

# Treatment of road traffic noise in EU countries with a focus on Directive 2002/49/EC

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## Abstract

The trend of continuous increase for mobility requirements results in a progressive increase in the use of vehicles of all modes of transport, which contributes to a significant increase in noise levels, especially in urban areas. The most significant noise in urban areas is traffic noise, where road traffic contributes the most. This paper reviews the treatment of road traffic noise in the European Union with a focus on Directive 2002/49 / EC. The paper presents the basics of the mechanisms of the institutional and management framework in the field of road traffic noise monitoring in EU countries. Also, the results of road traffic noise monitoring in EU countries, indicators of population exposure to road traffic noise, as well as indicators of the impact of road traffic noise on the health of the population, were presented.

**Keywords:** Road Traffic Noise, Noise pollution, Noise monitoring, Directive 2002/49/EC

## 1 Introduction

Technological advances in the field of road traffic and urbanization enables easier connection and a more efficient way of life, but still in the process there are many side effects that result in side consequences. Noise, as an inevitable phenomenon in this process, is one of these undesirable consequences, and it is necessary to pay special attention to it.

Noise as a form of environmental pollution, ie endangering and degrading the quality of life, has recently become an increasing problem. Noise in urban areas and the consequences that accompany noise are today one of the priority tasks of all experts dealing with the issue of improving living conditions. All solutions within the framework of solving the problem of noise and its impact on the environment, must be the fruit of technical knowledge and the use of the achievements of modern science. Noise problems should be addressed multidisciplinary with the participation of all responsible and interested parties.

The most effective, and at the same time the cheapest way to fight against noise is to prevent it from occurring. The application of this rule in a broader framework at the state level is ensured by regulatory acts that specifically determine the permissible noise limits. They are relied by acts that define measurement methods, condition monitoring, protective measures and planning. Therefore,

the basic problem of the research is the negative impacts and consequences of road traffic noise, ie noise sources, laws of distribution, effects of action and consequences that occur.

The aim of this paper is to emphasize the importance of the problem of noise pollution from road traffic and to encourage further theoretical and practical work on the consideration of this issue.

## 2 Basic provisions of Directive 2002/49/EC with a focus on road traffic noise

Directive 2002/49/EC about the assessment and management of environmental noise, is the basic legal document that treats road traffic noise in EU countries.

The aim of this Directive shall be to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise. To that end the following actions shall be implemented progressively: The determination of exposure to environmental noise, through noise mapping, by methods of assessment common to the Member States; Ensuring that information on environmental noise and its effects is made available to the public; Adoption of action plans by the Member States, based upon noise-mapping results, with a view to preventing and reducing environmental noise where

necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good.

Member States shall designate at the appropriate levels the competent authorities and bodies responsible for implementing this Directive, including the authorities responsible for making and, where relevant, approving noise maps and action plans for agglomerations, major roads, major railways and major airports. For Member States that have no national computation methods or Member States that wish to change computation method, the following methods are recommended for road traffic noise: The French national computation method NMPB-Routes-96 (SETRA-CERTU-LCPCSTB) [1].

### **3 Treatment of road traffic noise in EU countries**

In accordance with EU legislation, the competent authorities are obliged to inform the public about the effects of noise pollution and to consult on the measures they plan to take to address the problem of noise pollution. In this way, citizens can see how noise management measures can make real progress. Noise pollution is linked to a number of health problems, and the population of Europe exposed to high noise levels is growing. EU member states are obliged to record noise levels in large cities, on roads, railways and airports, and to devise plans to solve the problem. Road traffic is the leading source of noise pollution in cities. More detailed data on the extent of the problem of noise pollution in Europe are presented in the Report of the European Environment Agency (EEA), Environmental Noise in Europe - 2020. [2]

#### **3.1 Institutional and management mechanisms for road traffic noise monitoring in EU countries**

The European Environment Agency (EEA) is a European Union agency that provides a wide range of quality, verified and independent environmental information to all stakeholders involved in the development, adoption, implementation and evaluation of protection policies of environment, and also for the general public.

In cooperation with the European Environment Information and Observation Network (EIONET) with 38 member states, the EEA collects environmental information from individual countries, which are focused on providing timely, nationally validated and high quality data. These data form the basis of thematic and integrated environmental assessments. This information serves to support the processes of environmental management, the creation and assessment of environmental policy, as well as citizen participation.

The EEA manages the network and coordinates its activities by cooperating with National Focal Points (NFPs), usually national environmental agencies or ministries of the environment. NFPs are responsible for coordinating networks of National Reference Centers (NRCs), bringing together experts from national institutions and other bodies involved in environmental information. The National Reference Centers (NRCs) are appointed by the EEA members and the countries cooperating with them. NRCs are located in organizations that are regular collectors or suppliers of environmental data at the national level and / or possess relevant knowledge on various environmental issues, monitoring or modeling. There are currently 24 National Reference Centers, of which National Reference Center No. 17 deals exclusively with noise issues.

