European Environment Agency

Environmental noise in Europe — 2025

EEA Report 05/2025

European Environment Agency

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Executive summary

Millions of people across Europe are exposed to harmful noise levels from transport sources, making noise one of the leading environmental health risks in Europe. This *Environmental noise in Europe — 2025* report presents a comprehensive analysis of transport-related noise pollution and its associated health impacts, also identifying available solutions to reduce harmful exposure to noise.

According to the report, at least one in five Europeans lives in areas where noise exposure exceeds healthy limits, posing serious risks to health. Road traffic is identified as the dominant source of environmental noise, especially in densely-populated urban areas, where the highest numbers of people are affected.

In 2021 alone, prolonged exposure to transport noise in Europe was linked to an estimated 66,000 premature deaths, 50,000 new cases of cardiovascular diseases (CVDs) and 22,000 new cases of type 2 diabetes. In total over 1.3 million healthy life years were lost in Europe due to noise pollution.

Children and adolescents are particularly vulnerable to the effects of noise. Based on new research, it is estimated that in 2021 noise exposure from transport sources contributed to over 560,000 cases of reading comprehension impairment, 63,000 behavioural problems and 272,000 cases of children being overweight.

Beyond human health, high levels of environmental noise can also harm biodiversity, highlighting the need for additional actions to provide better protection to ecosystems. The report shows that at least 29% of the area protected under Natura 2000 in Europe experience noise levels that could be harmful to terrestrial wildlife, while underwater noise also presents a significant risk to marine habitats.

Now in its third edition, this current *Environmental noise in Europe — 2025* report draws on data collected under the 2022 reporting round of the Environmental Noise Directive (END), provided by European Union (EU) Member States (MSs) and other European Environment Agency (EEA) countries. For the first time, the 2025 edition assesses additional exposure and health effects against the updated, more stringent recommendations by the World Health Organization (WHO). Produced in collaboration with the EEA's European Topic Centre on Human Health and the Environment (ETC HE), the report focuses on six key areas:

- the number of people exposed to noise levels harmful to health;
- the health impacts and burden of disease (BoD) associated with environmental noise;
- progress towards the Zero pollution target on noise for 2030;
- impacts of noise on biodiversity and protected natural areas;
- accessibility to green and quiet areas in European cities;
- challenges and potential solutions to reduce noise impacts.

Main findings

The latest data provided by countries under the END reveal the extent of noise pollution in Europe. The findings of the *Environmental noise in Europe — 2025* report highlight the urgent need for stronger efforts to reduce environmental noise and its effects on human health, the environment and the economy.

Noise exposure — a widespread problem affecting over 100 million people in Europe

A significant proportion of Europe's population is exposed to transport noise levels that are harmful to health. The latest estimates show that approximately 112 million people — more than 20% of the population in Europe — are exposed to long-term noise levels from road, rail and aircraft sources that exceed the thresholds set by the END.

However, the latest scientific evidence indicates that health impacts already occur at noise levels below the thresholds at which countries are obliged to report under the END. For instance, the WHO environmental noise guidelines for the European region recommend substantially stricter noise levels, meaning that in reality many more individuals are exposed to transport-related noise that pose a risk to health. When considering these lower recommended levels, it is estimated that approximately 150 million people — more than 30% of the population — are exposed to long-term unhealthy noise levels from transport sources.

The problem of noise pollution is widespread. Unhealthy levels of noise pollution are experienced across all European countries. Road traffic is identified as the dominant source of environmental noise, especially in densely populated urban areas, where the highest numbers of people are affected. Based on END thresholds, road transport accounts for around 92 million people exposed to harmful day-evening-night noise levels and 58 million exposed during nighttime. In comparison, railway noise affects 18 million people during the day-evening-night period and 13 million at night, while aircraft noise impacts around 2.6 million (day-evening-night) and fewer than 1 million during the night. While rail and aircraft noise affect fewer people overall, they remain significant sources of local noise pollution, particularly near major rail transport corridors and airports.

Noise pollution is not only an annoyance, it can cause extensive health impacts

Whereas noise has typically been associated with impacts such as annoyance and sleep disturbance, its effects are much broader. Exposure to noise affects health through interconnected pathways, primarily stress and sleep disturbance. These factors can lead to inflammation and oxidative stress, which in turn contribute to a wide range of negative health outcomes, including cardiovascular and metabolic diseases, mental health disorders and even premature deaths.

In 2021, at least 66,000 premature deaths were linked to long-term exposure to transport noise, as well as 50,000 new cases of cardiovascular diseases and 22,000 new cases of type 2 diabetes. This corresponds to 0.7% of all new CVD cases, 1.3% of all type 2 diabetes cases and 1.1% of all premature deaths in that year being attributable to noise from transport sources. Additionally, according to new research, noise from transport could contribute to thousands of cases of depression and dementia.

Noise pollution from transport sources in Europe leads to the loss of approximately 1.3 million healthy life years annually, as measured using disability-adjusted life years (DALYs). DALYs combine the years of life lost (YLL) due to premature death with years lived in poor health, thus presenting a comprehensive measure of the full burden of disease of noise pollution. This also allows meaningful comparisons between different environmental risks. When compared to other environmental health threats, transport noise ranks among the top three — just behind air pollution and temperature-related (climatic) factors. Furthermore, it has a greater health impact than better-known risks such as second-hand smoke or lead exposure.

Noise pollution also poses risks to children's health

Chronic exposure to transport noise can also negatively affect children, especially as they are in an important learning and developmental phase. The effects of noise on children include delayed learning and cognitive impairment but also impacts such as an increased risk of being overweight. There are approximately 15 million children living in areas affected by harmful noise levels in Europe.

Based on new research, it is estimated that transport noise contributes to over 560,000 cases of reading difficulties, 63,000 behavioural issues and an estimated 272,000 cases of overweight children in Europe.

Transport noise is a threat to Natura 2000 natural areas

Noise pollution can impact both terrestrial and marine wildlife, influencing their behaviour, physiology, communication, and sensory perception, while also altering predator-prey dynamics. Noise can also disrupt ecosystem functions, including pollination by insects, affecting overall ecosystem productivity and health.

At least 29% of Europe's natural areas protected under Natura 2000 are affected by transport noise levels that could pose risks to terrestrial wildlife.

Underwater noise pollution from shipping, offshore construction and marine exploration disrupts marine life, causing stress and behavioural changes, particularly in species in Europe's waters that rely on sound for survival such as whales and dolphins. Areas with the highest underwater noise exposure in Europe include parts of the English Channel, the Strait of Gibraltar, parts of the Adriatic Sea, the Dardanelles Strait and some regions in the Baltic Sea.

While EU legislation addresses noise pollution in the marine environment, it does not currently cover noise impacts on terrestrial ecosystems and species.

Accessibility to quiet and green spaces in European cities could be improved

Access to quiet and green spaces provides health benefits including stress and annoyance reduction, particularly for individuals living in noisy environments.
The END and the 2018 WHO environmental noise guidelines emphasise the need to preserve and increase quiet spaces. These areas have a role in promoting well-being and can also support climate adaptation and nature restoration.

A geo-spatial analysis of 233 cities reveals that only 34% of the population can access green and quiet areas within a 400-metre walking distance from their homes, which is a common metric for acceptable accessibility. While northern European urban areas typically provide better access to such spaces, there remains a significant disparity in availability across other regions.

Limited progress made towards noise pollution target

Progress in decreasing the number of people exposed to harmful levels of noise has been slow. The 2021 EU action plan 'Towards zero pollution for air, water and soil' set out an indicative target to reduce by 30% the number of people chronically disturbed by transport noise by 2030 (compared to 2017 levels). It is estimated that between 2017 and 2022, the number of people annoyed by transport noise in the EU declined by only 3%. This reduction falls short of the pace needed to meet the zero pollution noise reduction objective.

Based on current projections to 2030, it is unlikely that the EU will meet the zero pollution target without additional measures. A business-as-usual scenario (that assumes the current rate of implementation of measures) modelled in the report, predicts that if no additional measures are taken, the situation by 2030 will remain unchanged. Under an optimistic scenario, where substantial additional measures are implemented, the number of people chronically disturbed by transport noise could decline by about 21%. However, this number is still short of the EU zero pollution ambition. Therefore, more substantial action at EU and national levels would likely be necessary to meet the target.

Increasing calls for action

Different stakeholders have raised significant concerns regarding ongoing noise pollution in Europe. The European Court of Auditors (ECA) has highlighted that, despite longstanding regulations, actions taken by the EC and selected Member States have been insufficiently effective at protecting citizens from noise pollution. The ECA considers that the absence of EU noise reduction targets disincentivises Member States from prioritising actions to reduce noise pollution effectively. Furthermore, the ECA points out that the current noise reporting thresholds cover only a portion of the population exposed to harmful levels. In its report, the ECA recommends that the EC assesses the feasibility of introducing EU noise-reduction targets in the END and of aligning the noise exposure reporting thresholds as closely as possible with those recommended by the WHO (1).

In 2023, the WHO's *Declaration of the Seventh Ministerial Conference on Environment and Health: Budapest Declaration*, focusing on the European region, reinforced the urgent need for action against various pollutants, including noise. The declaration emphasises the importance of collaboratively developing and implementing policies to reduce environmental noise while exploring the health benefits of interventions aimed at improving both air quality and noise pollution.

In its most recent implementation report from 2023, the EC has committed to strengthening ongoing short-term actions on source legislation and to improving the implementation of the END. The report also states that the EC will assess possible improvements to the directive, including the feasibility and benefit of establishing noise reduction targets at the EU level.

The scientific community has found adverse health effects at traffic noise levels even below the WHO recommendations, starting from as low as 45 decibel (dB) day-evening-night noise level (L_{den}) for various CVDs and diabetes. Given the significant role of noise as a risk factor for CVD and other adverse health effects, the scientific community has highlighted the necessity of raising awareness about

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(1) The noise thresholds of the END are set at 55 dB for the day-evening-night period (L_{den}) and 50 dB for the night period (L_{night}), while the WHO thresholds are source specific and are set at levels below the END.

noise among health professionals as a critical environmental risk, alongside air pollution and chemical exposure. It has been suggested that incorporating noise pollution into medical education and prevention guidelines is essential for developing more comprehensive and effective disease prevention strategies.

Solutions to reduce noise exist

While noise pollution poses significant challenges, there are effective solutions already available to mitigate its impact. Key solutions outlined in the report include:

Upstream measures that reduce noise at source, including regulatory and legislative actions

In general, these measures are found to benefit a larger segment of the population because they address all noise levels compared to localised interventions, which are only effective at hotspots. Measures at source that are backed up by regulation/legislation help to ensure consistent and effective application. Examples of such solutions could include:

- regulating noise emissions from road vehicles, such as reducing vehicle speed limits in urban areas, increasing the use of low noise tyres, and reducing noise from high emitters;
- regular rail grinding and maintenance to smooth tracks;
- optimising aircraft landing/take-off patterns to avoid populated areas and promoting the use of quieter aircraft.

Source measures are especially important to tackle road traffic noise, which is a prevalent source, but also for railway activity, which is expected to grow in the coming years.

Long-term strategies incorporating urban and transport planning

Long-term strategies incorporating urban and transport planning can provide a clear, iterative and achievable pathway for the delivery of tangible reductions in noise exposure, allowing for the prioritisation of preventive rather than reactive measures. This includes measures such as buffer zones between transport corridors and residential areas and sensitive locations (e.g. schools and hospitals); designing building orientation to minimise exposure; noise-sensitive indoor layouts; promoting sustainable mobility options (e.g. public transport, walking and cycling); and the creation of green and quiet spaces — all of which can also support better air quality, climate resilience and ecosystem restoration.

Other actions on climate, environment and health can contribute to noise reduction

On the one hand, reducing noise pollution can contribute to the objectives in other policy areas. On the other hand, noise reduction can also be achieved as an important co-benefit of actions taken in other policy domains. These include air quality and climate policies, nature restoration and preventive health initiatives related to cardiovascular and respiratory diseases and mental health.

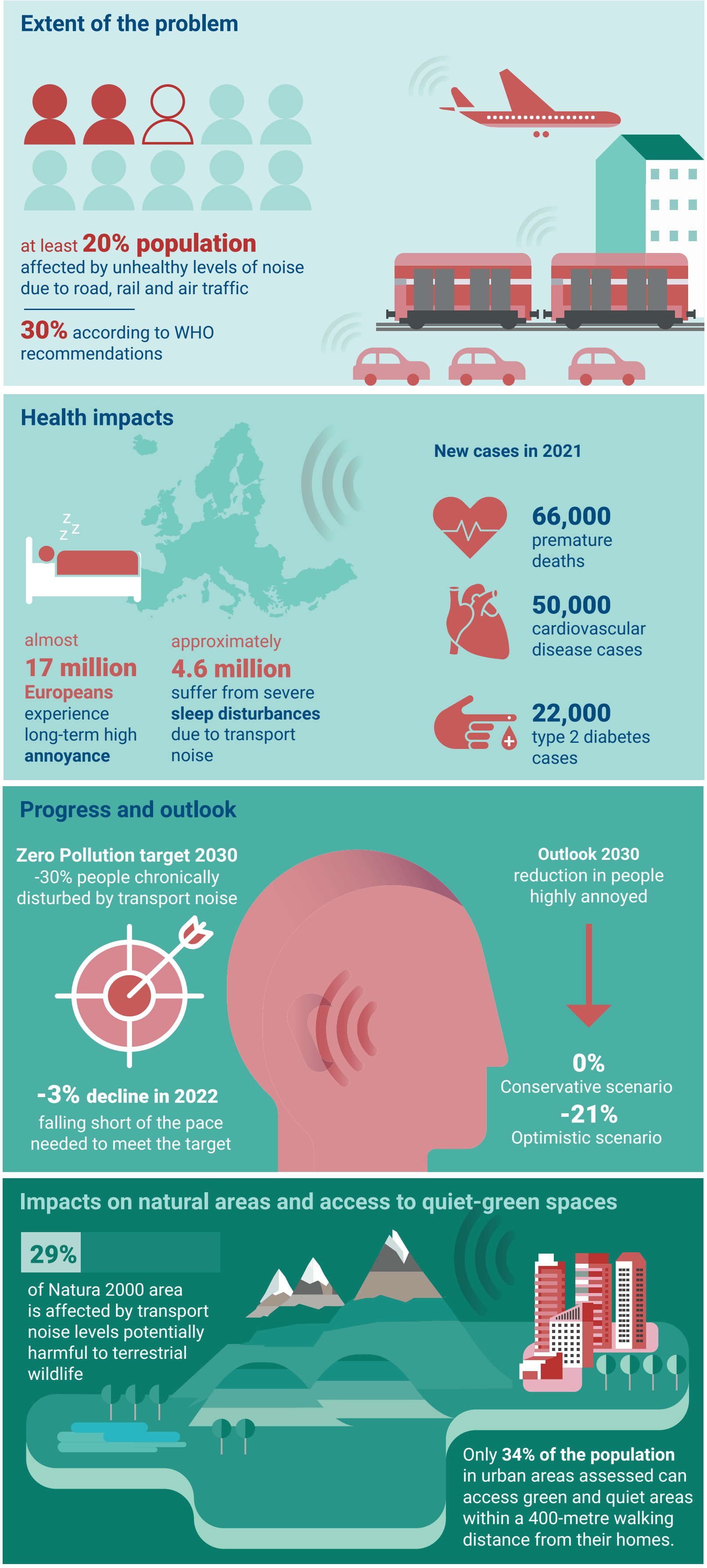
For instance, efforts to decarbonise cities and reduce pollution — through active mobility and investments in walking, cycling and public transport — can also deliver significant reductions in urban noise, especially in densely populated areas. The EU's biodiversity strategy and the Nature Restoration Regulation also present opportunities to reduce noise exposure. Creating and restoring green and blue spaces — such as urban forests, wetlands, parks and green corridors — not only improves ecological resilience but also increases the potential availability of quiet areas for recreation and restoration.

Additionally, various EU initiatives focused on preventive health, particularly concerning mental health and cardiovascular diseases, can be leveraged. Given that noise pollution is a significant risk factor for these conditions, integrating noise reduction into health strategies can yield beneficial outcomes for public well-being and resilience.

Reducing noise pollution can bring important benefits to the European economy and society

Noise pollution should also be considered in economic terms, as it causes a large BoD in Europe. In terms of economic (social) costs, years of health and life lost prematurely due to illness or death significantly reduce the human resource potential of an economy, and they are also a source of lost productivity. The report shows that noise pollution from transport sources results in annual economic costs of at least EUR 95.6 billion in Europe. This represents 0.6% of the total gross domestic product (GDP) each year. The latest EC implementation report outlines that implementing the noise measures proposed in some local and national action plans would be highly cost-efficient. A study commissioned by the EC found that for every euro spent on specific noise measures, there is a return of EUR 10 in social benefits. This indicates that when authorities in Member States adopt these specific noise measures, they not only address health concerns but also create long-term benefits for society. Noise mitigation can therefore provide economic opportunities and help establish EU manufacturers and industries as leaders in green innovation.

Figure ES.1 Key facts and figures from Environmental noise in Europe — 2025



Extent of the problem

at least **20% population** affected by unhealthy levels of noise due to road, rail and air traffic

30% according to WHO recommendations

Health impacts

almost **17 million Europeans** experience long-term high **annoyance**

approximately **4.6 million** suffer from severe **sleep disturbances** due to transport noise

New cases in 2021

66,000 premature deaths

50,000 cardiovascular disease cases

22,000 type 2 diabetes cases

Progress and outlook

Zero Pollution target 2030
-30% people chronically disturbed by transport noise

-3% decline in 2022
falling short of the pace needed to meet the target

Outlook 2030
reduction in people highly annoyed

0%
Conservative scenario

-21%
Optimistic scenario

Impacts on natural areas and access to quiet-green spaces

29% of Natura 2000 area is affected by transport noise levels potentially harmful to terrestrial wildlife

Only **34% of the population** in urban areas assessed can access green and quiet areas within a 400-metre walking distance from their homes.

1 Introduction

Noise pollution is an increasingly significant environmental and public health issue in Europe. Estimated to cause tens of thousands of premature deaths each year, it is also associated with a wide range of health conditions. These include cardiovascular, metabolic and neurological diseases, as well as mental health disorders. Consequently, noise pollution results in considerable health-related costs and a reduced quality of life for millions of people across the continent.

Since the World Health Organization (WHO) Regional Office for Europe published the *Environmental Noise Guidelines for the European Region* in 2018, the body of scientific evidence on the harmful effects of noise has continued to expand. More recent studies have established associations between noise exposure and a set of health outcomes that are broader than previously recognised. This reinforces the need for stronger, more comprehensive noise assessment and management policies.

While noise pollution can originate from many human activities, transportation systems — particularly road, rail and air traffic — remain the dominant sources throughout Europe. These sources are the primary focus of current policy frameworks and initiatives, including the European Union (EU) Environmental Noise Directive (END), the WHO guidelines and the European Commission (EC) zero pollution objective on noise. Transport noise is not only a leading contributor to health impacts but also exerts pressure on ecosystems, disrupts wildlife and acts in combination with other environmental stressors such as air pollution and climate change.

Ongoing urbanisation and increasing mobility demands are expected to further intensify exposure to transport-related environmental noise; this is particularly the case in densely-populated areas. In the EU, the END (Directive 2002/49/EC) provides the principal legislative framework for managing noise pollution from major transport sources. The directive requires countries to prepare strategic noise maps and action plans every 5 years for major roads, railways, airports and large urban areas. However, unlike air quality legislation, the END does not establish legally binding limit values for noise; it only sets reporting thresholds. This lack of limits has been identified by the European Court of Auditors (ECA) as a disincentive for Member States (MSs) to prioritise effective actions aimed at reducing noise pollution (ECA, 2025). Recognising noise as a significant public health issue and acknowledging the need for greater progress in reducing the number of people exposed to harmful noise levels, the EC adopted the zero pollution action plan in 2021, including a target to reduce the share of people chronically disturbed by transport noise by 30% by 2030.

Environmental noise in Europe – 2025 is a flagship assessment published every 5 years by the European Environment Agency (EEA). Based on data reported under the END by EU MSs and the EEA countries, it presents a detailed analysis of noise pollution across Europe and also examines its impacts on public health and the environment. The report is intended to support and inform policy development and guide effective noise mitigation measures. It will also help monitor progress toward key environmental objectives, including the 2030 zero pollution target on noise.

While previous editions primarily focused on exposure levels defined by the END thresholds, the 2025 edition places increased emphasis on assessing noise against the lower levels recommended by the WHO. This shift provides a more comprehensive understanding of the real-world impacts of noise exposure and supports ongoing policy discussions to strengthen the current legal framework through lower, more protective thresholds. In addition, this report introduces new insights into how the EU is progressing towards meeting the 2030 zero pollution ambition. It therefore marks an important step forward in assessing commitment and action on environmental noise.

1.1 Scope

The report mainly focuses on the 2022 reporting of strategic noise maps. It presents an updated overview and analysis of the noise situation in Europe as well as an assessment of the impacts on health and the environment (see Box 1.1). Through this analysis, the report aims to provide a deeper understanding of noise pollution and its impacts. This will help inform policy decisions and noise mitigation strategies that can improve the quality of life for European citizens.

The report is structured as follows:

- Chapter 2 '**Environmental noise pollution: extent of the problem in Europe**' presents the current noise situation in Europe. It assesses the number of people exposed to harmful noise levels from key sources — road, rail and aircraft traffic — in both urban and non-urban areas. Exploring the potential underestimation of noise exposure, it also discusses the implications of expanding the coverage of transport infrastructure beyond the limits of the END. In addition, the chapter evaluates changes in exposure between 2017 and 2022, providing an overview of historical trends to give broader context to the changes over time.

- Chapter 3 '**Health impacts and burden of disease (BoD) due to exposure to environmental noise**' assesses the negative health impacts of exposure to road, rail and aircraft noise in Europe. It does so using data from the END, the global BoD (GBD) study (IHME, 2021) and other key sources. It quantifies the BoD in terms of years of life lost (YLL), years lived with disability (YLD) and disability-adjusted life years (DALYs) and also estimates the related health costs. The chapter also highlights gaps between END thresholds and WHO guidelines and compares the health impacts of noise with those of other environmental pollutants.

- Chapter 4 '**Measuring progress towards the zero pollution target on noise: outlook to 2030**' evaluates progress towards the EU's zero pollution objective on noise. This objective aims to reduce the share of people chronically disturbed from transport noise by 30% by 2030 compared to 2017, using updated data from the 2022 round of noise mapping under the END. Presenting projections for 2030 under both conservative and optimistic scenarios, the chapter focuses on the number of people highly annoyed (HA) to assess whether the target is likely to be met. Based on analysis of the scenarios, the chapter provides several strategic insights into how the number of people affected by noise from transport could be significantly reduced and consequently how the zero pollution target for noise could be met.

- Chapter 5 '**Effects of environmental noise on biodiversity**' explores the evidence of the impacts of noise on terrestrial and marine wildlife. It presents the policy landscape and initiatives for mitigating noise impacts on biodiversity. It specifically assesses the extent of noise pollution within EU natural areas under Natura 2000, identifying challenges and potential solutions for preserving these vital habitats.

- Chapter 6 '**Accessibility to quiet green areas in urban centres**' explores the importance of accessibility to green areas in urban environments that are unaffected by noise. These are referred to as 'quiet areas' and the chapter highlights their role in supporting health, well-being and environmental quality. It analyses data from urban centres across Europe to assess how variations in the availability and spatial distribution of these areas influence accessibility for residents.

- Chapter 7 '**Challenges, solutions and opportunities**' outlines the current challenges in assessing and reducing noise pollution across Europe. The chapter highlights ongoing efforts and solutions implemented by EU MSs and the EU. It also identifies key opportunities to further address and mitigate the impacts of environmental noise.

Box 1.1

New in *Environmental noise in Europe — 2025*

The *Environmental noise in Europe* report presents a regular assessment of Europe's environmental noise and the associated impacts on health and the environment. Based on the latest official data available from EU MSs and EEA countries, this updated 2025 report presents new information, including:

- the current noise situation based on the latest data submitted under the END;
- an overview of the observed changes for 2017-2022;
- an outlook to 2030 based on a conservative and an optimistic scenario;
- a detailed up-to-date evaluation of the progress towards the zero pollution target on noise;
- an updated estimation of health effects, incorporating new evidence beyond the exposure–response relationships outlined in the WHO environmental noise guidelines for the European region (2018);
- an assessment of the extent of noise pollution within EU-protected areas and coastal areas;
- an assessment of the availability and accessibility of green areas unaffected by transport noise in urban centres;
- an overview of current challenges, solutions and opportunities in noise management and mitigation, based on practices implemented by countries and the EU, along with recommendations informed by the findings of this report.

1.2 Data used in this report

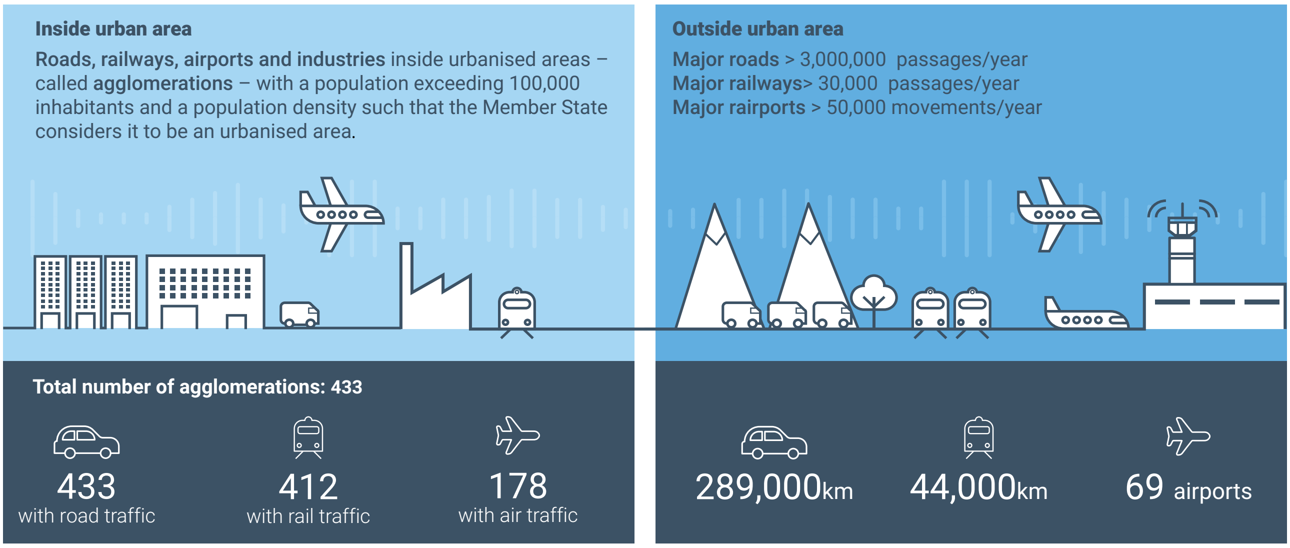
This report presents a comprehensive overview and up-to-date analysis of environmental noise in Europe. It is focused on the data officially reported by 31 EEA member countries including all 27 EU Member States (MS), Iceland, Liechtenstein, Norway and Switzerland in accordance with the END for the strategic noise maps of 2022. The END strictly applies only to EU MS but the European Environment Agency (EEA) collects data from additional EEA member countries. Throughout the report, the term '2022 strategic noise maps' is used; this is to ensure consistency with the naming convention of the EU environmental noise reporting rounds (i.e. 2012, 2017 and 2022). However, it is important to note that these maps reflect the noise situation of the previous calendar year, meaning that the 2022 maps represent data from 2021.

The data used cover noise sources, such as roads with more than 3,000,000 vehicle passages a year; railways with more than 30,000 train passages per year and airports with more than 50,000 movements per year, as well as all roads, railways, airports and industries in urban areas of more than 100,000 inhabitants (see Figure 1.1). Overall, the strategic noise maps from the END 2022 cover road, rail, air and industrial noise sources for 433 urban areas across the European territory; they also incorporate 289,000km of major roads, 44,000km of major railways and 69 major airports.

It is important to note that 2021 — the reference year for the 2022 strategic noise maps — was still affected by the COVID-19 pandemic in many European countries. On average, traffic volumes remained below pre-pandemic levels, particularly during the first half of the year. This context is important when interpreting the exposure data presented in the 2022 strategic noise maps, as some roads, railways, and, to a greater extent, airports may not have met the traffic thresholds defined by the END and were therefore excluded from the mapping. As a result, the reported data may, in some cases, underestimate typical long-term noise exposure, especially for transport modes that had not yet returned to normal activity levels in 2021.

Figure 1.1 **Coverage under the 2022 strategic noise maps of the END**

The strategic noise maps from the Environmental Noise Directive (END) 2022 cover noise sources from:



Inside urban area

Roads, railways, airports and industries inside urbanised areas – called **agglomerations** – with a population exceeding 100,000 inhabitants and a population density such that the Member State considers it to be an urbanised area.

Total number of agglomerations: 433

433 with road traffic

412 with rail traffic

178 with air traffic

Outside urban area

Major roads > 3,000,000 passages/year
Major railways> 30,000 passages/year
Major rairports > 50,000 movements/year

289,000km

44,000km

69 airports

Sources: EEA, based on data reported under the END (EEA, 2025) and EU, 2002.

While the END includes industrial noise within agglomerations, this report focuses primarily on transport noise. This focus aligns with recent EU policy priorities — particularly the EU zero pollution action plan which addresses transport noise specifically, with no explicit objectives related to industrial noise. Additionally, the WHO environmental noise guidelines for the European region (2018) do not provide recommendations or exposure-response relationships for industrial noise. This makes it difficult to assess its impact on human health using current methodologies. As a result, industrial noise is not examined in detail in this report.

In terms of noise indicators, the equivalent level for the day-evening-night noise period and the equivalent night level, as defined under the END, are used throughout the report (see Box 1.2). Within the END, these indicators are used to assess the number of people exposed to noise at the most exposed façade of the dwelling.

Box 1.2

EU noise indicators for strategic noise maps

L_{den}: refers to an A-weighted average sound pressure level (SPL) over all days, evenings and nights in a year, with an evening weighting of 5dB and a night weighting of 10dB.

L_{night}: refers to an A-weighted annual average night period of exposure.

Source: EU, 2002.

The fourth round of noise mapping was due to be finalised by countries by 31 December 2022. Because several countries did not submit the necessary data by the deadlines established in the END, gap-filling was implemented in these countries to ensure a comprehensive assessment of environmental noise across Europe. Box 1.3 presents the completeness at the date of data extraction for this report, i.e. 18 November 2024.

Box 1.3

Completeness of the data reported under the END — strategic noise maps 2022

This report is based on data submitted by countries under the END as of 18 November 2024. Overall, data completeness at the European level were high. However, a number of countries had not reported their data by this deadline. This may complicate comparisons of noise impacts across European countries.

For a detailed overview of data completeness by country, please refer to Annex 1. The table below illustrates the overall data completeness reported under the END for 2022; it indicates that the datasets for the EEA countries were approximately 84% complete.

Table 1.1 **Estimated completeness of the information reported under the END 2022 in terms of population exposure to noise, EEA-32 (excluding Türkiye)**

	Completeness of submitted data in %						
Source	Inside urban areas			Outside urban areas			Total
	Road	Rail	Air	Road	Rail	Air	All
L_{den} ≥55dB	82.2	79.2	91.1	87.3	94.3	95.5	**84.2**
L_{night} ≥50dB	82.2	80.0	97.3	89.4	94.6	94.3	**84.7**

Source: EEA, based on data reported under the END (EEA, 2025).

An overview of other data used throughout the report is presented in Table 1.2.

Table 1.2 Overview of other sources of data used throughout the report

Population data	Used to calculate impacts and country population averages from the Eurostat demographics database for the year 2021.	(Eurostat, 2025a)
Health data	Country-specific baseline incidence data from the GBD study for 2019. This reference year was chosen to avoid potential artefacts in disease incidence associated with increases linked to COVID-19 pandemic.	(IHME, 2021)
Economic data	European GDP for the year 2021.	(Eurostat, 2024)
Local administrative units (LAU)	LAU units and nomenclature of territorial units for statistics (NUTS) regions' boundaries and total population for the year 2021.	(Eurostat, 2021)
Land cover data	Land cover and street data from Urban Atlas, 2018.	(Copernicus, 2018)

Notes: GDP, gross domestic product. NUTS, nomenclature of territorial units for statistics.

1.3 END reporting thresholds versus WHO recommended noise levels

The EU END establishes noise reporting thresholds that MSs must use to map and report the number of people living in areas that exceed these thresholds. Specifically, the reporting thresholds are set at 55 decibels (dB) for the day-evening-night period and 50dB for the night period, reflecting outdoor noise levels as an annual average (EU, 2002).

In contrast, the levels recommended by the WHO are lower than the reporting thresholds established in the END (see Table 1.3). The WHO environmental noise guidelines for the European region (WHO, 2018) provide maximum outdoor exposure levels for different noise sources above which significant negative health effects may occur (see Box 1.4). Consequently, a knowledge gap exists regarding the assessment of noise impacts at the European level for values below the END thresholds.

This report explores health effects by considering both WHO and END thresholds in order to explore the difference in the estimated health effects between the two methods. However, despite this approach, it is likely that the health impacts of noise are still underestimated. Emerging research indicates that negative health effects can begin at much lower levels than the thresholds for reporting of exposure under the END and even the WHO recommendations. Many studies suggest that effect thresholds may be as low as a 45dB L_{den} (Münzel et al., 2025; ETC HE, 2024b).

Table 1.3 **END reporting thresholds and WHO recommended noise levels**

Noise source	Noise indicator	END reporting thresholds	WHO environmental noise guidelines
Road	L_{den} 24-hour annual average with weightings for the evening and night periods.	55dB	53dB
	L_{night} Annual average for the night period.	50dB	45dB
Rail	L_{den} 24-hour annual average with weightings for the evening and night periods.	55dB	54dB
	L_{night} Annual average for the night period.	50dB	44dB
Air	L_{den} 24-hour annual average with weightings for the evening and night periods.	55dB	45dB
	L_{night} Annual average for the night period.	50dB	40dB

Notes: L_{den}, day-evening-night noise level. L_{night}, night noise level.

Sources: EU, 2002 and WHO, 2018.

Box 1.4

WHO environmental noise guidelines for the European region

In 2018 the WHO regional office for Europe published a guidance document entitled 'Environmental noise guidelines for the European region'. To compile this guidance, the WHO commissioned a series of systematic reviews. These reviews evaluated evidence encompassing a large amount of previously-reported research from all over the world, including large-scale epidemiological studies and socio-acoustic surveys. These analyses led to the establishment of recommended noise levels for various sources, above which there is a relevant increase in negative effects. These levels are expressed in terms of L_{den} and L_{night} and relate to outdoor noise as an annual average (as outlined in Table 1.3). The recommendations for all sources of traffic noise were considered to be 'strong', meaning that the recommendation can be adopted as a policy in most situations. These guideline values are based on the confidence that reducing noise to the stated levels will outweigh any potential adverse consequences.

While the document does not explicitly specify how the recommended levels were set, the proposed thresholds appear to be based on the point at which 10% of the population reports being highly annoyed or highly sleep disturbed. This is why different sources have different noise recommendations. For example, the thresholds for aircraft noise are significantly lower than those for road or rail. This difference is attributed to the greater annoyance and sleep disturbance people experience from aircraft noise compared to road or rail noise at equivalent levels.

It is important to note that since the publication of the guidelines, subsequent studies have indicated that negative effects for road and rail noise may begin at levels as low as 45 L_{den}, particularly for some cardiovascular diagnoses or diabetes (Münzel et al., 2025; ETC HE, 2024b).

The assessment of population exposure to harmful noise levels using the WHO recommended levels relies on data reported under the END, as outlined in Section 1.1, along with extrapolations to lower noise levels, as described in ETC HE (2024b). In a limited number of cases, extrapolation was not necessary. This was because some countries, for all or specific sources and agglomerations, voluntarily provided data that extended below the END thresholds. However, this provision of data below the END reporting thresholds was still infrequent. Detailed data by country, source and agglomeration that were provided below the END thresholds can be found in the EEA Datahub (EEA, 2025).

