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des Directeurs des Routes

Conference of European
Directors of Roads

The European Noise Directive and NRAs: Final Summary Report CEDR Road Noise 2009–2013



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This report is:

FOR INFORMATION

1 Executive summary

CEDR Project Group Road Noise 2 (CEDR RN2) was established in 2009 with the aim of meeting the goals relating to road traffic noise specified as task 8 in CEDR's Strategic Plan 2009–2013 (SP2). In this plan, road traffic noise formed part of the Thematic Domain (TD) Construction, which focused on the role of the National Road Authorities (NRAs) in monitoring developments in various road-related issues, including those relating to environmental issues.

At the start of the CEDR RN2 work programme, it was identified that the noise mapping and action planning requirements of the EU Environmental Noise Directive (END) would form a significant component of the group's activities. Five subgroups were established to review and monitor activities associated with END noise mapping, END action planning, value for money in road traffic noise abatement, the EU noise calculation model (CNOSSOS-EU), and road noise research needs. It was generally perceived that addressing these issues would fulfil the requirements outlined in SP2.

With regard to the publication of the reports by the various subgroups, it was concluded that since the development of CNOSSOS-EU will continue after 2013, the outcome of this work would be summarised in a separate factsheet.

END noise mapping

This report presents the results of a survey sent to all CEDR members in order to ascertain the extent of planning and preparation works undertaken for compliance with EU END noise mapping. The results demonstrated that NRAs adopted either a strategic approach to noise mapping, using simplified input data, or an advanced approach with detailed data to prepare noise maps for their respective road networks. Significant differences were also found in grid sizes, calculation methodologies, and other issues used to predict noise levels at façades of exposed properties. These differences may have contributed to the wide range of costs reported by NRAs for undertaking their respective noise mapping programmes, ranging from less than €100 to more than €2,000 per kilometre. For the 2017 phase of strategic EU noise mapping, it is likely that all member states will be required to implement a common European calculation method, CNOSSOS-EU. Although not yet finalised, initial reports indicate that this new calculation methodology will be more complex and require additional datasets that are not readily available to NRAs.

Recommendation

To minimise the costs associated with undertaking EU strategic noise mapping in 2017, all NRAs should closely monitor or actively participate (through the relevant channels in their country, e.g. through their Noise Regulatory Committee representative) in the development of the proposed new calculation methodology (CNOSSOS-EU) to ensure that a simplified approach rather than a more complex approach is adopted. The more complex approach would lead to additional costs for NRAs because of the necessity to augment current approaches to data collection on their respective networks.

END noise action plans

In preparing noise action plans, one of the greatest challenges identified by CEDR members was the lack of available resources to implement the necessary noise abatement measures needed to reduce noise levels where they were deemed to be unacceptable based on criteria specified in member state action planning guidance documents. Therefore, most noise action plans tended not to include any specific goals or actions for reducing road traffic noise. Currently, the status and implementation of noise action plans are not well defined within NRAs. However, it is envisaged that with a more coherent approach to planning new or upgrading existing roads, the content of noise action plans could be the driving force for change in the approach to mitigating road traffic noise in locations where it is deemed to be unacceptably high. In addition, at national level, it is anticipated that noise action plans that are needed to comply with EU legislation could provide justification for NRAs when seeking additional funding for road maintenance and improvements.

Recommendation

NRAs should initially define the status of noise actions plans within their organisation and, where feasible, incorporate the content of such plans into their road planning and road maintenance processes in order to achieve quick wins when it comes to mitigating road traffic noise. Moreover, individual NRAs could, at national level, use the content of the noise action plans that are needed to comply with EU legislation as a justification for seeking additional funding for road maintenance and noise mitigation measures. CEDR should make the costs of compliance with the END action planning requirements available to European stakeholders.

Value for money in road traffic noise abatement

The recommendations arising from the work on value for money in road traffic noise abatement provide robust evidence for the implementation of better source-related noise reduction measures on vehicles, tyres, and surfaces prior to the introduction of road-side infrastructural noise reducing measures such as noise barriers and acoustic glazing on buildings. Exploiting the most cost-effective noise abatement measures that could be applied should lead to significant cost savings for NRAs and for society. This report clearly demonstrates that source-related noise measures (quiet vehicles and tyres) are by far the most cost-effective measures for reducing road noise from major roads, the cost varying from €16 to €4,200 per person per year. With regard to infrastructural noise-reducing measures, low-noise pavements proved to be the most cost-effective, while noise barriers were identified as being the most expensive approach to reducing noise annoyance.

Recommendation

CEDR should liaise closely with interested parties such as vehicle and tyre manufacturers to formulate a combination of measures that is appropriate for the treatment of road traffic noise. In addition, CEDR should also consider preparing a position paper for the Commission on the level of noise abatement achieved by the various noise mitigating measures used on national road schemes. With regard to mitigating noise at locations in close proximity to major roads, NRAs should examine the use of low-noise pavements as a first option because they have been shown to be the most cost-effective noise abatement measure in many cases.

CEDR road noise research needs

The report addressing road traffic noise research needs gives strong recommendations for road traffic noise topics that should form the basis of future noise research programmes undertaken by CEDR. Recommended topics regarding the design and development of effective and efficient solutions to abate noise, including their environmental and economic assessment, are considered to be priority issues.

Recommendation

In general, NRAs should focus attention on noise research topics relating to the design and development of effective and efficient solutions to abate noise, including their environmental, safety, and economic assessment. This could include the development and design of durable low-noise pavements (LNPs) to reduce vehicle emissions and improve sound absorption as well as the integration of multifunctional integrated solutions such as photovoltaic noise barriers to mitigate costs and increase environmental sustainability.

CEDR road noise factsheets

In addition to the activities outlined above, the CEDR Project Group Road Noise responded to a number of noise-related road traffic issues that arose during the work programme and had the potential to have a significant impact on how CEDR members reacted to various noise issues. To report on these issues, individual factsheets were drawn up. These factsheets contained the combined views of the CEDR RN2 members on each issue. The issues addressed in the form of factsheets included END major road data, END policy options, END noise mapping colour regimes, and CNOSSOS-EU. These factsheets outline a number of recommendations that should, if implemented, enhance how END data is processed. Moreover, they should, in general, improve the overall implementation of the END.

It is anticipated that adoption of these recommendations by CEDR members will lead to a more coherent and standardised approach to compliance with these specific EU END topics.

Finally, it is anticipated that this report will in future have a perceptible impact on the cost-effectiveness of implementing EU noise legislation in the various member states.

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3 Introduction

National Road Authorities (NRAs) face many challenges in providing the sustainable and efficient road networks that are required to satisfy the mobility needs of road users. Among these challenges is the need to reduce a range of environmental impacts associated with operating and maintaining such networks, including the requirement of EU and national legislation to monitor and minimise the impacts of road traffic noise.

In the CEDR Strategic Plan 2009–2013 (SP2), road traffic noise formed part of the Thematic Domain (TD) Construction, which focused on the role of the National Road Authorities (NRAs) in monitoring developments in areas such as standards and EU Directives as well as in environmental and road safety issues. CEDR Road Noise 2 (CEDR RN2) was set up with the objective of meeting the goals relating to road traffic noise (task 8 in SP2).

In SP2, the following specific goals were defined:

- to contribute to the efforts deployed by standardisation bodies to establish and update modern standards in line with the objectives of the NRAs and to facilitate the individual use of new standards;
- to monitor European lawmaking and take appropriate action on EU Directives;
- to develop and share knowledge on a sustainable infrastructure.

Seventeen CEDR member states participated in CEDR RN2, which was chaired by the Netherlands (Table 1).

Table 1: Members of CEDR Road Noise 2

Country	Name	Organisation
AT	Mr Klaus Gspan	ASFINAG, Motorway and Expressway Financing plc
BE	Ms Barbara Vanhooreweder	Agency for Roads and Traffic
CY	Ms Elena Sophocleous	Public Works Department of Cyprus
DE	Mr Wolfram Bartolomaeus	Federal Highway Research Institute (BAST)
DK	Mr Jakob Fryd	Danish Road Directorate
EE	Mr Villu Lükk	Estonian Road Administration
ES	Mr Jesús Rubio Alférez	Spanish Roads Department
FI	Mr Arto Kärkkäinen	Centre for Economic Development, Transport and the Environment
FR	Mr Marc Di Martino	Transport Infrastructures Department
GR	Ms Efterpi Giannopoulou	Greek Road Directorate
IE	Mr Vincent O'Malley	Irish National Roads Authority
IT	Ms Patrizia Bellucci	Italian National Road Administration (ANAS)
LV	Mr Guntis Graveris	Latvian State Roads
NL	Mr Wiebe Alberts (chairman)	Rijkswaterstaat Centre for Transport and Navigation
NL	Mr Nico Faber	Secretariat CEDR Project Group Road Noise
NL	Mr Michiel Roebben	Secretariat CEDR Project Group Road Noise
NO	Ms Ingunn Milford	Norwegian Public Roads Administration
PL	Mr Jacek Wojtowicz	Polish Directorate for National Roads and Motorways (GDDKiA)
SE	Mr Kjell Strömmer	Swedish Transport Administration

4 Objectives of CEDR Project Group Road Noise 2 (task 8)

At the opening meeting in The Hague in May 2009, CEDR RN2 recognised that the noise mapping and action planning requirements imposed by the EU Environmental Noise Directive (END) would form a significant component of the group's activities. The objectives of CEDR RN2 were identified with this in mind. In Table 2, these objectives are defined in accordance with the goals specified in SP2.