The National Noise Reference Center supports EEA activities on environmental noise, including related noise assessments and noise indicators. The NRC on Noise is the contact point and should provide an overview of noise maps and action planning in the country, as well as reporting by the EEA Member States on noise data in relation to the Environmental Noise Directive 2002/49/EC.

Eionet also includes seven European Topic Centers (ETCs). European Topic Centers (ETCs) are consortia of organizations in EEA member countries with an expert approach in specific areas of environmental protection, including the impact of noise, contracted by the EEA to support the implementation of EEA work programs.

#### **3.2 Exposure of the EU population to road traffic noise**

Noise pollution is one of the main environmental health problems in Europe. Tables 1 and 2 show indicators of the level of noise pollution in Europe [2], which provide an overview of the estimated number of people exposed to harmful levels of road noise with more than 3 million vehicles per year, which are above the level of noise indicators set by Directive 2002/49/EC. Indicators include urban and non-urban areas. The main source of noise pollution both in urban areas and outside them is road traffic.

Urban areas are defined according to Directive 2002/49/EC as a part of the territory designated by a Member State, which has over 100,000 inhabitants and a population density which the Member State considers to be an urban area. The number of people exposed to noise is summed only for the same source inside and outside urban areas, not across the source as this could lead to double counting. Lden 55 dB is the EU threshold for excessive noise exposure defined by the Environmental Noise Directive and indicates the average annual noise level during the day, evening and night. Lden 50 dB is the

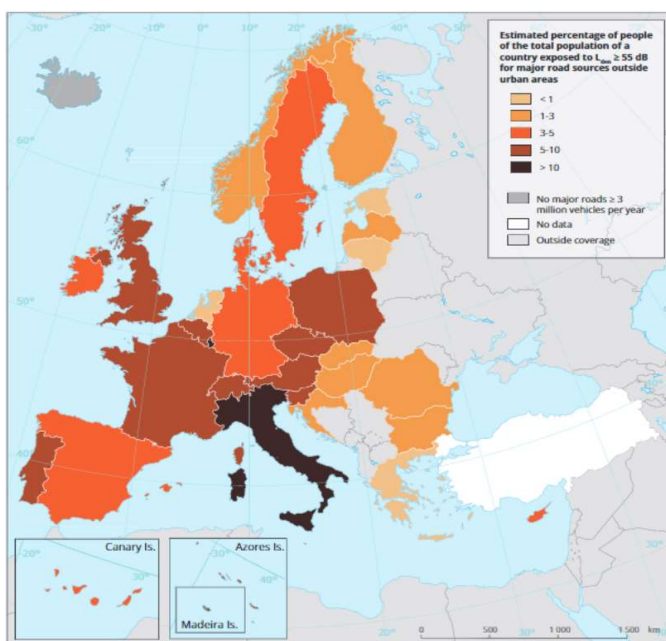
EU threshold for excessive noise exposure defined by the Environmental Noise Directive and indicates the average annual noise level during the night.

**Table 1.** Number of people exposed to average day-evening-night noise level ( $L_{den} \geq 55$  dB in Europe

Noise source	$L_{den} \geq 55$ dB	$L_{night} \geq 50$ dB	Agglomerations	Countries
Roads	78.236.200	55.088.700	In urban areas	EU-28
Main roads	30.574.800	20.705.700	Outside urban areas	EU-28
Roads	81.668.800	57.479.600	In urban areas	EEA-33
Main roads	31.142.900	21.096.500	Outside urban areas	EEA-33

**Table 2.** Number of people exposed to average noise level during the night ( $L_{den} \geq 50$  dB in Europe

Noise source	$L_{den} \geq 55$ dB	$L_{night} \geq 50$ dB	Agglomerations	Countries
Roads	78.236.200	55.088.700	In urban areas	EU-28
Main roads	30.574.800	20.705.700	Outside urban areas	EU-28
Roads	81.668.800	57.479.600	In urban areas	EEA-33
Main roads	31.142.900	21.096.500	Outside urban areas	EEA-33



**Figure 1.** Estimated percentage of the total population of the country exposed to  $L_{den} \geq 55$  dB of road traffic on major roads outside urban areas in 2017

Figure 1 shows the percentage of the country's population exposed to road traffic noise on major roads outside urban areas. [3] The percentage of the population exposed to road traffic noise on major roads outside urban areas ranges from less than 1% in the case of the Netherlands, Lithuania, Greece and Estonia to 10-12% in the case of Italy, Liechtenstein and Luxembourg.