1.4 Coverage limitation of the END: implications for the assessment

This report is based on the areas and noise sources covered by the END, as outlined in Section 1.2. Consequently, the assessment does not fully account for all urban areas, roads, railways, airports, or other noise sources across Europe. As a result, the findings presented here likely represent a considerable underestimation of the true impact of environmental noise. Considering a broader range of transport infrastructure than what is currently covered under the END would likely increase the impacts identified in this assessment. Chapter 2 provides a preliminary estimate of this underestimation, focusing on areas that are not currently included under the directive.

1.5 Comparability across countries

For the data presented in this report, countries have employed common noise assessment methods for Europe known as CNOSSOS-EU for the first time (EU, 2015). However, variations can be expected between countries regarding network coverage within urban areas and also the level of detail used as input data in the noise models. For example, different methods might be applied based on the types of buildings and the information available to local authorities about building layouts. Noise exposure can be assessed by focusing on the loudest façade of a building, whether it is a detached house, a semi-detached home, or an apartment building with known layouts. These differences mean that results from various countries might not be directly comparable. It is therefore important to interpret the findings of individual countries with caution.

2 Environmental noise pollution: extent of the problem in Europe

Key messages

- More than 20% of Europeans (112 million) live in areas where transport noise levels are harmful to health according to END thresholds. This percentage is much higher in many urban areas.
- When measured against the WHO's stricter noise recommendations, over 30% of Europeans are exposed to noise levels known to increase the risk of cardiovascular, metabolic and mental health disease.
- These figures are likely underestimated as many roads, railways, airports and urban areas are not fully covered by current EU noise reporting requirements.
- Road traffic is the main source of noise pollution in both urban and non-urban settings. Noise from railways and aircraft has a much lower impact in terms of the overall population, yet both are significant sources of local noise pollution.
- It is estimated that there has been a very small decline of 0.5% in the number of people exposed to unhealthy noise levels. This could be attributable to reduction measures between 2017-2022. However, it is challenging to draw definitive conclusions about this trend due to changes in the calculation methodologies employed between these years.

2.1 How big a problem is noise pollution in Europe? — Overall European picture in 2022

A significant proportion of Europe's population is exposed to transport noise levels that are harmful to health. The latest estimates show that approximately 112 million people — more than 20% of the population within the EEA-32 region (excluding Türkiye) — are exposed to long-term noise levels from road, rail and aircraft sources that exceed the thresholds set by the END. Table 2.1 provides a detailed breakdown of population exposure by noise source and location (urban versus non-urban areas).

The data clearly show that road traffic is the dominant source of environmental noise in both urban and non-urban settings. Based on the END thresholds, it accounts for around 92 million people being exposed to harmful day-evening-night noise levels (L_{den} ≥55dB), while 58 million are exposed during the nighttime (night noise level (L_{night}) ≥50dB). In comparison, railway noise affects 18 million people during the day-evening-night period and 13 million at night. In contrast, aircraft noise impacts around 2.6 million (day-evening-night) and fewer than 1 million during the night. While rail and aircraft noise affect fewer people overall, they remain significant sources of local noise pollution. This is particularly the case near major transport corridors and airports.

Urban areas are the most affected. Roughly 69 million people are exposed to harmful levels of road traffic noise in urban environments. Similarly, a larger share of the population is affected by railway and aircraft noise in urban areas compared to non-urban settings.

Table 2.1 **Estimated number of people exposed to long-term harmful levels of road, rail and aircraft noise, based on END thresholds, EEA-32 (excluding Türkiye)**

	Road	Railway	Aircraft
	Day-evening-night noise levels (L_{den} ≥55dB)		
Urban areas	68,860,000	9,210,000	1,630,000
Outside urban areas	23,020,000	8,360,000	960,000
Total	91,880,000	17,570,000	2,590,000
	112.04 million (24% of total population)		
	Nighttime noise levels (L_{night} ≥50 dB)		
Urban areas	43,840,000	6,440,000	480,000
Outside urban areas	14,450,000	6,510,000	330,000
Total	58,290,000	12,950,000	810,000
	72.05 million (16% of total population)		

Notes: The overall total number and percentage of people exposed may include double counting due to individuals being exposed to more than one source of noise.

Source: EEA, based on data reported under the END (EEA, 2025).

Noise pollution is a widespread issue affecting all countries. Unhealthy levels of noise pollution are prevalent in all European countries, as illustrated in Table 2.1. A total of 15 countries have more than 20% of their populations exposed to transport noise levels exceeding a 55dB L_{den}. Conversely, only three countries — Estonia, Slovakia and Portugal — are estimated to have less than 10% of their populations exposed to levels above the END thresholds.

When examining the absolute numbers, France, the largest EU country in terms of land area, reports the highest total population exposed to transport noise above a 55dB L_{den}, with an estimated 24 million people being affected. Meanwhile, Germany has the highest number of individuals exposed to harmful noise during the nighttime hours, affecting approximately 15 million people. In percentage terms, over 50% of the population is exposed to harmful noise levels in Cyprus and Luxembourg.

Table 2.1 **Estimated number of people and percentage exposed to harmful noise levels above END thresholds per country, EEA-32 (excluding Türkiye)**

		Number of people exposed ≥55dB L_{den}/≥50dB L_{night}				Percentage over country population
Country	**Indicator**	**Road**	**Rail**	**Air**	**All Sources Total**	**Total END thresholds**
Austria	L_{den}	2,081,600	780,700	39,300	2,901,600	32
	L_{night}	1,204,300	578,300	2,900	1,785,500	20
Belgium	L_{den}	2,400,300	441,900	99,000	2,941,200	25
	L_{night}	1,783,000	284,400	42,600	2,109,900	18
Bulgaria	L_{den}	1,123,200	116,400	1,900	1,241,400	19
	L_{night}	710,100	78,100	200	788,300	12
Croatia	L_{den}	702,400	24,700	0	727,100	19
	L_{night}	512,300	14,500	0	526,800	14
Cyprus	L_{den}	455,600	0	9,200	464,700	52
	L_{night}	324,100	0	3,500	327,600	36
Czechia	L_{den}	2,209,200	194,100	45,100	2,448,400	23
	L_{night}	1,356,300	146,200	14,900	1,517,500	14
Denmark	L_{den}	886,600	30,800	700	918,000	16
	L_{night}	602,700	14,700	600	618,000	11
Estonia	L_{den}	108,200	4,900	12,400	125,500	9
	L_{night}	38,900	3,800	1,800	44,500	3
Finland	L_{den}	824,300	124,000	2,300	950,600	17
	L_{night}	431,600	81,900	300	513,800	9
France	L_{den}	21,214,300	2,471,000	591,400	24,276,600	36
	L_{night}	12,644,600	1,656,200	212,300	14,513,100	21
Germany	L_{den}	17,270,900	3,770,900	852,500	21,894,300	26
	L_{night}	11,782,400	2,826,600	273,600	14,882,600	18
Greece	L_{den}	984,700	117,900	34,800	1,137,400	11
	L_{night}	608,200	79,200	13,700	701,000	7
Hungary	L_{den}	1,459,100	266,900	42,500	1,768,400	18
	L_{night}	956,100	185,400	6,200	1,147,700	12
Iceland	L_{den}	101,300	0	1,300	102,600	28
	L_{night}	54,300	0	800	55,100	15
Ireland	L_{den}	1,033,300	92,700	13,400	1,139,400	22
	L_{night}	538,400	60,800	3,600	602,800	12
Italy	L_{den}	8,936,100	5,329,300	264,100	14,529,500	25
	L_{night}	6,248,700	4,313,600	67,400	10,629,700	18
Latvia	L_{den}	304,400	29,500	2,300	336,100	18
	L_{night}	182,300	46,200	900	229,400	12
Lithuania	L_{den}	360,100	10,500	13,400	384,000	14
	L_{night}	195,000	7,400	4,900	207,400	7
Luxembourg	L_{den}	340,100	27,900	69,900	437,800	68
	L_{night}	245,900	19,600	48,700	314,200	49
Malta	L_{den}	54,000	0	11,100	65,100	13
	L_{night}	37,000	0	400	37,400	7
Netherlands	L_{den}	3,855,600	423,800	12,200	4,291,600	24
	L_{night}	2,194,900	242,200	600	2,437,600	14
Norway	L_{den}	762,600	109,800	23,600	896,100	17
	L_{night}	482,000	73,700	6,400	562,100	10
Poland	L_{den}	4,549,500	648,800	79,900	5,278,200	14
	L_{night}	3,043,300	458,400	15,800	3,517,500	10

Portugal	L_{den}	712,700	107,000	109,600	929,300	9
	L_{night}	421,100	76,100	48,100	545,300	5
Romania	L_{den}	3,980,700	395,500	19,200	4,395,400	23
	L_{night}	2,900,100	219,400	3,700	3,123,200	16
Slovakia	L_{den}	344,200	108,000	6,100	458,400	8
	L_{night}	206,300	77,000	600	283,900	5
Slovenia	L_{den}	193,000	46,100	0	239,000	11
	L_{night}	111,300	32,600	0	143,800	7
Spain	L_{den}	10,810,600	772,500	164,900	11,748,000	25
	L_{night}	6,485,000	506,400	21,700	7,013,100	15
Sweden	L_{den}	2,046,500	929,300	10,100	2,985,800	29
	L_{night}	1,140,500	738,100	0	1,878,700	18
Switzerland	L_{den}	1,834,400	194,000	61,100	2,089,500	24
	L_{night}	849,500	127,100	9,500	986,100	11

Notes: Colours from green to red. Red colour indicates higher percentages and higher number of population exposed to harmful noise levels. There are several countries where exposure has been totally or partially estimated. Please refer to Annex 1 and Annex 3 for data completeness per country and comparability interpretation.

Source: EEA, based on data reported under the END (EEA, 2025).

The variation among countries in the percentage of people exposed to harmful noise levels can be attributed to several factors. These include differences in noise mapping methodologies, the accuracy of input data and the structure and density of transport networks. Attributing factors also include the population density and number of agglomerations, as well as the effectiveness of noise management strategies. As such, country-by-country comparisons should be approached with caution (see Box 2.1).

Box 2.1

Challenges in comparing noise exposure across countries

Despite the adoption of the CNOSSOS-EU harmonised methodology for strategic noise mapping, comparability across countries remains difficult. Differences persist in both the accuracy of input data used and the extent of mapping. This is particularly the case for road and rail noise in urban areas — even within individual countries.

Countries using more precise data and conducting more comprehensive mapping often report higher numbers of people exposed to noise. This is not necessarily due to greater noise impact but rather reflects a more accurate assessment of exposure. For example, urban areas in Cyprus, Belgium and Luxembourg have mapped a large share of their street networks. This is likely to make their reported impacts appear higher compared to cities that assess only a selected set of busy roads. For more information on road and rail coverage in urban areas, see Annex 3.

The uneven road and rail coverage in urban areas means that many people exposed to harmful noise may be overlooked in areas where mapping is limited. On average, the coverage of roads within urban noise maps is about 66%, while railway noise coverage reaches approximately 80%. However, there is significant variation both across countries and between cities within the same country.

Besides coverage, the precision of the data used in modelling also influences results. These variations make cross-country and cross-city comparisons challenging. Countries with more detailed mapping and accurate input data are better positioned to reflect the true extent of environmental noise exposure.

When considering specific noise sources, the population exposed to road traffic noise surpasses that exposed to railway or aircraft noise in all countries. Railway and aircraft noise have a particular impact in countries with dense rail networks and major airports located near urban agglomerations.

In addition to transport noise sources, the END also considers industrial activity in urban areas (see Box 2.2). However, the number of people affected is very small compared to transport noise. Nonetheless, it can be an important source of noise in affected areas.

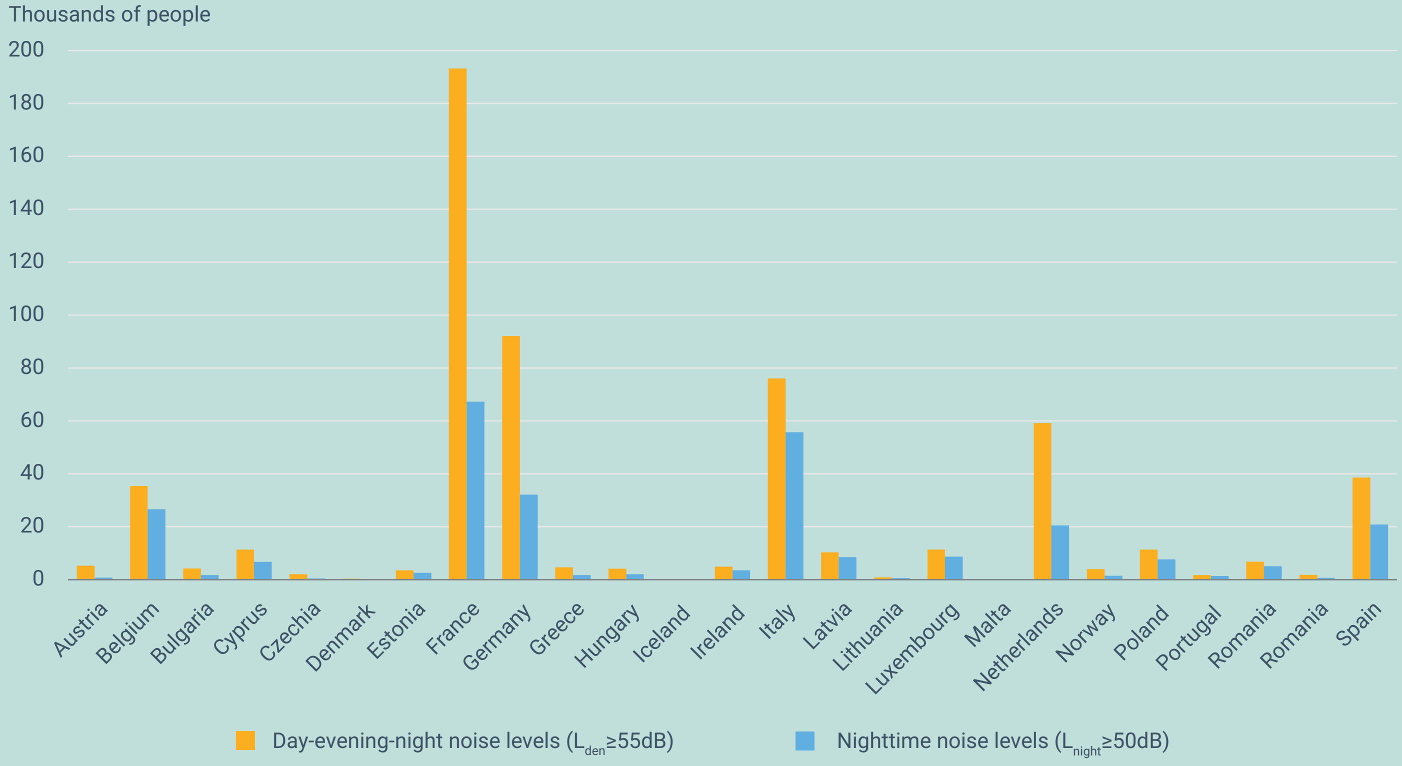
Box 2.2

Number of people affected by industry noise in urban areas

Strategic noise maps for urban areas defined under the END must account for noise from industrial sites, including ports. The impacts of industrial noise are typically very localised, as industries are usually situated in designated areas away from residential buildings. In many cases, these industrial sites fall outside the boundaries of established agglomerations. From the latest data, it is estimated that across all of Europe, a total of 584,000 people are exposed to noise levels of 55dB or higher during the day-evening time, while 277,000 are affected during the nighttime period. Therefore, industrial noise affects a much smaller population compared to transport noise sources.

Of all the countries, France experiences the highest industrial noise exposure, with approximately 193,000 people affected by noise levels of 55dB or higher during the day, evening or night. Germany follows with 92,000 people being exposed, while Italy is third with 76,000. On the other hand, some countries have minimal exposure to industrial noise such as Iceland, Denmark, or Lithuania.

Figure 2.1 **Number of people exposed to noise from industry, as defined by the END, EEA-32 (excluding Türkiye)**



Note: For completeness of data across countries, please refer to Annex 1.

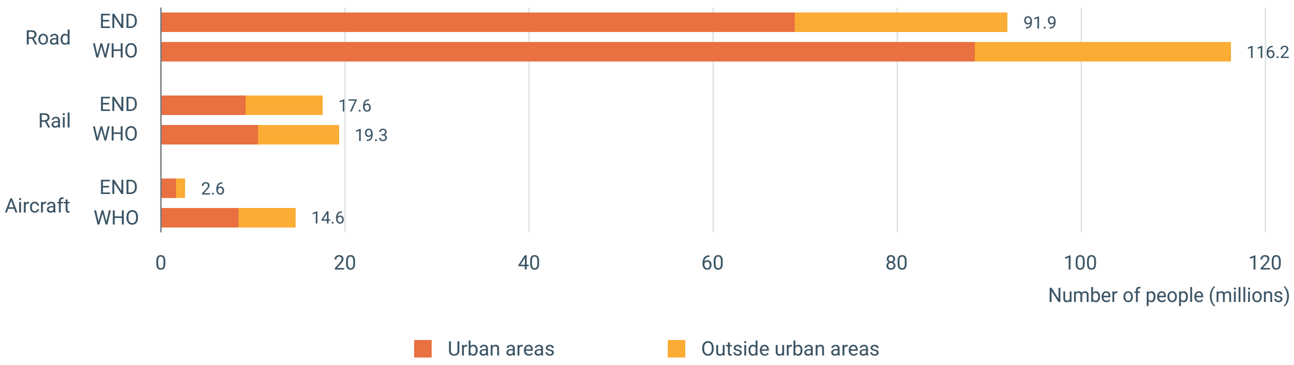
Source: EEA, based on data reported under the END (EEA, 2025).

2.2 Population noise exposure assessment based on WHO recommendations

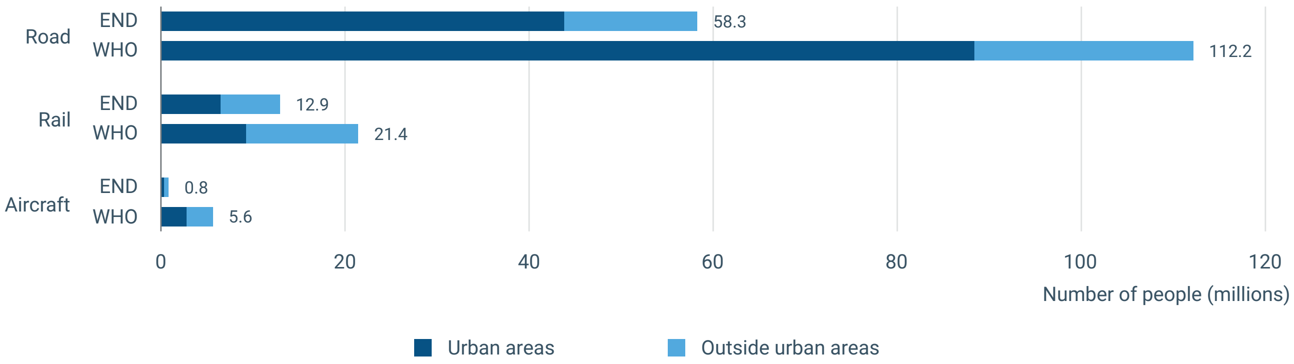
Many health impacts for Europe's population occur even at noise levels below the thresholds established by the END. WHO recommends lower noise levels (see Section 1.4), which means that many more individuals are identified as being exposed to transport-related noise that could adversely affect their health. When considering the WHO recommendations (see Figure 2.2), it is estimated that approximately 150 million people — over 30% of the population — are exposed to long-term unhealthy noise levels from transportation sources for the day-evening-night period. This represents a significant increase compared to END estimates. Furthermore, around 139 million people are estimated to be affected by harmful nighttime noise levels.

Figure 2.2 **Estimated number of people exposed to long-term harmful levels of road, rail and aircraft noise according to END thresholds and WHO recommended noise levels, EEA-32 (excluding Türkiye)**

Number of people exposed to day-evening-night (L_{den}) long-term harmful levels of noise based on END thresholds and WHO recommendations



Number of people exposed to nighttime (L_{night}) long-term harmful levels of noise based on END thresholds and WHO recommendations



Notes: Please refer to Section 1.3 for the WHO source specific thresholds used in this figure.

Source: EEA, based on data reported under the END (EEA, 2025) and the methodology described in Section 2 of ETC HE, 2024b.

The results show that applying the END thresholds provides a lower estimate of the number of people exposed to harmful noise levels. Specifically, these estimates are lowered by approximately 25% for day-evening-night exposure and nearly 48% for nighttime levels when compared to the WHO recommended levels.

Population exposure during the nighttime is significantly lower using the END thresholds. This is because the WHO recommended levels differ by a greater margin in dB compared to those for the day-evening-night period. For example, while the END sets nighttime thresholds at 50dB, the WHO recommends 45dB for road noise, 44dB for rail noise and 40dB for aircraft noise. The most substantial relative underestimation occurs with aircraft noise, as the WHO recommendations for aircraft noise are much more stringent than those for road or railway noise.

Additionally, as the END does not comprehensively cover all urban areas or account for every road, railway and airport across Europe (see Section 1.4), the actual number of people exposed is likely to be higher. An estimation of the total number of people potentially affected by noise is presented in Box 2.3.

Box 2.3

Implications of expanding END coverage for transport infrastructures

The END only covers major road, rail and airport infrastructures and agglomerations of more than 100,000 inhabitants (see Section 1.2).

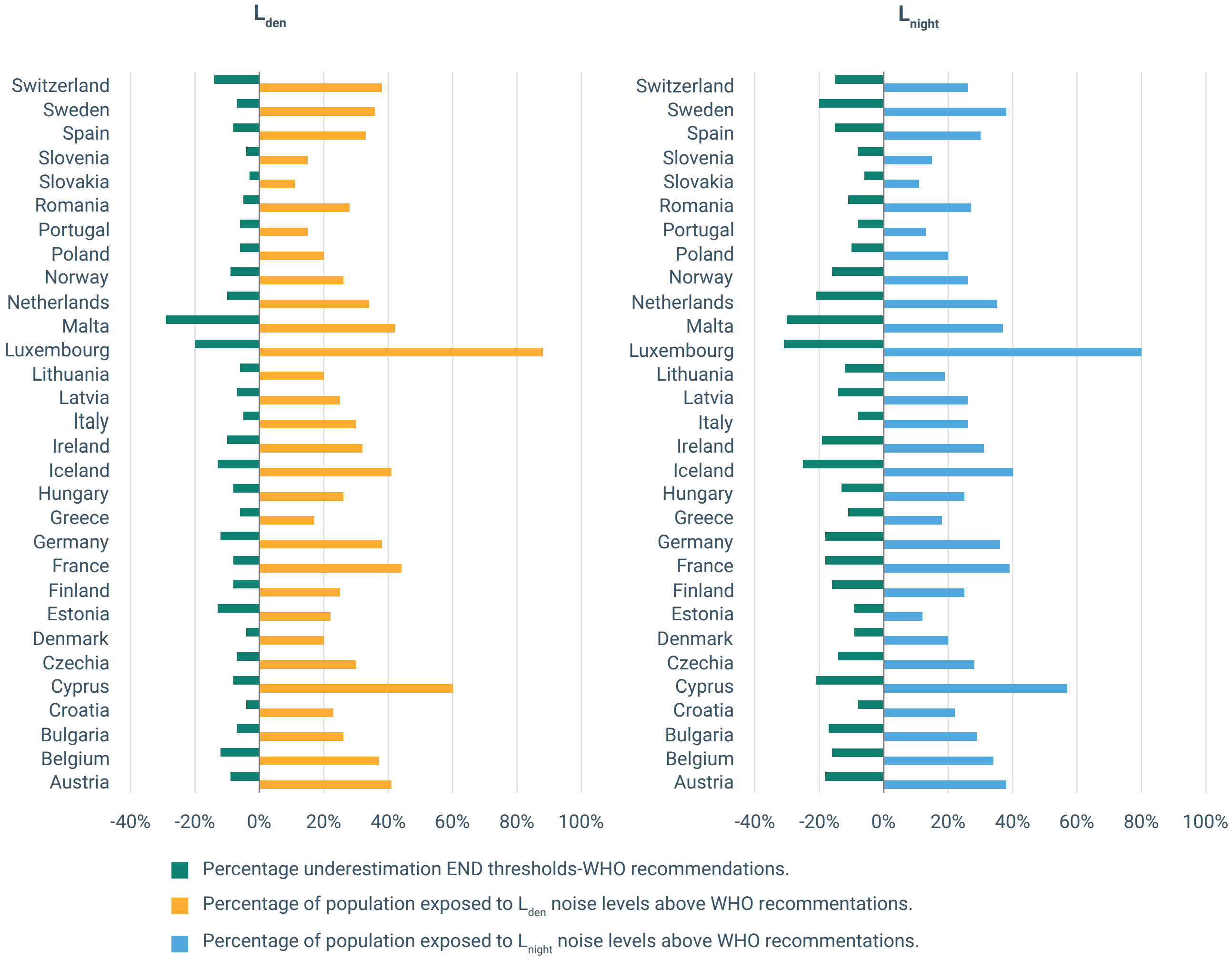
Preliminary analyses (see Annex 2) suggest that if a broader range of transport infrastructures were considered – specifically roads and railways outside agglomerations with fewer than 3 million vehicle and 30,000 train passes per year, as well as all roads and railways within smaller agglomerations of up to 50,000 inhabitants – the estimates of noise exposure could increase significantly:

- Approximately 200 million people could be exposed to road noise levels above a 55dB L_{den} and 135 million could experience nighttime levels exceeding a 50dB L_{night}.
- Around 130 million people might be exposed to rail noise levels above a 55dB L_{den}, with 86 million affected by nighttime levels over a 50dB L_{night}.

Source: EEA, Annex 2.

In terms of individual countries, considering WHO recommended levels, countries may underestimate the amount of people exposed to harmful levels by 3% to 30%. These underestimations are dependent on factors such as population density and the presence of major agglomerations and transport sources like railways and airports (see Figure 2.3).

Figure 2.3 **Percentage of people exposed to long-term harmful levels of road, rail and aircraft noise according to WHO recommended noise levels per country and percentage difference between END thresholds and WHO recommended levels, EEA-32 (excluding Türkiye)**



Notes: There are several countries where exposure has been totally or partially estimated. Please refer to Annex 1 and Annex 3 for data completeness per country and comparability interpretation.

Source: EEA, based on data reported under the END (EEA, 2025) and methodology described in Section 2 of ETC HE, 2024b.

2.3 Distribution of people exposed across noise levels

The END requires population exposure to environmental noise to be reported in 5dB bands above the defined thresholds for the L_{den} and L_{night}. Health risks increase with higher levels of exposure and the suitability of noise abatement measures may vary depending on both the noise source and the specific exposure range.

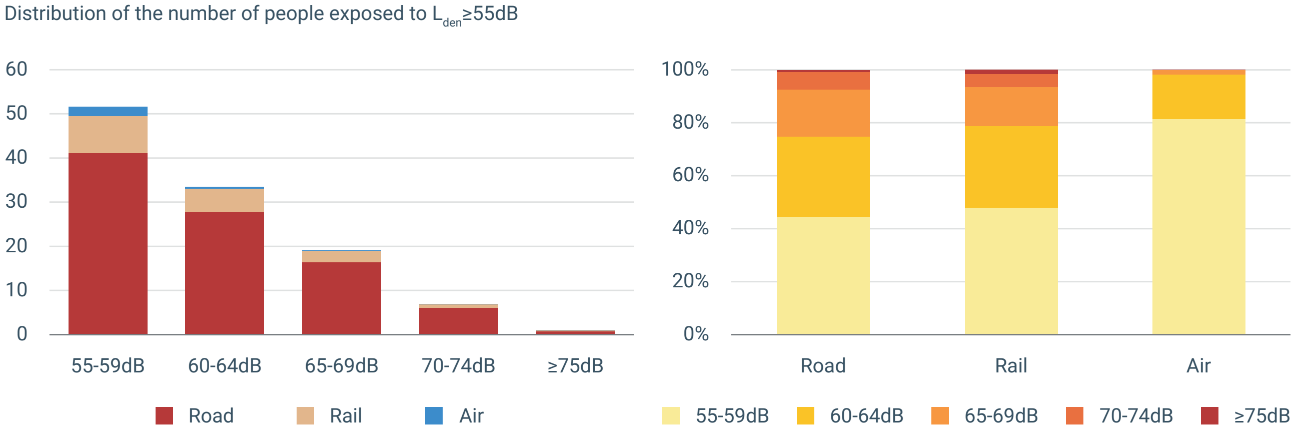
Figure 2.4 presents noise exposure data, as reported by the EEA member countries, for population exposure above a 55dB L_{den} and 50dB L_{night}. The majority of people exposed fall into the lower dB bands, i.e. a 55–60dB L_{den} and 50–60dB L_{night}. However, these levels are already associated with increased health risks (see Chapter 3).

A substantial number of people are exposed to higher noise levels. Specifically, around 17 million people are exposed to noise at or above a 65dB L_{den}, while approximately 11 million are exposed to nighttime noise at or above a 60dB L_{night}. Road traffic noise and railway noise are the sources which expose the highest number of people to these upper noise bands.

Figure 2.4 **Distribution of the exposed population within each source, per noise band, EEA-32 (excluding Türkiye)**

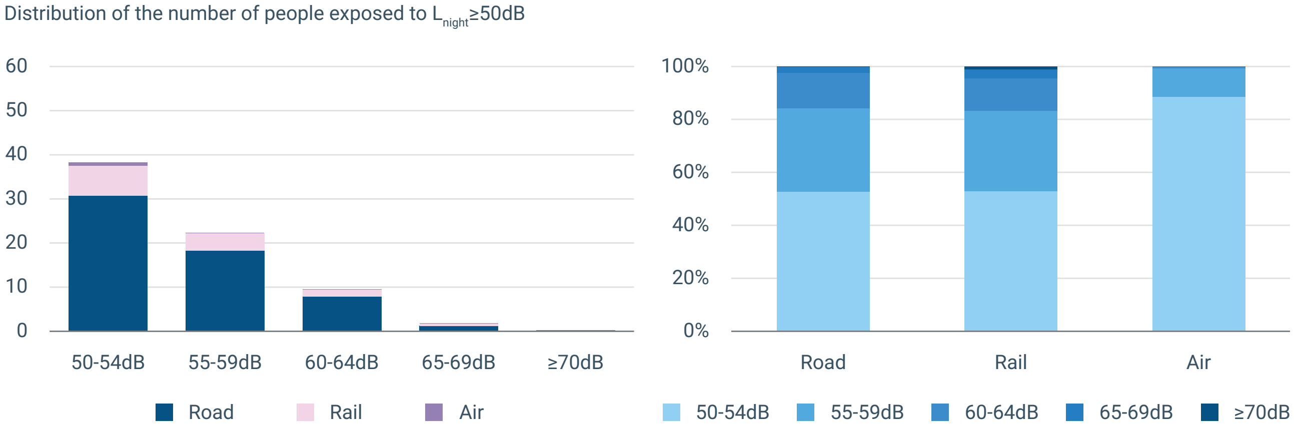
Distribution of the number of people exposed to noise from road, rail and air traffic in 5dB bands for the L_{den} period

Distribution of the exposed population within each source, per noise band, using the L_{den} indicator



Distribution of the number of people exposed to noise from road, rail and air traffic in 5dB bands for the L_{night} period

Distribution of the exposed population within each source, per noise band, using the L_{night} indicator



Source: EEA, based on data reported under the END (EEA, 2025).

2.4 Detailed assessment: population exposed to road, rail and aircraft noise in Europe

The number of people exposed to noise from road traffic far exceeds those exposed to rail and aircraft. This is true at the European level, at the country level and both inside and outside urban areas. This is due to the greater extent of the road network (see Table 2.3). Specifically, under the terms of the END, for the strategic noise maps of 2022, countries needed to assess noise levels for 289,000km of major roads with more than 3 million vehicle passages a year outside agglomerations; this is in addition to all roads within 433 urban areas. In contrast, there are 44,000km of major railways outside urban agglomerations, with 412 cities containing railway infrastructure. Additionally, there are 69 major airports while 178 cities experience some level of air traffic noise from either major or minor airports.

Table 2.3 **Estimated length of major road and rail infrastructure, number of major airports and agglomerations to be reported under END strategic noise maps for 2022, EEA-32, (excluding Türkiye)**

Source	Outside urban areas (major infrastructure)	Inside urban areas (number of agglomerations)
Road	289,000km	433 with road traffic
Rail	44,000km	412 with rail traffic
Aircraft	69 airports	178 with air traffic
Total agglomerations	**433**	

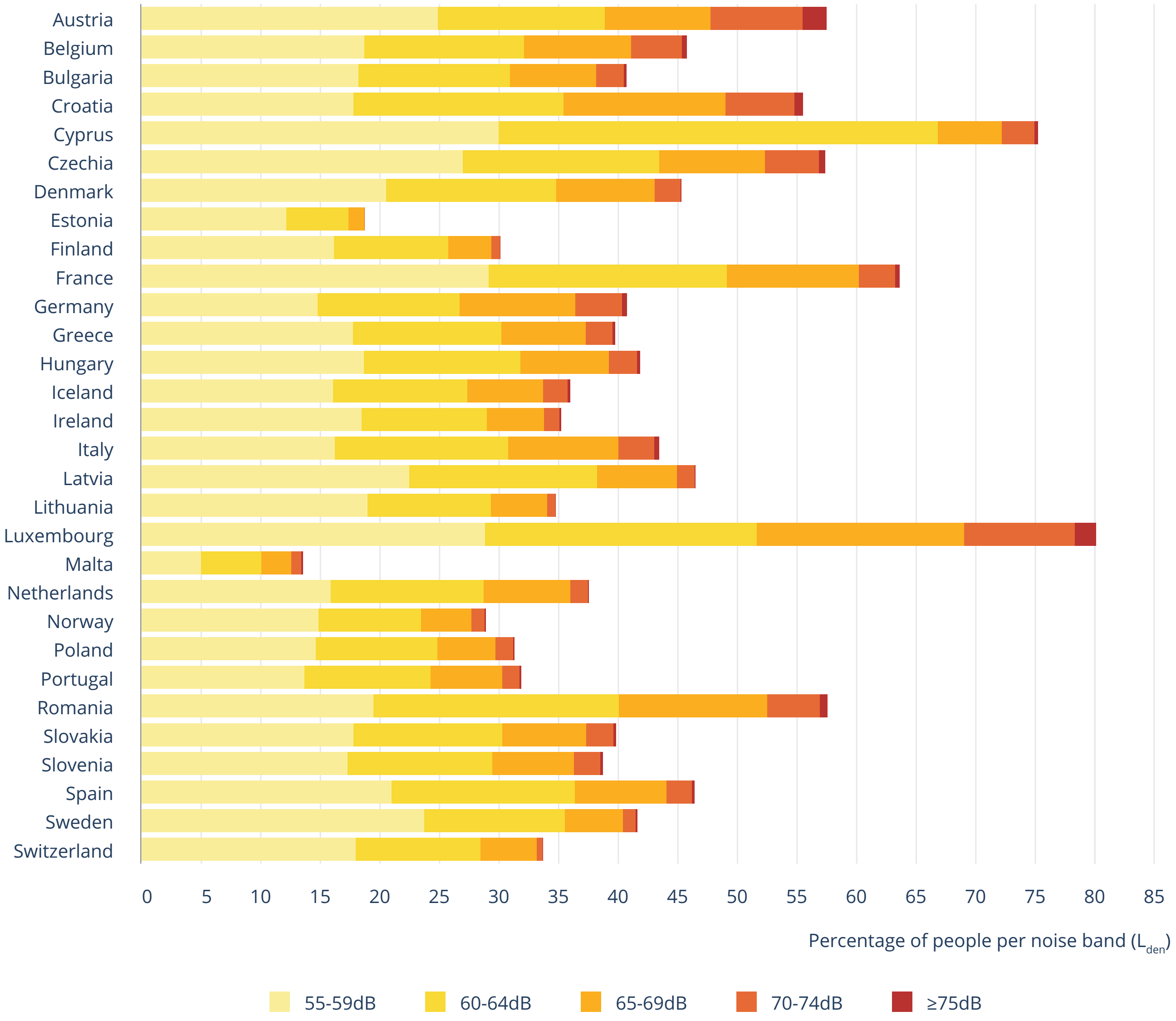
Source: EEA, based on data reported under the END (EEA, 2025).