Table 2: CEDR RN2 objectives in accordance with the goals of the CEDR Strategic Plan

Item	CEDR Road Noise 2 objective	TD Construction goal
1	To review CEDR members' approach to the strategic noise mapping of major roads in 2007 with a view to identifying best practice for the second round in 2012	To develop and share knowledge on a sustainable infrastructure
2	To assess CEDR members' responses to the European Commission and the European Environment Agency Working Group on the Assessment of Exposure to Noise (WG-AEN) questionnaire on the validation of national noise mapping methods and software in relation to assessment methods for noise indicators in relation to Directive 2002/49/EC	To take appropriate action on EU Directives
3	To review and assess CEDR members' approach to action planning in 2008 with a view to providing best practice advice for the second round in 2013	To develop and share knowledge on a sustainable infrastructure
4	To assess CEDR members' ambitions regarding the (on-going) procedure in the European Parliament (early 2009) on the new regulation on advanced safety features and tyres COM(2008) 316 (especially the tighter noise emission requirements (2001/43/EC)	To monitor European lawmaking
5	To assess CEDR members' views and support for tyre noise limits for heavy-duty vehicles in COM(2008) 316	To monitor European lawmaking
6	To assess and review CEDR members' views regarding the Tyre Label Directive	To monitor European lawmaking
7	To assess and review engine/vehicle noise limits	To monitor European lawmaking
8	To review CEDR members' position regarding input data requirements of the European Noise Model	To establish and update modern standards in line with the objectives of the NRAs
9	To review the acoustic characteristics of silent pavements (durability, labelling, and conformity checking)	To establish and update modern standards in line with the objectives of the NRAs
10	To review noise barrier standards and improvements (design, absorption, multifunction)	To develop and share knowledge on a sustainable infrastructure
11	To monitor the European position on Europe-wide noise limit values	To monitor European lawmaking

While some of the objectives outlined in Table 2 were addressed in detail (items 1, 2, 3, 7, and 8), others (items 4, 5, and 6) were assessed in a general manner to ascertain the feasibility of a more detailed analysis, while items 9, 10, and 11, including the impact of electric vehicles on the national road network, will be taken up in Task I6 by the task group Road Noise under SP3 (CEDR RN3).

In order to undertake the specific objectives identified by CEDR RN2, the following subgroups were formed, each with a designated subgroup leader:

- END noise mapping (subgroup leader Jesús Rubio Alférez)
- END action planning (subgroup leader Jakob Fryd)
- Value for money in road traffic noise abatement (subgroup leader Ms Ingunn Milford)
- Road traffic noise research needs (subgroup leader Ms Patrizia Bellucci)
- European noise model (subgroup leader Vincent O'Malley)
- Factsheets (subgroup leader Wiebe Alberts).

A total of five results-orientated reports were produced by CEDR RN2. In general, these subgroup reports assessed and evaluated CEDR member states' experiences with the following main topics: END noise mapping, END action planning, value for money in road traffic noise abatement, and CEDR road noise research needs. A fifth report was also produced, compiling the outcomes of the individual factsheets on END major road data, END policy options, END noise mapping colour regimes, and the CNOSSOS-EU computational model.

Towards the end of the group's activities, it was recognised that since the development of CNOSSOS-EU will continue after 2013, the outcome of this work should be summarised in a separate factsheet.

These subgroup reports can be downloaded from the CEDR website.

This final report outlines the main findings of the group's activities and highlights some of the key recommendations formulated by the various subgroups.

5 END noise mapping

5.1 Scope and objectives

This work focused on the noise mapping requirements specified in the EU Environmental Noise Directive (END) that was adopted on 25 June 2002 (Directive 2002/49/EC of the European Parliament and Council). EU member states are required to undertake the strategic noise mapping of major roads once every five years. The initial round of strategic mapping was completed in 2007. This was followed by the second round in 2012. The next phase of strategic noise mapping is due in 2017.

CEDR RN2 recognised the benefits to CEDR members of sharing the experiences of NRAs during the preparation of the first round of strategic END noise mapping. Thus, CEDR RN2 formed a subgroup to collate and analyse data on mapping procedures, difficulties encountered, and decisions taken during the planning and preparation of maps to satisfy the requirements specified in the END. The objective here was to make recommendations based on best practice used by the various participating national road authorities (NRAs).

5.2 Summary

The subgroup conducted a survey to ascertain the extent of planning and preparation works undertaken by each CEDR member state. Based on the responses received from the 19 member states, the existence of many difficulties in preparing END noise maps became evident.

During the first round of mapping, NRAs had taken many decisions that had significant impacts on the costs of noise mapping, the time taken to produce the maps, and the veracity of the final results. Significant differences were found mainly in the number of acoustic reflections taken into account, grid sizes, and calculation methodologies used to ascertain noise levels at the façades of exposed properties. These differences may explain the wide range of costs reported by the various member states to undertake their respective noise mapping programmes. The costs of mapping ranged from less than €100 per kilometre to more than €2,000 per kilometre. In addition, these differences also had an impact on how comparable the final noise maps were between the various member states.

In general, the various CEDR members approached the noise mapping process from two different angles. It appears that the approach taken was mainly dictated by either the noise calculation methodology adopted or the level and consistency of input data available in each member state. Some member states have their own established national approach to noise calculations while others tend to adopt a methodology developed by a neighbouring member state, e.g., Ireland adopted the UK CRTN methodology. The various noise calculation methodologies have a range of technical requirements that require input data with differing levels of accuracy. This is important because the level of accuracy of the input data has significant effects on the outcome of the noise calculations and the assessment procedures adopted for the calculation of population exposure statistics. The availability of traffic, population, and geographical input data imposed a number of constraints on the overall approach used to preparing strategic noise maps. This resulted in some member states adopting an approach to using many default input data values with simple definitions of roads, terrain, buildings, and exposed populations, while others implemented more detailed procedures to define these parameters.

It is anticipated that for the next phase of strategic noise mapping in 2017, it is likely that all member states will be required to implement a common European calculation method, CNOSSOS-EU. Although not yet finalised, initial reports indicate that this method will require additional datasets that are not readily available to NRAs. It is possible that CNOSSOS-EU will be a complex model requiring high computational resources and experienced personnel to implement it correctly. Furthermore, any new method will have to be validated by each member state against their national method in order for it to be accepted nationally. This will entail member states that already have a national method having to undertake strategic noise mapping in duplicate, which will result in additional costs being incurred by NRAs, especially in situations where discrepancies arise.

CEDR RN2 has also identified that coordinating efforts with other administrations responsible for the preparation of noise maps for other sources—such as railways, airports, or other roads—would represent a progressive step. The input datasets required for the assessment of the propagation of noise away from the source are generally the same, regardless of the type of source. For example, in a situation where a major road is in close proximity to a major railway, it would be appropriate for the authorities mapping the road and railway to work together and share datasets that are mutually required (e.g. the digital terrain model, building data, or land use). Similarly, population data will be required by all authorities developing noise maps for road, rail, industrial, or aircraft sources. This cooperation will ease the costs associated with noise mapping for all authorities and will ensure that common datasets are used across all assessments.

To achieve their objectives, END strategic noise maps should be of consistent quality, easy to interpret, and comparable across member states. However, a balance should be found between the level of effort required to produce such maps and the quality of the final results in terms of accuracy and comparability. In an effort to achieve this objective, this report provides a number of recommendations on issues such as the input data used, the noise modelling process, and the presentation and dissemination of the final mapping results.

5.3 Conclusions and recommendations

In advance of using CNOSSOS-EU, a number of different technical, methodological, and legal issues will have to be resolved before its use becomes common practice in member states. It is anticipated that on completion of the 2017 round of END mapping, a significant number of issues will have to be resolved that will pave the way for establishing an approach to a common mapping procedure with the objective of achieving comparable, reliable, understandable, and useful strategic noise maps.

It is understood that in the 2017 round of the END, the European Commission intends to introduce the collection of data on populations exposed to noise bands lower than those established in the original END. The proposed noise bands are L_{den} 50–54 dB and L_{night} 40–44 dB. While this requirement may not be mandatory, it is more than likely that it will be strongly recommended. Current CEDR RN2 members have determined that a lowering of noise bands will have significant implications for CEDR NRAs from both a technical and cost perspective.