#### 4 Assessment of the impact of road traffic noise on the health of residents

Exposure to environmental noise can lead to disturbances, stress reactions, sleep disorders, poor mental health and well-being, cognitive impairment in children, as well as negative effects on the cardiovascular and metabolic system. The World Health Organization (WHO) has identified noise as the second most significant environmental cause of ill health in Western Europe, and the first is air pollution.

One of the most important documents in the framework of monitoring and reporting on the impact of environmental noise, as well as certain types of traffic, which is implemented by the European Environment Agency (EEA), is the report Environmental noise in Europe 2020. Table 3 shows more detailed data on the estimated number of people suffering from different health outcomes due to road traffic noise. [2]

**Table 3.** Estimated number of persons suffering from different health outcomes due to road traffic noise, 2017, EEA-33

	High annoyance	High sleep disturbance	Ishaemic heart disease	Premature mortality
In urban areas	12 525 000	3 242 400	29 500	7600
Outside urban areas	4 625 500	1 201 000	10 900	2 500

Most research to date has focused on the direct cause-and-effect relationships between transport noise and health outcomes. The most significant current evidence base on the cause-and-effect relationship between noise and health has been published by the WHO Regional Office for Europe in the form of Environmental Noise Guidelines for the European Region.

As a result of scientific evidence, the guidelines recommend a set of health outcomes that can be quantified by Health Impact Assessment (HIA), which are shown in Table. [4]

Instead of estimating the number of premature deaths, the World Health Organization (WHO) has developed methods for quantifying the Burden of Disease (BoD) [5] from environmental noise using DALYs (Disability-Adjusted Life-Year) [6], which combines years of life lost due to premature mortality and years of life lost due to time spent in conditions weaker than complete health conditions.

**Table 4.** Recommended health outcomes for assessing the impact of road traffic noise on the health of residents

Noise source	Outcomes that can be quantified by assessing the impact of noise on health	Outcomes that can potentially be quantified by assessing the impact of noise on health
Road traffic	Incidence of ischemic heart disease Harassment Sleep disorder	Incidence of stroke Incidence of diabetes

This methodology was used to calculate the burden of disease as a consequence of disturbance, sleep disturbance and reading impairment, using exposures and reactions as well as the proportion attributed to the population for Ischaemic Heart Disease (IHD).

The Disability Weight factors (DW) reported in the WHO reports were used in the budget. Table 5 shows the burden of disease outcomes estimated on the basis of noise data resulting from reports under Directive 2002/49/EC. [7]

**Table 5.** Recommended health outcomes for assessing the impact of road traffic noise on the health of residents

Health effect	Public health impact (DALYs/year) and (DALYs/year) per million	Health effects included in different approaches to estimating noise BoD		
		2011 [8]	2014 [9]	2018 [10]
High annoyance	453 000 900 per million people	YES	NO	NO
High sleep disturbance	437 000 800 per million people	YES	YES	NO
Ischaemic heart disease	156 000 300 per million people	YES	YES	YES
Cognitive impairment in children	75 -	YES	NO	NO

The results roughly show that due to the impact of environmental noise on health effects, about a million healthy years of life are lost each year. In terms of individual noise sources, road traffic noise as the most common source of environmental noise has the largest contribution to the burden of disease due to noise (75%), followed by rail (20%), air transport (4%) and industrial noise (0.5 %).

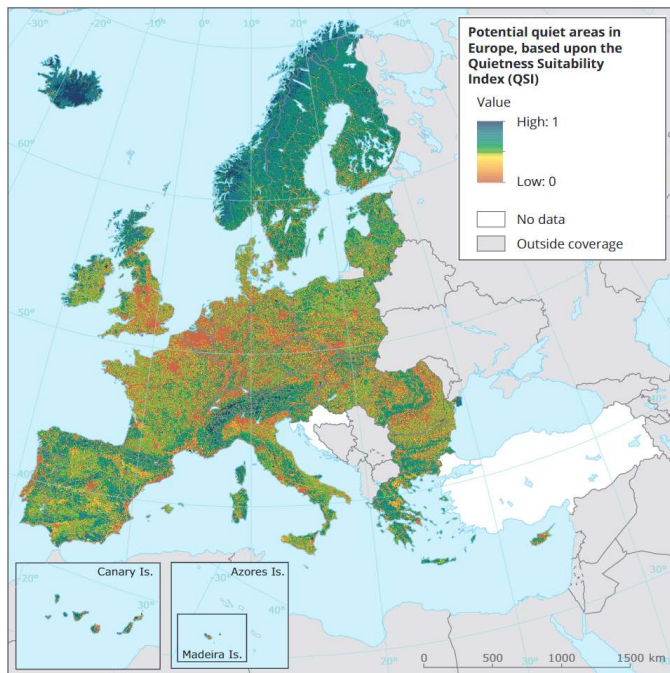
The decline in the quality of health of the population in Europe under the influence of environmental noise also has economic consequences. There are different approaches to quantifying the economic costs of noise due to health, one of which relies on the allocation of monetary costs per "DALY". [11] Although the cost estimate for DALY may vary from country to country, assuming that the monetary cost per DALY is € 78,500, the resulting economic impact of noise is estimated at € 35 billion for distress, 34 billion on sleep disorders, € 12 billion on IHD and € 5 million on cognitive impairment in children. [12] Monetary costs can also exist as a result of reduced house prices, lost working days and reduced land use opportunities.