2.4.1 Population exposed to road traffic noise

It is estimated that approximately 69 million people are affected by levels of road traffic noise of at least 55dB during the day-evening-night period inside urban areas. Adding to this figure, the number of people exposed to major roads outside urban areas is estimated to be 23 million. In terms of nighttime noise, the figures are 44 million and 14 million, respectively. This means that, according to the END thresholds, 20% of the population during the day-evening-night period and 13% during the nighttime period are exposed to high levels of road traffic noise. As noted in Section 2.2, these values are likely underestimated.

A large number of people across countries and cities are exposed to road traffic noise in urban areas. As shown in Figure 2.5 and Map 2.1, most countries and cities report that 30-50% of their urban populations are exposed to road noise levels of 55dB or higher during the day-evening-night period. Therefore, the issue of road traffic noise and associated negative health effects in urban areas is not confined to a few cities or specific countries; it is a widespread concern throughout Europe.

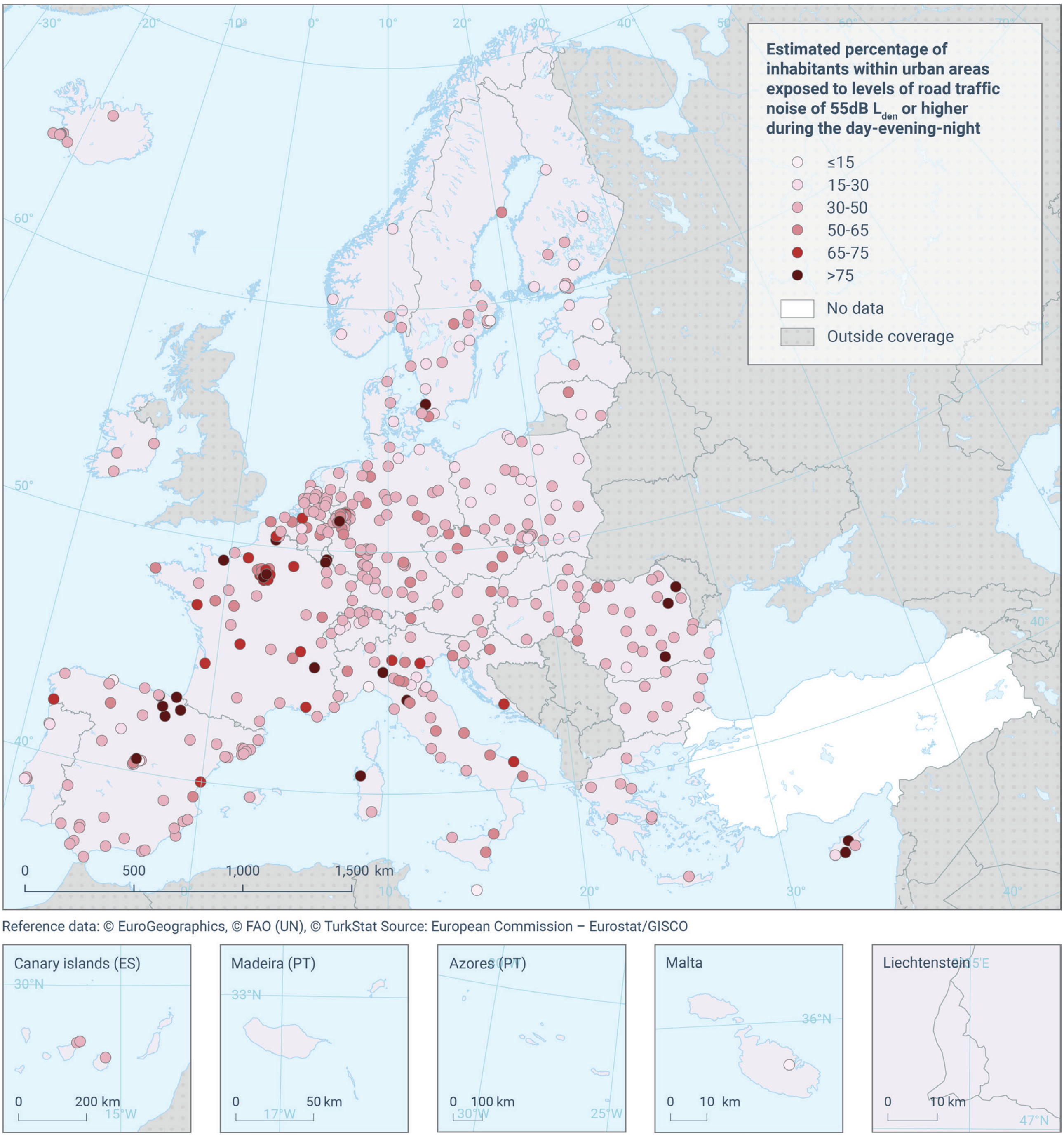
Figure 2.5 **Estimated percentage of inhabitants within urban areas across countries exposed to road traffic noise levels using the day-evening-night indicator (L_{den}), based on END thresholds**



Notes: For comparability and interpretation of data across countries, please refer to Box 2.1 and Annex 1 and 3.

Source: EEA, based on data reported under the END (EEA, 2025).

Map 2.1 Estimated percentage of inhabitants within urban areas exposed to levels of road traffic noise of 55dB L_{den} or higher during the day-evening-night



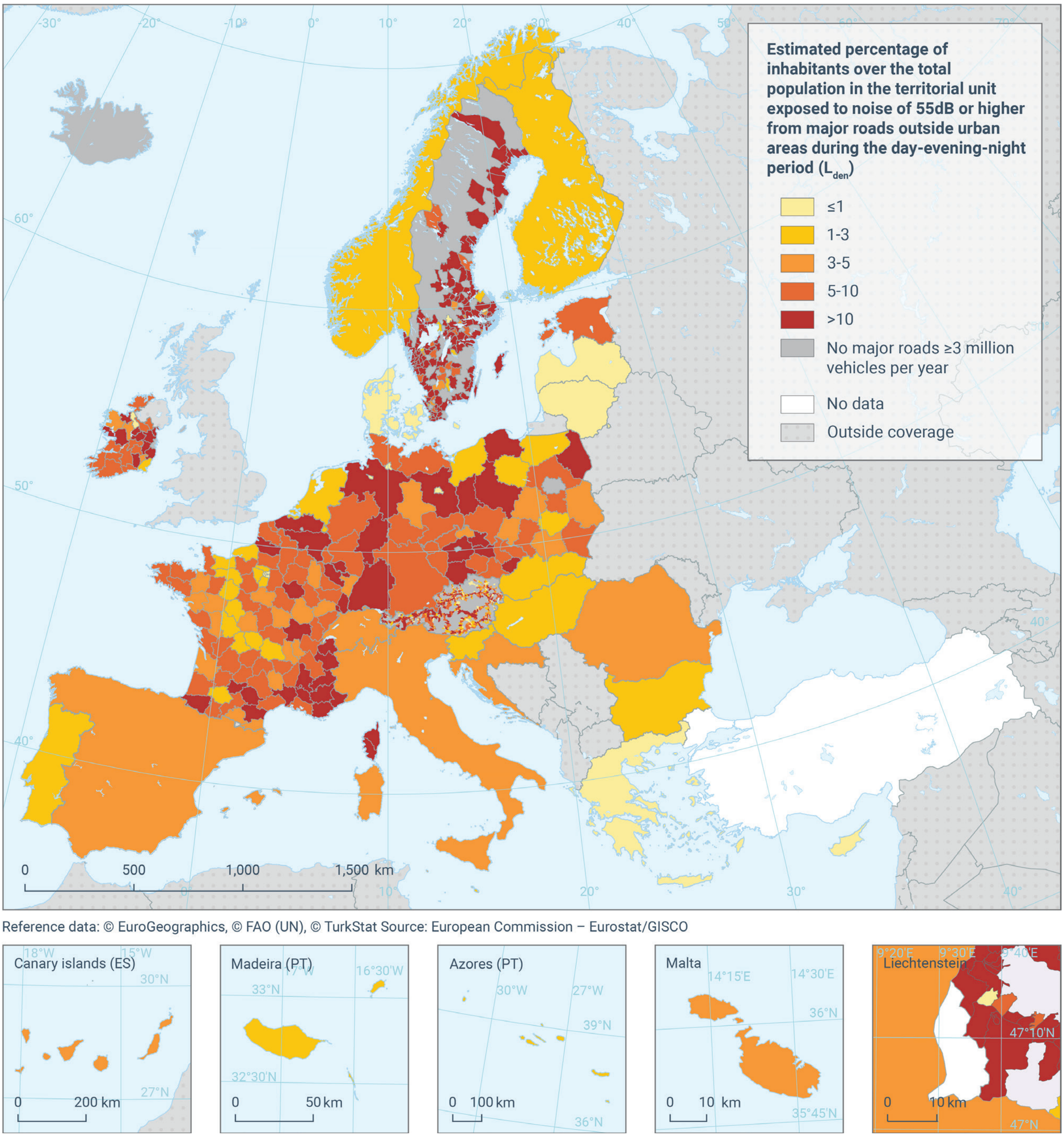
Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: For comparability and interpretation of data across countries, please refer to Box 2.1 and Annex 1 and 3.

Source: EEA, based on data reported under the END (EEA, 2025).

Map 2.2 illustrates the percentage of a country's population exposed to noise from major roads located outside urban areas. Certain regions show significantly higher exposure levels; this is especially the case in areas with extensive road networks and dense populations. The proportion of individuals affected by noise from these major roads varies widely among different territorial units; specifically, it ranges from less than 1% in Lithuania, Latvia and Denmark to over 5% in Estonia and Luxembourg. In countries that report smaller territorial units, notable variations can be observed within the country itself. Areas closer to roads or with a higher density of roads and inhabitants tend to have a higher percentage of people exposed to noise.

Map 2.2 **Estimated percentage of inhabitants over the total population in the territorial unit exposed to noise of 55dB or higher from major roads outside urban areas during the day-evening-night period (L_{den})**



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: Population exposed in territorial units as reported by countries. Countries may report population exposure data at different administrative levels (LAU, NUTS, or national level), which explains the variation in data granularity across countries. Countries with incomplete data are totally or partially estimated at the country level.

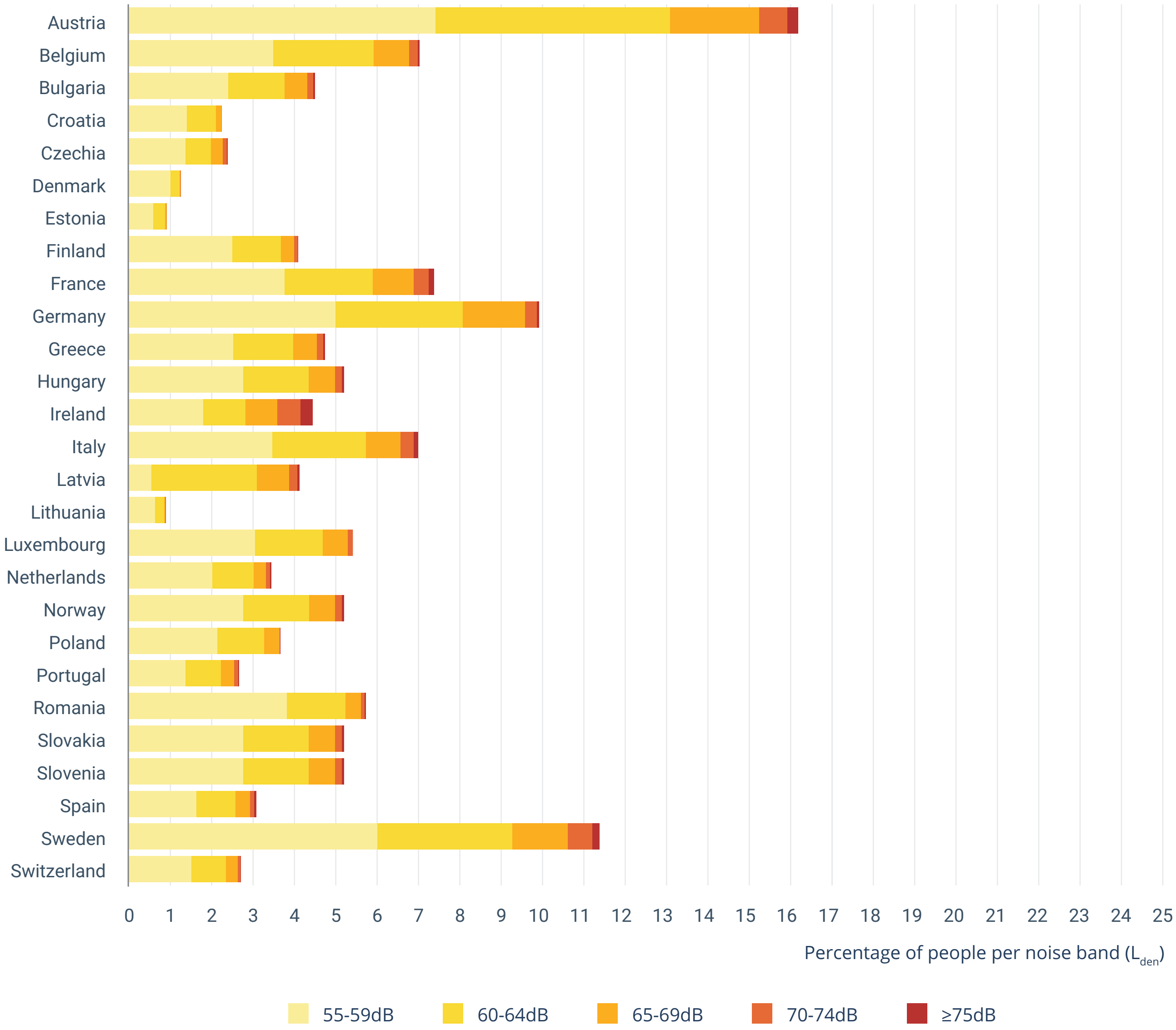
Source: EEA, based on data reported under the END (EEA, 2025).

2.4.2 Population exposed to rail traffic noise

Rail traffic is the second most dominant source of environmental noise in Europe. More than 17 million people are estimated to be exposed to rail traffic noise of at least 55dB during the day-evening-night period. Of these, 9.2 million are exposed to railway noise sources within urban areas and 8.4 million are exposed to major railway noise sources outside urban areas. Nighttime railway noise of 50dB or higher affects approximately 13 million people. This equates to 6.4 million people inside urban areas and 6.5 million people outside urban areas. As a result, it is estimated that railway noise above the END thresholds affects 4% of the population during the day-evening-night period and 3% during the nighttime period.

The number of people exposed to rail traffic noise inside urban areas varies greatly between countries. The central part of Europe is where a higher number of people inside urban areas are exposed to railway noise levels of at least 55dB L_{den}. On average, at the European level, 6% of people living in urban areas are exposed to rail traffic noise of at least 55dB L_{den}. Specifically, more than 10% of urban inhabitants in Austria and Sweden are exposed to railway traffic noise above the END day-evening-night period threshold (Figure 2.6). In terms of the percentage of people exposed to railway noise, the highest rates are also seen in urban areas of countries located in central Europe (Map 2.3). The proportional differences in exposure to railway noise across cities could be due to whether or not urban trams and light railways are included in the noise mapping exercise (see Annex 3 for railway urban coverage per country). For instance, Austria the country with the highest share of the population exposed to railway noise in urban areas takes into account trams and underground railways.

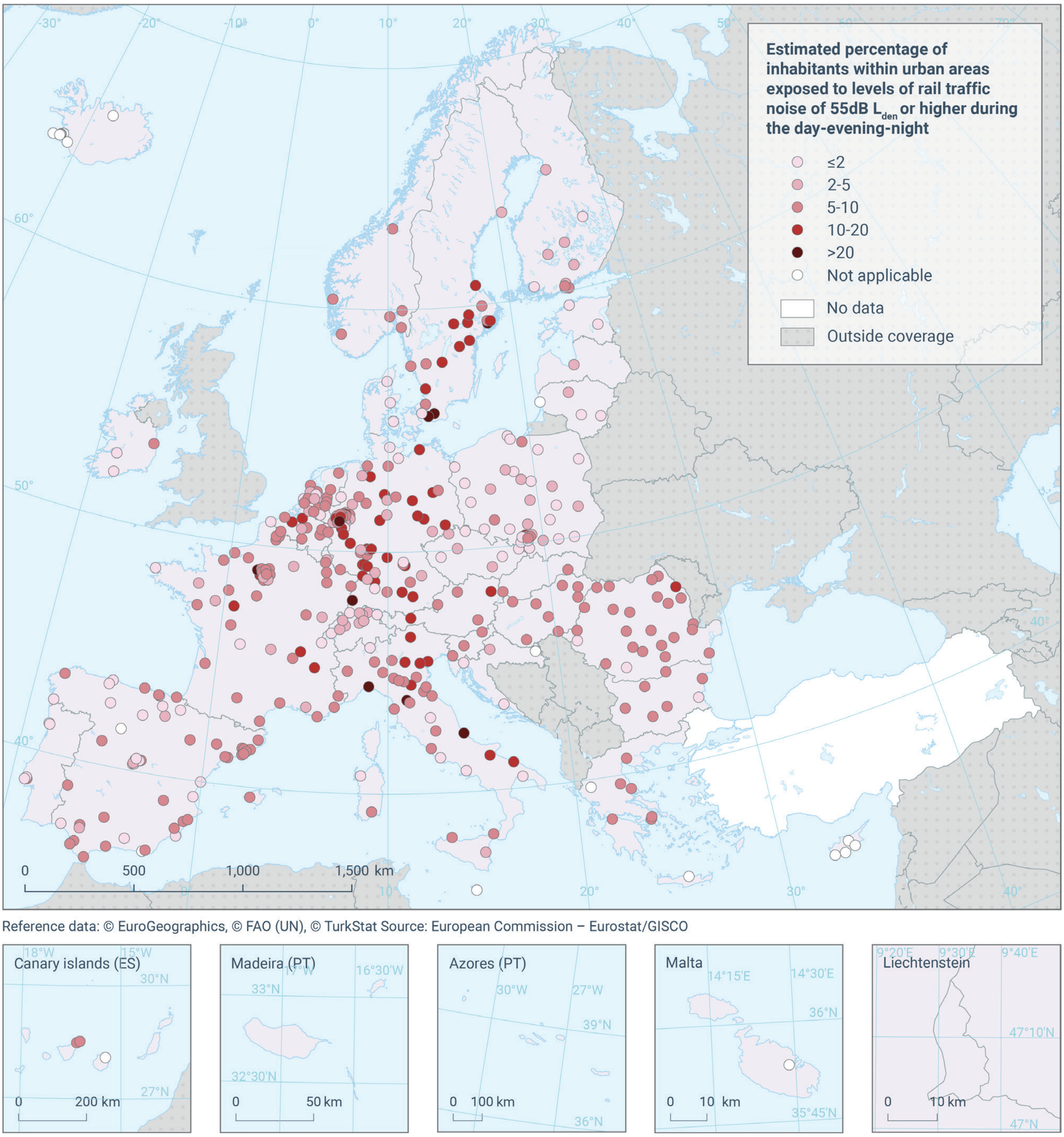
Figure 2.6 Estimated percentage of inhabitants within urban areas across countries exposed to rail traffic noise levels using the day-evening-night indicator (L_{den}), based on END thresholds



Notes: For comparability and interpretation of data across countries, please refer to Box 2.1 and Annex 1 and 3.

Source: EEA, based on data reported under the END (EEA, 2025).

Map 2.3 Estimated percentage of inhabitants within urban areas exposed to levels of rail traffic noise of 55dB L_{den} or higher during the day-evening-night



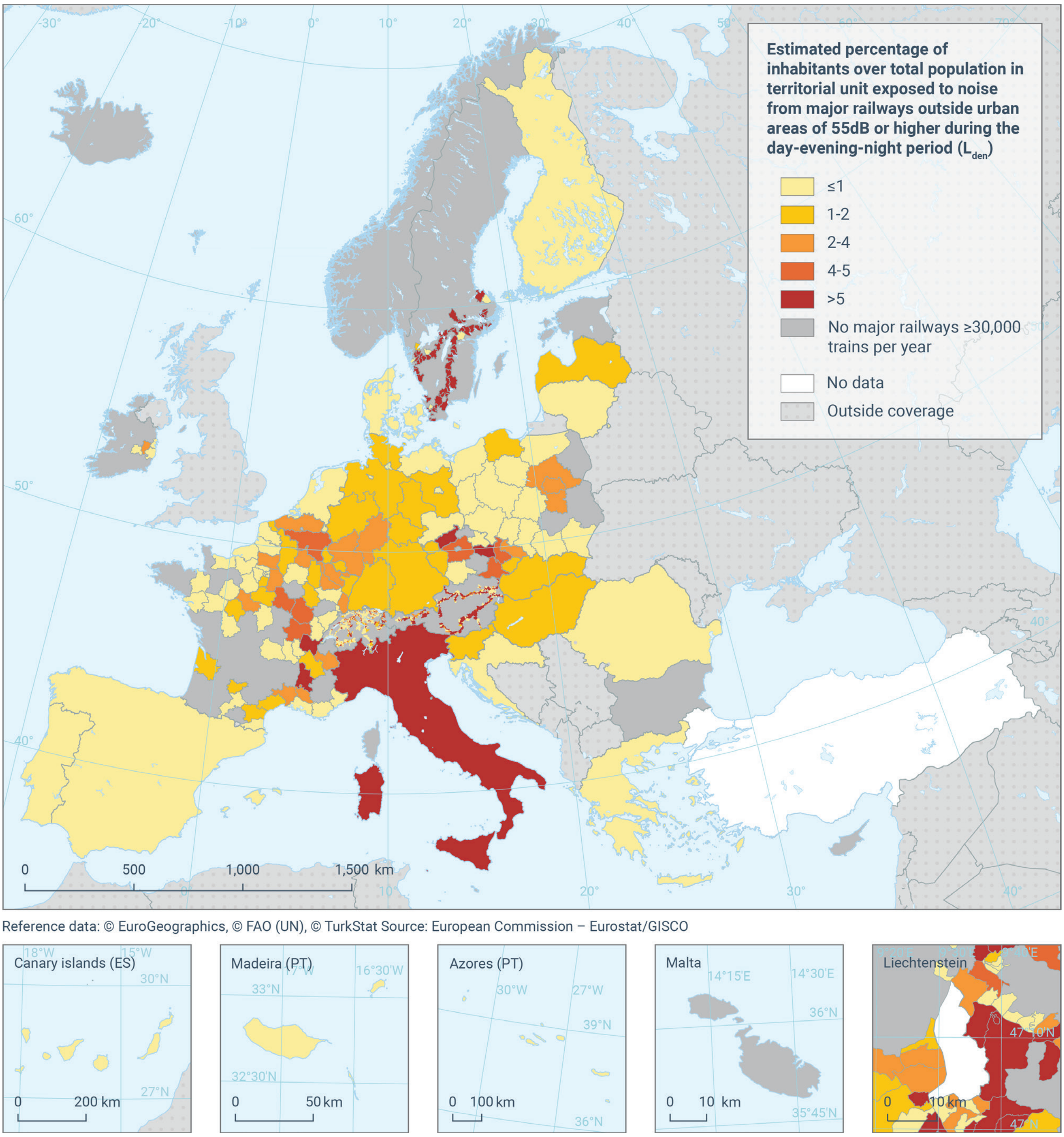
Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: For comparability and interpretation of data across countries, please refer to Box 2.1 and Annex 1 and 3.

Source: EEA, based on data reported under the END (EEA, 2025).

Map 2.4 shows the percentage of a country's population exposed to noise from major railways located outside urban areas. Certain regions show significantly higher exposure levels, especially in countries with extensive rail networks and dense populations. Germany has the largest number of railways by far, exceeding 30,000 passages per year. In terms of absolute numbers, Germany and Italy have the highest populations exposed to railway noise levels above 55dB L_{den} outside urban areas. The proportion of individuals affected by noise from these major railways varies widely among different territorial units and countries. Parts of Germany, France, Czechia, Italy, Sweden, Belgium and Austria show a high percentage of the population exposed to noise levels exceeding 55dB L_{den}.

Map 2.4 **Estimated percentage of inhabitants over total population in territorial unit exposed to noise of 55dB or higher from major railways outside urban areas during the day-evening-night period (L_{den})**



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: Population exposed in territorial units as reported by countries. Countries may report population exposure data at different administrative levels (LAU, NUTS, or national level), which explains the variation in data granularity across countries. Countries with incomplete data are totally or partially estimated at country level.

Source: EEA, based on data reported under the END (EEA, 2025).

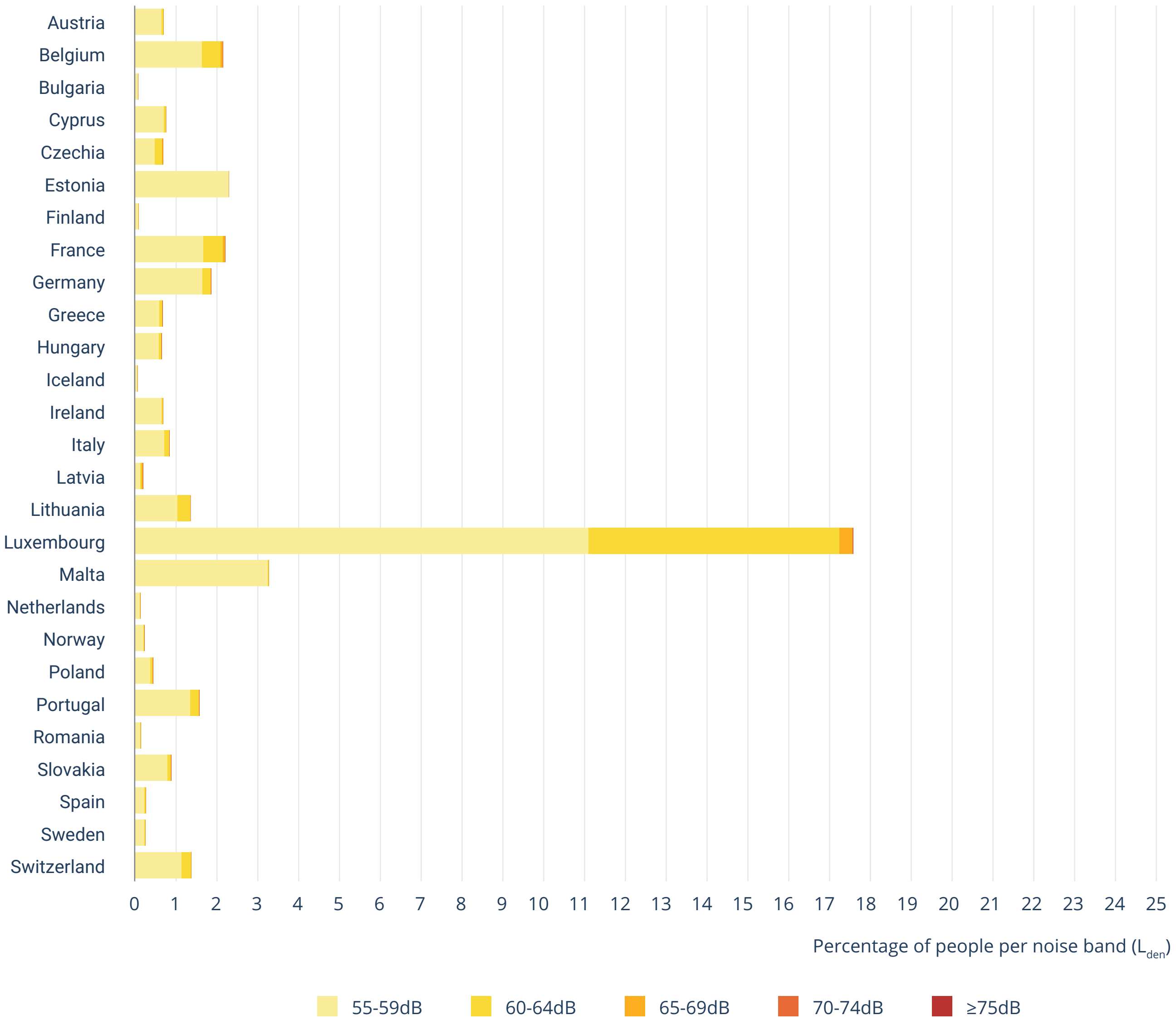
2.4.3 Population exposed to air traffic noise

Under the terms of the END, air traffic noise is defined as noise caused by aircraft landings and take-offs in the areas surrounding airports. Therefore, air traffic noise affects a much smaller proportion of the population than road or rail traffic noise.

According to estimates using current data, aircraft noise exposes approximately 1.6 million people to levels of 55dB or higher during the day-evening-night period inside urban areas. Adding to this figure, the number of people exposed to noise from major airports outside urban areas is estimated to be one million. In terms of nighttime noise, the figures are 0.5 and 0.3 million, respectively. As a result, it is estimated that aircraft noise above the END thresholds affects about 0.5% of the population during the day-evening-night period and 0.2% during the nighttime. These values represent a very small proportion of the total EU population. However, it is an important source of noise, because it is regarded as more annoying than road or railway noise (see Chapter 3).

Figure 2.7 shows the percentage of the urban population exposed to aircraft noise in each country. The country with the largest proportion of people exposed to aircraft noise above 55dB L_{den} inside urban areas is Luxembourg with 18%. This is followed by Malta, Belgium, Estonia and France which have around 2 to 3% of their urban population exposed to high noise levels from aircraft noise. These results are to some extent likely due to the number of airports within a country, as well as how far airports are from urbanised areas. Larger countries may have a smaller percentage of the population exposed to aircraft noise because they represent an average over all agglomerations; this includes those that are not exposed to aircraft noise. It can also be seen that exposure to aircraft noise in the very high noise bands (≥70dB) is not present.

Figure 2.7 **Estimated percentage of inhabitants within urban areas across countries exposed to air traffic noise levels using the day-evening-night indicator (L_{den}), based on END thresholds**

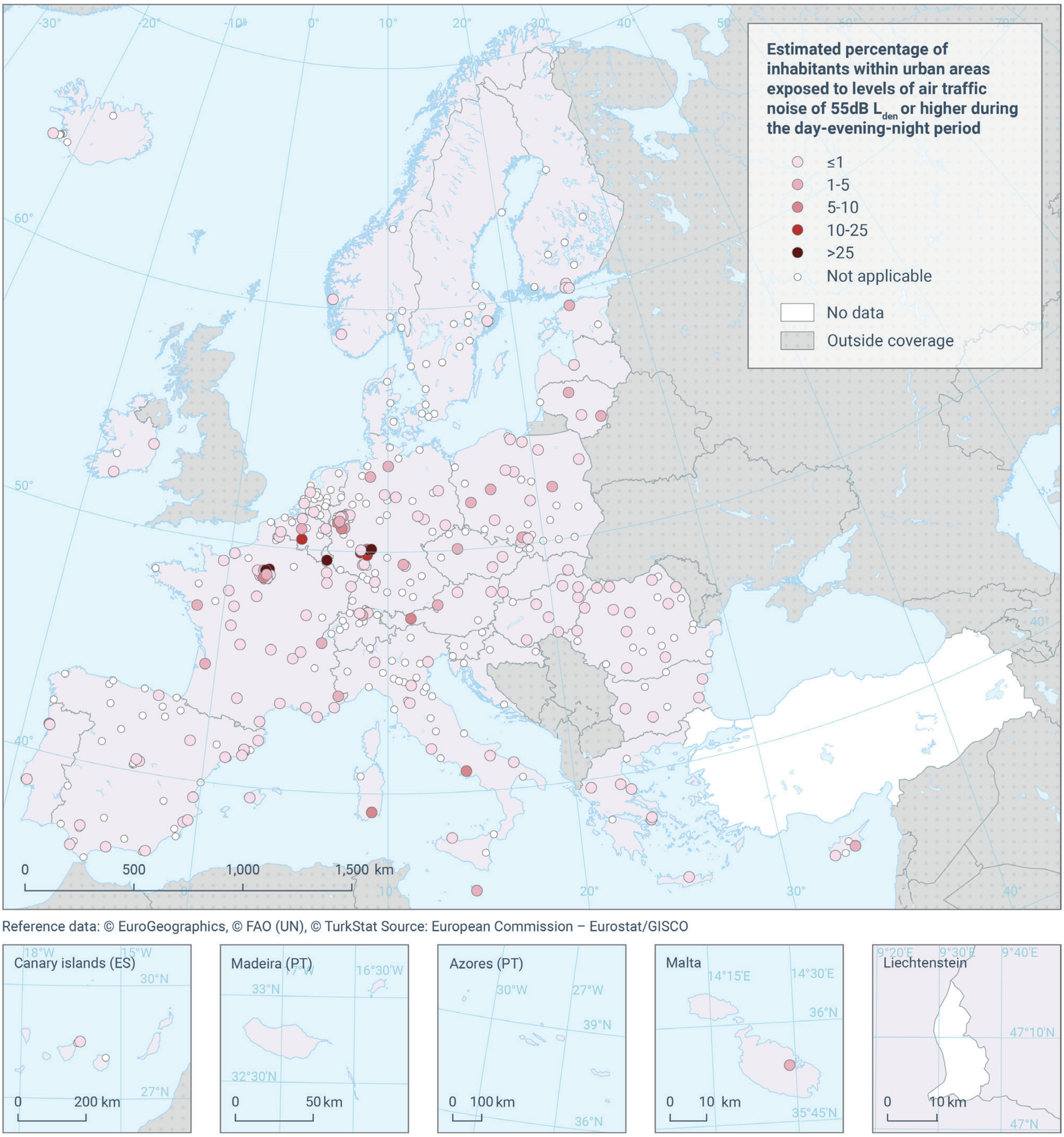


Notes: For comparability and interpretation of data across countries, please refer to Box 2.1 and Annex 1 and 3.

Source: EEA, based on data reported under the END (EEA, 2025).

Larger urban areas generally have higher numbers of people exposed to aircraft noise, particularly those located near to major airports. However, smaller urban areas with busy touristic airports can also experience significant exposure. In some cases, such as for Luxembourg for instance, the high percentage of people affected is due to flight paths passing directly over densely-populated areas. However, urban areas with the highest number of people exposed to aircraft noise do not systematically coincide with urban areas with the highest percentage of people exposed to day-evening-night levels of 55dB or higher (see Map 2.5). This variability may depend on aircraft traffic volumes as well as local factors such as location and the surroundings of an airport.