Recommendation 1

To minimise the costs associated with undertaking the required EU strategic noise mapping in 2017, all NRAs should closely monitor or actively participate (through the relevant channels in their country, e.g. through their Noise Regulatory Committee representative) in the development of the proposed new calculation methodology (CNOSSOS-EU) to ensure that a simplified approach rather than a more advanced approach is adopted. They should also inform the relevant representative that the introduction of noise bands lower than 55 dB L_{den} and 45 dB L_{night} beyond the validation distance of a noise calculation method will only add additional uncertainty and inaccuracy to the reported noise mapping data. This would mean that NRAs would have to incur additional costs in order to augment current data collection methodologies.

CEDR RN2 has identified that coordinating efforts with other administrations responsible for the preparation of strategic noise maps for other sources—such as railways or other roads—would represent a progressive step to strategic noise mapping. This cooperation will ease the costs associated with noise mapping for all authorities and will ensure that common databases are used across all assessments.

Recommendation 2

NRAs should work together with noise mapping bodies across all disciplines (road, rail, industry, air, and agglomerations) to ensure cost-sharing and access to all relevant datasets.

On reviewing the END strategic noise maps produced by CEDR national road authorities in 2007, it became clear that the colours used by each member state to depict the various noise bands differed significantly across Europe (Figure 1). This meant that noise maps could not be compared across member states. At European level, there appears to be no coordination regarding the choice of colours to be used for the various noise bands under consideration.

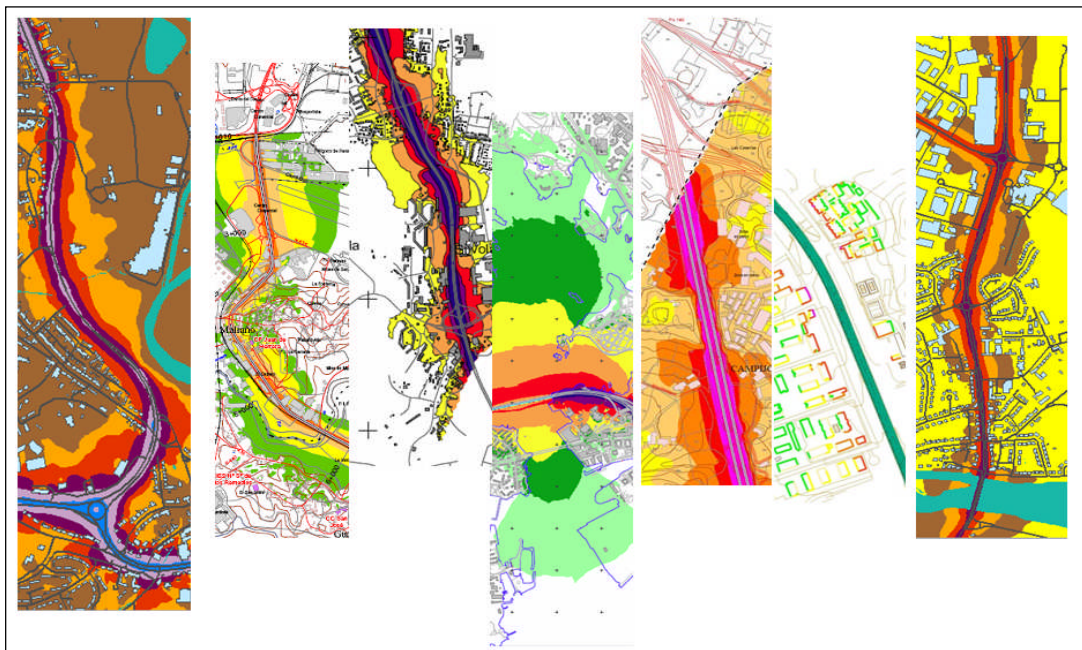



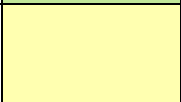





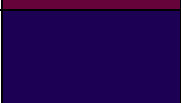


Figure 1: Sample of noise maps from a number of member states with different colour regimes

CEDR RN2 prepared a proposal (Table 3) on the use of colours for future strategic noise mapping programmes. In preparing the proposal, consideration was given to the use of specific colours for various noise bands, for example, green for noise bands below 50 dB and red for the noise band 65–69 dB.

Table 3: Colour code as proposed by CEDR RN2

Noise band [dB]	Colour	RGB code	HEX code	Name
less than 35	none	-	-	-
35–39		R: 35 G: 132 B: 67	#238443	Moderate sea green
40–44		R: 120 G: 198 B: 121	#78C679	Greyish green
45–49		R: 194 G: 230 B: 153	#C2E699	Light greyish chartreuse green
50–54		R: 255 G: 255 B: 178	#FFFFB2	Pale yellow
55–59		R: 254 G: 204 B: 92	#FECC5C	Light brilliant amber
60–64		R: 252 G: 141 B: 60	#FD8D3C	Brilliant tangelo
65–69		R: 255 G: 9 B: 9	#FF0909	Light brilliant red
70–74		R: 179 G: 6 B: 34	#B30622	Moderate amaranth
75–79		R: 103 G: 3 B: 59	#67033B	Dark rose
80 and more		R: 28 G: 0 B: 84	#1C0054	Deep blue violet

In order to standardise END strategic noise maps across the EU, it is recommended that each individual CEDR member state should follow the colour regime proposed in Table 3 when mapping noise from major roads.

The proposal also recommends that the area to be mapped should be limited to the validation distance of the model.

Recommendation 3

NRAs should, where possible, promote the use of the proposed colour code in any future noise mapping programmes. The use of the proposed colour code will allow NRAs to compare noise maps across member states.

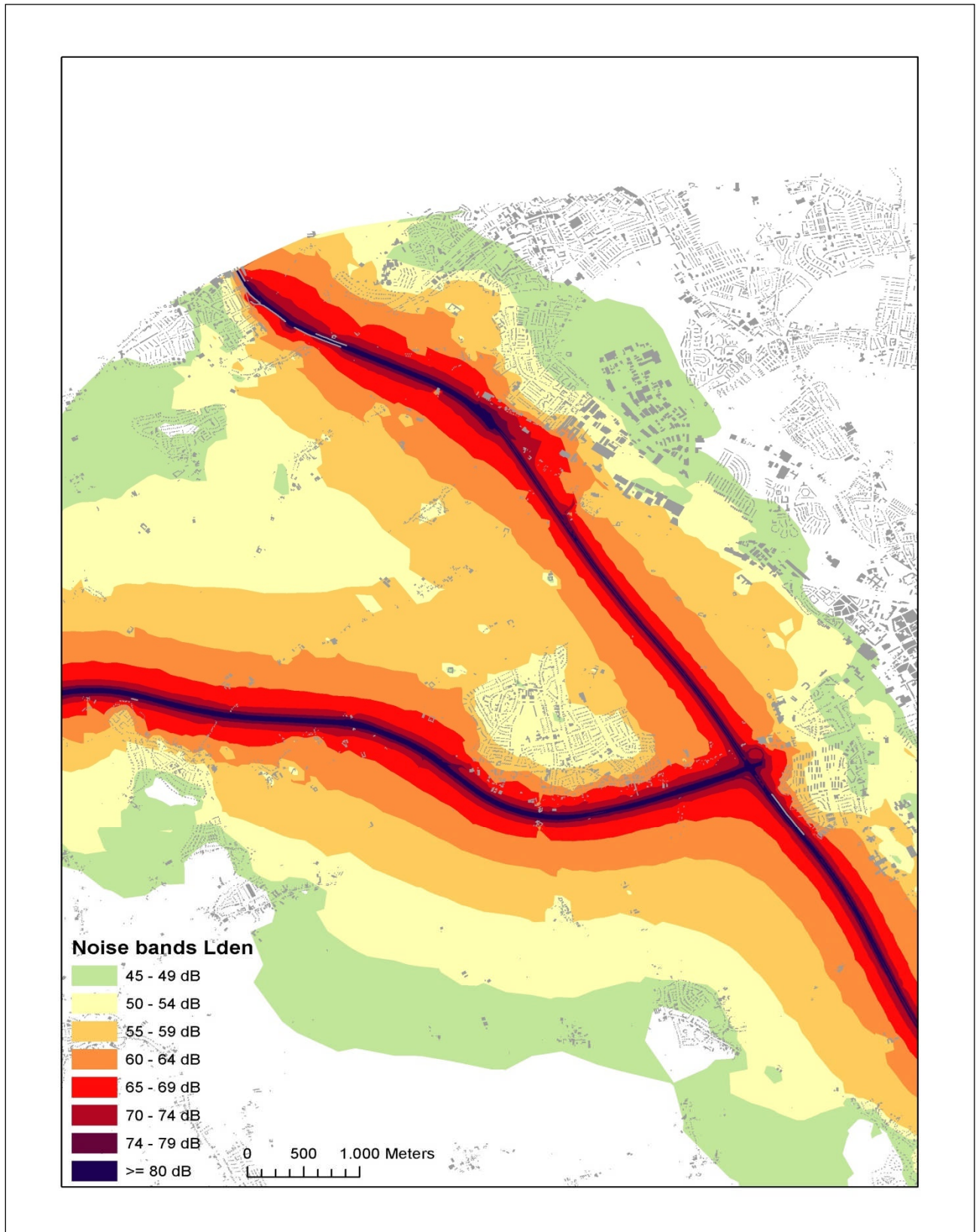


Figure 2: Example of a strategic noise map using the proposed new colour scheme

6 END noise action plans

6.1 Scope and objectives

The scope of the work addressing END action plans focuses primarily on the procedures used for undertaking noise action planning and any significant difficulties the various NRAs encountered in preparing the first round of noise action plans in 2008. Based on the outcome of the findings, a number of best practice recommendations are specified. These recommendations should assist road authorities when undertaking future noise action planning.

