traffic noise.

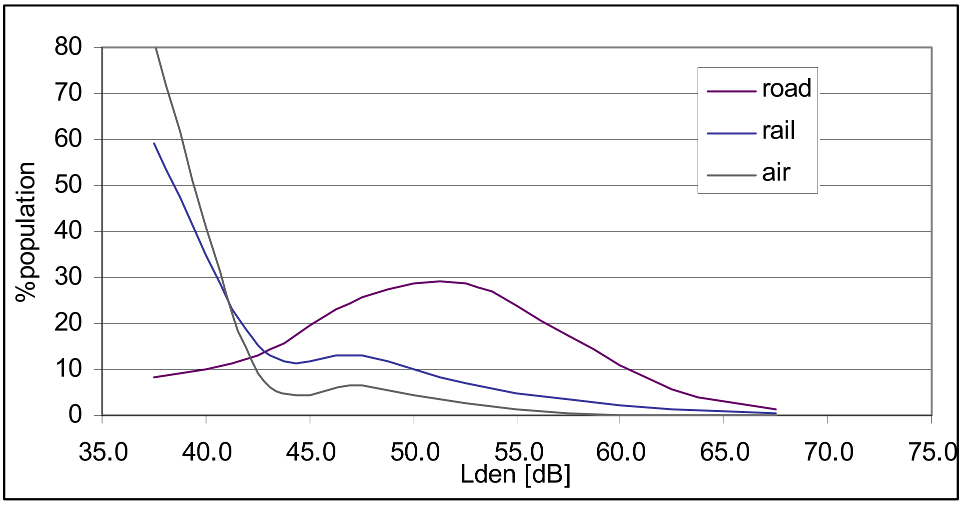

Figure 3: Distribution of Dutch population over noise exposure for noise by road, rail and air traffic.

As a result of the volume growth, as modelled by the SCENES-TREMOVE combination and shown in table 2, an overall change in noise exposure was estimated for the different scenarios. On the basis of the distributions shown in figure 3, the resulting change in the percentage of people being highly annoyed is calculated and shown in table 4.

Table 4: Expected percentage of highly annoyed (%HA) due to road traffic and rail traffic in the different scenarios in the population the Netherlands.

	%HA Road	*relative to 2005*	*%HA Rail*	*relative to 2005*
2005N	4.49%	100%	0.51%	100%
2010N	4.64%	103%	0.54%	106%
2010P	4.63%	103%	0.55%	106%
2010F	4.67%	104%	0.55%	106%
2010E	4.66%	104%	0.55%	106%
2020N	4.98%	111%	0.58%	113%
2020P	4.98%	111%	0.59%	114%
2020F	4.99%	111%	0.59%	115%
2020E	4.82%	107%	0.61%	120%

These numbers are also illustrated by figure 4 and figure 5, which show the development of the noise annoyance in the Netherlands due to traffic volume growth.

The figures for the Netherlands as a whole are very similar to the figures found in the more detailed case study in Amsterdam. All scenarios will lead to an increase of noise annoyance due to road noise as well as rail noise. All scenarios, apart from the extended scenario, show virtually the same figures. The extended scenario will lead to relatively less road noise annoyance, but will lead to a larger increase of rail traffic noise annoyance.

The reason that both methods produce similar results is caused by the standardisation of the distribution curves that assign population over the noise exposure categories. The curves represent a spatial distribution of the population that is common for developed countries. Some people live around road and rail but most live at some distance from main roads. There is no reason to assume that the conclusions drawn on basis of these two case studies are not valid for other European countries since the distribution curves that assign population to noise exposure categories are likely to be valid for other European countries. Locally there may be some differences, for example in cities with relatively much rail or in areas with relatively much residential development along secondary roads.

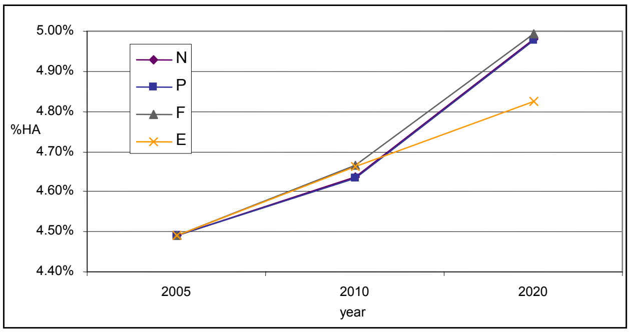

Figure 4: Development of percentage highly annoyed (%HA) due to road traffic noise in the Netherlands.