Map 2.5 Estimated percentage of inhabitants within urban areas exposed to levels of air traffic noise of 55dB L_{den} or higher during the day-evening-night period



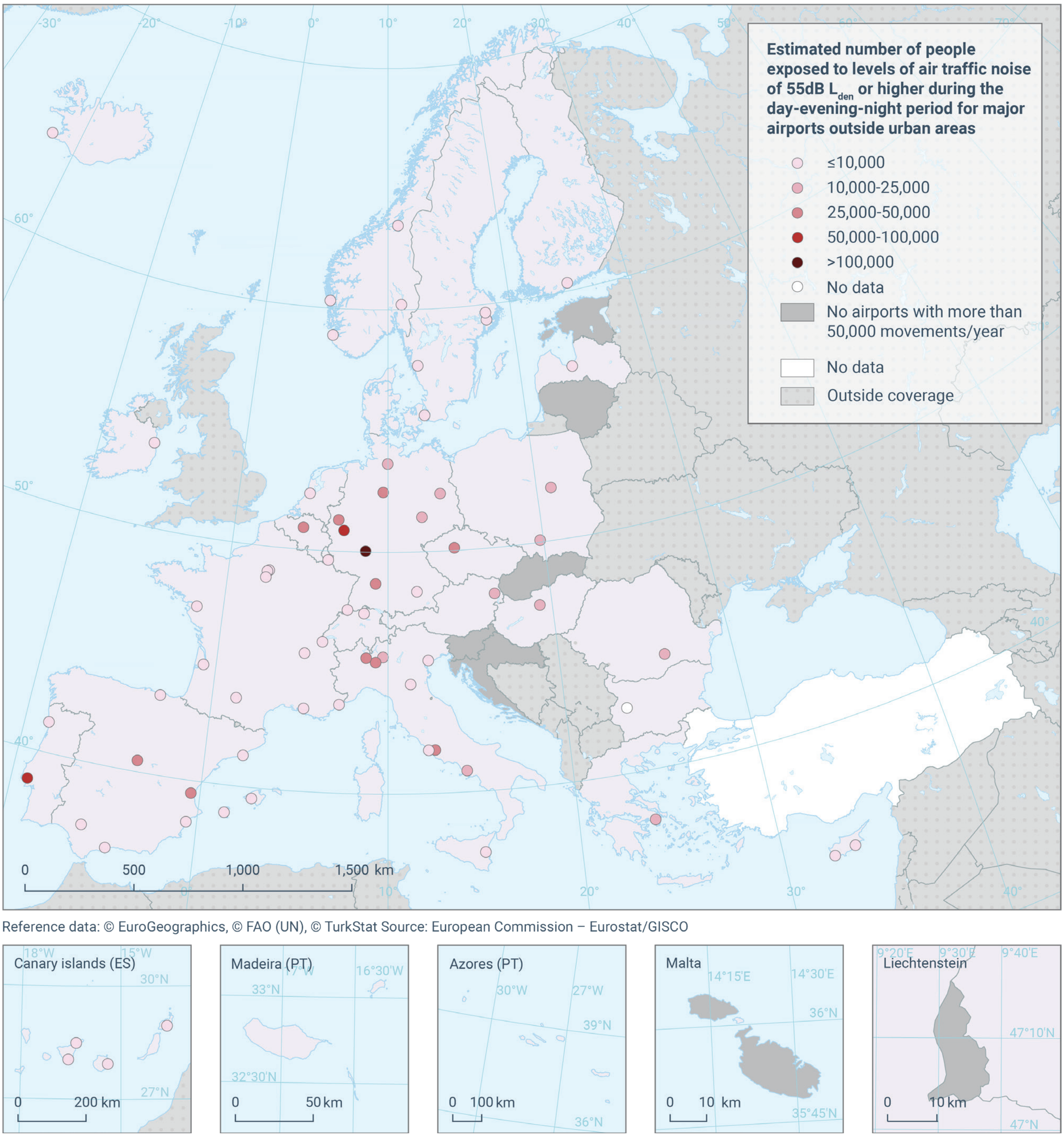
Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: For comparability and interpretation of data across urban areas, please refer to Annex 1.

Source: EEA, based on data reported under the END (EEA, 2025).

Map 2.6 shows the estimated total number of people outside urban areas who are exposed to aircraft noise from major airports under the END during the day-evening-night period. The major airports exposing the highest number of people to air traffic noise outside agglomerations are Frankfurt am Main, Lisbon Portela and Cologne-Bonn.

Map 2.6 **Estimated number of people exposed to levels of air traffic noise of 55dB L_{den} or higher during the day-evening-night period for major airports outside urban areas**



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: For comparability and interpretation of data across urban areas, please refer to Annex 1.

Source: EEA, based on data reported under the END (EEA, 2025).

2.5 Trends in population exposure to transport noise

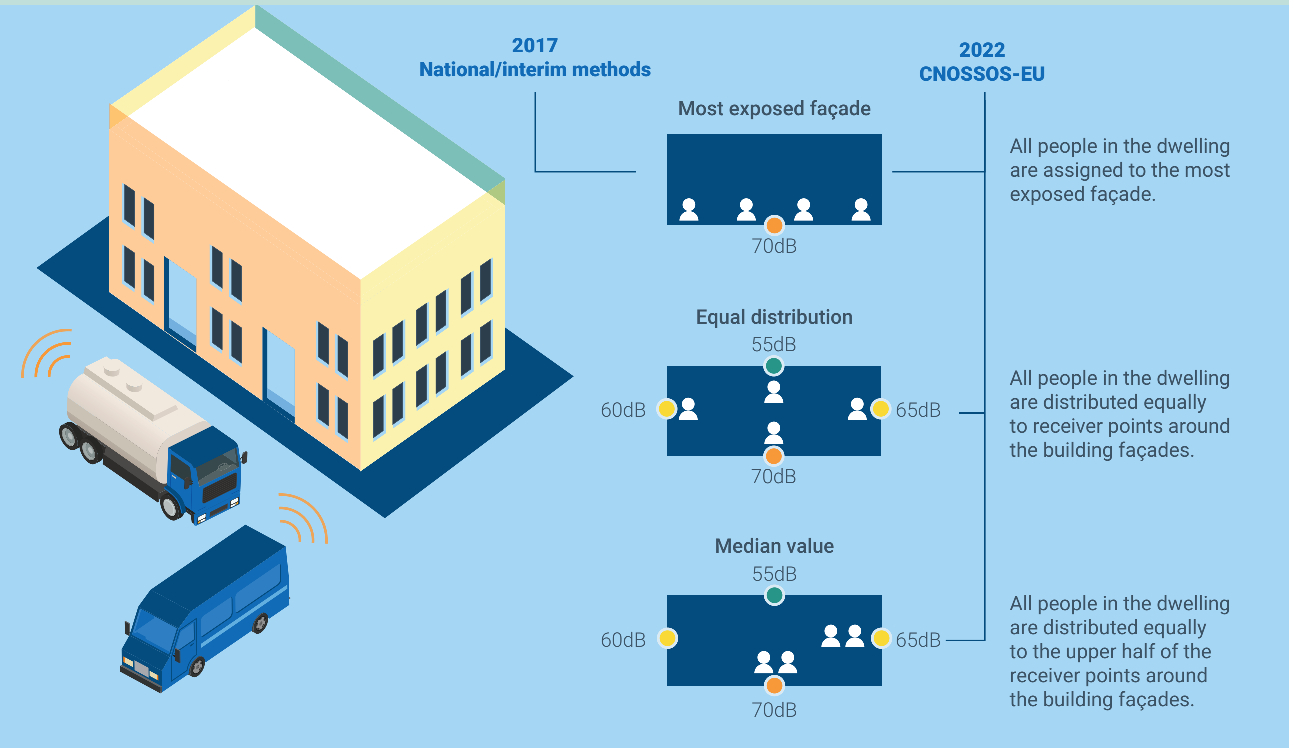
For the 2022 round of strategic noise mapping, all EU MSs were required to use the CNOSSOS-EU to prepare noise maps in accordance with the END. In previous mapping rounds, MSs were able to use their own national noise calculation methods. The new CNOSSOS-EU methodology is expected to reduce variation across countries; however, it represents a significant departure from many previously-used methods. Differences in propagation methods, emission values and criteria for counting exposed individuals (see Box 2.4) complicate direct comparisons with data from previous reporting rounds.

Box 2.4

CNOSSOS-EU

As of January 1, 2019, MSs are required to use a new assessment methodology for noise mapping known as CNOSSOS-EU. This methodology differs significantly from the national calculation methods previously employed; this is particularly the case in how noise levels are calculated and how receiver points are distributed around building façades (see example of change in the distribution of people exposed to noise in a dwelling below).

Figure 2.8 Different methods used for noise mapping



All people in the dwelling are assigned to the most exposed façade.

All people in the dwelling are distributed equally to receiver points around the building façades.

All people in the dwelling are distributed equally to the upper half of the receiver points around the building façades.

Most exposed façade
Location of dwelling within building footprint is available: e.g. detached, semi-detached and terraced houses or single apartments per floor level.

Equal distribution
Dwellings are arranged within an apartment building such that have a single façade.

Median value
Dwellings have more than one façade or no information is available on how many façades there are in the dwelling.

Notes: CNOSSOS-EU allows the use of three different methods depending on the knowledge of the dwelling layout. Some countries were already using CNOSSOS-EU in 2017.

Source: Based on EU (2015).

Box 2.5

Main changes in population exposure to transport noise between 2017 and 2022

The following key changes in population exposure to noise have been observed at the European level between the noise mapping rounds of 2017 and 2022 (see Annex 4 for details).

- **Shift in exposure to lower noise bands:** in 2022 a larger proportion of the population was reported as being exposed to noise levels in the 55–60dB L_{den} band. Meanwhile, the percentage of people exposed to high levels of above 65dB L_{den} decreased compared to 2017.
- **Significant reduction in nighttime noise exposure:** there was a notable decline in the population exposed to nighttime noise. In addition, as for day-evening-night noise levels, in 2022 there are more individuals in the lower 50–55dB L_{night} band.
- **Overall decrease in population exposed:** the total number of people exposed to noise from road, rail and air traffic sources declined, with the most significant reduction occurring in aircraft noise.
- **Reduction of major transport infrastructures and number of agglomerations:** there was a decrease in major transport infrastructures reported under the END in 2022. The lengths of major roads and railways and the number of airports as well as the number of agglomerations of 100,000 or more have decreased.
- **Variability in population exposure change:** the changes between 2017-2022 are highly dependent on source and country. This variability may arise from differences in how the CNOSSOS-EU methodology compares to previously-used national methods. Some countries reported increased noise exposure, while others saw decreases.
- **Variability in population exposure between urban and non-urban areas:** the changes were particularly evident in population noise exposure from major sources outside agglomerations.

It is important to note that the changes observed cannot be solely attributed to the transition to the CNOSSOS-EU methodology. Factors such as different data sources, modelling choices and actual changes in noise pollution may also play a significant role. Additionally, 2021 — the year in which the noise mapping was conducted — was still influenced by lower transportation activity, due to lingering COVID-19 effects. This could also explain some of the observed variations especially for aircraft noise.

At the European level, the 2022 strategic noise maps show significant changes in the reported number of people exposed to noise compared to previous years. Such large differences were not observed between earlier reporting rounds. This suggests that the variation is largely due to methodological changes introduced with the CNOSSOS-EU methodology. The main changes identified are summarised in Box 2.5.

To enable meaningful trends of the number of people exposed to noise over time, a harmonised baseline was established for the year 2017, using the CNOSSOS-EU methodology introduced in the 2022 reporting round. To ensure consistency, 2022 strategic noise map results were adjusted using available 2017 data on traffic volumes, population distribution and transport infrastructure, as reported under the END. This allowed for a backward estimation of the number of people exposed to noise in 2017 from road, rail and aircraft sources, using both the L_{den} and L_{night} indicators.

The full methodology is described in the report '*Development of a 2017 Baseline to Monitor Noise under the Zero Pollution Objectives*' (ETC HE, 2024a). The results of this harmonised 2017 baseline compared to the 2017 reported data are illustrated in Figure 2.9. This baseline supports monitoring progress towards the zero pollution targets (see Chapter 4).

Based on this baseline, it is estimated that between 2017 and 2022 there was a small decrease in the number of people exposed to noise above END thresholds by approximately 0.6 million for both the day-evening-night and nighttime periods. This represents a decrease of about 0.5% for the day-evening-night period and 0.8% for the nighttime period between 2017 and 2022. This decrease is comparable to the reduction observed between 2012 and 2017 (Figure 2.9).

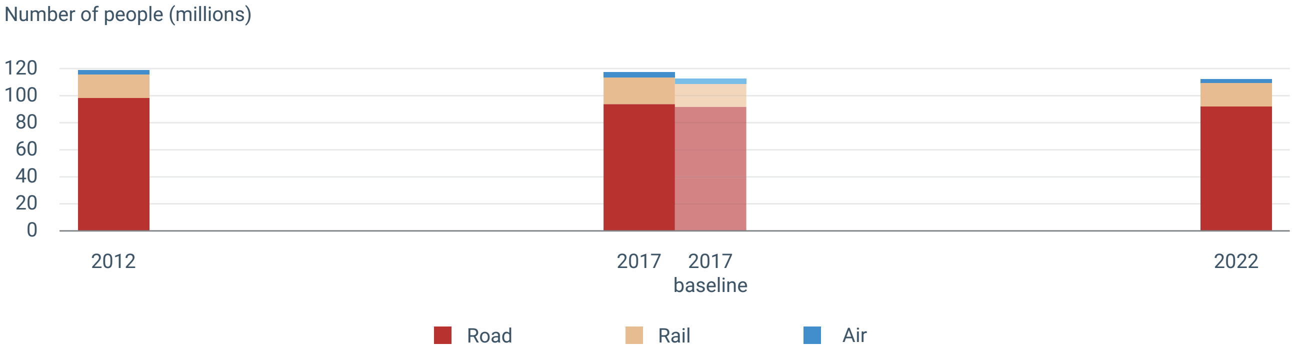
Regarding specific noise sources, day-evening-night noise levels indicate an estimated slight increase of approximately 0.2 million in the population exposed to road traffic noise. In contrast, there is an estimated significant decrease of about 1.5 million for air traffic noise. This is likely attributed to the lingering effects of COVID-19, which may have resulted in lower traffic levels at many airports compared to typical years. Conversely, the number of individuals exposed to railway noise is estimated to have increased by 0.7 million.

When examining nighttime levels, there is an estimated slight decrease of around 0.6 million in the population exposed to road traffic noise. However, exposure to railway noise at night is estimated to have increased by 0.6 million, while air traffic noise is estimated to have decreased by 0.5 million.

Figure 2.9 **Past trends in the estimated number of people exposed to long-term harmful levels of noise for both the day-evening-night and nighttime periods across the EEA-32 (excluding Türkiye)**

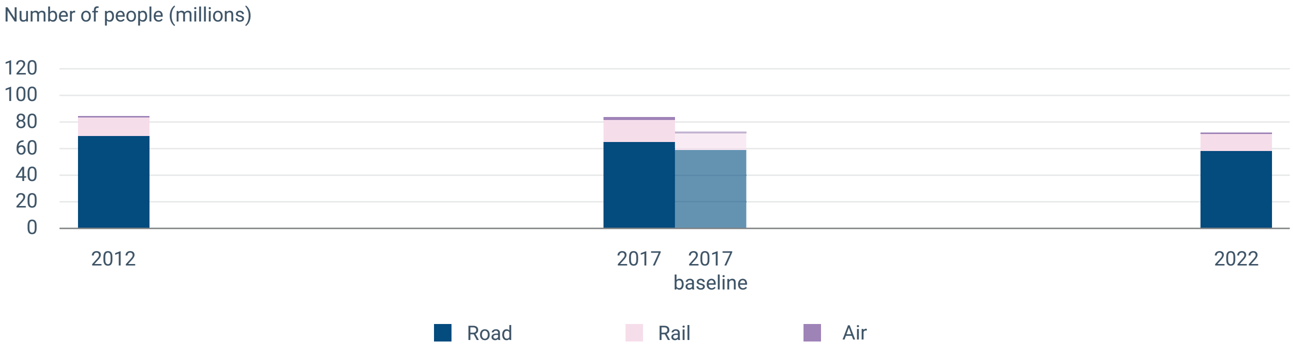
People exposed to L_{den}≥55dB

National noise assessment methods (2012-2017) and common noise assessment method (2017 baseline-2022)



People exposed to L_{night}≥50dB

National noise assessment methods (2012-2017) and common noise assessment method (2017 baseline-2022)



Notes: 2017 baseline based on the methodology described in ETC HE (2024a).

Source: EEA, based on data reported under the END (EEA, 2025).

3 Health impacts and burden of disease due to exposure to environmental noise

Key messages

- Environmental noise is a systemic health stressor that disrupts multiple bodily systems, contributing to cardiovascular and metabolic diseases, mental health disorders and even premature death.
- Chronic exposure to noise from transport contributes to 66,000 premature deaths annually in Europe, while also leading to 50,000 new cardiovascular disease cases and 22,000 cases of type 2 diabetes. Additionally, according to new research, noise could contribute to thousands of cases of depression and dementia.
- Nearly 17 million Europeans suffer long-term high annoyance due to noise from transport and approximately 4.6 million experience severe sleep disturbances.
- Transport noise impacts children's development, contributing to over 560,000 cases of reading difficulties, 63,000 cases of behavioural issues and an estimated 272,000 cases of being overweight linked to transport noise exposure.
- Noise pollution from transport sources results in the loss of 1.3 million healthy life years annually in Europe, equivalent to an annual economic cost of at least EUR 95.6 billion, representing around 0.6% of the region's gross domestic product (GDP) each year.
- The health impacts presented are likely an underestimation. Health effects from environmental noise can happen at much lower levels than those reported under the END. Using the more stringent WHO recommended levels, the health impacts and BoD are increased by about 20% compared with the figures presented above. In addition to this, the assessment does not cover all urban areas, roads, railways and airports across Europe, only those included in the END.
- To fully quantify the health impacts of noise and present a complete health impact assessment, data on levels below the 55dB L_{den} and 50dB L_{night} are needed.
- Noise pollution is a leading environmental risk factor to health. When compared to other environmental health risks, transport noise ranks among the top three — just behind air pollution and temperature-related factors. It also has a greater health burden than better-known risks such as second-hand smoke or lead exposure.

3.1 Environmental noise — a systemic health stressor

Living in areas exposed to transport noise significantly increases the risk of developing various health conditions. These conditions include annoyance, sleep disturbance, cardiovascular and metabolic diseases, mental health disorders and even premature death. Noise pollution affects biological processes by triggering physiological and psychological stress responses, as well as disrupting sleep and circadian rhythms. In recent years, a growing body of research has deepened the understanding of the wide-ranging health impacts of noise, revealing its potential effects on numerous body systems beyond the traditional cardiometabolic issues previously associated with noise exposure. This section outlines the biological mechanisms involved and explains why noise should be considered a systemic health stressor.

3.1.1 Biological mechanisms – how does environmental noise affect human health

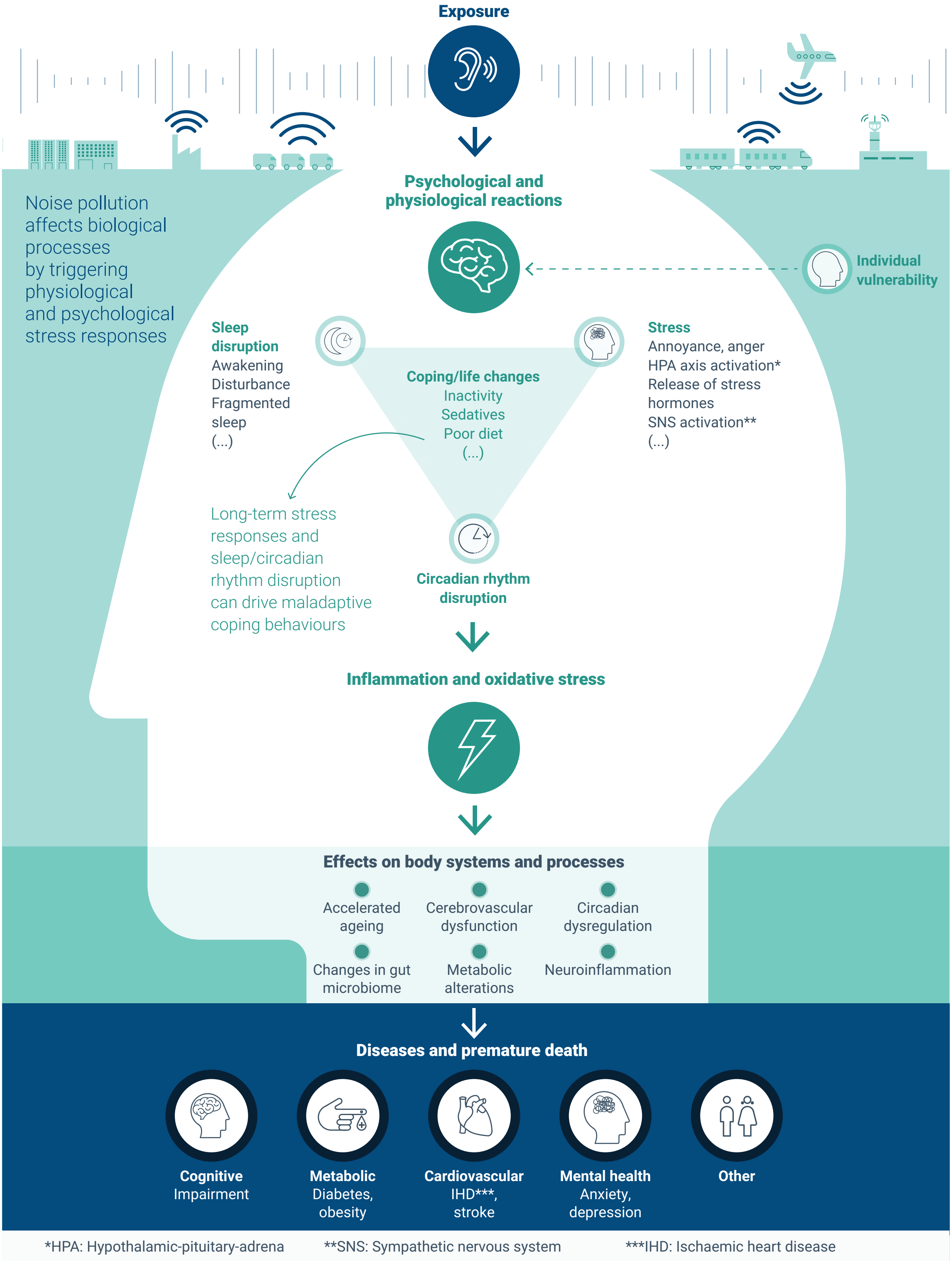
Noise exposure impacts health through interconnected pathways, primarily causing stress and sleep disturbance but also, most likely, the disruption of circadian rhythms. All these impacts combine to potentially contribute to a range of systemic health problems.

Environmental noise can have serious impacts on human health by triggering both physical and psychological stress responses, as well as other harmful effects throughout the body. While high noise levels are known to directly damage the auditory system, chronic exposure to low-level noise activates the body's stress response. Another significant pathway is through noise-induced sleep disturbances, which can lead to sleep deprivation. This is called the noise reaction model and was initially developed to explain how noise exposure impacts the cardiovascular and metabolic systems (Münzel et al., 2014, 2018). However, in recent years, this model has been further expanded to incorporate a broader range of stress responses, risk factors and health outcomes (Hahad et al., 2024; Arregi et al., 2024; Yang et al., 2024), reflecting a growing understanding of noise as a systemic environmental stressor.

Figure 3.1 illustrates how noise indirectly affects health by triggering stress responses, sleep disturbances and circadian rhythm disruption. These effects activate the sympathetic nervous system (SNS) and the hypothalamic-pituitary-adrenal (HPA) axis, leading to the release of stress hormones like cortisol and adrenaline (Münzel et al., 2014). Prolonged activation promotes inflammation and oxidative stress, damaging cells and tissues over time (Arregi et al., 2024). Chronic noise exposure keeps the body in a constant state of arousal, disrupting organ function and accelerating biological ageing. Disturbed sleep further impairs hormonal regulation, glucose metabolism and blood pressure control; it is also linked to insulin resistance, obesity and type 2 diabetes (Potter et al., 2016). All these stress, as well as sleep and circadian disruptions, may also lead to unhealthy coping behaviours, such as reduced physical activity and increased alcohol use, compounding the health impacts of noise.

Over time, these stress and sleep-related mechanisms can result in systemic health problems, with clear impacts on the cardiovascular system, including high blood pressure, heart disease and stroke. They can also impact on the metabolic system, with potential effects including insulin resistance, obesity and type 2 diabetes. Furthermore, they can also affect the brain, with evidence pointing to cognitive decline and potential links to Alzheimer disease (Hahad et al., 2024; Münzel et al., 2018). Emerging evidence also suggests that noise may disrupt the functions of other organs, including the liver, kidneys, pancreas and gut. Consequently, this might lead to conditions like fatty liver disease, kidney damage and digestive disorders, though more research is needed in this area (Yang et al., 2024; Arregi et al., 2024). These interconnected pathways — stress and sleep disturbance — not only contribute independently to various health issues but also interact to intensify the overall burden of chronic disease associated with prolonged noise exposure.

Figure 3.1 Biological indirect pathways through which environmental noise impacts health



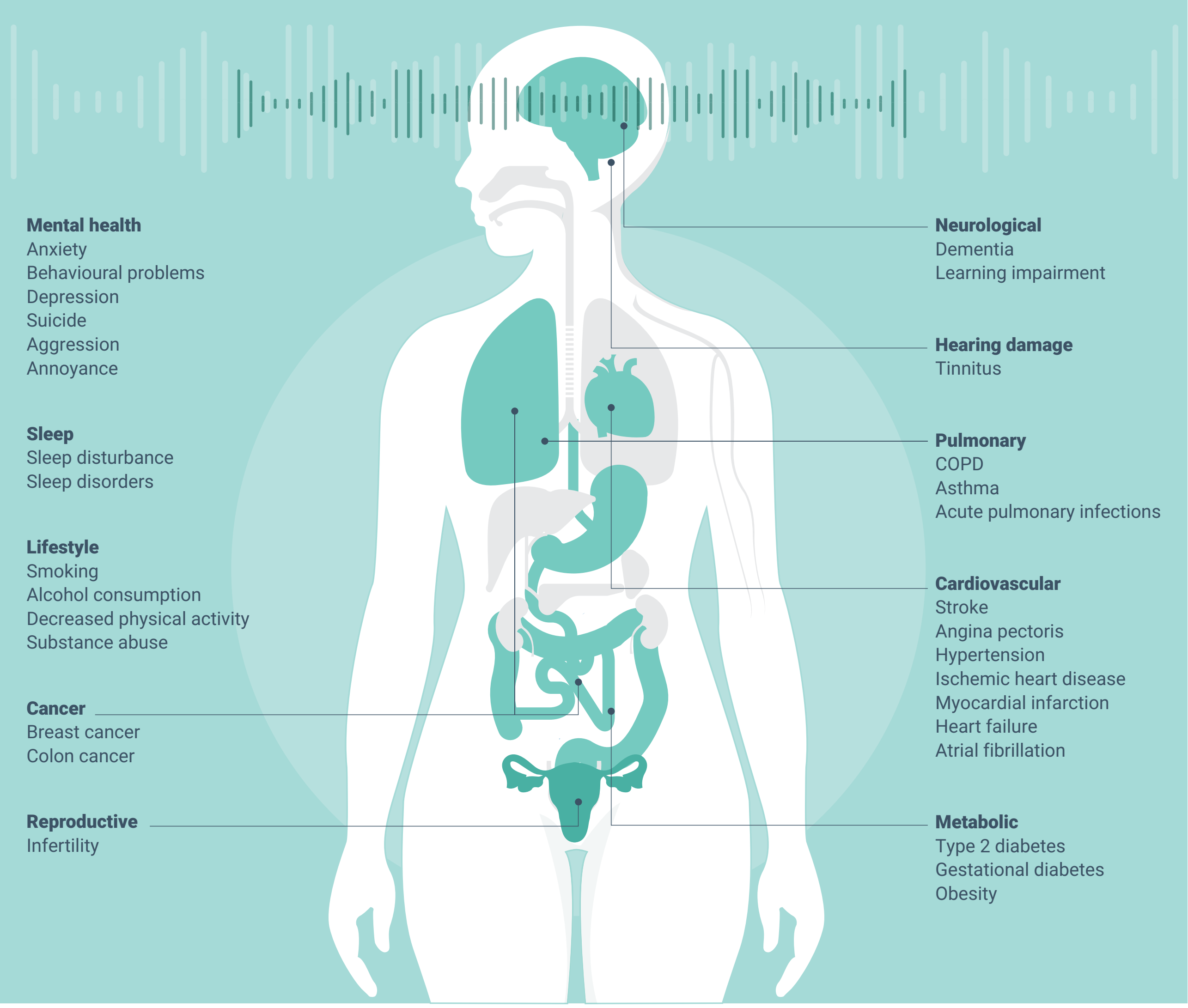
Note: Non-exhaustive list of diseases or risk factors or system disfunctions.

Sources: Adapted from Arregi et al., 2024; Münzel et al., 2018; Hahad et al., 2024; Phan and Malkani, 2019.

3.1.2 Health effects of environmental noise: a growing evidence base

Since the publication of the WHO environmental noise guidelines for the European region in 2018 (WHO, 2018), the body of evidence linking noise exposure to adverse health outcomes has grown substantially. This expanding research base has increased the understanding of the wide-ranging health effects of environmental noise (see Figure 3.2), particularly from transportation sources such as road traffic, railways and aircraft.

Figure 3.2 The broad health effects of transportation noise



Notes: List of potential and established impacts. Non-exhaustive list of diseases or system disfunctions.

Sources: Adapted from Hahad et al., 2024.

In recent years, new studies have explored associations between environmental noise and an array of health outcomes beyond the traditionally-recognised cardiometabolic impacts. Evidence on established health effects has been outlined in a recent meta-analysis (ETC HE, 2024b) and includes several cardiovascular diseases (CVDs), type 2 diabetes and all-cause natural mortality. In children, impacts include reading impairment, behavioural difficulties and obesity (ETC HE, 2025c). In terms of emerging evidence, traffic noise has been linked to certain types of cancer (Andersen et al., 2018; Roswall et al., 2023; Sørensen et al., 2021), dementia (Cantuaria et al., 2021), suicide (Wicki et al., 2023) and depression (Hegewald et al., 2020; He et al., 2019). It has also been linked to tinnitus (Cantuaria et al., 2023), respiratory problems (Zhang et al., 2024; Franklin and Fruin, 2017), infertility (Sørensen et al., 2024b) and a variety of cause-specific mortality outcomes (Sørensen et al., 2024a). Several novel investigations have also provided finer insights into the relationship between noise exposure and cardiometabolic diseases, including ischaemic heart disease (IHD), stroke and diabetes (Sørensen et al., 2024a). New research also consolidates the evidence that negative health effects start to occur at lower levels than the END thresholds i.e. a 55dB L_{den} and 50dB L_{night} and even below the WHO recommendations. In fact, many studies show effect levels from as low as a 45dB L_{den} (ETC HE, 2024b). Apart from long-term effects of noise, emerging evidence also suggests that acute exposure to noise could also lead to negative effects (see Box 3.1).

In conclusion, a growing body of research shows that the health impacts of noise from road, rail and aircraft are broader and more significant than has been previously estimated. As a result, noise is increasingly considered a systemic environmental health stressor. Furthermore, many adverse effects begin at noise levels below the WHO recommended levels.

Box 3.1

Short-term health effects of transportation noise

While much of the research on transportation noise has focused on its long-term effects on chronic diseases, growing evidence suggests that acute noise exposure can have immediate consequences for health. Environmental noise can cause sleep disturbances and heightened stress responses. Both of these are associated with physiological effects that may contribute to acute health events. Beyond momentary annoyance or sleep disturbance, studies have linked loud traffic events to an increased risk of cardiovascular hospitalisations and mortality, as well as suicides and intake of certain types of medications.

Sources: Wicki et al., 2024; Saucy et al., 2021; Itzkowitz et al., 2023.

3.2 EU-wide noise health risk assessment (HRA)

This section presents the noise HRA used to estimate and communicate the BoD associated with transport noise pollution at the European level. While Chapter 2 focuses on the number of people exposed to harmful noise levels, this section quantifies health risks using both the number of people affected by specific outcomes and the overall BoD. The updated HRA is based on new noise exposure data and the latest scientific evidence on health effects. Box 3.2 summarises the key updates introduced in this edition.

The full methodology is detailed in the European Topic Centre on Human Health and the Environment (ETC HE) report, *Environmental Noise Health Risk Assessment* (ETC HE, 2024b), with a complete list of noise – health effect relationships provided in

Annex 5. For Section 3.2.2 on the impacts of noise on children's health, the results are published in the ETC HE report *Health effects of transportation noise for children and adolescents: an umbrella review and burden of disease estimation* (ETC HE, 2025c).

The health impacts presented here are likely an underestimation. Health effects from environmental noise can happen at much lower levels than those reported under the END (see Section 3.3). In addition to this, the assessment does not cover all urban areas, roads, railways and airports across Europe, only those included in the END (see Section 1.2).

Box 3.2

Key updates in the 2025 EU-wide noise HRA

Every 5 years, the EEA updates its estimates of the BoD from transportation noise based on the latest data and scientific evidence. The 2025 HRA incorporates several key updates:

- **Updated population exposure data:** this HRA uses noise exposure data from the 2022 round of noise mapping. Population exposure is now calculated differently due to the mandatory implementation of the CNOSSOS-EU methodology (see Section 2.5 for details). This new methodology has an impact on the number of people exposed as well as the distribution of people within noise bands.
- **Inclusion of new health outcomes:** recent epidemiological studies have strengthened the evidence base. This has allowed for higher-quality meta-analyses, particularly for road traffic noise. As a result, the 2025 HRA includes new health outcomes such as all-cause natural mortality, type 2 diabetes and a broader range of CVDs, beyond just IHD. Behavioural difficulties and the prevalence of being overweight are also new outcomes included in the estimations of the impacts of noise on children's health.
- **Estimations below END reporting thresholds:** previously, HRAs were based on exposures of 55dB L_{den} and 50dB L_{night}, the reporting thresholds set by the END. This edition includes estimates using both the END thresholds and additional calculations based on the WHO recommendations.
- **Lower effect thresholds:** growing evidence suggests that adverse health effects occur at much lower noise levels than the END thresholds and even below WHO recommendations. In this edition, the thresholds for increased risk of CVD, type 2 diabetes and all-cause natural mortality have been set to start at a 45dB L_{den}.
- **Updated disability weights (DWs) for sleep disturbance and annoyance:** a new WHO-coordinated study (Charalampous et al., 2024) has provided updated DWs for high annoyance and high sleep disturbance. These updated DWs, which are significantly lower than those used in previous assessments, have now been incorporated into the BoD calculations.

3.2.1 Estimated health burden of environmental noise: number of people affected

In Europe, according to the latest available data from the END strategic noise maps of 2022, long-term exposure to transportation noise is estimated to result in nearly 17 million people experiencing high annoyance and more than 4.5 million suffering from severe sleep disturbances. Each year, noise from road traffic, railways and aircraft is estimated to contribute to approximately 50,000 new cases of CVD, 22,000 cases of type 2 diabetes and 66,000 premature deaths. A detailed breakdown by noise source and affected area is provided in Table 3.1. People in urban areas are worst affected and the main source contributing to negative health effects is road traffic noise. While these estimates focus on adults, transportation noise also has considerable health impacts on children, as explored in Section 3.2.2.

Table 3.1 **Estimated number of people suffering from different health outcomes due to noise from road, rail and aircraft based on END thresholds, EEA-32 (excluding Türkiye)**

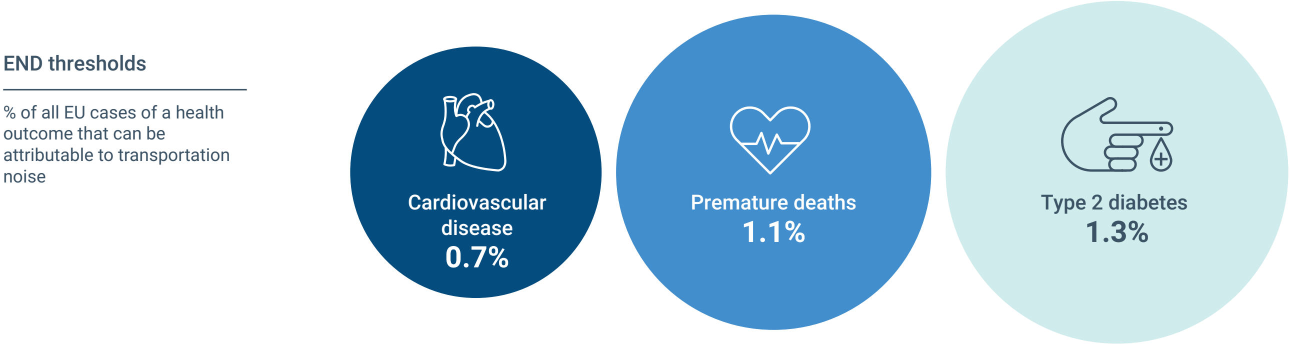
		High annoyance	High sleep disturbance	CVD	Type 2 diabetes	Premature mortality (b)
Inside urban areas	Road	9,954,600	2,364,700	32,000	14,400	42,100
	Rail	1,443,900	604,600	4,000	1,600	5,100
	Air	431,600	87,700	500	200	600
Outside urban areas	Road	3,334,500	798,600	8,900	4,100	11,700
	Rail	1,455,500	706,900	4,600	2,000	6,000
	Air	258,900	62,300	100	0	100
	Total (a)	**16,879,000**	**4,624,800**	**50,100**	**22,300**	**65,600**

Notes: (a) There may be some double counting, mainly for high annoyance and high sleep disturbance because of the combined effects of multiple sources.
(b) Refers to all-cause natural mortality

Source: EEA, calculated using the methodology from ETC HE, 2024b.