6.2 Summary

The primary objective of this work is to provide a mechanism that allows for the sharing of practical knowledge on noise management and noise abatement between national road authorities and others. Currently, there are very few studies evaluating the work undertaken for the preparation of noise action plans at European level. In order to be in a position to adopt a common approach to action planning and to share knowledge within CEDR member states, CEDR RN2 found that it was important to undertake research to establish how member states approached END action planning.

The subgroup addressing END noise action plans investigated how technical decisions—such as the selection of noise indicators, noise mitigation measures, public consultation, and other aspects of noise action planning—are taken into account in the preparation of noise action plans. On the basis of responses to a questionnaire provided by 19 CEDR member states, the report describes and discusses experiences relating to the constraints and problems encountered in preparing noise action plans as well as solutions, strategies for noise abatement, and the process of public consultation.

Based on the outcome of the survey, the respondents believe that the following issues, if addressed, should ensure that noise action plans are prepared using a consistent methodology and that they deliver a clear purpose to NRAs:

- In revising the END, the European Commission should provide definitions and guidelines on how best to represent 'quiet areas' in noise action plans.
- The European Commission should provide guidance notes for the preparation of noise action plans, including practical methodologies to help NRAs undertake a cost-benefit analysis of plans. In addition, there should be a best practice guide on how to prioritise funds for noise control.
- NRAs should initially specify the status of their respective noise action plans and ensure that the content of their plans informs the basis for the allocation of budgets for noise mitigation.
- NRAs should include targets to be achieved in noise action plans.
- NRAs should plan to improve cooperation between noise mapping stakeholders when preparing noise action plans.
- NRAs should focus more on public consultation during the preparation of their plans.
- When planning strategic noise mapping and action planning programmes, NRAs should be aware of the short timeline between the completion of the strategic noise mapping programme and finalisation of actions plans.

The protection of 'quiet areas' is highlighted in the END. Such areas are deemed to contribute positively to public health. Therefore, member states are required to address them in noise action plans. Based on the responses to the survey, it seems that most action plans did not address 'quiet areas' in too much detail. In addition, although some (< 50%) CEDR members have a working definition of quiet areas, the definitions appear to be vague. Consequently, it is difficult to see how any of the definitions could be adopted as a harmonised definition for quiet areas across Europe. Therefore, to comply with the intentions specified in the END regarding 'quiet areas', there appears to be a need for a more precise definition of 'quiet areas' and guidance on the identification and protection of 'quiet areas' and how they should be included in noise action planning.

The costs associated with preparing first-round noise action plans varied significantly across NRAs. Most NRAs completed their plans at a cost ranging between €25,000 and €100,000. However, the costs incurred in two member states were significantly higher (Figure 3). It is reported that these increased costs are mainly attributed to data acquisition and the deployment of external consultants because there was no correlation between the kilometres of road covered by the action plans and resources used in preparing the plans.

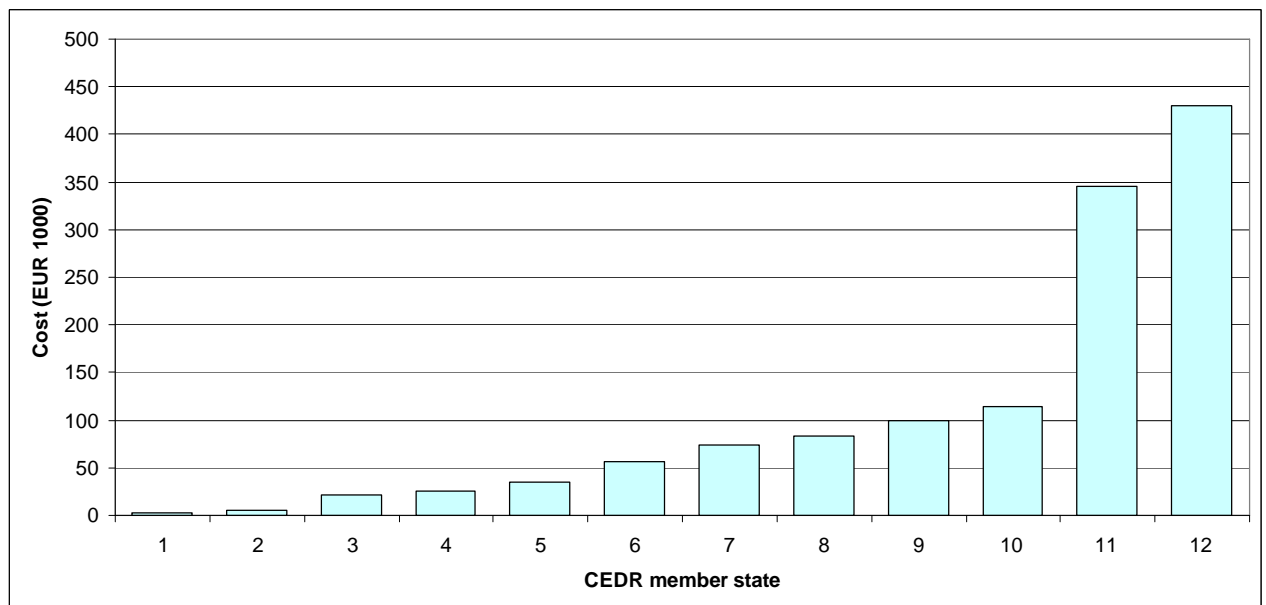


Figure 3: Costs associated with preparing first-round noise action plans across CEDR NRAs

Member states have adopted a variety of approaches to the noise limit values NRAs should use when it comes to considering noise mitigation measures to address noise issues. While some member states have legally binding noise limit values, others tend to rely on guidance values or design goals.

Table 4 outlines the approach adopted by certain member states when considering action for noise mitigation in noise action plans. While the table is far from being a complete overview of noise limits adopted, it was generally found that a range of levels between L_{den} 58 dB and 70 dB have been used. CEDR should perhaps consider developing a harmonised approach to specifying noise limit values on taking action on noise issues identified in noise action plans.

Table 4: Noise limit values/guidance values used by certain NRAs when considering noise mitigation in noise action plan

Member state	Limit/guidance value
Austria	$L_{den} = 60$ dB, $L_{night} = 50$ dB
Belgium (Flanders)	Existing roads: $L_{den} = 70$ dB and $L_{night} = 60$ dB, New roads: $L_{den} = 60$ dB and $L_{night} = 50$ dB
Belgium (Wallonia)	L_{den} : 65 dB (cities) and 62 dB (outside cities) in front of houses L_{night} : 55 dB (cities) and 52 dB (outside cities) in front of houses
Cyprus	$L_{den} = 70$ dB, $L_{night} = 60$ dB
Denmark	$L_{den} = 58$ dB (consider noise-reducing asphalt), 68 dB (consider noise barriers or façade insulation)
Germany	$L_{den} = 65$ dB to 70 dB, $L_{night} = 55$ dB to 60 dB, depending on the federal state
Greece	$L_{den} = 70$ dB, $L_{night} = 60$ dB
Ireland	The choice of an 'action level' was left to the discretion of the Action Planning Body i.e. the local authorities. The EPA recommends that proposed onset levels for assessment of noise mitigation measures for noise due to road traffic are as follows: $L_{den} = 70$ dB and $L_{night} = 57$ dB.
Netherlands	To begin with, the Netherlands took all noise measures from road projects and maintenance programmes in the years 2008–2013. These measures were used to calculate the outcome of these measures in terms of noise levels at residential housing. Before-and-after calculations concentrated on the effect on the amount of housing with noise levels above 65 dB L_{den} . Although levels exceeding the national noise limit values were used to get noise measures into road projects, the Netherlands did not use levels exceeding the national noise limit values to prioritise the noise measures. In fact, the Netherlands did not prioritise noise measures at all.
Norway	$L_{Aeq,24h} = 42$ dB indoor in existing dwellings. The noise limit value is binding according to Norwegian law.
Poland	In Poland, a so-called 'M indicator' is used. The 'M indicator' takes into account the value of exceeding noise limit values and the number of people living in a particular area. It prioritises the actions to reduce the negative noise impact on residential areas. The areas where the 'M indicator' has the highest value, have priority. In some action plans an 'M indicator' was set using L_{den} or L_{night} .
United Kingdom	Two criteria have been set out in Noise Action Plans to determine whether noise mitigation needs to be considered. These are 'Important Areas' and 'First Priority Locations' and are defined as follows: Important Areas with respect to noise from major roads will be where the 1% of the population that are affected by the highest noise levels from major roads are located according to the results of the strategic noise mapping. Important Areas with First Priority Locations: Important Areas that have road traffic noise levels in excess of 76 decibels according to the results of the strategic noise mapping. * In the Major Roads (outside agglomerations) Noise Action Plan, the total population is the number of people within the 50 dB $L_{A10,18h}$ contour from major roads outside agglomerations according to the 2001 census. In the individual agglomeration Noise Action Plans, the total population is the total number of people living in the agglomeration according to the 2001 census.