## 5 The concept of Quiet areas in Europe countries

Directive 2002/49/EC recognized the need to preserve areas of good acoustic quality called "quiet areas". [13] Although there is no single definition of the term "quiet area", experts generally agree that a quiet area is a location of pleasant sound and in which noise, noise or unwanted sound does not exist or at least is not dominant. In addition to the above, quiet areas generally have other qualitative characteristics, ie they offer a safe and clean place, a pleasant view, preferably including green space or water. These areas are usually found in city parks, inside apartment blocks, in backyards and gardens. In rural areas, they often coincide with natural parks or protected areas, but they can also be part of an agricultural area or unused land outside the city.

In 2014, the European Environment Agency (EEA) developed a methodology for identifying potential peaceful areas in the open, based on the Quietness Suitability Index (QSI) parameter. [14] This index is based on a combination of contour noise maps that exceed the thresholds defined by Directive 2002/49/EC of 55 dB Lden, as well as land use elements and land cover areas that indicate naturalness using the "hemeroby index". This index ranges from 0 (noisy areas) to 1 (quiet / quiet areas). Using this methodology, the European Environment Agency (EEA) has developed a map at European level showing potential peaceful areas in order to obtain a complete map of coverage at European level. Figure 2 shows an overview of potential peaceful areas in Europe.





**Figure 2.** Potential peaceful areas in Europe, based on the Silence Convenience Index (QSI)

## 6 Conclusion

Current assessment methodologies roughly show that due to the impact of environmental noise on health effects, about a million healthy years of life are lost each year. Most research to date has focused on the direct cause-and-effect relationships between transport noise and health outcomes. If individual noise sources are analyzed, road traffic noise as the most common source of noise from the environment has the largest contribution to the burden of disease due to noise with about 75%.

Directive 2002/49/EC provided a wide range of possibilities for action to reduce the harmful effects of road traffic noise. However, the greatest contribution should be made by Member States by creating their own monitoring systems and action plans in line with the latest scientific knowledge. Therefore, effective action to reduce noise pollution from road traffic is possible with an appropriate system of monitoring, measurement and modeling of noise, production of noise maps, reporting on population exposure to noise, application of adequate tools and techniques, defining and implementing action plans and more effective measures to reduce noise.

## References

- [1] E. Murphy and E. King, *Environmental Noise Pollution: Noise Mapping, Public Health, and Policy*. Oxford: Elsevier Inc., 2014.
- [2] E. Peris *et al.*, "Environmental noise in Europe — 2020," Copenhagen, 2019.
- [3] M. José Ramos, "Noise indicators under the Environmental Noise Directive," Copenhagen, 2019.
- [4] World Health Organizations, "Environmental Noise Guidelines for the European Region," Copenhagen, 2018.
- [5] R. Haneef *et al.*, "Recommendations to plan a national burden of disease study," *Arch. Public Heal.* 2021 791, vol. 79, no. 1, pp. 1–8, Jul. 2021.
- [6] S. D. Grosse, D. J. Lollar, V. A. Campbell, and M. Chamie, "Disability and Disability-Adjusted Life Years: Not the Same," *Public Health Rep.*, vol. 124, no. 2, p. 197, 2009.
- [7] I. Van Kap, "Study on methodology to Perform environmental noise And health assessment," Bilthoven, 2018.
- [8] L. Fritschi, "Burden of disease from environmental noise Quantification of healthy life years lost in Europe," Copenhagen, 2011.
- [9] O. Hänninen *et al.*, "Environmental Burden of Disease in Europe: Assessing Nine Risk Factors in Six Countries," *Environ. Health Perspect.*, vol. 122, no. 5, p. 439, 2014.
- [10] Institute for Health Metrics and Evaluation (IHME), "Findings from the Global Burden of Disease Study," Seattle, 2018.
- [11] R. Dickens, M. Angulo, S. Turner, J. Gill, M. Abdul, and H. Hirani, "Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet," London, 2014.
- [12] R. Torfs, "Quantification of health risks using DALYs and external health costs," Mechelen, 2003.
- [13] T. Cox, "Quietest places in the world," *Am. Sci.*, vol. 102, no. 5, pp. 382–385, 2014.
- [14] European Environment Agency, "Quiet areas in Europe — The environment unaffected by noise pollution," Copenhagen, 2016.