Based on these data, it is estimated that approximately 0.7% of all annual CVD cases, 1.3% of all new type 2 diabetes cases and 1.1% of all natural cause mortality deaths in Europe could be attributed to transportation noise exposure (see Figure 3.3).

Figure 3.3 **Percentage of total EU cases of cardiovascular disease, type 2 diabetes and premature mortality attributable to transportation noise based on END thresholds**



Notes: Premature deaths refer to all-cause natural mortality.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

Box 3.3

What is the risk for cardiometabolic diseases and premature mortality due to noise exposure from transport sources?

Based on the relationships illustrated in Annex 5, the following overview outlines the increased risks from exposure to different noise levels from road, rail and aircraft in relation to cardiometabolic diseases and premature mortality.

Table 3.2 Percentage of increased risk attributable to noise

Percentage of increased risk attributable to noise against those non-exposed	Long-term outdoor noise levels at the most exposed façade L_{den} (dB)			
	50dB	55dB	60dB	65dB
Cardiovascular disease	2%	3%	5%	7%
Type 2 diabetes	3%	7%	10%	13%
Premature mortality (all-cause natural)	3%	6%	9%	11%

It should be noted that estimates of premature deaths and cardiometabolic diseases are based on the concept of attributable cases, in which risk estimates from epidemiological studies are used to calculate the burden of disease at the population level. This approach is commonly applied to environmental exposures, where a direct cause of death or disease typically cannot be identified — unlike in cases such as accidents or poisoning.

3.2.2 Impact of transport noise on children's health

Overall, according to data from the END, the estimated number of cases of behavioural problems and reading impairment among children aged 6 to 17 years amounts to 63,200 cases and 564,500 cases respectively. In addition to this, new evidence shows the links between transport noise and being overweight; it is therefore estimated that 271,700 children could be overweight due to noise. A breakdown by source and area is shown in Table 3.3.

The majority of these cases — approximately 84% — can be attributed to road traffic noise, particularly in urban areas. Rail traffic noise contributes to about 15% of the cases, while noise from aircraft accounts for roughly 1%. This distribution underscores the importance of road traffic in contributing to developmental and physiological effects faced by children in noisy environments.

Table 3.3 **Estimated number of children aged 6-17 years suffering from reading impairment, behavioural problems and overweight due to noise from road, rail and air based on END thresholds, EEA-32 (excluding Türkiye)**

		Behavioural problems	Reading impairment	Overweight
Inside urban areas	Road	41,700	355,800	173,400
	Rail	4,700	42,500	20,700
	Air	500	5,500	2,200
Outside urban areas	Road	11,100	116,500	48,600
	Rail	5,000	41,100	25,700
	Air	200	3,000	1,100
	Total (a)	**63,200**	**564,500**	**271,700**

Note: (a) There may be some double counting due to combined effects of multiple sources.

Source: ETC HE, 2025c.

3.2.3 Estimated health burden of environmental noise: disease burden in DALYs

In terms of adults in 2021, approximately 1.1 million healthy years were lost due to road traffic noise, 230,000 healthy years were lost due to railway noise and 21,000 healthy years were lost due to aircraft noise. These figures amounted to a total of nearly 1.4 million years of healthy life being lost across Europe in 2021 (Table 3.4). This means that while health risks may be low, the widespread exposure affects millions, creating a substantial overall health burden. The data show that road traffic noise contributes the highest overall burden, with all-cause premature mortality emerging as the primary contributor. Compared to previous estimates from 2020, annoyance and sleep disturbance now account for a smaller share of the total health burden due to noise. This change is mainly due to two key factors. Firstly, there has been a significant reduction in the disability weight (DW) for annoyance and for sleep disturbance, following updates by the WHO Regional Office for Europe (see Box 3.4). Secondly, there has been an inclusion of a broader range of noise-related mortality causes in this assessment. Unlike the 2020 assessment, which considered only premature mortality from IHD, the current evaluation accounts for all natural causes of death, based on new scientific evidence. It should be noted that the impacts of noise on children are not included in this BoD calculation. This is because the associated DALYs are typically very small or unavailable; this is particularly the case for outcomes like being overweight, for which no standard DALY estimates exist.

Table 3.4 **Estimated number of DALYs due to road rail and aircraft in areas covered under the END, EEA-32 (excluding Türkiye)**

	Health effect	Road	Rail	Aircraft	Total per health outcome (b)
YLD	High annoyance	146,200	31,900	7,600	185,700
	High sleep disturbance	31,600	13,100	1,500	46,200
	CVD	27,000	5,200	400	32,600
	Diabetes type 2	34,300	6,700	400	41,300
YLL	Premature mortality (a)	875,300	172,700	11,300	1,059,300
DALYs	**YLD+YLL**	**1,114,400**	**229,600**	**21,200**	**1,365,200**

Notes: (a) Refers to all-cause natural mortality.
(b) There may be some double counting mainly for high annoyance and high sleep disturbance due to combined effects of multiple sources.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

Box 3.4

DALYs for environmental noise

Health burden is commonly measured in DALYs. DALYs is a measure of disease burden that quantifies the impact of both mortality and morbidity in a single, comprehensive indicator. It accounts for:

- YLL: the number of years lost due to premature death caused by disease;
- YLD: the number of years spent living with a disease or disability that affects quality of life.

One DALY represents one lost year of healthy life, whether due to illness, disability, or premature death. The total number of DALYs across a population reflects the gap between the current health status and an ideal scenario in which everyone lives to an advanced age, free from disease and disability (WHO, 2016).

Since different diseases and conditions impact health and quality of life to varying degrees, each health outcome is weighted according to its severity. To calculate years lost due to disability, each year is assigned a DW ranging from 0 (perfect health) to 1 (death). For environmental noise, new DWs have been developed in a study coordinated by the WHO Regional Office for Europe, replacing those used previously. These updated weights for annoyance and sleep disturbance are significantly lower than those applied in the 2018 WHO environmental noise guidelines for the European region. This has consequently lead to lower overall estimates of morbidity from annoyance and sleep disturbance in BoD calculations.

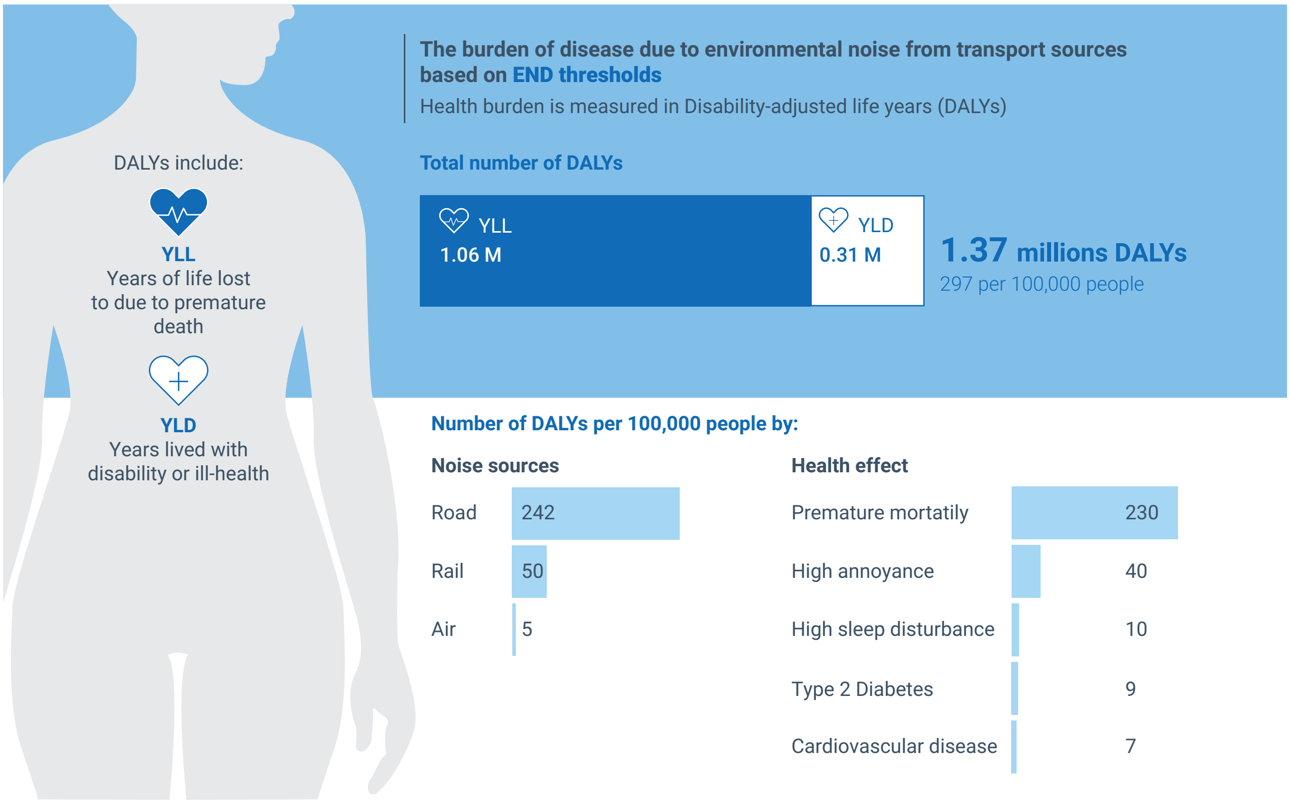
Table 3.5 **Disability weights (DWs) for annoyance and sleep disturbance**

Health condition	Updated DWs (WHO, 2024)	Previous DWs (WHO, 2018; WHO and JRC, 2011)
Long-term severe annoyance	0.011	0.02
Long-term sleep disturbance	0.010	0.07

For example, living with high sleep disturbance due to noise for 50 years is equivalent in terms of DALYs to dying half a year earlier than expected (0.01 * 50 = 0,5).

Figure 3.4 illustrates the DALY rates per 100,000 inhabitants. It shows that exposure to noise accounts for nearly 300 DALYs per 100,000 people using the END thresholds.

Figure 3.4 **BoD due to environmental noise from transport sources based on END thresholds, EEA-32 (excluding Türkiye)**



Notes: Premature deaths and YLL refer to all-cause natural mortality. There may be some double counting mainly for high annoyance and high sleep disturbance due to combined effects of multiple sources. END, Environmental Noise Directive.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

3.2.4 Economic burden of environmental noise

Exposure to noise pollution from road, rail and air traffic has serious health consequences that translate into significant economic losses. These losses arise from increased mortality and morbidity, which reduce quality of life; higher healthcare expenditures for treating noise-related conditions and also lower labour productivity due to increased absenteeism from illness.

In this assessment, the economic impact of noise-related health effects is quantified using the DALYs valuation method. This approach calculates the economic burden by multiplying the DALYs estimated in the BoD assessment (Section 3.2.3) by the monetary cost of a DALY. Drawing on various studies, including the 'Handbook on the external costs of transport' (EC, 2020d), a monetary value of EUR 70,000 per DALY is applied to estimate the financial cost of noise pollution. For further details on the methodology, please refer to ETC HE (2024b). It should be noted that, in addition to the costs reflected in DALYs, noise pollution can lead to other significant economic impacts, such as productivity losses and depreciation of property values.

Table 3.6 presents the approximate economic costs associated with noise pollution from road, rail and air traffic. It is estimated that noise pollution results in annual losses of EUR 95.6 billion in Europe, representing 0.62% of the region's GDP each year.

Table 3.6 **Estimated cost of noise pollution from road, rail and aircraft sources in billion euros and expressed as share of Europe's GDP, EEA-32 (excluding Türkiye)**

END thresholds		Road	Rail	Aircraft	Total ([a])
Costs in billion (EUR)	Morbidity	16.7	4.0	0.7	21.4
	Mortality	61.3	12.1	0.8	74.1
	Total	**78.0**	**16.1**	**1.5**	**95.6**
% of GDP		**0.51%**	**0.10%**	**0.01%**	**0.62%**

Notes: ([a]) There may be some double counting mainly for high annoyance and high sleep disturbance due to combined effects of multiple sources.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

3.2.5 Overview of health impacts per country

Table 3.7 presents a summary of the estimated number of premature deaths per year and DALYs per 100,000 population by country. The data indicate that road traffic noise is the leading contributor to noise-related premature deaths and DALYs across all European countries.

Larger countries, such as France and Germany, report the highest total number of premature deaths attributed to noise exposure. However, when looking at DALY rates per 100,000 population, similar to the patterns discussed in Section 2.2, smaller but densely-populated countries tend to show higher rates. Country differences in the baseline health data also have influence.

Table 3.7 **Estimated number of premature deaths per year and DALYs per 100,000 population by country based on the END thresholds, EEA-32 (excluding Türkiye)**

Country	Selected health impacts per country							
	Premature deaths/year				DALYs per 100,000 people/year			
	Road	Rail	Air	**Total**	Road	Rail	Air	**Total**
Austria	1,200	400	0	**1,600**	270	90	0	**370**
Belgium	1,400	200	0	**1,600**	240	40	10	**290**
Bulgaria	1,100	200	0	**1,200**	360	40	0	**400**
Croatia	540	10	-	**550**	290	10	0	**300**
Cyprus	230	-	0	**230**	560	0	10	**570**
Czechia	1,400	100	0	**1,500**	290	20	0	**320**
Denmark	470	10	0	**480**	170	0	0	**170**
Estonia	60	0	0	**60**	90	0	10	**100**
Finland	360	60	0	**420**	140	20	0	**160**
France	11,600	1,100	200	**12,900**	350	40	0	**390**
Germany	10,000	2,100	200	**12,300**	250	60	0	**310**
Greece	650	80	10	**740**	120	15	0	**135**
Hungary	1,050	180	20	**1,250**	245	40	5	**290**
Iceland	30	-	0	**30**	210	0	0	**210**
Ireland	320	40	0	**360**	150	20	0	**170**
Italy	6,060	4,700	40	**10,800**	190	160	0	**350**
Latvia	230	15	0	**245**	270	20	0	**290**
Lithuania	250	5	5	**260**	190	5	5	**20**
Luxembourg	180	10	20	**210**	620	40	110	**770**
Malta	20	-	0	**20**	90	-	10	**100**
Netherlands	1,800	180	0	**1,980**	220	20	0	**240**
Norway	260	45	5	**310**	110	20	0	**130**
Poland	2,700	320	20	**3,040**	170	20	0	**190**
Portugal	450	50	30	**530**	90	10	10	**110**
Romania	3,700	260	0	**3,960**	430	30	0	**450**
Slovakia	170	50	0	**220**	80	20	0	**100**
Slovenia	100	20	-	**120**	100	20	0	**120**
Spain	6,090	410	20	**6,520**	260	20	0	**280**
Sweden	950	490	0	**1,440**	180	100	0	**280**
Switzerland	640	70	10	**720**	160	20	0	**180**

Note: Please refer to Section 2.2, Annex 1 and Annex 3 for comparability issues across countries.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

3.2.6 *Exploring additional health impacts of noise: assessment of depression and dementia*

While the primary HRA in previous sections concentrates on key health effects — such as annoyance, sleep disturbance, cardiometabolic outcomes and premature mortality — noise also has broader implications for people's health and well-being. As discussed in Section 3.1, a growing body of evidence indicates that noise affects human health beyond traditional cardiometabolic systems. Depression and dementia have emerged as likely consequences of transportation noise, as both conditions are linked to oxidative stress and inflammation — reactions that can be triggered by noise-related responses such as annoyance, negative emotions and sleep disturbance (see Figure 3.1). Given the increasing number of studies on dementia and the rise in systematic reviews on depression, these two outcomes are quantified in this assessment to highlight potential impacts that may not be captured in the main EU-wide noise HRA (Röösli et al., 2025).

According to the thresholds set by the END, transportation noise may have contributed to approximately 300,000 cases of depressive disorders and 19,000 cases of dementia in Europe in 2021. This translates to a total loss of 48,000 DALYs for depressive disorders and 75,000 DALYs for dementia. A detailed breakdown by source and area can be found in Table 3.8.

Table 3.8 Estimated yearly number of new cases of depressive disorders and dementia due to noise from road, rail and air transport, EEA-32 (excluding Türkiye)

		Depressive disorders	DALYs	Dementia	DALYs
Inside urban areas	Road	191,900	30,500	11,300	45,700
	Rail	22,900	3,600	1,500	6,000
	Air	2,400	400	150	600
Outside urban areas	Road	53,700	8,600	3,500	14,200
	Rail	27,400	4,300	2,100	8,600
	Air	1,300	200	100	400
	Total	**299,600**	**47,600**	**18,700**	**75,400**

Notes: DALYs, disability-adjusted life years.

Source: ETC HE internal data, calculated with the meta-analysis described in Röösli et al., 2025.

These numbers account for 0.8% of all new cases of depressive disorders and 1.7% of new dementia cases in Europe. If future research confirms these outcomes and relationships, they could add an additional 123,000 DALYs to the noise-related BoD in Europe. This data shows the impact of transportation noise on significant mental health issues across the European population.

3.3 Health risks and impacts based on the WHO recommended levels

To present a more complete health impact assessment, data on populations exposed below a 55dB L_{den} and 50dB L_{night} are needed as negative effects begin at lower levels than those reported under the END. Many individuals are exposed to these lower noise levels (see Section 2.1), which still pose health risks. When applying the more stringent WHO recommendations (see Section 1.3), the estimated health impacts are greater than those presented in the previous section. Estimates based on WHO recommended levels are detailed in the following sections. Overall, including populations exposed to these lower noise levels increases the health burden by approximately 20%, although impacts vary depending on the specific health outcomes and sources.

3.3.1 Estimated health risks of environmental noise based on WHO recommendations

When using the WHO thresholds, around 21 million adults living in agglomerations or near major noise sources are HA by noise from road traffic, railways and aircraft. Meanwhile, approximately seven million adults experience severe sleep disturbances due to nighttime noise (see Table 3.9). Additionally, annual health impacts from environmental noise — including road, rail, aircraft and industrial sources — are estimated to cause 63,000 new cases of CVD, 28,000 cases of type 2 diabetes and 82,000 premature deaths.

When compared to the END thresholds, by applying the WHO guideline level, the overall health effects are higher by approximately 20% and sleep disturbance is higher by up to 30%. Sleep disturbance is particularly underestimated by applying the END thresholds. This is because the WHO nighttime noise recommended levels are considerably lower than those set by the END.

Table 3.9 Estimated number of people suffering from different health outcomes due to noise from road, rail and aircraft based on WHO recommended levels, EEA-32 (excluding Türkiye)

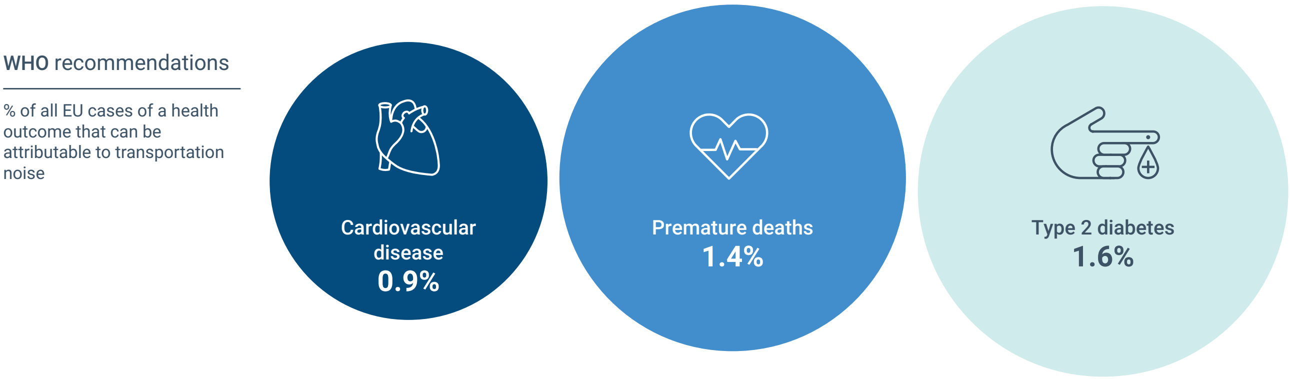
Number of cases		High annoyance	High sleep disturbance	CVD	Type 2 diabetes	Premature mortality (a)
Inside urban areas	Road	11,617,300	3,644,200	40,200	18,300	53,100
	Rail	1,561,000	810,000	4,500	1,900	5,800
	Air	1,342,300	361,200	1,900	800	2,500
Outside urban areas	Road	3,731,400	1,063,600	10,600	4,800	14,000
	Rail	1,494,700	802,100	4,800	2,000	6,200
	Air	965,000	354,500	600	300	800
	Total (b)	**20,711,700**	**7,035,600**	**62,600**	**28,100**	**82,400**

Notes: (a) Refers to all-cause natural mortality.
(b) There may be some double counting mainly for high annoyance and high sleep disturbance due to combined effects of multiple sources.
CVD, cardiovascular disease.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

Based on these WHO recommended levels, it is estimated that approximately 0.9% of all annual CVD cases, 1.6% of all new type 2 diabetes cases and 1.4% of all natural cause mortality deaths in Europe could be attributed to transportation noise exposure (see Figure 3.5).

Figure 3.5 **Percentage of total EU cases of CVD, type 2 diabetes and premature mortality attributable to transportation noise based on WHO recommended levels**



Notes: Premature deaths refer to all-cause natural mortality.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

Children are also affected, with negative impacts starting below the END thresholds. Using the recommended levels by the WHO, it is estimated that there are up to 80,000 cases of behavioural problems, 608,000 cases of reading impairments and 344,000 cases of being overweight (see Table 3.10).

Table 3.10 **Estimated number of children aged 6-17 years suffering from reading impairment, behavioural problems and overwight due to noise from road, rail and air transport based on WHO recommendations, EEA-32 (excluding Türkiye)**

		Behavioural problems	Reading impairment	Overweight
Inside urban areas	Road	52,700	385,700	219,200
	Rail	5,300	44,800	23,700
	Air	2,400	7,600	10,600
Outside urban areas	Road	13,200	123,700	57,600
	Rail	5,100	41,800	26,400
	Air	1,500	4,400	6,900
	Total	**80,300**	**608,100**	**344,400**

Source: ETC HE, 2025c.

3.3.2 Estimated health burden in DALYs based on WHO recommendations

Using the WHO lower noise level guidelines lead to a 21% increase in DALY estimates, bringing the total burden to 1.7 million years of healthy life lost (see Table 3.11). Sleep disturbance showed the greatest difference, at approximately 30%. This is because WHO nighttime noise thresholds are significantly lower than those set by the END (see Section 1.3). Additionally, the health burden from aircraft noise differed most compared to other sources; this highlights the impact of the lower WHO exposure thresholds for aircraft.

Figure 3.6 illustrates the DALY rates per 100,000 inhabitants. It shows that exposure to noise accounts for nearly 375 DALYs per 100,000 people using the WHO thresholds.

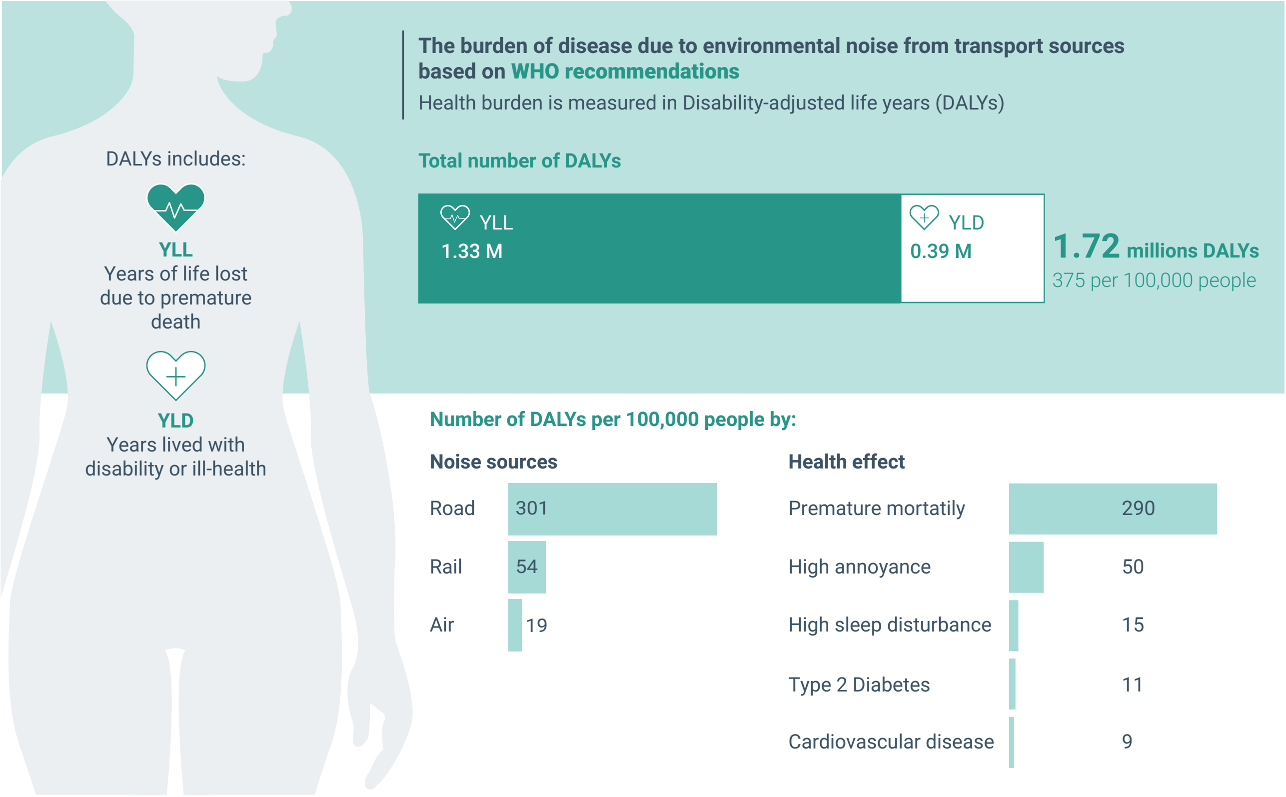
Table 3.11 **Estimated number of DALYs due to road, rail and aircraft in areas covered under the END based on WHO recommendations, EEA-32 (excluding Türkiye)**

	Health effect	Road	Rail	Aircraft	Total per health outcome (b)
YLD	High annoyance	168,800	33,600	25,400	227,800
	High sleep disturbance	47,100	16,100	7,200	70,400
	CVD	33,400	5,700	1,700	40,800
	Type 2 diabetes	41,900	7,200	2,100	51,200
YLL	Premature mortality (a)	1,091,700	187,800	53,300	1,332,800
DALYs	YLD+YLL	1,382,900	250,400	89,600	1,724,000

Notes: (a) Refers to all-cause natural mortality.
(b) There may be some double counting mainly for high annoyance and high sleep disturbance due to combined effects of multiple sources.
CVD, cardiovascular disease. YLD, years lived with disability. YLL, years of life lost. DALYs, disability-adjusted life years.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

Figure 3.6 **BoD due to environmental noise from transport sources based on WHO recommended levels, EEA-32 (excluding Türkiye)**



Notes: Premature deaths and YLL refer to all-cause natural mortality. There may be some double counting mainly for high annoyance and high sleep disturbance due to combined effects of multiple sources.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

Based on the DALYs estimated when considering populations exposed up to the WHO recommendations, the estimated economic costs increase to EUR 120.6 billion, or 0.78% of Europe's GDP.

3.3.3 Overview of health impacts per country based on WHO recommendations

Table 3.12 presents a summary of the estimated number of premature deaths per year and the DALYs per 100,000 population by country based on the WHO recommended levels. Applying the WHO recommendations results in significantly higher estimates of premature deaths and DALY rates per 100,000 population compared to when using the END thresholds.

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Table 3.12 **Estimated number of premature deaths per year and DALYs per 100,000 population by country based on WHO trecommendations, EEA-32 (excluding Türkiye)**

Country	Selected health impacts per country							
	Premature deaths/year				DALYs per 100,000 people/year			
	Road	Rail	Air	**Total**	Road	Rail	Air	**Total**
Austria	1,450	410	70	**1,930**	330	100	20	**450**
Belgium	1,500	200	300	**2,000**	270	40	60	**370**
Bulgaria	1,500	130	0	**1,630**	500	40	0	**540**
Croatia	650	20	-	**670**	350	10	0	**360**
Cyprus	250	-	0	**250**	610	0	20	**630**
Czechia	1,700	100	80	**1,880**	350	25	20	**395**
Denmark	600	15	0	**615**	220	5	0	**225**
Estonia	70	0	45	**115**	110	0	90	**200**
Finland	550	70	0	**620**	210	30	0	**240**
France	13,500	1,300	600	**15,400**	400	40	20	**460**
Germany	13,100	2,400	960	**16,460**	320	60	30	**410**
Greece	920	90	80	**1,090**	170	20	20	**210**
Hungary	1,400	210	110	**1,720**	330	50	30	**410**
Iceland	50	-	0	**50**	290	0	10	**300**
Ireland	415	45	20	**480**	210	20	10	**240**
Italy	7,000	4,800	300	**12,100**	220	155	15	**390**
Latvia	280	20	15	**315**	320	30	20	**370**
Lithuania	330	10	30	**370**	260	5	30	**295**
Luxembourg	200	10	50	**260**	680	40	220	**940**
Malta	45	-	20	**65**	200	0	95	**295**
Netherlands	2,500	200	20	**2,720**	300	30	0	**330**
Norway	400	50	15	**465**	160	20	10	**190**
Poland	3,600	360	130	**4,090**	230	20	10	**260**
Portugal	540	60	180	**780**	100	10	45	**155**
Romania	4,300	300	55	**4,655**	500	35	10	**545**
Slovakia	230	60	10	**300**	100	30	10	**140**
Slovenia	130	25	-	**155**	130	30	0	**160**
Spain	7,530	460	150	**8,140**	320	20	10	**350**
Sweden	1,200	550	20	**1,770**	230	110	5	**345**
Switzerland	955	80	65	**1,100**	230	20	25	**275**

Notes: Please refer to Section 2.2, Annex 1 and Annex 3 for data completeness per country and comparability issues.

Source: EEA, calculated using the methodology from ETC HE, 2024b.

3.4 Noise pollution in context: a comparison of the health impacts with other environmental pollutants

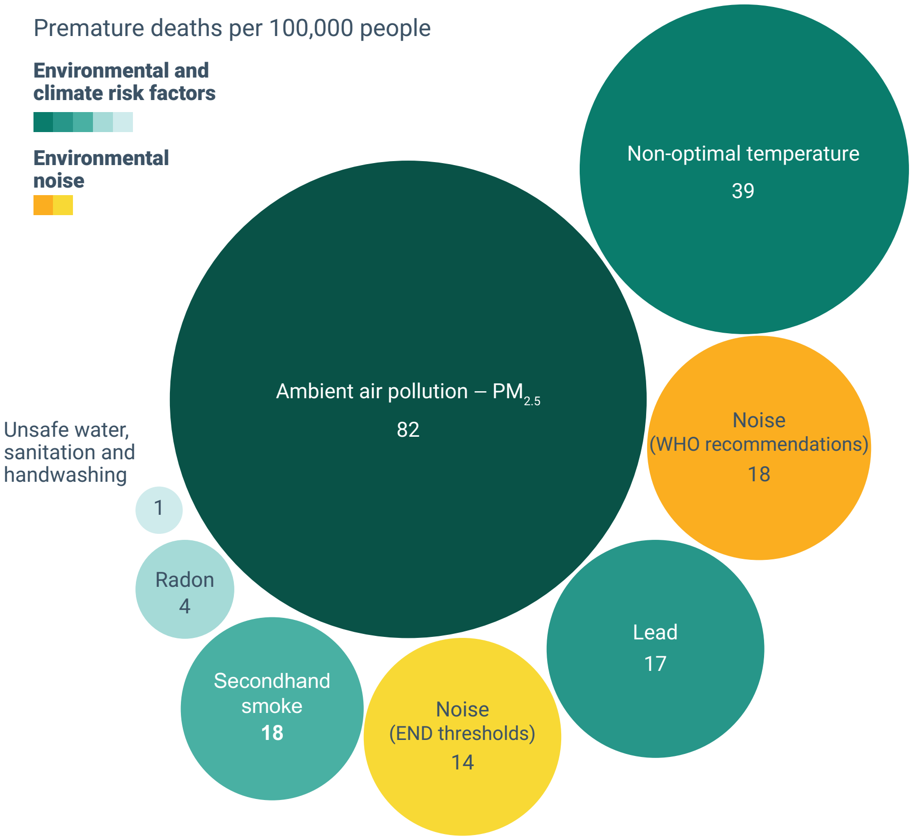
Europeans face exposure to a range of environmental risk factors that significantly affect human health, including noise pollution. A study by Hänninen et al. (2014) identified traffic noise as one of the leading contributors to ill health due to environmental factors in western Europe. Recent research (Clark et al., 2025) further confirms that noise remains a significant environmental risk factor impacting health across the continent.

This section provides an overview comparing the impacts of noise pollution, as discussed in previous sections, with other environmental and climate health stressors in Europe. To facilitate this comparison, we use data from the GBD study (IMHE, 2021), which addresses a range of environmental health risk factors. These include heat and cold stress, lead poisoning, second-hand smoke, radon exposure and unsafe water, sanitation and also handwashing. Additionally, health impacts from ambient air pollution are included, referencing 2021 data from the EEA (EEA, 2024a). The evaluation focuses on premature deaths and the BoD, measured in DALYs.

Figure 3.7 and Figure 3.8 illustrate the health impacts associated with specific environmental pollutants. The data reveal that noise pollution from transportation sources is a significant environmental risk factor for health in Europe, affecting both premature mortality and the overall BoD. Transport noise is responsible for approximately 14 premature deaths per 100,000 people; this increases to 17.9 deaths when evaluated using WHO recommendations. Additionally, when considering both mortality and morbidity, transport noise accounts for about 297 DALYs per 100,000 population under the END thresholds; this rises to 374.8 DALYs under WHO recommendations. Compared to other environmental health risks, transport noise ranks among the top three, following air pollution and temperature-related factors, posing a greater health burden than more commonly recognised risks, such as second-hand smoke or lead exposure.

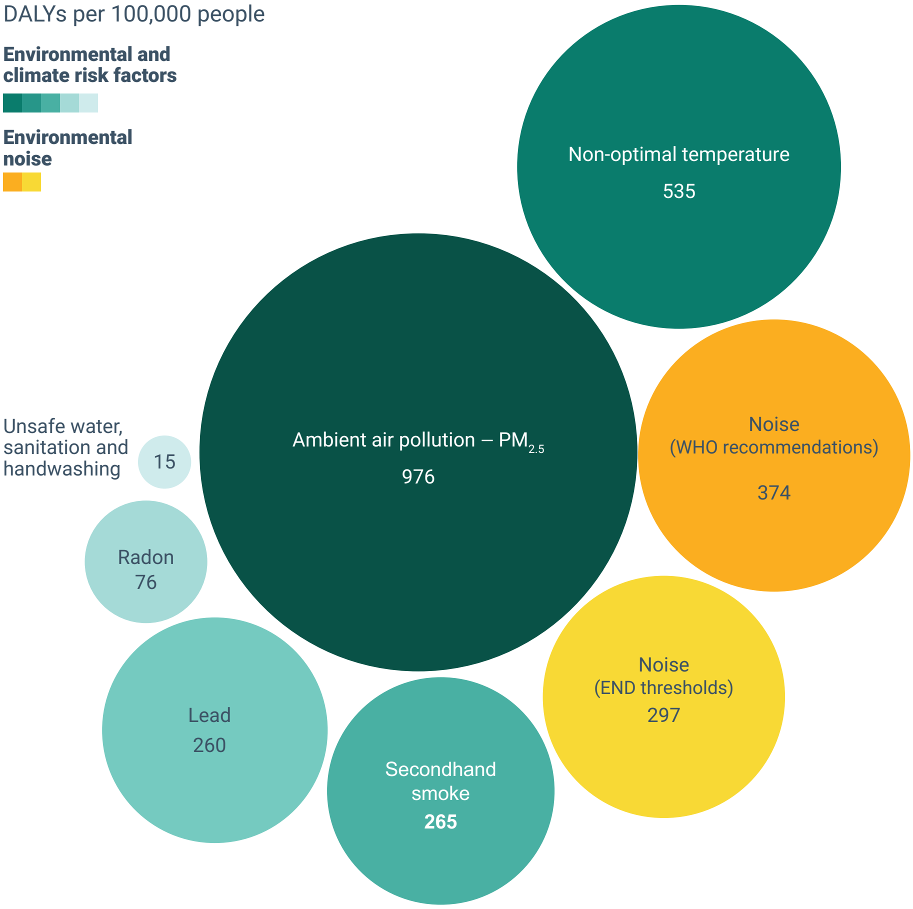
Ambient air pollution — particularly from fine particulate matter ($PM_{2.5}$) — is the leading environmental contributor to disease. It is responsible for approximately 82 premature deaths and 976 DALYs per 100,000 population. Non-optimal temperatures, especially cold exposure, follow as the second largest contributor, with 39 premature deaths and 534 DALYs per 100,000. In comparison, transport noise contributes about one-third of the burden of $PM_{2.5}$ but exceeds that of second-hand smoke (11.7 deaths, 264.9 DALYs per 100,000 people), lead exposure (17.3 deaths, 76.0 DALYs per 100,000 people), radon (3.5 deaths, 76 DALYs per 100,000 people) and unsafe water, sanitation and handwashing (0.5 deaths, 15.5 DALYs per 100,000 people).