In general, all noise action plans relate to noise impact on residential buildings, while approximately 80–90% also considered noise impacts on hospitals, old people's homes, institutes of education, and child-care institutions (

Figure 4).

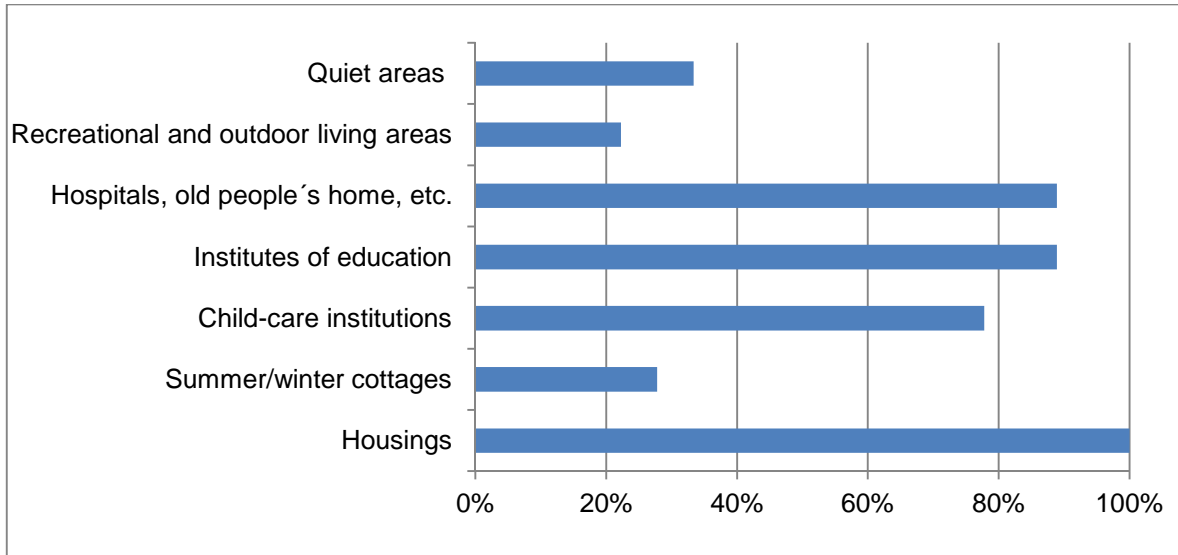


Figure 4: Noise-sensitive areas considered by various member state noise action plans

With regard to the approaches adopted in noise action plans for mitigating noise, most member states tended to give preference to the use of noise barriers (Figure 5) as a priority option. Low-noise road surfaces, land-use planning, and façade insulation are other measures commonly considered by member states.

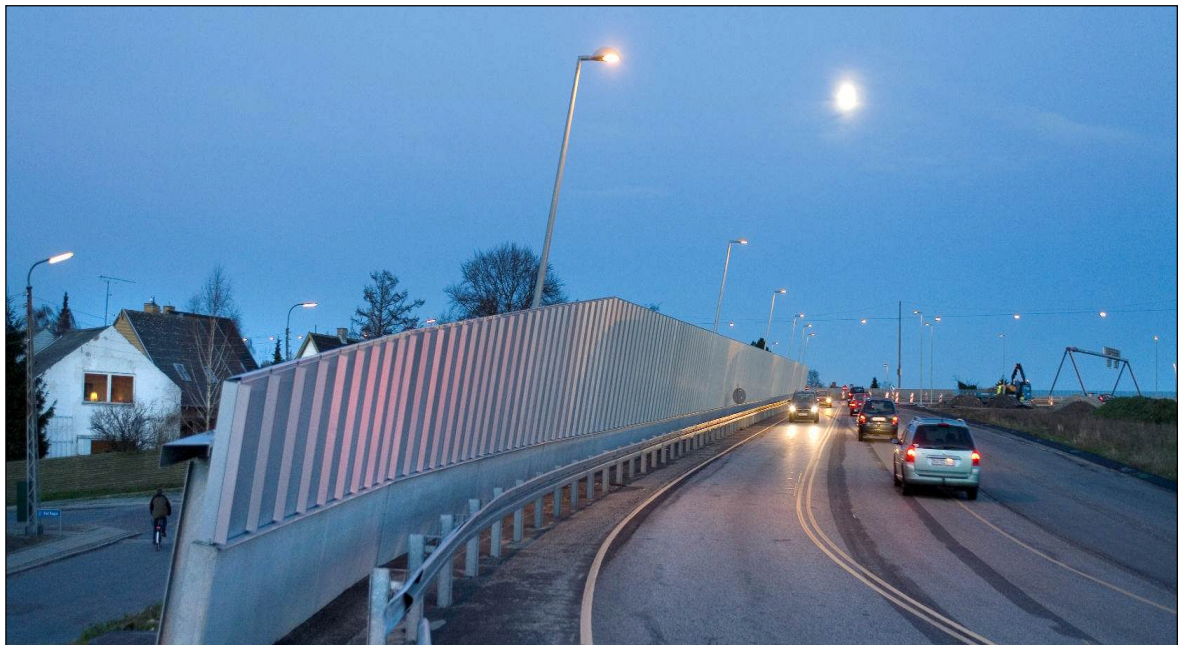


Figure 5: Noise barriers tend to be the option most favoured by member states for noise mitigation

6.3 Conclusions and recommendations

In general, the greatest challenges experienced by most member states were, firstly, the status of the noise action plan within the NRA and, secondly, the lack of resources available for implementing the noise abatement measures identified in the plans. The majority of respondents stated that the status of the noise action plan is unclear. For instance, it is not very clear what type of document a noise action plan should be (e.g. a policy, planning, or financial document) and how it should interact with other plans. It appears that an action plan describes the noise situation but has no binding obligations to allow for the mitigation of such noise issues. Most member states indicated that the noise action plan is similar in nature to a policy statement where objectives have been described on a general level. It currently seems that the END (or the transposing national legislation) lacks a clear enforcement regime, e.g. where noise action plans could be linked to the planning procedures adopted for transport infrastructure development.

Recommendation 4

NRAs should initially define the status of noise actions plans within their organisation and, where feasible, incorporate the content of such plans into their road planning and road maintenance processes in order to achieve quick wins when it comes to mitigating road traffic noise. Moreover, individual NRAs could, at national level, use the content of the noise action plans that are needed to comply with EU legislation as a justification for seeking additional funding for road maintenance and noise mitigation measures. CEDR should make the costs of compliance with the END action planning requirements available to European stakeholders.

Many countries are currently in the middle of an economic crisis, which has also impacted on budget allocations for noise mitigation. It is difficult to prepare detailed action plans for noise abatement measures in the absence of designated funding. Similar to the noise maps, the action plans operates over a five-year period, while budgetary funding for noise control measures, if allocated, typically covers a much shorter time frame. However, it is important to note that a noise action plan can be a driving force for change and that the contents of the plan may help NRAs, nationally, to seek additional funding for network maintenance in terms of noise abatement.

Recommendation 5

It is proposed that the road traffic noise mitigation measures outlined in a member state's noise action plan required by EU legislation may be used by member state NRAs as justification for seeking additional funding for road maintenance at national level. CEDR should make the costs of compliance available to European stakeholders.

One of the objectives of the END is to define a common approach that seeks to avoid, prevent, or reduce on a prioritised basis harmful effects, including annoyance, due to exposure to environmental noise. The preparation of noise action plans is a complex process that involves a number of different stakeholders, e.g. railway companies, airport authorities, the general public, etc. In the responses received on the challenges encountered in implementing noise action plans, it was noted that cooperation between the relevant stakeholders was not sufficient and that there was insufficient focus on the process of creating the plan.

Recommendation 6

Member state NRAs should develop plans to improve cooperation between relevant stakeholders that have responsibilities for preparing noise action plans under the noise legislation and should share their experience of this with CEDR colleagues.

As specified in Annex 5 of the END, an action plan must include financial information, if available, on budgets, cost-effectiveness assessments, and cost-benefit assessments. Approximately 60% of CEDR members reported having a specific budget for noise abatement. The remaining 40% reported having no allocated budget (Figure 6). To comply with the END, CEDR RN2 members believe that cost-benefit analysis (CBA) should form an integral part of the noise action planning process. CBA can be used to prioritise the various noise abatement measures and can illustrate the socio-economic benefits of using such measures. The results of this study identified that over 80% of NRAs did not undertake any cost-benefit assessment of their noise action plans during the first phase of action planning (Figure 6). In countries where cost-benefit analysis was undertaken, it seems to be used exclusively at a local level, e.g. for the prioritisation or optimisation of selected projects. No CEDR member reported undertaking CBA on action plans on a larger scale.