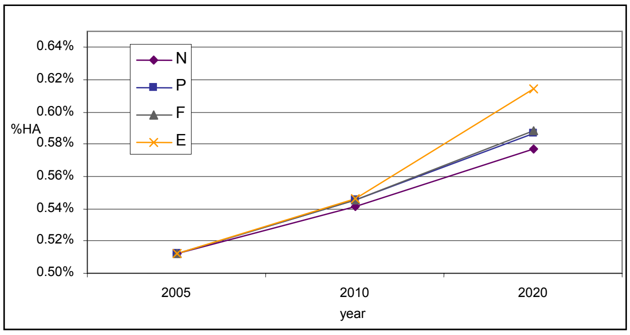

Figure 5: Development of percentage highly annoyed (%HA) due to rail traffic noise in the Netherlands.

Please note again that the scales of both figures are different. The percentage of highly annoyed by rail traffic is considerably lower than the percentage highly annoyed by road traffic. Again, taking both road traffic noise and rail traffic noise into account, overall the extended scenario gives the lowest increase in the number of people being highly annoyed.

X.4. Results for air traffic

Because of the limitations of passenger volume figures as input for the method presented for road and rail traffic, the possible changes in aircraft noise exposure are taken on the basis of literature.

The SOURDINE project will define new approach and take-off procedures for all European airports supported by the SOURDINE project. This will lead to a reduction of area exposed to noise levels (L_{Amax}) higher than 65 dB by 50%. This reduction will considerably reduce noise annoyance. The information available at this stage is however not sufficient to make quantitative estimates of the effect on aircraft noise annoyance.

The X-noise network however does produce estimates of new aircraft noise abatement technology. The project is a cluster of research projects, aiming to develop technologies to reduce turbo machinery, exhaust and airframe noise. One of the relevant projects within the cluster is the SILENCER project, launched in 2001. This project is a €110-million euro project brings 50 European companies, universities and research institutes together in a concerted effort to reduce jet engine noise while controlling equipment cost, weight and performance. A wide range of engine technologies are being tested, from low-noise fans to nozzle jet-noise suppressors, as well as modifications to parts of the aircraft itself such as wings and landing gear in order to reduce their noise 'signature'. The overall goal is to reduce aircraft noise by as much as 6 dB (decibels) by 2008. Although the introduction of noise reducing technologies will take time to be fully implemented, the effect of the full emission reduction is assessed.

While it remains unsure whether such an ambition will be achieved it gives some estimate of possible reductions as a result of technology development. The distribution curve presented in figure 3 can be used to estimate the reduction of people that are highly annoyed by air traffic as a result of such technology development. When the full reduction of 6 dB(A) is applied to the Dutch exposure, the percentage of people being highly annoyed (%HA) drops from 0.48% to 0.11%. This is a substantial reduction which highlights the dominance of technology development over traffic volume developments in the estimation of noise annoyance.

Since aircraft noise abatement technology is not part of the four ASSESS policy scenarios it is not possible to compute impacts per scenario.

X.5. Conclusion and discussion

An assessment was made of the consequences of traffic volume growth of road and rail traffic for the noise annoyance by road and rail traffic, using a case study in Amsterdam and data for the whole the population of the Netherlands. The results of the two approaches are very similar. All scenarios will lead to an increase of noise annoyance due to road noise as well as rail noise in 2010 and 2020. All scenarios, apart from the extended scenario, show virtually the same figures. The extended scenario will lead to relatively less road noise annoyance, but will lead to a larger increase of rail traffic noise. The percentage of highly annoyed by road traffic is considerably higher than the percentage highly annoyed by rail traffic. Taking both road traffic noise and rail traffic noise into account, overall the extended scenario gives the lowest increase in the number of people being highly annoyed.

In this approach, the volume changes are assumed to take place on the existing network and the route choice is assumed to be unchanged. Also, no noise abatement measures were assessed for road and rail traffic could be taken into account. New links in the network can change the noise annoyance situation. If new (rail) roads are projected outside populated areas, they can relieve the infrastructures in populated areas and decrease noise annoyance. On the other hand, if route choice changes due to congestion, noise annoyance can increase, because roads that are currently quiet can become busy and cause more people to be exposed to noise. Noise abatement measures, such as the implementation of silent road surface types, can reduce noise to a large extent. On the other hand, the popularity of heavy passenger cars (SUV's) and diesel engines may increase the noise emission from road traffic.

For air traffic, the effect of volume changes can not be modelled in the same manner. As described in the method section, the growth in passenger kilometres cannot be used to calculate the changes in noise annoyance. On the basis of literature regarding European projects which develop technologies to reduce turbo machinery, exhaust and airframe noise, the reduction in noise emissions by aircrafts can be considerable. If the full reduction goal of 6 dB is reached, the number of people being highly annoyed in the Netherlands will be less than 25% of the current number of people being highly annoyed. Although the introduction of noise reducing technologies will take time to be fully implemented, it can be concluded that it is likely that the current efforts of the European commission and the White Paper on transport to improve aircraft noise abatement technology is much more effective to reduce of noise annoyance by aircraft noise than policies aiming to reduce air traffic volumes.