Figure 3.7 **Annual premature deaths per 100,000 people attributable to selected environmental risk factors, EEA-32 (excluding Türkiye)**



Sources: Values for non-optimal temperature, lead, second-hand smoke, radon and unsafe water, sanitation and handwashing are based on data from the GBD Study 2021 (IHME, 2021); values for transport noise pollution are derived from data presented in Sections 3.2 and 3.3 of this report; and estimates for ambient air pollution are based on 2021 data from the EEA (EEA, 2024a).

Figure 3.8 **Annual DALYs per 100,000 people attributable to selected environmental risk factors, EEA-32 (excluding Türkiye)**



Notes: DALYs for air pollution include all-cause mortality, IHD, asthma, stroke, diabetes, lung cancer and COPD.

DALYs, daily-adjusted life years. IHD, ischaemic heart disease. COPD, chronic obstructive pulmonary disease.

Sources: Values for non-optimal temperature, lead, second-hand smoke, radon and unsafe water, sanitation and handwashing are based on data from the GBD Study 2021 (IHME, 2021); values for transport noise pollution are derived from data presented in Sections 3.2 and 3.3 of this report; and estimates for ambient air pollution are based on 2021 data from the EEA (EEA, 2024a).

Box 3.5

Effects below WHO recommendations

Negative health effects from noise can occur at levels below the WHO recommendations. Many studies have found adverse effects beginning at noise levels as low as 45dB (ETC HE, 2024b).

Applying these lower noise effect thresholds of 45 dB would increase the estimated number of premature deaths due to noise to approximately 28 premature deaths per 100,000 population and 580 DALYs per 100,000 people.

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4 Measuring progress towards the zero pollution target on noise: outlook to 2030

Key messages

- Without additional measures, potentially including regulatory or legislative changes, the EU is unlikely to meet its 2030 zero pollution target of reducing the number of people chronically disturbed by transport noise by 30%.
- Under an optimistic scenario, where substantial additional measures are implemented, the number of people highly annoyed by noise is predicted to decline by about 21% between 2017 and 2030. Under a conservative scenario, the number of people highly annoyed by noise is predicted to remain unchanged.
- Reducing exposure to road transport remains a major challenge in achieving the 2030 zero pollution target, with much greater effort being required. Efforts are also needed to mitigate the negative health impacts from projected growth in rail activity.
- The majority of people affected by noise are exposed to moderate, rather than very high noise levels. Therefore, to meet the 2030 zero pollution target, interventions should focus not only on areas with severe noise issues but also on areas where noise levels are moderate.
- A combination of measures involving upstream measures aimed at reducing noise at source, improved urban and transportation planning, as well as significant reductions in traffic within urban areas can deliver significant reductions towards meeting the 2030 zero pollution target.

4.1 Monitoring the EU zero pollution ambition for transport noise

In 2021, the EC adopted an action plan 'towards zero pollution for air, water and soil' under the European Green Deal (EC, 2021a; 2021d). One of the headline targets of the zero pollution action plan is to reduce the number of people chronically disturbed by transport noise by 30% by 2030 (see Box 4.1).

Box 4.1

The 2030 zero pollution target on noise for Europe

Given the negative impact of noise on human health and the large number of people affected, reducing environmental noise is a key target under the zero pollution action plan (EC, 2021d). Specifically, by 2030, the aim is to reduce the number of people chronically disturbed by noise from transport by 30% compared with 2017. To meet this objective, the EC has identified the need to:

- monitor progress towards achieving a 30% reduction in the number of people chronically disturbed by noise by 2030;
- improve the noise-related regulatory framework on tyres, road vehicles, railways and aircraft at the EU level and also at the international level;
- review progress in 2022 and consider if there is a need to set noise reduction targets at the EU level in the END;
- improve the integration of noise action plans into sustainable urban mobility plans, benefiting from an extension of clean public transport and active mobility.

Since the establishment of the zero pollution target for noise in 2021, several assessments have evaluated progress towards this target including:

- *Zero pollution outlook 2022* (EC, 2022) and *Zero pollution monitoring assessment 2022* (EEA, 2022b);
- *Zero pollution monitoring and outlook 2025* (EEA and JRC, 2025).

These assessments used preliminary data for 2022 across the EU-27 countries.

The 2030 zero pollution target for noise refers to reducing the number of people who are 'chronically disturbed by noise'. This term includes a range of negative health effects such as annoyance, sleep disturbance and cardiometabolic issues amongst others. High annoyance is considered a good indicator of the adverse health impacts of noise, as it can be a harbinger of more severe health problems. Therefore, it is used as a proxy for chronic disturbance to monitor progress towards the 2030 zero pollution noise target.

Regarding the sources covered, the target does not explicitly specify which types of transport are included. Progress is assessed using data from the END, which focuses on noise from road, rail and aircraft sources. Because the percentage of people highly annoyed (HA) by noise varies by source and begins at exposure levels well below the END thresholds, progress and outlooks are monitored using the source specific WHO recommended levels.

Due to changes in calculation methodologies between reporting years and the need to track progress based on 2017 data as indicated by the zero pollution ambition, a 2017 baseline had to be estimated, as explained in Section 2.5.2. Based on the calculated 2017 baseline, to achieve the 2030 zero pollution target for noise it is necessary to decrease the number of HA people by 6.4 million (see Figure 4.1).

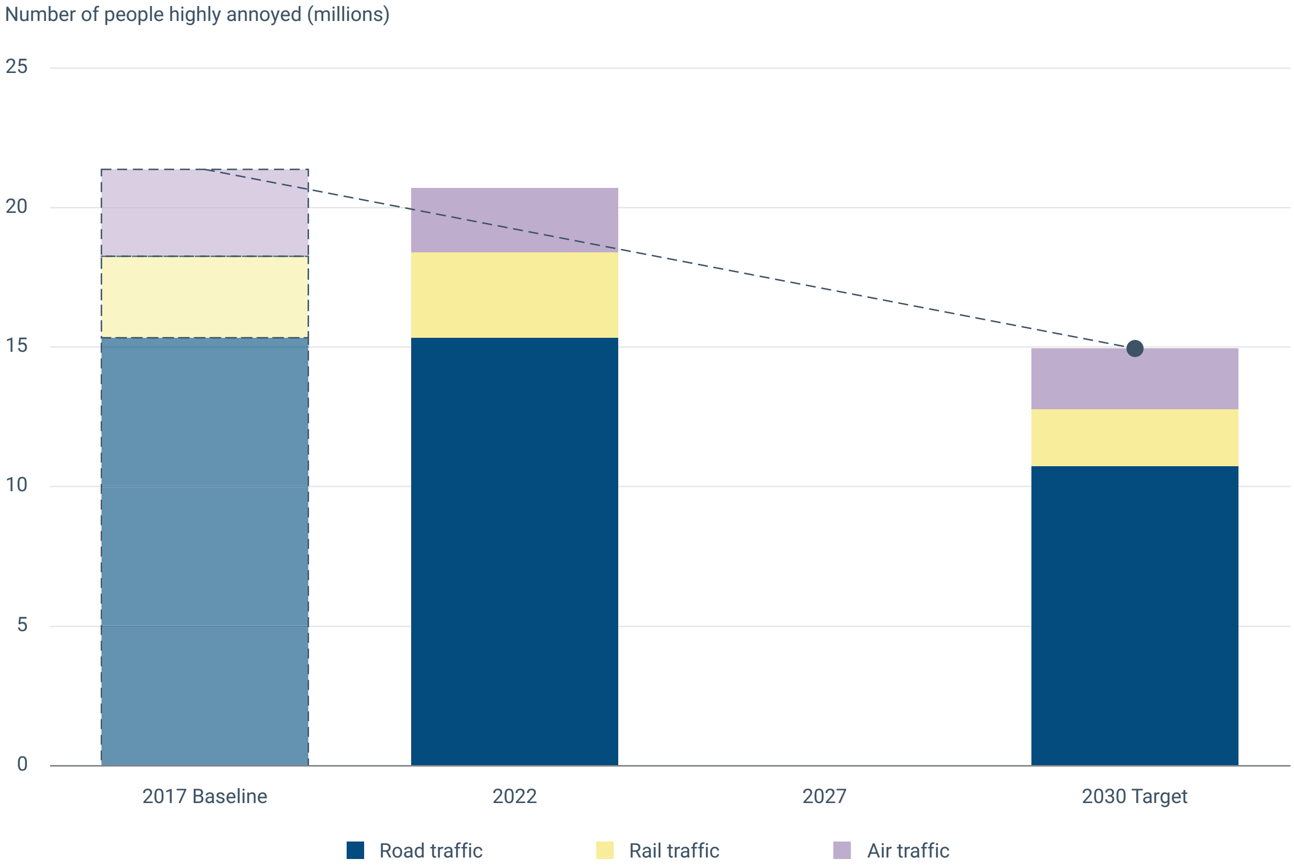
Box 4.2

The UN's sustainable development goals (SDGs)

The SDGs, collectively known as the 2030 agenda for sustainable development, outline key global challenges and provide a comprehensive framework for addressing urgent sustainability issues (UN, 2025). Widely recognised, they guide national policies and promote action across critical areas for people and the planet.

Although noise is a cross-cutting issue relevant to many SDGs, it is not explicitly mentioned among the 17 goals or 169 targets. However, the findings of this and previous chapters are particularly relevant to Target 11.6, which aims to reduce the per capita environmental impact of cities by 2030 and also Target 3.9 on reducing illnesses and death from hazardous chemicals and pollution.

Figure 4.1 **Estimated number of people highly annoyed by noise from road, rail and aircraft traffic based on 2017 baseline, 2022 and 2030 zero pollution target, EEA-32 (excluding Türkiye)**



Notes: Based on the exposure-response functions outlined in the WHO environmental noise guidelines for the European region (WHO, 2018), outlined in Chapter 2, Section 2.3 and WHO source-specific recommended noise levels.

Sources: EEA, based on data reported under the END (EEA, 2025); 2017 baseine based on methodology outlined in ETC HE, 2024a.

A closer look at different noise sources reveals mixed trends. Road traffic noise has seen some progress, with reductions of 4% in high annoyance and 5% in high sleep disturbance. However, railway noise has slightly increased by 2% for annoyance and 1% for sleep disturbance. In contrast, aircraft noise appears to have dropped significantly. This, however, is likely a temporary effect of the COVID-19 pandemic, which led to reduced air traffic. As air travel returns to pre-pandemic levels, the number of people affected by aircraft noise could rise again.

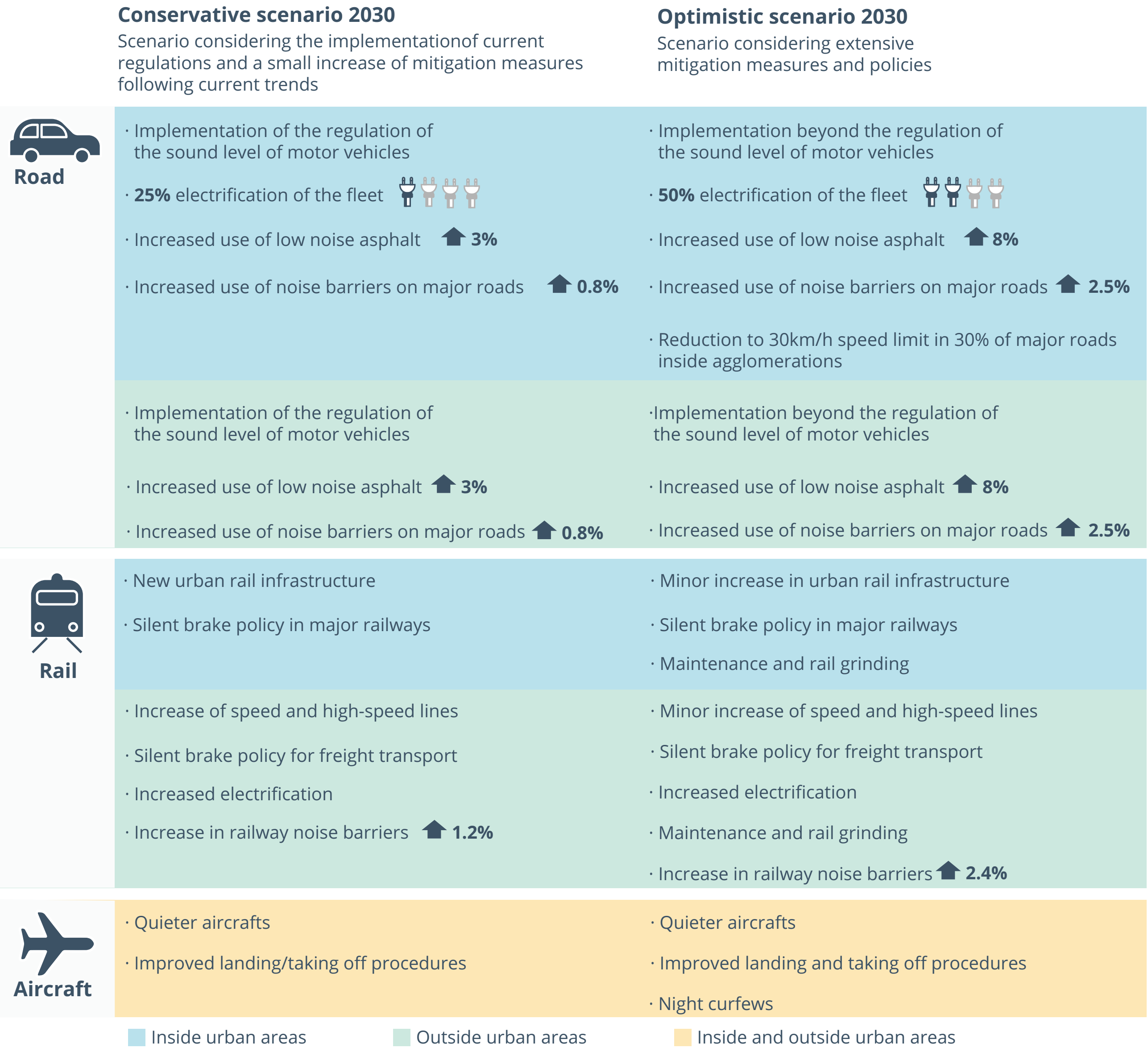
Looking ahead, achieving the 2030 zero pollution target for noise will be particularly challenging. Despite concerted efforts, the overall number of people exposed to harmful noise levels has remained stable over the past decade (EEA, 2024b). Given the ongoing population growth and rising mobility demands, a key question remains: can the 2030 target still be met? The next section explores future projections to assess the feasibility of achieving this objective using the latest 2022 data for the EEA-32 countries (excluding Türkiye) (see Section 1.2).

4.2 Exploring two scenarios for transport noise to 2030

Two scenarios were developed to assess whether or not the 2030 zero pollution target on noise can be achieved. The methodology is described in the ETC HE report *Methodology for calculating projected health impacts from transportation noise — Exploring two scenarios for 2030* (ETC HE, 2024d). The initial outlook was published in 2022; the updated version incorporates new data from 2022 strategic noise maps as well as minor adjustments to the methodology.

The number of people HA by transport noise was projected under two scenarios, one conservative (less ambitious) and one optimistic. The conservative scenario assumes fulfilment of the existing legal requirements to reduce noise at source, as well as the implementation of some non-binding mitigation measures. The optimistic scenario assumes the implementation of a set of more ambitious noise mitigation measures that go beyond current regulations. Figure 4.2 provides an overview of the measures included in both scenarios. Different measures are included depending on the noise source and the type of area. In both scenarios, projections of population growth and transport activity are considered in combination with the implementation of the measures.

Figure 4.2 **Overview of measures and degree of implementation for each source of transport noise included in the conservative and optimistic scenarios**



	Conservative scenario 2030 Scenario considering the implementationof current regulations and a small increase of mitigation measures following current trends	**Optimistic scenario 2030** Scenario considering extensive mitigation measures and policies
Road 🟦	· Implementation of the regulation of the sound level of motor vehicles · **25%** electrification of the fleet · Increased use of low noise asphalt ⬆ **3%** · Increased use of noise barriers on major roads ⬆ **0.8%**	· Implementation beyond the regulation of the sound level of motor vehicles · **50%** electrification of the fleet · Increased use of low noise asphalt ⬆ **8%** · Increased use of noise barriers on major roads ⬆ **2.5%** · Reduction to 30km/h speed limit in 30% of major roads inside agglomerations
🟩	· Implementation of the regulation of the sound level of motor vehicles · Increased use of low noise asphalt ⬆ **3%** · Increased use of noise barriers on major roads ⬆ **0.8%**	·Implementation beyond the regulation of the sound level of motor vehicles · Increased use of low noise asphalt ⬆ **8%** · Increased use of noise barriers on major roads ⬆ **2.5%**
Rail 🟦	· New urban rail infrastructure · Silent brake policy in major railways	· Minor increase in urban rail infrastructure · Silent brake policy in major railways · Maintenance and rail grinding
🟩	· Increase of speed and high-speed lines · Silent brake policy for freight transport · Increased electrification · Increase in railway noise barriers ⬆ **1.2%**	· Minor increase of speed and high-speed lines · Silent brake policy for freight transport · Increased electrification · Maintenance and rail grinding · Increase in railway noise barriers ⬆ **2.4%**
Aircraft 🟨	· Quieter aircrafts · Improved landing/taking off procedures	· Quieter aircrafts · Improved landing and taking off procedures · Night curfews

🟦 Inside urban areas 🟩 Outside urban areas 🟨 Inside and outside urban areas

Notes: In addition to measure implementation, all scenarios have considered projected population growth and transport activity change. These may outweigh the benefits of the measures considered.

The projections are based on different hypotheses, assumptions and approximations, each of which has associated uncertainties.

The projections assume uniform implementation of the measures in all countries. The potential for reduction in each country depends on how many actions/measures have already been implemented.

Source: ETC HE, 2024d.

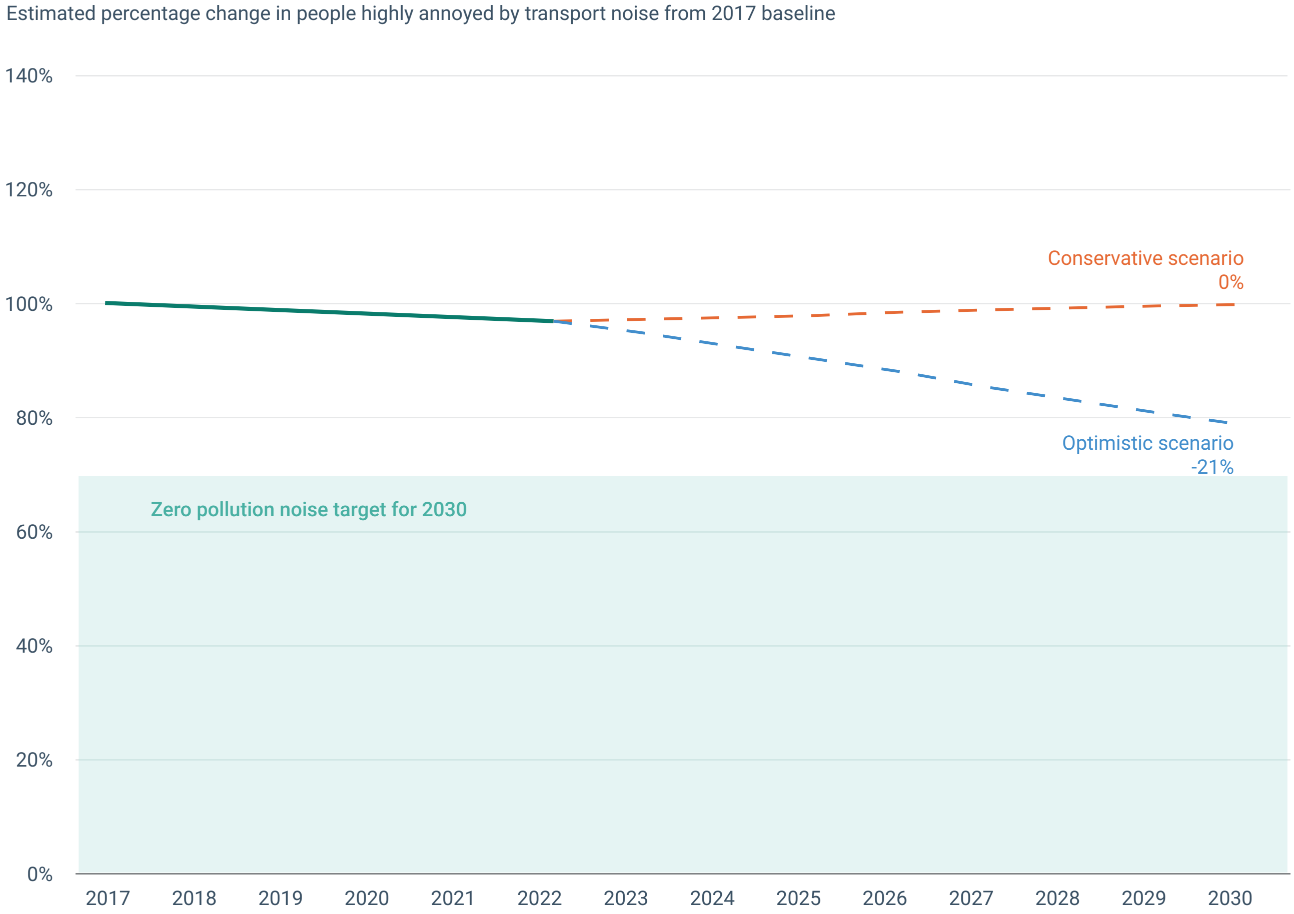
4.3 Transport noise outlook to 2030 — can the zero pollution ambition target be met?

The results of this outlook assessment suggest that while a decrease in the number of people HA by noise is anticipated, achieving a reduction of at least 30% in the number of people chronically disturbed by transport noise levels by 2030 is unlikely without additional measures which could be supported by regulatory or legislative changes (see Figure 4.3).

- **Optimistic scenario**
  Under an optimistic scenario that includes the implementation of a substantial set of additional measures, the number of people HA by transport noise in the baseline year is predicted to decline by about 21% by 2030.

- **Conservative scenario**
  Under a conservative scenario, the number of people HA is predicted to remain unchanged (0%).

Figure 4.3 Estimated percentage change in number of people highly annoyed by noise from transport in Europe from the 2017 baseline year to 2030 under conservative and optimistic scenarios



Notes: Based on the exposure-response functions outlined in the WHO environmental noise guidelines for the European region (WHO, 2018) starting at WHO recommended noise levels.

Sources: EEA, based on data reported under the END (EEA, 2025); methodology outlined in ETC HE, 2024d, and ETC HE, 2024a.

Although the EU outlook assessment does not extend its investigation beyond 2030, a country study from Germany suggests that the target of a 30% reduction in the number of chronically disturbed people due to noise could be achieved by 2040 under a business-as-usual scenario that assumes the action implementation rate, as in recent years (see Box 4.3).

Box 4.3

Assessment of the zero pollution objective on noise in Germany

In Germany, three scenarios have been developed to assess the potential for noise reduction through typical individual measures and their combinations.

The feasibility of reaching the targets outlined in the zero pollution action plan was evaluated across three distinct scenarios focusing on the years 2030 and 2040. The scenarios were do-nothing, business-as-usual and very ambitious.

The findings of this study indicate that while maintaining the current implementation of noise measures in Germany may not allow for a 30% reduction in the number of people chronically disturbed by transport noise by 2030, it remains possible to achieve this target by 2040 if the current rate of application of these measures continues. These measures include the implementation of Directive 540/2014/EU on vehicle emissions, the electrification of heavy-duty vehicles and buses, ongoing renewal of road surfaces and the introduction of speed reductions in urban areas. Measures also include the continuous enforcement of Germany's noise abatement program for motorways and federal roads and the enforcement of national noise regulations in new road constructions.

Source: Heidebrunn et al., 2024.

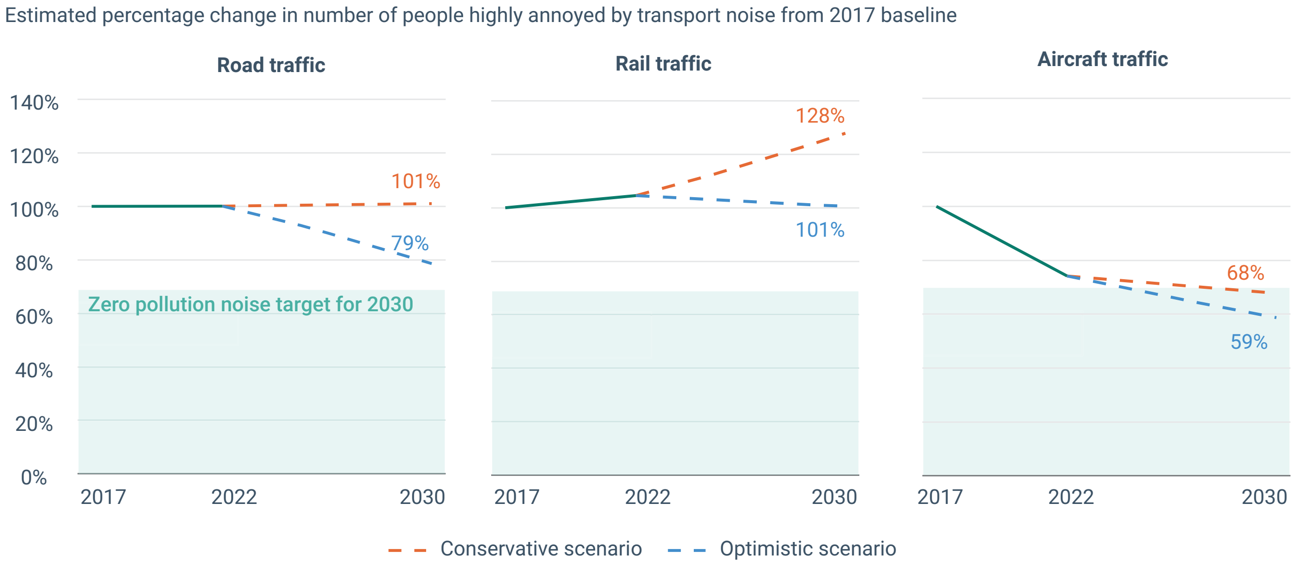
4.4 Road, rail and aircraft noise — what is possible for each of these sources?

Although the 2030 zero pollution noise target is unlikely to be reached for all sources of transport noise combined, projections differ for rail, road and aircraft. In order to achieve the 2030 zero pollution noise target it will, in practice, be necessary to focus efforts on road transport, as the overall impact is driven by this source. Figure 4.4 shows the projected percentage change from the 2017 baseline to 2030 in the number of people HA by noise from the three transport sources.

Based on the scenarios modelled:

- The number of people HA by road traffic noise is projected to increase by 1% under the conservative scenario or decrease by up to 21% under the optimistic scenario.
- The number of people HA by rail noise is projected to increase by up to 28% under the conservative scenario and remain the same under the optimistic scenario. The increases in numbers affected by railway noise are mainly driven by a projected substantial growth in rail activity.
- The number of people HA by aircraft noise is projected to decrease significantly, by up to 41% under the optimistic scenario and 32% in the conservative scenario.

Figure 4.4 **Projected percentage change from 2017 baseline to 2030 in the share of people highly annoyed by noise from rail, road and aircraft under a conservative and an optimistic scenario, EEA-32 (excluding Türkiye)**



Notes: Based on the exposure-response functions outlined in the WHO environmental noise guidelines and source specific WHO recommended noise thresholds.

Source: EEA, based on data reported under the END (EEA, 2025); methodology outlined in ETC HE, 2024d, and ETC HE, 2024a.

Considering the transport sources separately, it appears that only aircraft noise could achieve a 30% reduction, with a 32% decrease in the share of people HA by aircraft noise being achieved through a conservative scenario. This scenario entails the progressive uptake of quieter aircraft, combined with improved landing and take-off procedures. The optimistic scenario suggests that a fall of up to 41% in the share of people HA by aircraft noise could be achieved with additional measures, including night curfews. This projected trend is backed up by recent commitments from the aircraft sector and the EC (see Section 7.3.3), which can result in a reduction of noise levels.

The predicted increase in railway transport activity is much larger than that predicted for road and aircraft traffic. Whilst this may lead to overall benefits in terms of other factors (such as reduced air pollution or greenhouse gas emissions), here only noise is considered. This predicted increase in railway activity, leads to increased noise levels in the areas affected and outweighs the benefits of the silent brake policy and other measures considered in the scenarios. It is unlikely that a decrease in the share of people exposed to railway noise will be achieved by 2030. Therefore, a set of additional measures would be needed to reduce the amount of people chronically disturbed by railway noise. There are some EU initiatives, however, that could change this trend in the future (see Chapter 7).

The implementation of a combination of measures could reduce the number of people HA by road traffic noise by up to 21%. These measures include a fleet made up of 50% electric vehicles in cities, reducing speed limits; introducing stricter noise emission regulations for vehicles and increasing the application of low noise asphalts and noise barriers. However, without these measures the scenarios analysed showed no pathway to significant reduction in the share of people HA by road traffic noise.

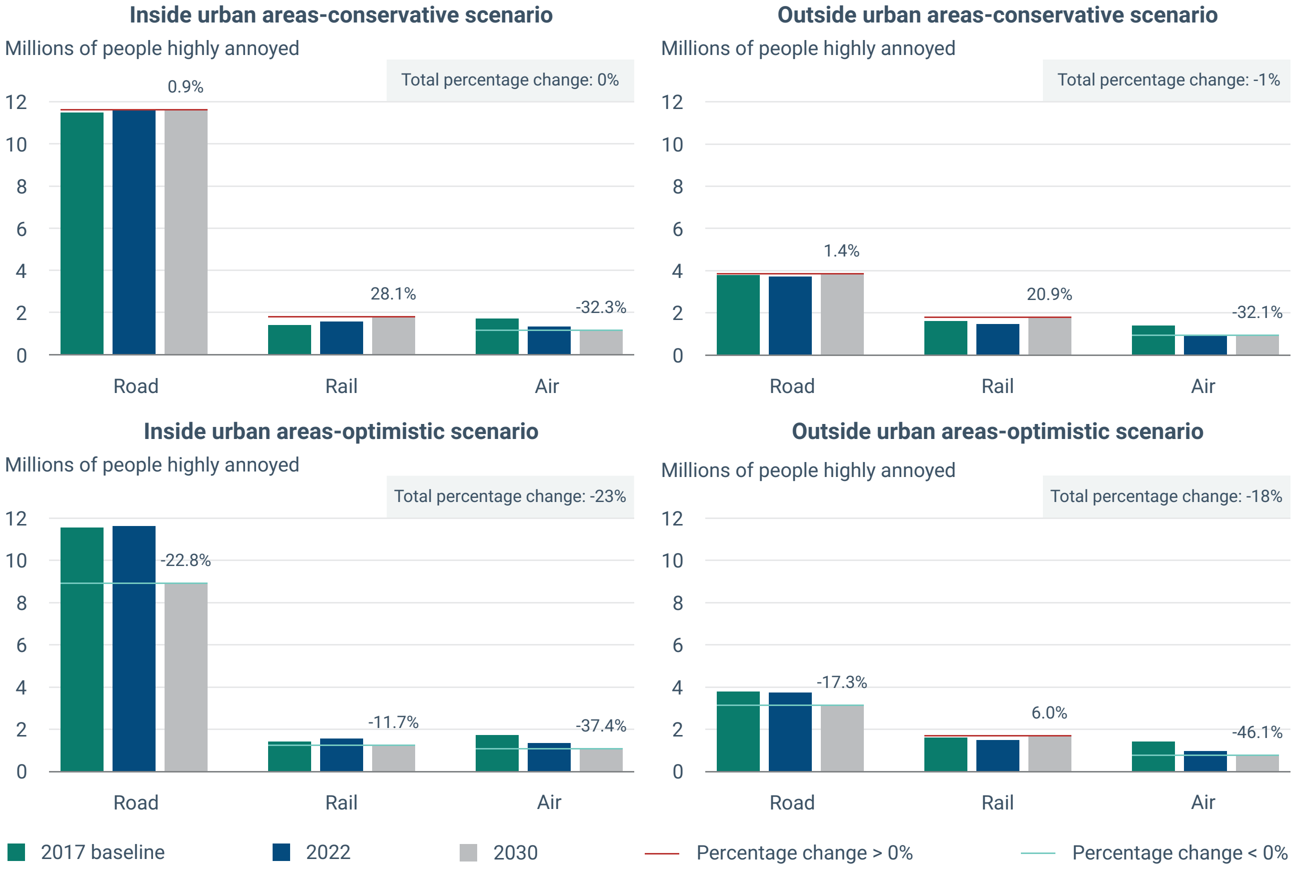
4.5 Urban versus non-urban areas: comparing noise reduction potential

As shown in Figure 4.5, the number of people affected by noise exposure differs significantly between urban and rural areas (i.e. inside agglomerations as reported by the END and outside agglomerations from major noise sources). Urban areas have a higher population density and are also more affected by noise pollution because of dense transport infrastructure and the high demand for mobility. Consequently, a significantly larger number of people are exposed to harmful noise levels in urban areas compared to areas outside agglomerations. The projections for noise levels in 2030 also reflect these disparities.

In urban areas, the range of potential noise mitigation measures is substantially broader, particularly concerning road traffic. Under the optimistic scenario, the number of people HA by noise in urban areas could be cut by nearly 23% from the 2017 baseline year through the implementation of a set of measures. These measures include increasing the proportion of electric vehicles to 50%, reducing speed limits, implementing noise emission regulations for vehicles and extending the use of low-noise asphalts and noise barriers. In contrast, non-urban areas have a more limited set of options for mitigating road noise. While there may be more opportunities to implement noise barriers along non-urban infrastructures, source measures related to traffic management are more limited, making it more challenging to decrease the number of people adversely affected. As shown in Figure 4.5, under the conservative scenario, the number of people HA by road noise outside urban areas could only be reduced 1% if no additional measures are implemented.

A similar trend is observed with rail noise, where the optimistic scenario indicates a greater potential for reducing annoyance in urban settings compared to rural ones. Conversely, for aircraft noise, the potential for reduction is higher in non-urban areas. This is largely because many airports are situated outside urban centres, impacting surrounding towns that are not classified as agglomerations.

Figure 4.5 **Projected percentage change from baseline to 2030 in the share of people HA in the conservative scenario (left) and highly annoyed in the optimistic scenario (right) by noise from rail, road and aircraft inside and outside urban areas, EEA-32 (excluding Türkiye)**



Notes: Based on the exposure-response functions outlined in the WHO environmental noise guidelines and WHO recommended noise thresholds.