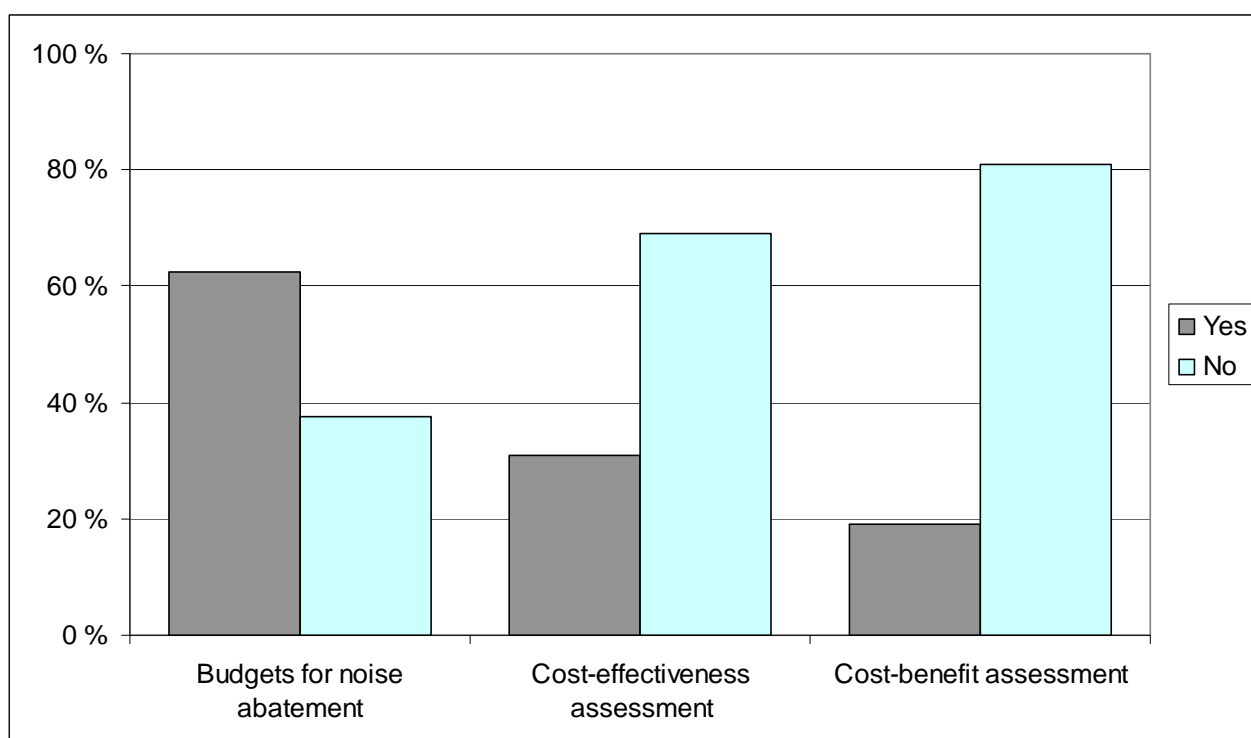


Figure 6: Financial information associated with NRAs' noise action plans as required by Annex 5 of the END

Recommendation 7

NRAs should contact their national noise regulatory committee representative to request that the European Commission prioritises the development of a harmonised cost-benefit assessment tool for analyses of noise action plans. CEDR RN3 should provide input to the EC on costs and benefits as needed.

7 Value for money in road traffic noise abatement

7.1 Scope and objectives

The purpose of this work is to provide support to NRAs when developing policies, strategies, and plans for future noise abatement in order to reduce annoyance and adverse noise effects on human health. In order to provide a recommendation on which strategy would be most beneficial to society in general, this report focuses on reduction in noise annoyance and the associated cost of implementing various noise abatement measures. Using the approach specified in this report, CEDR RN2 anticipates that more noise reduction can be achieved for every euro spent on noise abatement.

7.2 Summary

Based on the data reported in the first round of strategic noise mapping, approximately 90 million inhabitants in Europe are exposed to road traffic noise greater than L_{den} 55 dB. Table 5 lists the main predicted results following an investment of €6 billion over a 20-year cycle over a range of different noise mitigation measures. It is estimated that the cost of reducing noise annoyance varies from €16 to €4,200 per person per year. The findings clearly show that noise reduction at source is much more cost-effective than treating noise at the receiver. This has the potential to lead to significant cost savings to NRAs as it would reduce the need to provide infrastructural measures such as noise barriers, façade insulation, and low-noise pavements and reduce associated congestion and maintenance.

Table 5: Possible noise abatement measures, their potential for reducing road traffic noise annoyance, and the cost of reducing the number of annoyed people

Noise abatement measure	Reduction annoyed people (million)	Cost reduction annoyed people (€ per person per year)
Vehicle noise reduction: 5 dB	31.5	16
Vehicle noise reduction: 3 dB	19.7	18
Thin-layer asphalt	2.2	136
Single-layer porous asphalt	1.1	290
Façade insulation ¹	0.5	570
Double layer porous asphalt	0.3	940
Noise barriers	0.07	4,200

¹ The façade insulation measure used involves replacing two windows. As for the reduction of noise annoyance, the effect of façade insulation on indoor noise levels is supposed to be 60% as efficient as lowering the outdoor noise levels with the same amount of decibels.

There is on-going work in the European Union to update current vehicle and tyre noise emission standards. Current results illustrate that appropriate actions to reduce noise from vehicles could provide very good value for money.

7.3 Conclusions and recommendations

In keeping with the central theme of the END, both (inter)national policies and local policies should aim to achieve high levels of human health and environmental protection.

This study demonstrates that reducing noise from vehicles is more than seven times less expensive than any other measure outlined above and has fewer disadvantages. The CEDR RN2 recommendation to NRAs is to have a strategy for encouraging the exploitation of the most cost-effective actions to mitigate noise. This could involve one of the following:

- advising national governments to adopt positions on proposals for new regulations or the revision of existing regulations concerning sound levels from motorised vehicles and advising national governments to promote the use of low-noise tyres;
- working with vehicle and tyre manufacturers to agree better methods of noise control, addressing the vehicles, traffic management (including ITS), and—where relevant—the infrastructure.

Recommendation 8

CEDR should liaise closely with interested parties such as vehicle and tyre manufacturers to formulate a combination of measures that are appropriate for the treatment of road traffic noise. In addition, CEDR should also consider preparing a position paper for the Commission on the level of noise abatement achieved by the various noise-mitigating measures used on national road schemes.

At national level, NRAs should consider the following when treating areas exposed to unwanted noise:

- The use of porous asphalt or thin-layer asphalt, where appropriate, as the preferred measure to reduce general noise annoyance.
- Double-layer porous asphalt is significantly more costly than single-layer, even though it provides twice as much noise reduction than a single-layer surface. Double-layer porous asphalt is probably more suitable as a local measure than as a measure to reduce general noise annoyance because a single-layer surface gives better value for money.
- The continuation of research and testing in order to develop safer and more durable higher-quality noise-reducing pavements that give greater value for money.

Recommendation 9

With regard to mitigating noise at locations in close proximity to major roads, NRAs should, where appropriate, exploit low-noise pavements as a first option because they have been shown to be the most cost-effective noise abatement measure. This can be used in combination with other measures such as traffic management.

In situations where low-noise pavements do not deliver sufficient reductions in noise levels in specific local situations, member states should consider the use of noise barriers and façade

insulation as more effective solutions. This is demonstrated in

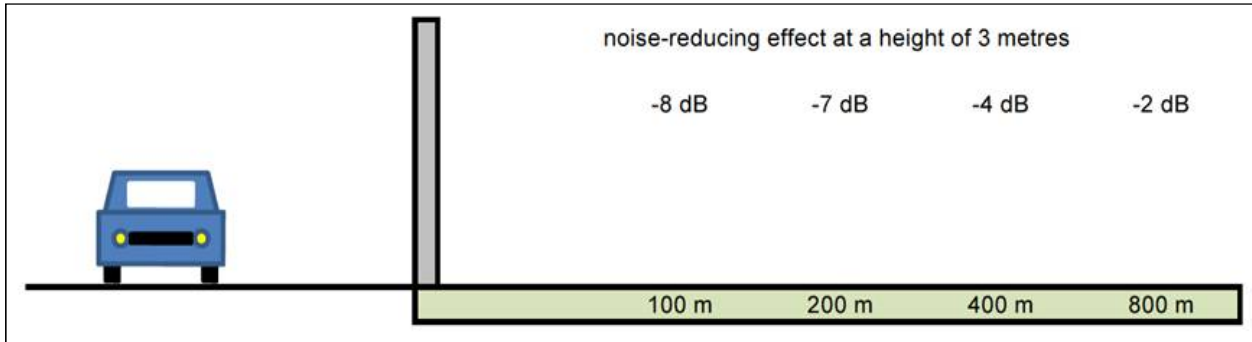


Figure 7, where a 4-metre-high noise barrier can deliver up to an 8-dB reduction in noise levels at receivers 100 m away from the source.