Source: EEA, based on data reported under the END (EEA, 2025); methodology outlined in ETC HE, 2024d, and ETC HE, 2024a.

4.6 Distribution of people affected by noise across noise bands

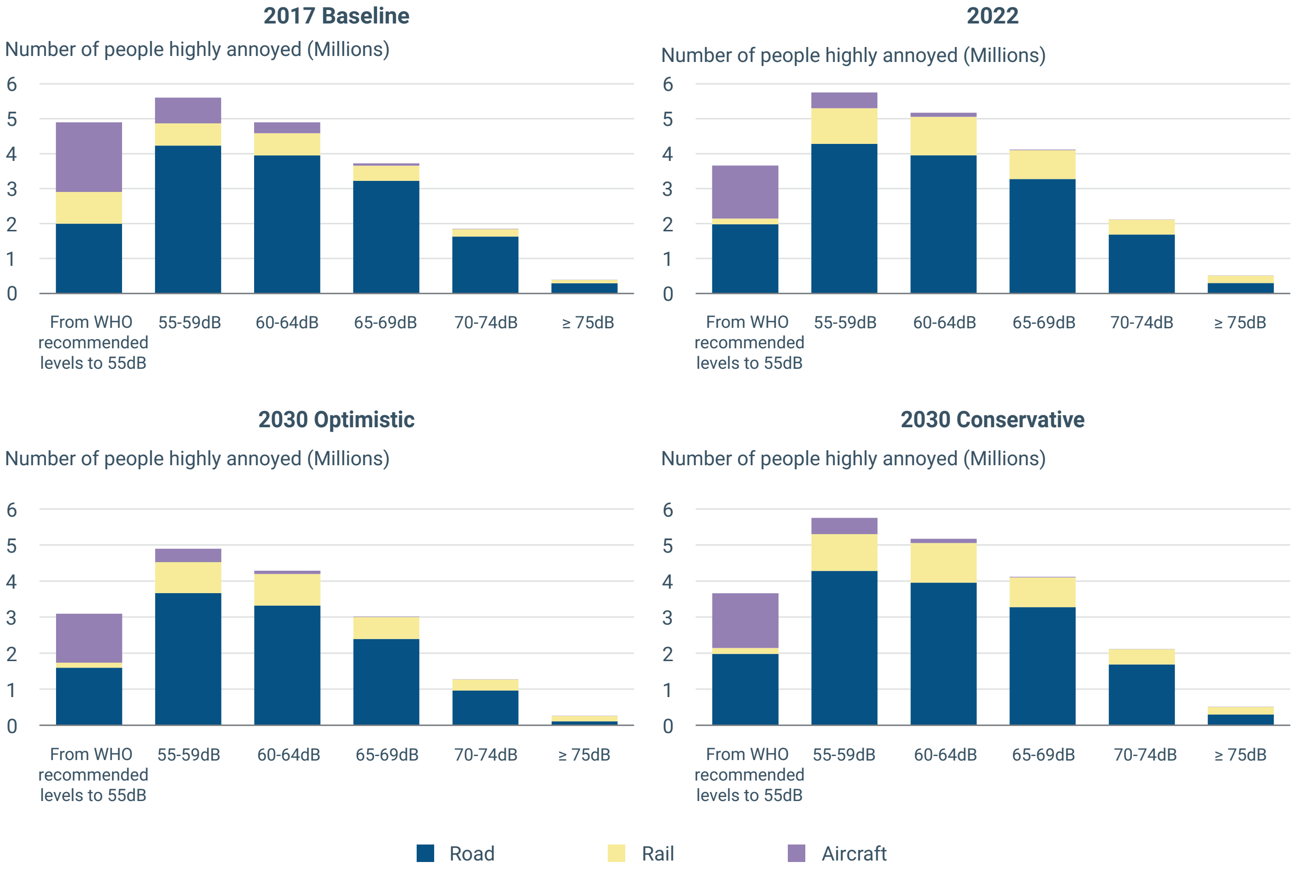
Analysis of noise exposure data indicates that the majority of the health burden associated with transport noise comes from those exposed to moderate noise levels, rather than high levels of noise. Therefore, focusing efforts on reducing the number of people exposed to these moderate levels of noise will result in the biggest overall health benefits. For example, data from 2022 shows that about 70% of the population affected by transport noise was HA at noise levels below 65dB during the day-evening-night period.

Figure 4.6 illustrates the number of people that were HA in 2022, along with projections for 2030. The data are organised into five noise bands. Additionally, the figure includes a category for people who are estimated to be HA at levels below a 55dB L_{den} down to the recommended WHO levels.

Under both scenarios for 2030, most people projected to experience long-term high annoyance due to transport noise will be exposed to noise levels in the bands below 65dB L_{den}.

Furthermore, the figure shows that even if the number of HA people decreases as projected in the scenarios, a substantial proportion will still be exposed to noise levels harmful to health as per the WHO guidelines. This concern is especially relevant for aircraft noise, as the WHO recommended levels for this source are much lower than those set by the END.

Figure 4.6 **Number of people highly annoyed by transport noise in 2022 and projected for 2030, by noise band and transport source, EEA-32 (excluding Türkiye)**



Notes: Based on the exposure-response functions outlined in the WHO environmental noise guidelines and WHO recommended noise thresholds.

Source: EEA, based on data reported under the END (EEA, 2025); methodology outlined in ETC HE, 2024d, and ETC HE, 2024a.

4.7 How could the target be achieved?

The outlook analysis provides several strategic insights into how the number of people affected by noise from transport could be significantly reduced and consequently how the objective for noise could be met (Table 4.1).

Table 4.1 Summary of conclusions from outlook analysis regarding strategies for reaching the zero pollution target

Reducing road traffic noise

Road traffic is the dominant source of environmental noise in Europe. In 2022, over 15.3 million people were HA by road traffic noise — significantly more than the 3.1 million affected by railway noise and the 2.3 million impacted by aircraft noise (using WHO recommendations). As road noise represents the largest share of total exposure, any increase or decrease in this source strongly influences the overall noise outlook.

Anticipating trends in increasing the number of people affected by railway noise

Although railway noise currently affects fewer people than road traffic, projections suggest its impact could grow due to higher activity, faster trains and new infrastructure. Proactive and enhanced efforts are therefore needed to manage this future challenge.

Addressing all noise levels, not just hotspots

To make significant progress, mitigation strategies must also address moderate noise levels, not just the most extreme hotspots. A large portion of the population is chronically exposed to harmful noise levels below 60dB, which account for most of the disease burden. Aircraft noise is a key example: even with projected reductions, many people will remain exposed to levels above WHO's recommendations (in the range of a 45–54dB L_{den}).

Prioritise upstream measures that reduce noise at the source

Actions that target noise at the source are the most effective and benefit the largest number of people, yielding broader results than localised solutions like noise barriers. Effective source-focused measures include:

- regulating noise emissions from road vehicles including interaction with pavement;
- reducing vehicle speed limits in urban areas;
- regular rail grinding and maintenance to smooth tracks;
- optimising aircraft landing/take-off patterns to avoid populated areas;
- promoting the use of quieter aircraft.

Adopt a comprehensive, combined measures approach

No single measure will be sufficient to achieve a significant reduction in people affected by transport noise. A combination of strategies is needed, such as:

- actions that target noise at the source;
- more sustainable urban and transport planning;
- significant cuts in urban road traffic volumes;
- better integration of noise considerations into urban planning and building design (e.g. establishing buffer zones around transport corridors and orienting buildings to shield noise-sensitive areas).

Integrated approach with other environmental policies

Tackling noise pollution in isolation may miss broader opportunities. By integrating noise abatement efforts with policies to address air pollution, climate change or nature restoration, synergies can be achieved.

Reinforcing the regulatory framework for source-based measures

The analysis in this chapter shows that existing efforts alone are not enough. Additional legislative and regulatory measures at the EU level could support and accelerate progress towards the 2030 zero pollution target. New EU regulations tackling noise at source and setting out obligations to act upon critical levels could help to reduce the number of people affected by noise.

The results of the outlook agree with previous studies on the health benefits of noise mitigation measures (see Box 4.4). A number of these conclusions from the outlook have also been identified by different countries from the noise European Environment Information and Observation Network (Eionet) as being instrumental in significantly reducing transportation noise (see Chapter 7). Chapter 7 also provides additional analysis of the potential benefits from addressing noise through urban planning initiatives and from an integrated regulatory approach.

Box 4.4

Assessment of potential health benefits of noise abatement measures in the EU

Between 2019 and 2021 the EC commissioned a study to assess the health benefits offered by different abatement noise measures for road, rail and air traffic. The so-called 'Phenomena' study modelled the benefits of potential noise measures, some of which were accompanied by tighter or revised regulations. The project concluded that a reduction of 20% or more could be achieved with a combination of different noise measures, including revised and strengthened EU policies.

More specifically, the project estimated that quieter roads, quieter tyres, lower vehicle sound limits and increased electrification accompanied by the necessary regulatory changes could reduce the health burden from road traffic noise between 18% to 24% by 2030. The results also suggested that the health burden of railway noise could be reduced between 37-52% with smoother and quieter vehicles and tracks. The best single measure for reducing health effects due to noise from aircraft was found to be the introduction of a night curfew at all airports. If applied, the health burden was estimated to reduce by 30-60% by 2030. However, this measure is also associated with high costs. A combination of measures such as improved take-off procedures, dispersion/concentration of flights, the phasing out of the noisiest aircraft and accelerated fleet replacement with quiet aircraft could achieve a higher health burden reduction of about 44-46%, while also delivering cost savings.

Source: EC, 2021c.

5 Effects of noise on biodiversity

Key messages

- Noise pollution impacts both terrestrial and marine wildlife, influencing their behaviour, physiology, communication and sensory perception. It also alters predator-prey dynamics and disrupts ecosystem functions, including pollination and plant reproduction.
- At least 29% of the total area of Europe's Natura 2000 network is affected by high transport noise levels. This emphasises the need for integrated management strategies that prioritise both biodiversity and quietness.
- Strictly protected areas for biodiversity conservation, where the extent of human activities are limited, are most effective in preserving quiet natural environments.
- Areas with the highest underwater noise exposure in Europe include parts of the English Channel, the Strait of Gibraltar, parts of the Adriatic Sea, the Dardanelles Strait and some regions in the Baltic Sea.

5.1 Impacts of noise on terrestrial and marine wildlife

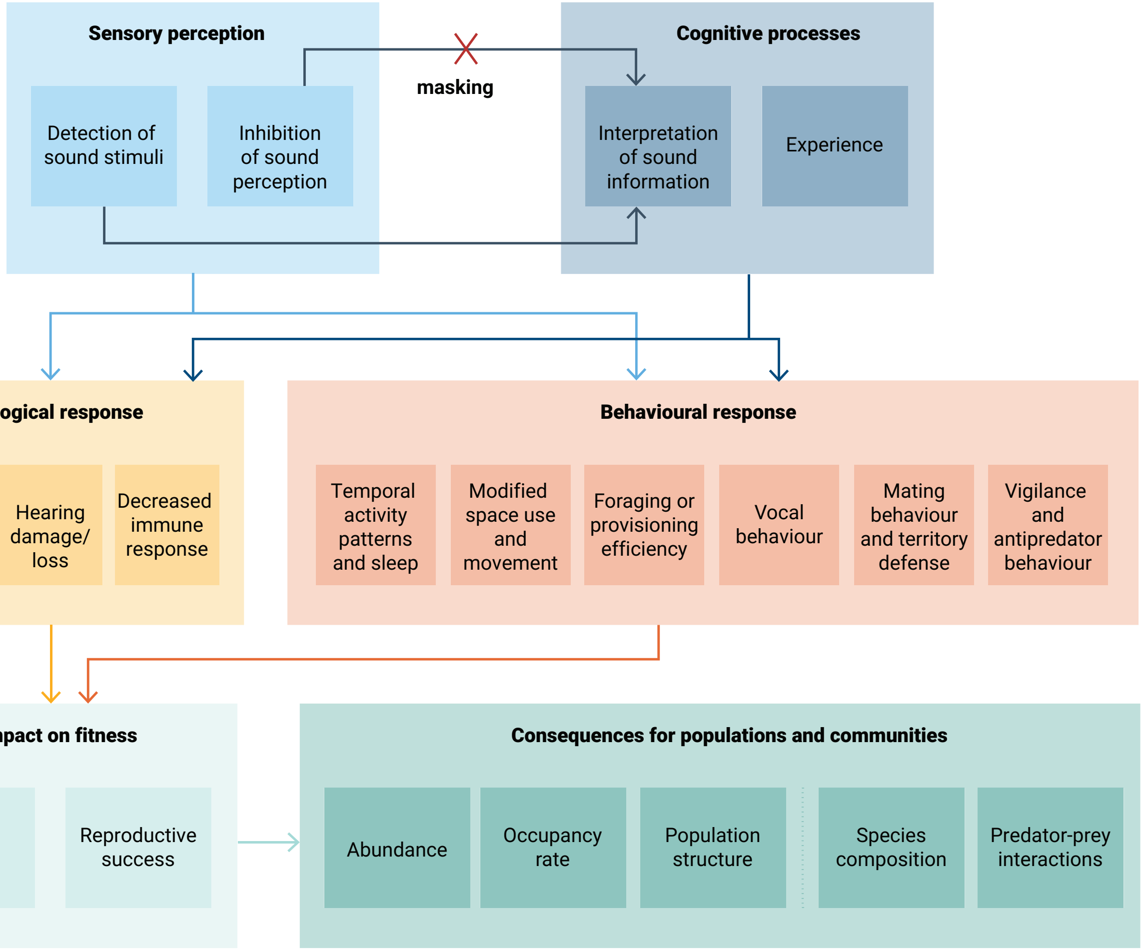
Noise pollution affects not only humans but also significantly impacts biodiversity, influencing various behavioural, physiological, communication and sensory perception processes (EEA,2020).

On land, transportation noise — originating from roads, railways and aircraft — is a primary source of noise pollution in both urban and rural areas. As human activities expand, the effects of transportation noise on biodiversity have become an important area of research. However, not all species are equally affected by noise pollution. Studies have predominantly focused on birds, followed by mammals, amphibians, insects, reptiles and arachnids (McCauley et al., 2017) (see Table 5.1 and Figure 5.1).

Table 5.1 **Overview of impacts of environmental noise on terrestrial biodiversity**

Behavioural changes	Transportation noise can alter animal behaviour. Many species rely on sound for communication, navigation and detecting predators or prey. Noise can interfere with these activities, leading to changes in foraging, mating and territorial behaviours (Luo et al., 2015; Derryberry et al., 2020; Bent et al., 2021; Chou et al., 2023).
Physiological stress	Chronic noise exposure can induce physiological stress, causing elevated heart rates, hormonal imbalances and weakened immune responses, which can impact overall health and fitness (Berlow et al., 2022; Zaffaroni-Caorsi et al., 2023; Meillère et al., 2024).
Habitat use and distribution	Noise pollution can cause animals to avoid suitable habitats, altering species distribution. This displacement may force some species into less favourable habitats, potentially affecting their survival and reproductive success. (Khanaposhtani et al., 2019; Senzaki et al., 2020; da Silva et al., 2023).
Reproductive success	Noise can disrupt mating calls and other reproductive behaviours, resulting in lower reproductive success. For instance, birds that use songs to attract mates may struggle to communicate effectively in noisy surroundings (Bent et al., 2021).
Interference with predator-prey dynamics	Interference with predator-prey dynamics: noise can mask sounds made by predators or prey, disrupting natural predator-prey relationships and leading to increased predation risk or decreased hunting success (Chou et al., 2023).
Community structure	Noise-tolerant species may outcompete noise-sensitive ones, altering community composition and shifting the dominant species in an area (McClure, 2021).
Ecosystem functioning	Alterations in species behaviour, distribution and community dynamics can have cascading effects on ecosystems. For instance, disturbances caused by noise may influence pollinators, potentially disrupting plant reproduction and affecting overall ecosystem health (Francis et al., 2012; Dominoni et al., 2020; Phillips et al., 2021).

Figure 5.1 **Mechanistic pathways involved in the impact of anthropogenic noise on wildlife**



Notes: Masking effect occur when a noise is close, reducing ability to hear other sounds.

Source: Adapted from Francis and Barber, 2013.

Underwater noise pollution from shipping, offshore construction and marine exploration disrupts marine life, causing stress and behavioural changes. This is particularly the case in species that rely on sound for survival, such as whales and dolphins (EEA-EMSA, 2025). Many aquatic organisms depend on sound for key biological functions. This makes them vulnerable to anthropogenic noise, which can have synergistic and cumulative effects on their behaviour and ecosystem roles (European Marine Board, 2021).

Noise pollution can alter marine animal behaviour in varying degrees. At low levels, it may be detectable but not disruptive. In contrast, at higher intensities, it can mask acoustic signals and interfere with vestibular (responsible for balance and spatial orientation), reproductive and nervous system functions (Moretti and Affatati, 2023). One documented response to masking noise is the 'Lombard effect', where animals, including marine mammals and fish, raise the amplitude or pitch of their signals to compensate for background noise (Erbe et al., 2018); (Hawkins and Popper, 2017).

Box 5.1

How anthropogenic noise pollution disrupts avian predation in urban Amsterdam

In Amsterdam, a study was conducted to explore how human-induced disturbances, particularly anthropogenic noise pollution (air traffic, industry, rail traffic, and road traffic), affect avian predation. Over two months, plasticine caterpillars were placed in *Quercus robur* trees to measure how factors like artificial lighting at night, population density, urban heat island effect, and noise pollution influenced predation rates.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The results showed that noise pollution was the most consistent factor reducing predation. Higher noise levels led to birds avoiding these areas, decreasing their foraging efficiency. In the first month, increased lighting and warmer temperatures seemed to attract more insectivorous birds, boosting predation. However, by the second month, these effects diminished, and noise pollution had a stronger negative impact, possibly due to longer exposure.

These findings highlight the significant role noise pollution plays in disrupting urban ecosystems and suggest that measures like sound barriers and better lighting management could help mitigate these effects, supporting biodiversity and ecological balance in cities.

Source: Krijnen and Hernández-Agüero, 2025.

Increased background noise also affects navigation, as seen in fish and coral larvae, which rely on sound cues for orientation (Simpson et al., 2005; Lecchini et al., 2018). Furthermore, it can impair predator-prey interactions by preventing animals from detecting predators or locating prey, leading to altered escape and foraging behaviours (Ferrari et al., 2018).

Noise pollution in marine environments can also cause physical harm. High-intensity impulsive sounds, such as those from pile driving and explosions, have been linked to barotrauma — tissue damage caused by pressure changes — in fish, with the severity depending on exposure levels (Popper et al., 2019). Studies on invertebrates remain limited, but research has found noise-induced tissue damage in molluscs both in controlled experiments and in the wild (André et al., 2011; Solé et al., 2017). Additionally, seismic survey airgun noise has been linked to zooplankton mortality (McCauley et al., 2017) and shipping noise has been shown to induce biological changes in reef-building mussels, including at the DNA level (Wale et al., 2019).

Box 5.2

How noise pollution is affecting marine life in Norway

In Norway's Vestfjorden, noise pollution from oil exploration, shipping and whale-watching, disrupts marine life, especially whales. Research reveals that increased boat and seismic airgun noise interferes with whale feeding and communication. While blue whale sightings have increased, threats such as seismic activity affecting plankton and unregulated noise persist. Measures such as reducing boat presence and exploring quieter vessels to mitigate the impact are suggested by the project researchers. The fjord's biodiversity faces challenges, but proactive noise reduction could restore balance.

© João Santos, Well with Nature EEA

Source: Bertella et al., 2025.

Recent studies suggest that even aquatic plants may be affected by noise pollution. Laboratory research has shown that noise can alter seagrass morphology and ultrastructure, with potential ecological consequences for seagrass meadows (Solé et al., 2021). Despite its significance, research on stress responses to underwater noise remains limited. However, existing studies indicate that marine mammals and fish exhibit stress responses when exposed to both impulsive and continuous noise; these include increased heart rates and changes in stress-related hormone levels (Miksis et al., 2001; Rolland et al., 2012; Debusschere et al., 2016; Yang et al., 2021).

Overall, noise pollution is a common environmental stressor affecting a wide range of species across terrestrial and marine ecosystems. While some progress has been made in understanding its impacts, further research is needed to address knowledge gaps and inform mitigation strategies.

5.2 Policy landscape in addressing noise pollution and biodiversity protection

While EU legislation exists to address noise pollution in the marine environment, terrestrial ecosystems and species are not explicitly covered. Instead, pressures on protected habitats and species, with no explicit mention of noise, are broadly addressed under the Birds Directive and the Habitats Directive. The EU Marine Strategy Framework Directive (MSFD) sets EU threshold values for underwater noise. Table 5.2 summarises a number of relevant legislative measures which can directly or indirectly support reductions in the impacts of noise.

From a policy perspective, the END serves as the primary legislative framework for assessing and managing environmental noise from sources such as roads, railways and aviation, as well as industry in urban areas. However, its focus is primarily on mitigating human health impacts, with no direct provisions for addressing the noise effects on wildlife. The directive does acknowledge, however, the importance of preserving 'quiet areas' in to maintain good acoustic quality across the European soundscape, which can have benefits for people but also for terrestrial biodiversity. It distinguishes between two types of quiet areas. Those found in urban areas are referred in the directive to as 'quiet area in an agglomeration' and those found outside urban areas are referred to as 'quiet area in open country'.

Table 5.2 Summary of EU and international legislations on noise pollution and its impact on terrestrial and marine environments

Legislation	Year	Scope	Key provisions
Convention on Biological Diversity (CBD)	1992	Terrestrial and marine	Biodiversity protection: calls for the conservation of biological diversity, which includes addressing threats such as pollution that can adversely affect species and ecosystems.
EU Habitats Directive 92/43/EEC	1992	Terrestrial	Species and habitat conservation: requires MSs to establish a strict protection regime for species and habitats. This includes measures to avoid significant disturbance of protected species in Natura 2000 sites.
EU END (Directive 2002/49/EC)	2002	Human health with potential benefits for terrestrial biodiversity	Assessment and management: requires MSs to assess and manage environmental noise through strategic noise mapping and action plans every 5 years. Public information: ensures public access to information on environmental noise and its effects.
EU MSFD Directive 2008/56/EC	2008	Marine	Good environmental status: aims to achieve a good environmental status for EU marine waters. Descriptor 11 (2): Specifically addresses the introduction of energy, including underwater noise, as a pollutant that must be monitored and controlled.
EU Birds Directive 2009/147/EC	2009	Terrestrial	Habitat protection: requires MSs to take appropriate steps to avoid pollution or deterioration of habitats or any disturbances affecting birds.
EU Nature Restoration Regulation 2024/1991	2024	Terrestrial and marine	Relation to noise pollution: while not explicitly targeting noise pollution, restoring natural habitats can mitigate its impacts by enhancing ecosystem resilience and providing natural buffers against noise.

Sources: CBD, 1992; EU, 1992, 2002, 2008, 2009, 2024.

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(2) Descriptor 11 targets underwater noise pollution, requiring monitoring and control to prevent adverse effects on marine life and maintain good environmental status.

In addition to those listed in Table 5.2, other EU policies and initiatives contribute to terrestrial biodiversity conservation. These include the Biodiversity Strategy for 2030 (EC, 2020b), the Eighth Environment Action Programme (EU, 2022) and the Pollinators Initiative (EC, 2023a). Additionally, the Green City Accord (EC, 2025c) promotes cleaner, healthier urban environments, with noise reduction identified as a priority area. The EU's commitment to green urban planning, as outlined in (EC, 2013), emphasises the importance of large green spaces for biodiversity conservation (Arévalo et al., 2022).

Within the EU, the MSFD addresses underwater radiated noise (URN) by setting threshold levels and requiring the monitoring of the adverse effects in EU waters. A key action under the zero pollution action plan is reducing URN through EU-wide threshold values established in 2022 by the Technical Group on Noise (JRC, 2023). The MSFD mandates that energy introduction, including continuous URN from shipping, must remain at levels that do not negatively impact the marine environment (EEA-EMSA, 2025).

At the international level, the International Maritime Organization (IMO) updated its guidelines on the reduction of URN in 2023 (IMO, 2023). The revised guidelines establish mechanisms for defining baseline URN levels, setting quantitative reduction targets where feasible and possibly aligning URN mitigation with energy efficiency compliance measures in the future, such as the energy efficiency design index (EEDI) and carbon intensity indicator (CII).

Based on the guidelines and ahead of agreeing on a possible regulatory framework, the IMO agreed to continue the work on reducing URN from ships by also approving a draft action plan outlining the next steps through a number of tasks to be carried out by IMO states through the relevant IMO organs. These include:

- establishing an experience-building phase (EBP) during which MSs and international organisations are invited to share lessons learned and best practices that have emerged in the implementation of the revised guidelines with a target completion date of 2026;

- enhancing public awareness, education and seafarer training;

- developing targets and policies for underwater noise reduction;

- developing tools to collect data and share information;

- encouraging more research on underwater noise and its impacts on the marine environment.

5.3 Assessment of EU natural protected areas affected by noise

The EU's key biodiversity initiative, the Natura 2000 network, designates protected areas with both cultural and economic significance. Operating within the framework of the EU's biodiversity strategy, this network emphasises policies aimed at safeguarding biodiversity and preserving quiet areas. These quiet areas serve as green corridors that support endangered species and there is growing advocacy for establishing quiet buffer zones around them to enhance their protective function.

The results of the assessment from the ETC HE report *European assessment of quiet areas in open country* (ETC HE, 2024c) showed that in Natura 2000 sites, most locations have a quietness suitability index (QSI) above 50%, as shown by the green shades in Map 5.1. This visual representation facilitates the rapid identification of regions with higher environmental quality in terms of quietness.

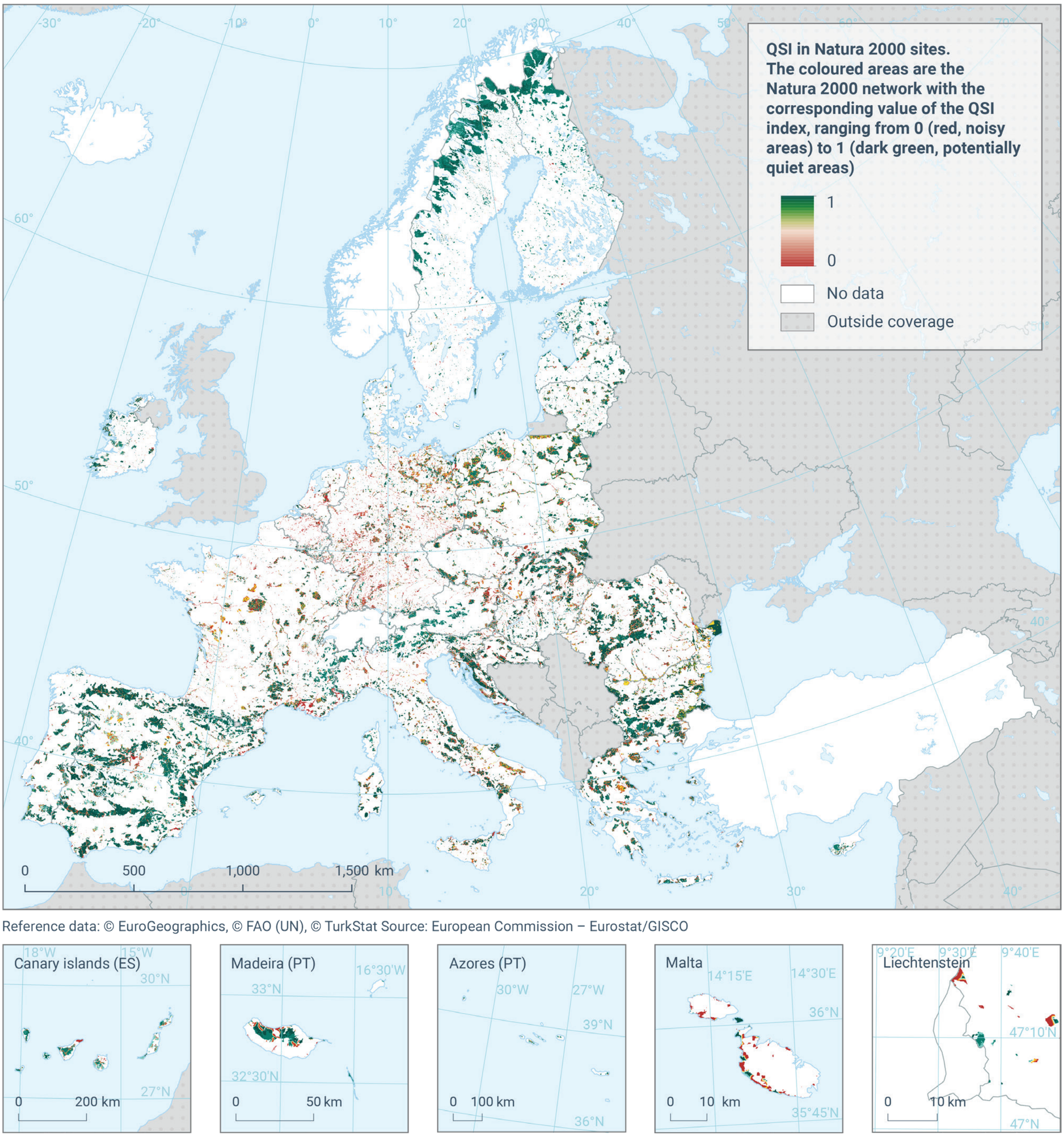
Box 5.3

Quietness Suitability Index (QSI)

Quietness Suitability Index (QSI): The EEA developed a methodology called the QSI to measure potential quiet areas in the open country. This index is based on the combination of contour maps that exceed the END thresholds of a 55dB L_{den} (for sources of road, rail, airport, industry and agglomerations). The index also incorporates land use and land cover elements that indicate naturalness i.e. hemeroby. The QSI index ranges from 0 (noisy areas) to 1 (quiet areas). Using this methodology, a Europe-wide map showing potential quiet areas was derived.

Source: ETC HE, 2024c.

Map 5.1 QSI in Natura 2000 sites. The coloured areas are the Natura 2000 network with the corresponding value of the QSI index, ranging from 0 (red, noisy protected areas) to 1 (dark green, potentially quiet areas)



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Source: ETC HE, 2024c.

The analysis shows that overall, 29% of the total Natura 2000 area is exposed to transport noise at levels that could negatively impact biodiversity. In contrast, 30% of Natura 2000, in terms of total surface, can be classified as quiet. The remaining 41% of the area of Natura 2000 sites falls into an intermediate category; these areas are not currently quiet, but with appropriate management strategies, they have the potential to be restored or maintained as quiet areas. It should be noted that the percentage of quiet areas drops to 15% when considering the entire territory (both inside and outside Natura 2000 sites).

Finland and Sweden have the highest proportion of protected sites classified as quiet, with a QSI above 0.75 in over 50% of cases. In contrast, more than half of the protected areas in Malta, Luxembourg, Belgium, the Netherlands and Germany are considered potentially noisy. These results align with the overall quietness trends across the entire territory (inside and outside protected areas) observed in these countries. This highlights the challenges of preserving quiet areas in regions with high population density and extensive transport networks.

In accordance with the biodiversity strategy for 2030, at least 10% of both marine and terrestrial areas should be strictly protected. Protected areas with strict conservation objectives (International Union for Conservation of Nature (IUCN) classes I and II), where human activities are restricted, were found to be the most effective in preserving quietness. Fewer than 10% of these areas are classified as noisy, demonstrating that stricter regulations play a key role in maintaining quiet environments.

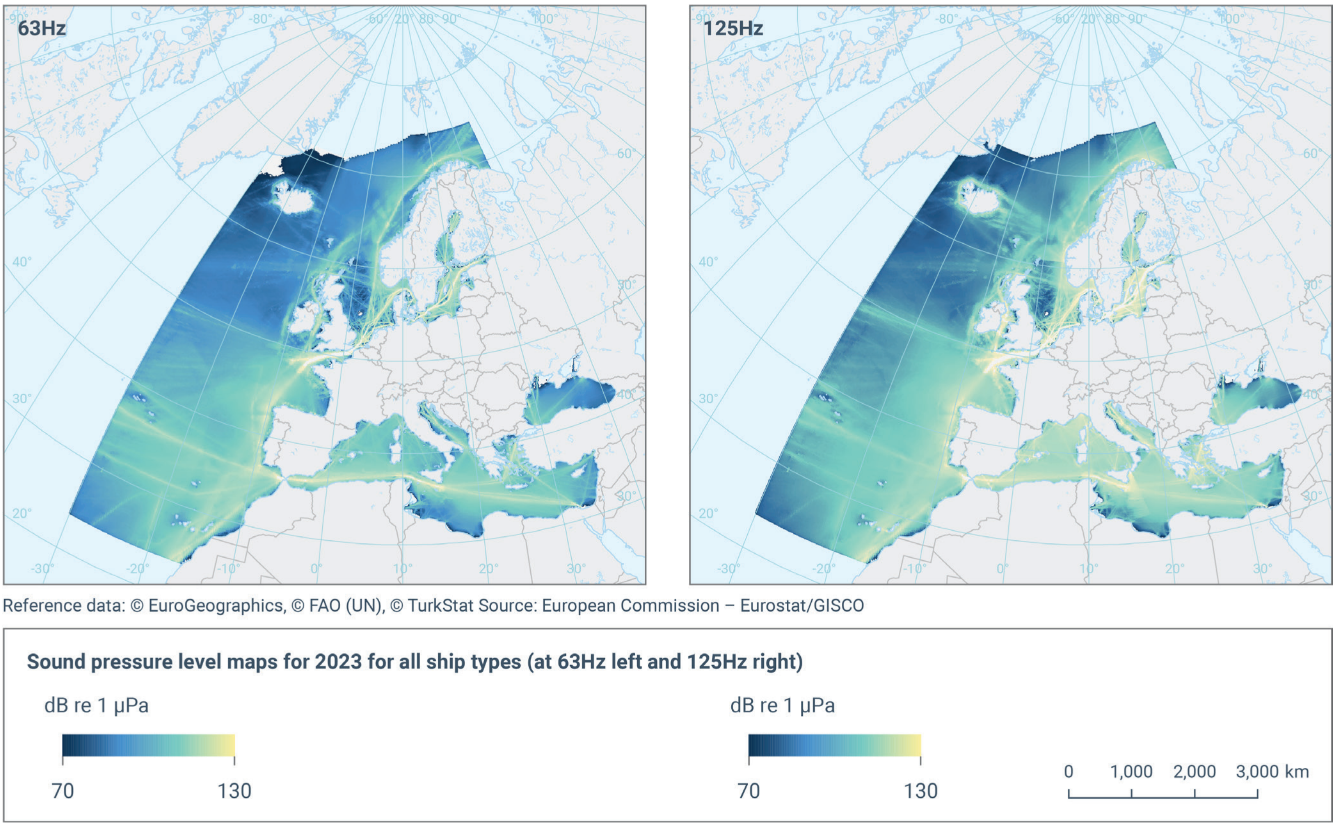
5.4 Assessment of areas affected by anthropogenic Underwater Radiated Noise (URN)

URN has received comparatively less attention than other pollutants, but it is now gaining important focus at both the international and European level. Under the MSFD, it was agreed that no more than 20% of a given marine habitat area, should be exposed to high levels of continuous underwater noise over a year (JRC, 2023).

The European Maritime Safety Agency (EMSA)-financed project NAVISON has generated soundscape maps using an advanced parametric source model for continuous broadband URN. Currently, the highest URN sound pressure levels (SPLs) in Europe are recorded in areas such as the English Channel, the Strait of Gibraltar, parts of the Adriatic Sea, the Dardanelles Strait and certain regions of the Baltic Sea. In contrast, the lowest SPL values are found in the north-western part of the North-East Atlantic Ocean, particularly around the Denmark Strait and the Irminger Sea, as well as in the southern Mediterranean Sea (see Map 5.2).

Many noise sources such as seismic surveys and offshore wind farms are currently not regulated. This is primarily due to insufficient empirical data on their potential effects on marine organisms. For these noise sources, the main objective is to combine monitoring efforts to map the spatial and temporal distribution of these sources, with experimental research to assess the potential impact of the noise. This approach will help determine whether regulation of these activities is necessary (Lamoni and Tougaard, 2023).