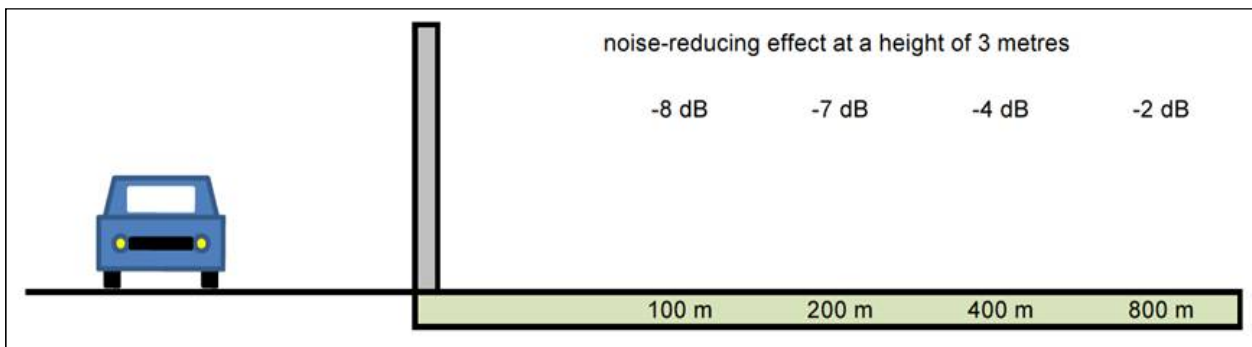


Figure 7: Example of noise reduction behind a 4-metre-high noise barrier (speed: 80 km/h; heavy trucks: 15 %; soft ground between road and receiver)

8 CEDR road noise research needs

8.1 Scope and objectives

CEDR Road Noise 1 (RN1) produced a comprehensive report on road noise research needs across CEDR members in 2008. In order to establish the status of current road traffic noise research across Europe since the publication of the report, CEDR RN2 repeated this survey in 2011.

The scope of this survey on knowledge gaps in noise assessments and abatement techniques was to define the state of the art in road noise research and identify research themes to support the development of future joint research projects supported by NRAs as well as other European frameworks such as the CEDR Transnational Road Research Programme, EU Framework Programmes, etc.

8.2 Summary

This report describes the results obtained from a survey of the 16 CEDR RN2 members. The survey aimed to elucidate priority noise research themes common to the European arena, to identify a shared and common approach to noise research across Europe, and to promote future national and joint research projects. The questionnaire identified ten main thematic domains that were also defined by a number of related noise issues. In order to identify the issues that were in need of in-depth study, research, and development, participants were requested to assign a priority ranking to the various domains and issues.

The following top five thematic domains were found to be of interest to most CEDR member states:

- rolling noise;
- improved or new socio-economic instruments to promote efficient noise abatement;
- advanced noise reduction technologies between source and receivers;
- advanced computation and measurement methods for more accurate assessment of noise exposure;
- active noise mitigation measures.

Themes that were related to approaches or methodologies capable of abating road traffic noise are considered to be of primary importance. In particular, the priority list reasserts the common view that noise must initially be reduced at source before consideration should be given to using infrastructural measures such as noise barriers between the source and receiver.

The need for high-quality and consistent input data as well as calculation models capable of producing high quality outputs in order to improve strategic noise map reliability were also highlighted and reasserted by the previous survey.

In order to elucidate the preferred approach to addressing noise issues emerging from the survey, all the thematic domains were clustered into the following three main categories:

- A. noise assessment and indicators
- B. policy and socio-economic actions
- C. techniques and technologies for noise abatement

The result of grouping the thematic domains in this way shows that the cluster addressing 'noise assessment and indicators' achieved the highest score. The importance of improving the thematic domain on computation and measurement methods has been reasserted to encourage the development of more reliable evaluation methods for assessing noise perceptions. Research themes that achieved less attention were those related to 'dose-effect relationships' and 'specific indicators'.

As identified in the 2008 survey, domains in the cluster 'techniques and technologies for noise abatement' maintained their high ranking. However, as was especially evident in the previous edition of the survey, the thematic domain relating to rolling noise was deemed to be of primary importance. Common opinion is that passive mitigation systems must be enhanced in order to abate noise effectively and efficiently, especially at source.

Another filtering step was implemented to achieve a priority list of topics for future research. This process examined the current research activities of each member state. For example, research themes already being financed by at least three countries were removed. In such cases, no new research should be conducted, and relevant results should be shared by countries participating in that research. Conversely, if a research theme is planned by at least two member states, it would be placed in the priority list.

Results from this final filtering process show that for the most interesting thematic domain on rolling noise, just one topic survived data filtering. A similar result was also achieved for the thematic domain on improved and socio-economic instruments to promote efficient noise abatement. Therefore, the main priority has been given to themes related to noise abatement, in particular to the development of environmentally and economically sustainable mitigation measures.

8.3 Conclusions and recommendations

The results of the questionnaire highlight the need for more research on road noise. High priority was assigned to research themes relating to noise abatement, in particular to the development of environmentally and economically sustainable mitigation measures. Medium priority was given to research themes relating to noise mapping and cost-benefits analysis assessments of noise impact and noise abatement. Therefore, CEDR RN2 strongly recommends focusing attention on topics relating to the design and development of effective and efficient solutions to abate noise, including their environmental and economic assessment.

Recommendation 10

In general, NRAs should focus attention on noise research topics relating to the design and development of effective and efficient solutions to abate noise, including their environmental and economic assessment. This could include the development and design of concepts for safe and durable low noise pavements to reduce vehicle emissions and improve sound absorption as well as the integration of multifunctional integrated solutions such as photovoltaic noise barriers to mitigate costs and increase environmental sustainability.

Based on this overall recommendation, CEDR RN2 has two specific recommendations.

Firstly, to use the information on noise research needs when defining, planning, and prioritising new research and development activities in relation to:

- the national research programmes of individual NRAs;
- regional and bi-lateral cooperation between the NRAs of several EU member states;
- the CEDR transnational programme on research (ERA-NET Road and ERA-NET Transport);
- the Forum of European National Highway Research Laboratories (FEHRL) programme Forever Open Road;
- EU research programmes such as Horizon 2020.

This recommendation sounds simplistic, but does in fact require significant effort and resources to get involved in noise research projects/programmes at transnational level. To cope with these preconditions, one has to focus on specific programmes. For this reason, the follow-up activities focus on the recent CEDR 2012 call on noise: integrating strategic noise management into the operation and maintenance of national road networks.

Recommendation 11

NRAs should use available information on noise-related research needs when defining, planning, and prioritising new research and development activities.

Secondly, to use the information on noise research needs in the scope of CEDR Road Noise 3, whose mission, during the period 2013–2017, will be to focus on the collation, dispersion, implementation, and adoption of noise research results from recent innovative noise research projects undertaken within CEDR member states.

Recommendation 12

When defining the scope of the CEDR Road Noise 3 work programme, NRAs should use available information on noise-related research.



Figure 8: An example of a multifunctional integrated solution where photovoltaic cells are integrated into noise barriers.

9 CEDR road noise factsheet report

9.1 Scope and objectives

During the course of the RN2 work programme, a number of important noise issues arose that had the potential to impact CEDR NRAs. The groups therefore agreed to address these issues as they arose in the form of 'information factsheets'. The scope of the factsheets was restricted to road noise issues that needed to be addressed expeditiously because they had the potential to have an influence on the interests of CEDR NRAs. In total, four factsheets were produced between 2009 and 2013.

The general objective of the factsheets was to produce a well considered response, as agreed by all CEDR RN2 members, to issues that reflected the best interests of the CEDR organisation and NRAs.

9.2 Summary

The following contains a summary of three factsheets addressing END major road data, END policy options, and CNOSSOS-EU. The factsheet addressing the END colour proposal was incorporated into the END noise mapping section above.

END major road data

In accordance with the requirements of the END, the European Environment Agency (EEA) published a comprehensive overview of noise exposure data on its website. In 2011, CEDR RN2 carried out an assessment of the EEA data for noise exposure along major roads. This assessment identified a number of anomalies associated with the data. These anomalies called into question the veracity of the published data. It is the view of CEDR RN2 members that any data published on the EEA website should be robust and consistent because this END noise exposure data has the potential to be a key driver for noise abatement at European level.

The issues associated with the major road data published on the EEA website may be attributed to several sources of errors. Important errors may be related to the incorrect handling of data (such as rounding off data to the nearest hundred, misinterpretation of the definition of dwellings, the definition of noise bands, and missing major roads data inside agglomerations).

END policy options

The recent European Commission (EC) END implementation report identified several implementation issues and a number of other shortcomings that various NRAs encountered during the preparation of their strategic noise maps and action plans in 2007 and 2008 respectively. The EC report identified several policy options in two main areas, namely improvements of implementation and further development of legislation. By undertaking a survey of its CEDR members, CEDR RN2 formulated a common view on the proposed options (see recommendations). This view was then communicated to the EC by completing the EC's Directorate General Environment consultation questionnaire.

CNOSSOS-EU

In line with the END, the EC embarked upon the preparation of a common noise assessment method (CNOSSOS-EU) for strategic noise mapping across the EU. The objective of having a common assessment method is to improve the reliability and comparability of noise mapping results. During a meeting of the Noise Regulatory Committee (NRC) in June 2010, EU member states were invited to nominate experts to be involved in the development and implementation process of CNOSSOS-EU. The first meeting of this Technical Forum of Experts took place in November 2010. This expert group then established a number of working groups to assess various aspects of a common calculation method addressing the requirements of the directive.

In June 2012, the Commission announced a call for tenders to develop the next phase of the CNOSSOS-EU framework. The overall objective of the call is to have a common noise assessment methodology operational for the third round of noise mapping in 2017 and to develop a set of guidelines for the competent use of the CNOSSOS-EU framework. This contract was formally awarded in December 2012.

At a recent meeting of the Regulatory Committee on Noise, a new platform (Communication and Information Resource Centre for Administrations, Businesses and Citizens, CIRCABC) was announced for the implementation of phase B of CNOSSOS-EU. On this platform, one national expert per EU member state can bring forward the national discussion, addressing CNOSSOS-EU issues. This platform will act as an expert group to follow progress in the development of the CNOSSOS-EU project as well as the development of the guidelines.

The legislative progress for implementing CNOSSOS-EU will be discussed further by the NRC over the next few years.

9.3 Conclusions and recommendations

END major road data

In order to improve NRAs' output of future END noise mapping in terms of (more) accurate noise exposure data, a number of recommendations were formulated. The most important recommendation is that a data quality assessment be used. NRAs should have quality control procedures in place to assess the quality of their data, using such variables as household size, residential density, and distance of noise contours before the data is reported to the competent END authority of the relevant EU member state.

Recommendation 13

Quality control procedures should be put in place to assess the quality of strategic noise mapping data before reporting the data to the member state authority responsible for implementing the END.

END policy options

The most important policy option considered desirable for the improvement of the END is the development of a harmonised noise mapping methodology that would allow for the comparison of noise maps across Europe. There is, however, less consensus on the extent to which a harmonised method should be used: specifically for strategic END mapping only or also for detailed noise mapping of road projects. There was a general consensus within the group that the introduction of mandatory EU noise limits values that cannot be exceeded would be counterproductive for most member states. Many member states already have limit values in place that have been adapted to local conditions. Setting EU-wide limit values might be both unrealistic and unwelcome and could have the potential to generate high costs for member state NRAs.

CNOSSOS-EU

On the topic of CNOSSOS-EU, the following recommendations were given in the first drafting phase of CNOSSOS-EU:

- Ideally, input data for traffic flows should be available from regular national traffic counting already undertaken by the NRAs.
- The effect of low-noise road surfaces should be derived from national datasets to account for national differences.
- The geometry of traffic lanes and noise screens should be available from existing databases that were generated during the first two rounds of strategic noise mapping.
- For the propagation model, the type of ground (G value)—especially in close proximity to roads—should be given by default values.

For the further implementation phase of CNOSSOS-EU, it is recommended that in order to ensure the simplicity of CNOSSOS-EU and the availability of road-related data (traffic flow, low-noise surface corrections, geometry of lanes, and noise screens), close collaboration should be encouraged between CEDR Project Group Road Noise members and the person in their country who is responsible for CNOSSOS-EU .

10 Conclusions and recommendations

CEDR Project Group Road Noise 2 (CEDR RN2) was established in 2009 with the objective of meeting the goals relating to road traffic noise specified as task 8 in CEDR's Strategic Plan 2009–2013 (SP2). In this plan, road traffic noise formed part of the Thematic Domain (TD) Construction, which focused on the role of the National Road Authorities (NRAs) in monitoring developments in various road-related issues, including those relating to environmental issues.

The noise mapping and action planning requirements of the EU Environmental Noise Directive (END) formed a significant component of the group's activities. Five results-orientated reports were produced by CEDR RN2. These reports assessed and evaluated CEDR member state experiences with END noise mapping, END action planning, value for money in road traffic noise abatement, and CEDR road noise research needs. A fifth report was also produced compiling the outcomes of the individual factsheets on END major road data, END policy options, END noise mapping colour regimes, and the CNOSSOS-EU computational model.

Some of the main recommendations arising from the various reports include:

Noise mapping:

- To minimise the costs associated with undertaking the required EU strategic noise mapping in 2017, all NRAs should closely monitor or actively participate (through the relevant channels in their country, e.g. through their Noise Regulatory Committee representative) in the development of the proposed new calculation methodology (CNOSSOS-EU) to ensure that a simplified approach rather than a more advanced approach is adopted. They should also inform the relevant representative that the introduction of noise bands lower than 55 dB L_{den} and 45 dB L_{night} beyond the validation distance of a noise calculation method will only add additional uncertainty and inaccuracy to the reported noise mapping data. This would mean that NRAs would have to incur additional costs in order to augment current data collection methodologies.
- NRAs should work together with noise mapping bodies across all disciplines (road, rail, industry, air, and agglomerations) to ensure cost-sharing and access to all relevant datasets.
- NRAs should, where possible, promote the use of the proposed colour code in any future noise mapping programmes. The use of the proposed colour code will allow NRAs to compare noise maps across member states.

Action planning:

- NRAs should consider integrating the content of noise action plans into their respective planning process or asset management programmes.
- It is proposed that the road traffic noise mitigation measures outlined in a member state's noise action plan required by EU legislation may be used by member state NRAs as justification for seeking additional funding for road maintenance at national level. CEDR should make the costs of compliance available to European stakeholders.
- Member state NRAs should develop plans to improve cooperation between relevant stakeholders that have responsibilities for preparing noise action plans under the noise legislation and should share their experience of this with CEDR colleagues.

- NRAs should contact their national noise regulatory committee representative to request that the European Commission prioritises the development of a harmonised cost-benefit assessment tool for analyses of noise action plans. CEDR RN3 should provide input to the EC on costs and benefits as needed.

Value for money in road traffic noise abatement:

- CEDR should liaise closely with interested parties such as vehicle and tyre manufacturers to formulate a combination of measures that are appropriate for the treatment of road traffic noise. In addition, CEDR should also consider preparing a position paper for the Commission on the level of noise abatement achieved by the various noise mitigating measures used on national road schemes.
- With regard to mitigating noise at locations in close proximity to major roads, NRAs should, where appropriate, exploit low-noise pavements as a first option because they have been shown to be the most cost-effective noise abatement measure. This can be used in combination with other measures such as traffic management.

CEDR road noise research needs:

- In general, NRAs should focus attention on noise research topics relating to the design and development of effective and efficient solutions to abate noise, including their environmental and economic assessment. This could include the development and design concepts for safe and durable low-noise pavements to reduce vehicle emissions and improve sound absorption as well as the integration of multifunctional integrated solutions such as photovoltaic noise barriers to mitigate costs and increase environmental sustainability.
- NRAs should use available information on noise-related research needs when defining, planning, and prioritising new research and development activities.
- When defining the scope of CEDR Road Noise 3 work programme, NRAs should use available information on noise-related research.

CEDR road noise factsheet report:

- Quality control procedures should be put in place to assess the quality of strategic noise mapping data before reporting the data to the member state competent authority for implementing END.

The final report provides a number of recommendations that should, if implemented, enhance how all future END activities are undertaken. More specifically, the research report provides a solid foundation for noise research needs in Europe going forward.

Finally, it is anticipated that the future impact of this report and the associated reports from the RN2 subgroups will have a perceptible impact on the cost-effectiveness of implementing EU noise legislation by the various member states.

List of abbreviations

ANAS	Azienda Nazionale Autonoma delle Strade
ASFINAG	Autobahnen- und Schnellstraßen-Finanzierungs-Aktiengesellschaft
BAST	Bundesanstalt für Straßenwesen
CBA	cost-benefit analysis
CEDR RN1	CEDR Project Group Road Noise under Strategic Plan 2005–2009 (Task C3)
CEDR RN2	CEDR Project Group Road Noise under Strategic Plan 2009–2013 (Task 8)
CEDR RN3	CEDR Task Group Road Noise under Strategic Plan 2013–2017 (Task I6)
CIRCABC	Communication and Information Resource Centre for Administrations, Businesses and Citizens
CNOSSOS-EU	Common Noise Assessment Methods in Europe
EC	European Commission
EEA	European Environment Agency
END	Environmental Noise Directive
ERA	European Research Area
EU	European Union
FEHRL	Forum of European National Highway Research Laboratories
FP	Framework Programme
GDDKiA	Generalna Dyrekcja Dróg Krajowych i Autostrad
HGV	heavy goods vehicles
LNP	low-noise pavement
NRA	National Road Authority
NRC	Noise Regulatory Committee
SP2	CEDR's Strategic Plan 2009–2013
SP3	CEDR's Strategic Plan 2013–2017
TD	Thematic Domain
UK CRTN	Calculation of Road Traffic Noise (UK)
WG-AEN	Working Group on the Assessment of Exposure to Noise

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