Map 5.2 **SPL maps for 2023 for all ship types (at 63Hz left and 125Hz right)**



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Sound pressure level maps for 2023 for all ship types (at 63Hz left and 125Hz right)

Notes: SPL, sound pressure level. dB re µPa, a decibel relative to 1 micropascal. SPL calculations are performed for two 1/10-decade (one tenth of a decade or decidecade) bands, with nominal centre frequencies (63Hz and 125Hz) corresponding to the EU's Marine Strategy Framework Directive environmental status indicators for low-frequency continuous sound (2008/56/EC).

Source: EMSA, 2024.

5.5 Current actions to protect terrestrial and marine biodiversity from noise

Several EU-funded research initiatives under Horizon 2020 and Horizon Europe contribute to noise pollution mitigation. Notably, two new projects launched in 2024: AquaPLAN (³) and PLAN-B (⁴). AquaPLAN aims to quantify the combined impacts of light and noise pollution on aquatic biodiversity, facilitating evidence-based management strategies through interdisciplinary approaches. PLAN-B focuses on understanding and mitigating the effects of light and noise pollution on terrestrial biodiversity and ecosystem services, supporting biodiversity restoration and aligning with the EU biodiversity strategy's objectives.

The LIFE PortSounds (⁵) project, for instance, aims to reduce underwater noise pollution in Cartagena Port, Spain, where maritime traffic significantly impacts marine biodiversity. By mapping noise sources and monitoring the effects on bottlenose dolphins, pilot whales and striped dolphins, the project assesses the impact of marine traffic on these species. Around 200 cetaceans have already been observed and researchers are using hydrophones to collect data and develop predictive models to identify noise sources and mitigation strategies. One key measure is cutting the SPL by up to 10dB by reducing the average speed of large ships from 20 to 10 knots. Reducing vessel speed from 20 to 10 knots is expected to lower noise levels, benefit marine life and also reduce carbon dioxide (CO_2), nitrogen oxides (NO_X) and sulfur oxides (SO_X) emissions. The project's findings and mitigation measures may be applied to other ports to improve conservation efforts (EC, 2023b).

(³) Aquatic Pollution from Light and Anthropogenic Noise: management of impacts on biodiversity.

(⁴) The Path Towards Addressing Adverse Impacts of Light and Noise Pollution on Terrestrial Biodiversity and Ecosystems.

(⁵) LIFE 3.0 - LIFE20 ENV/ES/000387.

6 Accessibility to quiet and green areas in urban centres

Key messages

- Quiet and green areas can provide psychological restoration and help reduce noise annoyance. Individuals living in noisy areas have a greater need for access to quiet spaces.
- The END and the 2018 WHO environmental noise guidelines highlight the importance of preserving quiet areas. Increasing these areas can further promote well-being and support climate adaptation and nature restoration.
- An analysis of 233 cities revealed that only 34% of the population can access green and quiet areas within a 400-m walking distance from their homes — a widely used metric for measuring acceptable accessibility.
- Overall, northern European urban areas generally offer better access to green and quiet spaces compared to other regions.
- Nearly half (49%) of the green areas in the analysed cities are exposed to noise levels of 55dB L_{den} or higher.

6.1 Why are quiet and green areas beneficial in reducing the negative impacts of noise pollution?

Quiet and green areas play a crucial role in mitigating the negative impacts of noise pollution, benefiting individuals and communities in three significant ways: reducing noise annoyance, providing psychological restoration and lowering noise exposure.

- **Reduction of noise annoyance:** access to green spaces, whether through nearby parks or the availability of views of greenery, contributes to a decrease in annoyance caused by road and railway noise (Schäffer et al., 2020; Gidlöf-Gunnarsson and Öhrström, 2007). Likewise, having a quiet side space or quiet courtyard clearly decreases annoyance due to road traffic noise (Gidlöf-Gunnarsson and Öhrström, 2010; Bodin et al., 2015). It has also been associated with reduced blood pressure (Brown and van Kamp, 2017). Furthermore, natural sounds, such as flowing water or birdsong, have also been shown to reduce negative responses to noise, providing a soothing auditory environment (Leung et al., 2017; Jeon et al., 2010). The presence of these sounds can mask urban noise and provide psychological relief, further enhancing the acoustic quality of the environment.

- **Psychological restoration:** green and quiet environments provide essential spaces for psychological restoration. People are naturally drawn to these areas for activities such as reading, relaxation and escaping the hustle and bustle of city life (Payne and Bruce, 2019). Research from the Netherlands further supports the view that those living in noisy areas have a heightened need for access to quiet spaces (The Health Council of the Netherlands, 2006). These areas serve as retreats where people can recharge mentally and emotionally, helping to alleviate the stress and tension caused by a noisy urban atmosphere.

- **Reduction of noise exposure:** besides reducing annoyance and providing psychological benefits, green infrastructure and quiet urban quarters can act as effective buffers against noise pollution. These environments function as natural barriers that protect residential areas and sensitive buildings from excessive noise exposure. By strategically incorporating green spaces into urban design, cities can mitigate the impact of environmental noise while also enhancing the aesthetic appeal of the area (Stuhlmacher et al., 2024).

These points highlight the significant potential of green and quiet areas to improve health and well-being (see Box 6.1).

Box 6.1

Reducing noise annoyance: the positive impact of increasing green spaces

The promotion of urban greening is increasingly recognised as an essential priority within EU policy, offering significant benefits for those affected by noise pollution. Research indicates that access to green spaces can reduce noise annoyance and other negative reactions. For example, a study by Schäffer et al. (2020) found that residential greenery could decrease annoyance from road traffic noise by 6dB and from rail noise by 3dB.

An EU-wide assessment outlined in the report *Evaluation of the Benefits of Green Space on Noise-Related Effects: A Health Impact Assessment on Annoyance* (ETC HE, 2025b) quantified the health benefits of green spaces in terms of reduction of high noise annoyance under two scenarios.

1. **WHO recommendations for universal access in all European agglomerations:** being able to access at least 0.5 hectares (ha) of green space within a 300-m walking distance could lead to a reduction of 104,500 highly annoyed adults (1.1%) from road noise, resulting in 1,100 fewer DALYs. For rail noise, this would reduce annoyance among 10,200 individuals (0.7%), translating to 100 fewer DALYs.
2. **Uniform 10% increase in green spaces in all European agglomerations:** this scenario projects even greater benefits, with an estimated 882,700 adults (9.6%) experiencing decreased annoyance from road noise, leading to 9,700 fewer DALYs. For rail noise, this would mean 93,000 individuals (6.8%) would be less annoyed, resulting in 1,000 fewer DALYs.

Source: ETC HE, 2025b.

6.2 Overview of policy-related documents supporting quiet areas

Two key documents support policies related to quiet areas: the END and the WHO environmental noise guidelines for the European region (WHO, 2018). These are summarised in Table 6.1.

Table 6.1 Summary of relevant policy documents related to quiet areas in Europe

Relevant policy documents	Main aspects concerning the protection of quiet areas
END	The directive touches upon two main aspects. The designation and the protection of quiet areas. The directive encourages the identification and protection of quiet areas, especially in urban environments. MSs are guided to delineate areas that are undisturbed by noise, thereby preserving these environments for the benefit of residents and biodiversity. In addition to the designation of quiet areas, the directive mandates the protection of these designated areas through action plans. These plans should consider the need to protect and restore quiet areas, aiming to reduce overall noise levels and enhance the quality of life for residents.
WHO environmental noise guidelines for the European region	The guidelines emphasise the importance of reducing noise while conserving quiet areas. They state that efforts to decrease noise exposure in one location should not result in increased noise levels elsewhere; existing large quiet outdoor areas must be preserved. Additionally, the guidelines highlight that quiet areas are highly valued by the public, particularly by those affected by continuous noise from road or rail sources. To mitigate noise exposure, annoyance and sleep disturbances, the guidelines recommend ensuring access to a quiet side of residential properties.

One of the WHO's guiding principles (WHO, 2018) emphasises the importance of 'reducing exposure to noise while conserving quiet areas'. This highlights the necessity of preserving areas of good acoustic quality — namely, quiet or tranquil environments. If these areas are neglected, a greater number of people may become exposed to harmful noise levels.

The END recognises the need to preserve areas of good acoustic environmental quality, referred to as 'quiet areas', to protect the European soundscape. It distinguishes between two types of quiet area. Those found in urban areas are referred to in the directive as a 'quiet area in an agglomeration' and those found outside urban areas are referred to as a 'quiet area in open country'.

As noted in the previous EEA report on environmental noise in Europe (2020), the END does not offer a clear definition of quiet areas, which leaves countries with ample room for interpretation. Similarly, the EC (EC, 2023c) highlighted in its report on the implementation of the END that the designation and protection of quiet areas have primarily occurred in urban settings, revealing a need for greater emphasis on identifying and safeguarding quiet areas in rural regions.

Therefore, the definition of a quiet area is quite broad (see Box 6.2). Quiet areas possess characteristics that extend beyond simply low noise levels; they are designed to offer restorative and pleasing environments (EEA, 2014). These areas often include parks, green spaces, forests, agricultural lands, water bodies and brownfield sites. While individuals actively seek tranquillity, they also desire safe, clean environments with pleasant views, ideally enhanced by green spaces or water features (Salomons et al., 2013). Additionally, quiet areas are often perceived as having a pleasing soundscape, incorporating natural sounds. Therefore, local resident experiences and needs are essential for shaping these spaces, necessitating public involvement through participatory methods like surveys and community engagement (van Kamp and Woudenberg, 2025). Examples of quiet areas can be found in the report *Quiet areas, soundscaping and urban sound planning* by the EPA Network Interest Group on Noise Abatement (Peeters and Nusselder, 2021).

Box 6.2

Definition of 'quiet area'

Quiet areas can also be named as tranquil areas or calm areas as these terms relate closely to the experience of people using these areas. Although there is not a unique definition of the term 'quiet area', experts generally agree that a quiet area is one with a pleasant soundscape and where noise, i.e. unwanted sound, is absent or at least not dominant. In addition to this, quiet areas generally have further qualities than low noise levels. For instance, they offer a safe and clean place or a pleasant view, preferably with green space or water. These areas can be found in a variety of places, including parks in towns, within building blocks, in courtyards, in gardens and in leisure areas. In rural areas, they often coincide with natural parks or protected areas, but they may also be part of an agricultural area or unused land outside the city.

Source: EEA, 2020.

6.3 Which urban centres provide the most accessible green and quiet areas? — An assessment of availability and accessibility to quiet areas unaffected by traffic noise in European urban centres

The results are based on an EU-wide assessment outlined in the report *Access to quiet green areas in European Urban Centres* (ETC HE, 2025a) which investigates accessibility and availability to green areas unaffected by traffic noise in urban centres. Availability and accessibility to quiet green areas are defined based on the following criteria:

- green spaces must be at least 0.25ha in size and free from road traffic noise (i.e. levels below 55dB during the day-evening-night period);
- residents must be able to reach these areas within a 400-m walking distance.

For an overview of the methodology used, please see Box 6.3. The methodology was applied to 233 urban centres where all the required information was available.

Box 6.3

Overview of methodology for assessing accessibility to quiet green areas in urban centres

The END gives a legal definition of 'agglomeration'. It means that it is part of a territory, delimited by the MS, having a population in excess of 100,000 persons and a population density such that the MS considers it to be an urbanised area. To have more comparable delineations and stability (fewer changes over time), the urban centre delineation described by Eurostat was used (EC, 2021b; Dijkstra et al., 2019). Therefore, all data in this assessment refer to urban centres and not the entire agglomeration delimited within the END.

The assessment of accessibility was carried out through a three-step process as follows:

1. Identification of green urban areas. The Copernicus 2018 Urban Atlas dataset already provides a category delineating 'green urban areas' as public spaces for recreation, including parks, gardens and managed suburban natural areas. Since distinguishing these from forests at city fringes can be challenging, the 'forests' class was also included in the analysis. The dataset captured areas ≥0.25ha.
2. The identification of potential quiet green areas involved adding an acoustic quality attribute to the previously-defined green urban areas. For this purpose, data reported by MSs under the END was considered, specifically noise contour bands from various noise sources (which are not mandatory). 'Quiet green' areas were then defined as those green urban areas that experienced noise levels below a 55dB L_{den} due to road traffic noise.
3. Accessibility was measured by mapping service areas, which cover all streets within a 400-m walk from a potential quiet green area. 400m was used as an 'acceptable walking distance' based on recent interpretations of the UN Sustainable Development Goal (SDG) 11.7, related to universal access to safe and inclusive green and public spaces. Although the 400-m walking distance threshold differs from the WHO recommendation for universal access to green space, it is used in this assessment because it is widely applied in EC evaluations, including the *Quality of Life in European Cities* report. Based on this, data from the Urban Atlas were used to estimate how many people live within walking distance of a quiet green area.

Source: ETC HE, 2025a.

Overall, the results indicate that on average 34% of the population can access areas that offer both green and quiet environments within a 400-m walking distance from their homes. 400m was used as an 'acceptable walking distance' based on recent interpretations of the UN Sustainable Development Goal (SDG) 11.7, related to universal access to safe and inclusive green and public spaces (UN Habitat, 2021). Moreover, only 13% of the assessed urban centres provide a significant proportion of their residents with access to quiet green spaces. The availability and accessibility of green areas unaffected by transport noise vary significantly across the 233 urban centres analysed. Northern countries tend to have a larger proportion of quiet green areas and greater accessibility compared to their southern counterparts, where quiet-green areas are typically less abundant. Among the green areas within the 233 urban centres analysed, 49% (i.e. 135,000 ha) is exposed to noise levels of 55dB L_{den} or higher.

Map 6.1 and Figure 6.1 illustrate the various combinations of availability and accessibility to green and quiet areas in the analysed cities. Distinct patterns emerge across European urban centres, allowing for the identification of five key groups ranging from low to high availability and accessibility of quiet green areas. Figure 6.2 provides examples for each category, showing how the size, distribution and location of these areas influence their accessibility.

- **Low availability and low accessibility to quiet green areas** (in red Map 6.1, Figure 6.1 and Figure 6.2): urban centres in this category, making up 46% of those analysed, have quiet green areas covering only 5% of their land, with just 22% of the population having access — significantly below the European average of 34%. These cities are predominantly in central and southern Europe, where high density and development pressures limit green space availability. Heavy traffic further diminishes the acoustic quality of existing parks, rendering them less tranquil. For example, Valletta has only 0.8% of its land designated as quiet green space, but 18% of its highly dense population can still access these areas.

- **Low availability and medium accessibility to quiet green areas** (in orange Map 6.1, Figure 6.1 and Figure 6.2): this group, comprising 25% of the urban centres analysed, exhibits low availability (averaging 6.3%) but relatively higher accessibility, with about 45% of the population able to reach these spaces. Accessibility rates can reach up to 60% in cities like Gijón and León in Spain. Unlike in the first group, these cities are dispersed across Europe. For instance, Utrecht has only 4.1% availability, yet 41% of its residents have access, thanks to smaller patches of green spaces preserved from traffic noise.

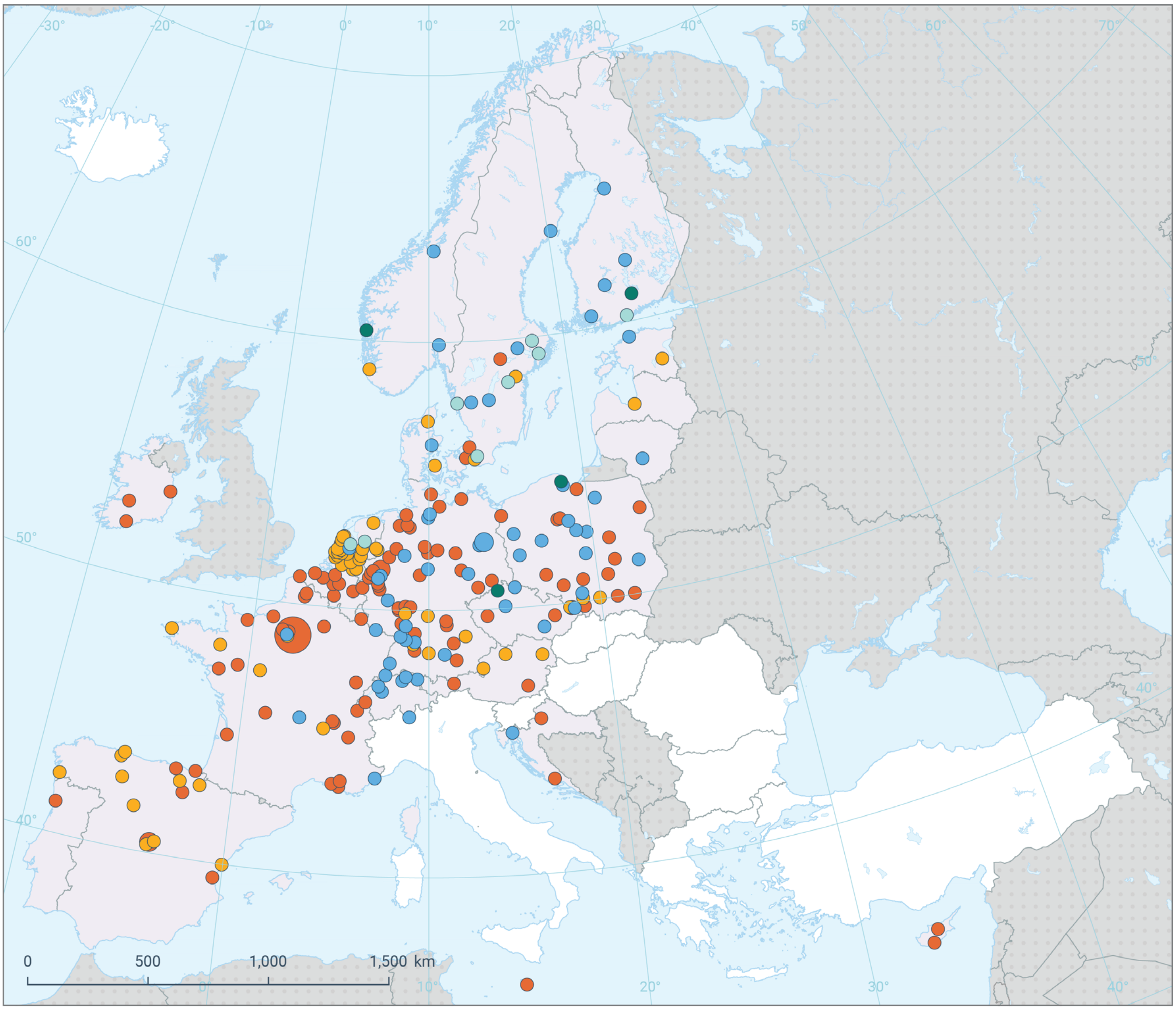
- **Medium availability and low accessibility to quiet green areas** (in light blue Map 6.1, Figure 6.1 and Figure 6.2): representing about 24% of urban centres, this group features higher availability (averaging 10%) but low accessibility, with only 35% of the population able to access these areas. Zurich exemplifies this group, with around 16% of its land qualifying as potential quiet green space. However, these areas are unevenly distributed, primarily in large parks, and many are impacted by traffic noise at or above the 55dB L_{den}, limiting access.

- **High availability and medium accessibility to quiet green areas** (in dark green Map 6.1, Figure 6.1 and Figure 6.2): a small number of urban centres possess a high proportion of quiet green areas, covering between 19% and 29% of their land. These cities offer above-average accessibility, with 44% of the population able to reach these spaces, compared to the European average of 34%. For instance, 26% of Bergen's area is quiet and green, but many areas are concentrated in parks on the city's outskirts. Access is therefore limited for 59% of residents who live beyond a 400-m walking distance from these parks.

- **High availability and high accessibility to quiet green areas** (in light green Map 6.1, Figure 6.1 and Figure 6.2): only a few urban centres in northern Europe, like Sweden and Finland, as well as parts of western Europe such as the Netherlands, exhibit both high availability and accessibility to quiet green areas. In these cities, over 65% of the population has access to these spaces, which cover an average of 14% of urban land. Stockholm serves as an example, with evenly distributed quiet green areas allowing 64% of residents easy access, one of the highest rates in Europe. This more uniform spatial distribution significantly enhances overall accessibility for residents.

These results across urban centres show that the presence of quiet green areas within a city does not guarantee that the population has easy access to these areas and vice versa. Cities with higher accessibility do not necessarily have larger areas of quiet green spaces, while those with extensive quiet green areas may not provide access to a significant portion of the population. This highlights the importance of considering accessibility when designating green and quiet areas to ensure that they benefit as much population as possible.

Map 6.1 Degree of accessibility to green areas unaffected by transport noise in 233 urban centres



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Degree of accessibility to green areas unaffected by transport noise in 233 urban centres

Group

- ● Low quiet green areas — low population access
- ● Low quiet green areas — medium population access
- ● Medium quiet green areas — low/medium population access
- ● Medium quiet green areas — high population access
- ● High quiet green areas — medium population access

Urban centre population

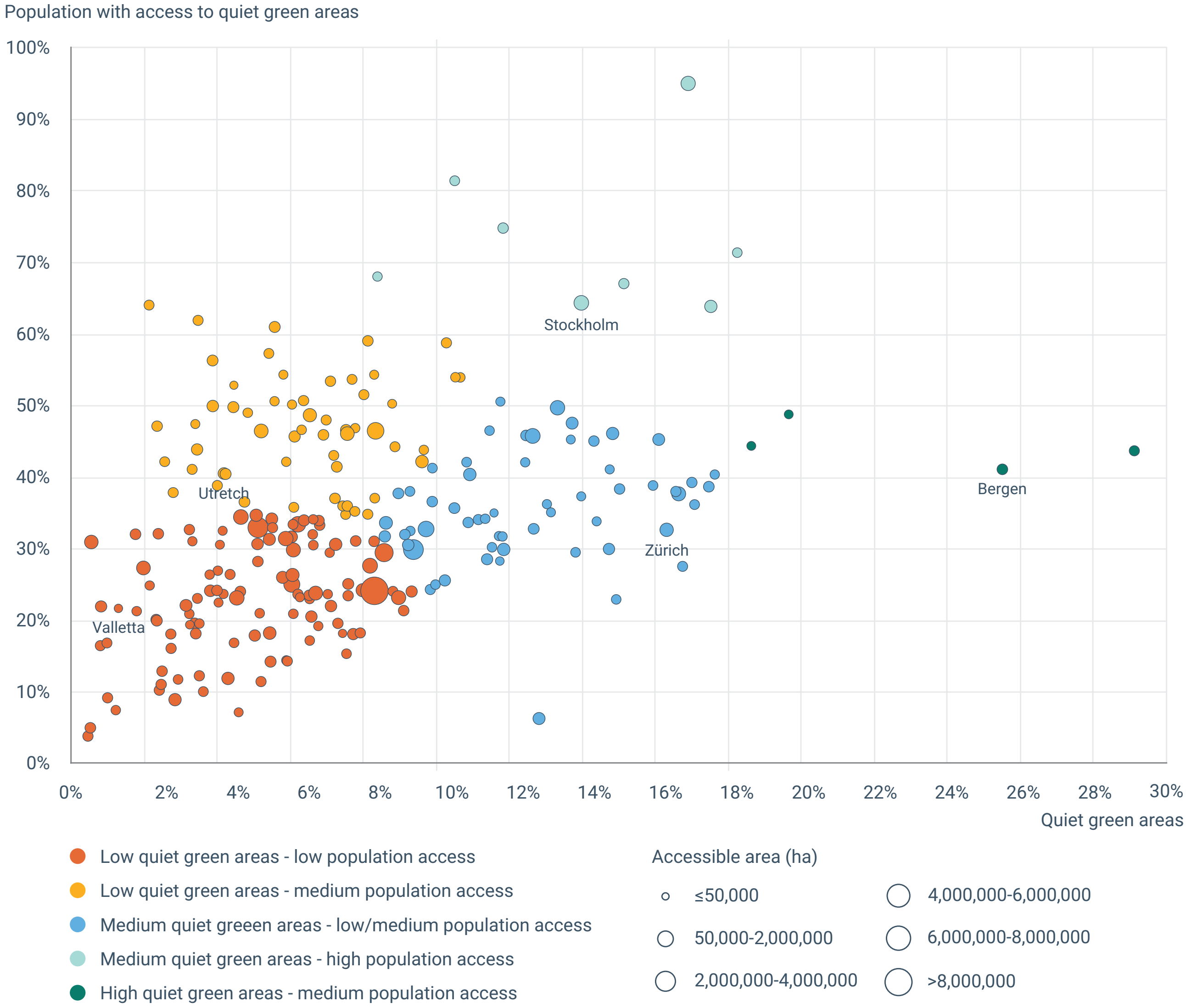
- ○ ≤50,000
- ○ 50,000-2,000,000
- ○ 2,000,000-4,000,000
- ○ 4,000,000-6,000,000
- ○ 6,000,000-8,000,000
- ○ >8,000,000

- ☐ No data
- ▨ Outside coverage

Notes: Colour relates to a combination of low-medium-high levels for both indicators. The size of the points in the figure corresponds to the accessible, quiet green area.

Source: ETC HE, 2025a.

Figure 6.1 **Relationship between quiet green areas and percentage of population having access to those areas**



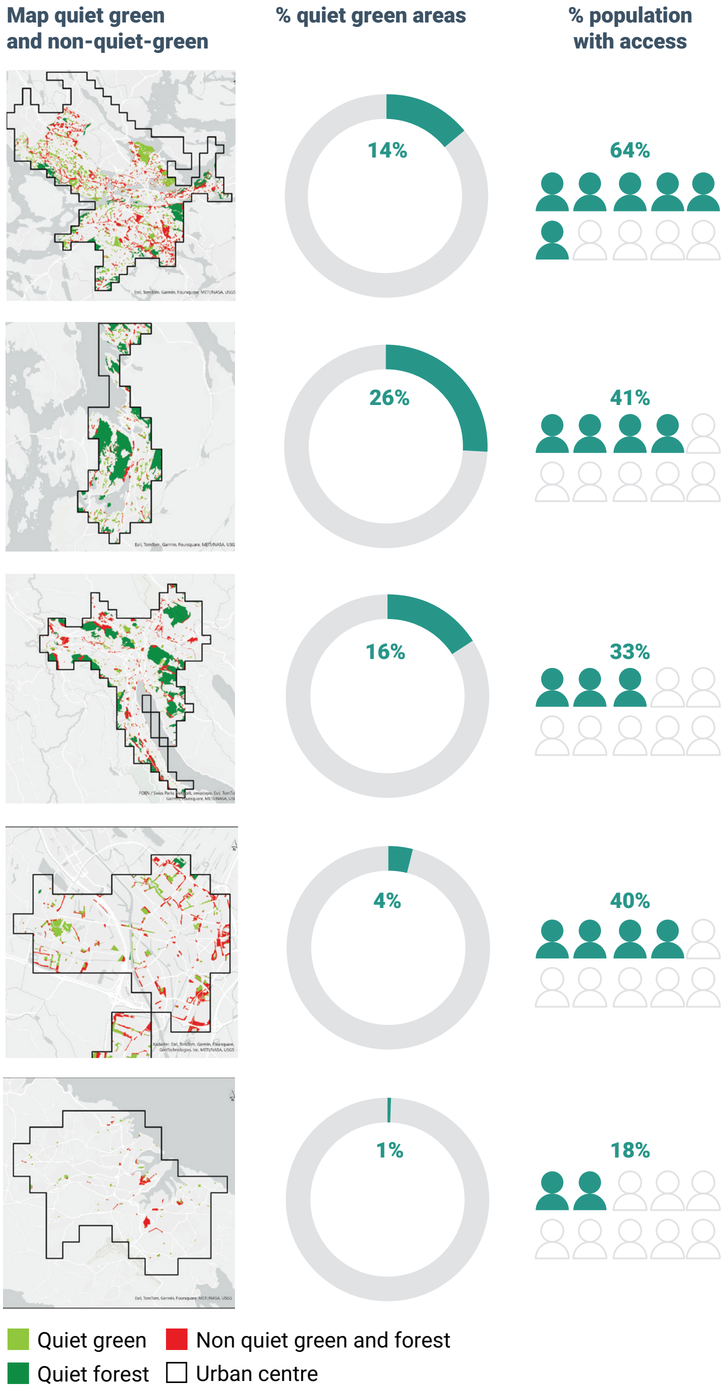
Notes: Colour relates to a combination of low-medium-high levels for both indicators. The size of the points in the figure corresponds to the accessible, quiet green area. Cities named in the figure are illustrated in Figure 6.2.

Source: ETC HE, 2025a.

6.4 Policy implications for protecting and increasing accessibility to green areas unaffected by noise

The observed availability and distribution of quiet green areas highlight the challenge of ensuring broad and equitable access to these spaces for all residents. Among the 233 cities analysed, only 30 have over 50% of their population within a 400-m walking distance of quiet green areas. With 400m being considered an acceptable accessibility and translating to a five-minute walk to these areas (UN Habitat, 2021), it has been adopted by many countries, including the EU, to monitor Target 11.7.1 of the UN's SDG 11. Even when quiet green areas are present, their uneven distribution can create disparities in accessibility. For example, if green spaces are predominantly located in specific neighbourhoods, residents in other areas may still lack adequate access to them, despite the overall availability of these areas.

Figure 6.2 Examples of different categories in relation to accessibility and availability to quiet green areas



Stockholm

Stockholm has 14% of quiet green areas, distributed homogenously across the city. Because of this homogenous distribution, about 64% of its population has a quiet green area within a 400-m walk — one of the highest values in Europe.

Bergern

Bergen is one of the cities with more quiet green areas (26% of its land area). Although their accessibility is relatively high (44%), because they are areas that are concentrated in large parks, this results in lower accessibility compared with other cities with a similar or even lower share of quiet green areas.

Zurich

Zurich has 16% of quiet green areas, which is above the European average. However, these areas are concentrated in large parks, with some of them located towards the city's periphery. Also, most of the green areas inside the city are affected by noise levels (in red). Therefore, only one-third of the population can access quiet green areas within a 400-m walk.

Utrecht

Utrecht has 4% of quiet green areas, which is well below the European average (7%). However, these areas are distributed across the city. This results in an accessibility similar to other cities, doubling the available quiet green areas (see Bergen, for example).

Valletta

Valletta, given its dense urban area's geographic setting, has a low percentage of green areas and most of them are impacted by road traffic noise (in red). As a result, the 0.8% of quiet green areas can only be reached by 18% of its population.

Source: ETC HE, 2025a.

Based on the preceding analysis, cities that aim to increase accessibility to quiet green areas could adopt several strategies to enhance accessibility to them. Potential initiatives include: (i) protecting existing green spaces to maintain good acoustic quality and (ii) increasing the number of green areas within the city. Effectively implementing these strategies requires integrated planning and coordination across multiple sectors, including urban planning, open space design, architecture and noise control (Maag, 2016). However, achieving such coordination can be challenging due to competing land-use priorities, limited budgets and conflicting stakeholder interests (Scheuer and Vranken, 2024).

The first strategy — protecting existing quiet areas — aligns with the END, which requires MSs to identify quiet areas and develop measures to maintain their acoustic integrity.

The second strategy — creating new green areas — is often more complex but aligns with various urban greening policies. These policies include the Green City Accord, the EU Nature Restoration Law and the EU biodiversity strategy. They also include the EU strategy on adaptation to climate change, the UN's SDG 11.7 and also WHO recommendations for universal access to green spaces. These efforts can provide synergistic benefits for individuals affected by noise pollution. Future strategies might involve creating green corridors, pocket parks and pedestrian-friendly zones that not only reduce noise pollution but also promote social interaction (Radicchi, 2017).

Community engagement is also critical in implementing quiet areas effectively. Successful outcomes require active participation from local communities. Public consultations and participatory planning processes ensure that residents' needs and preferences are taken into account, leading to more effective and accepted solutions. An illustrative example can be found in the case study conducted in Limerick (see Box 6.4).

Box 6.4

Quiet area investigation — a soundscape assessment of People's Park, Limerick (Ireland)

Limerick City and County Council conducted a soundscape assessment of People's Park, which includes soundwalks and binaural analysis to determine potential interventions to preserve the tranquillity of urban public green spaces. This initiative is part of broader efforts to identify and preserve quiet areas under the environmental noise regulations, with public participation playing a key role in evaluating the park's acoustic qualities.

The assessment took place in 2023 and 2024 and focused on the park's acoustic features that contribute to tranquillity. Preliminary findings show that natural sounds, particularly birdsong, dominate the park's acoustic environment and are perceived positively by participants. However, areas near heavily trafficked roads receive lower ratings for acoustic quality, indicating a need for improvement.

Engaging citizens provided valuable insights for noise action planning, helping to identify investment opportunities and designate quiet areas. Recommendations from the assessment of People's Park include enhancing the park's soundscape by incorporating pleasant human-preferred sounds, for instance water features and sound art which might help improve the sensory experience for visitors.

Source: Jennings, 2024.

7 Challenges, solutions and opportunities

Key messages

- Reducing population exposure to noise in Europe requires better implementation of existing legislation, better coordination across governance levels, greater public and political engagement and increased investment in mitigation measures.
- The ECA recommends assessing the feasibility of: (i) introducing EU noise-reduction targets and noise limits in the END; (ii) aligning reporting thresholds as closely as possible with those recommended by the WHO.
- The WHO emphasises the need for interim targets and long-term roadmaps to guide national and local authorities in gradually lowering noise exposure.
- The EC is supporting action and knowledge development on transport noise through revisions and evaluations of the END, the launch of the zero pollution action plan and new measures to reduce railway noise. Such measures include requiring retrofitting freight trains and designating quieter routes, as well as a tyre noise labelling requirement.
- Countries are implementing a variety of measures to reduce noise pollution, supported by the legal framework of the END. While common methods like low-noise asphalt, building insulation and noise barriers are commonly used, there are other emerging strategies. These include controlling high emitters via new technology, reducing speed limits, raising public awareness and reinforcing national noise policies.
- Opportunities for cross-sectoral action — particularly with air quality, climate, transport and nature legislation — can be explored to maximise noise reduction health benefits.

7.1 Challenges and opportunities in reducing population noise exposure in Europe

The following sections argue that reducing population exposure to noise in Europe requires better implementation of existing legal frameworks, better coordination across governance levels, more robust and consistent data, greater public and political engagement and more investment in sustainable and equitable noise mitigation strategies.

7.1.1 Challenges identified by the EEA and Eionet

Based on the findings of this report as well as previous assessments (EEA, 2020; EEA and JRC, 2025), the primary concern continues to be the high number of people that remain exposed to harmful levels of transport noise. In spite of the measures undertaken, the current pace of progress in reducing population exposure is too slow to meet environmental targets. This underscores the need for more ambitious and effective action in the years ahead.

A number of barriers are identified by the EEA in relation to the reporting process and tracking progress under the END. These are as follows.

- Delays in reporting obligations under the END: there are significant delays in the submission of data by reporting countries. For example, by December 2024 — 2 years after the official deadline — five EU MS had not submitted any data for the 2022 round of strategic noise mapping. As a result, the EEA must fill these gaps in order to assess the noise situation at the EU level, which complicates efforts to present a complete picture. With complete and timely reporting, country-specific data would be far more reliable.

- Reporting of noise action plans: as reported by the EEA (2020), many countries either fail to submit action plans or deliver plans of inconsistent quality. To address earlier delays, the EC extended the deadline between noise map submission and corresponding action plans to 2 years. In addition, a new standardised format for action plans was introduced under the 2021 END Implementing Decision (EU) 2021/1967 (EU, 2021). Despite these measures, many action plans with deadlines of 18 January 2025 are still outstanding.

- Implementation of noise action plans: while countries are required to prepare noise action plans, there is no legal obligation to implement measures within those plans (EEA, 2020); the decision on whether to act or not is left to the discretion of the competent authority. Even when appropriate measures are included in action plans reported under the END, there is currently no systematic mechanism to track their implementation. This makes it difficult to assess progress. Competent authorities may have less incentive to implement noise action plans because there are no specific enforcement measures in place for cases where the actions outlined in the plans are not carried out. Furthermore, as previously mentioned in this report, there are no specific EU-level requirements to reduce noise exposure. As a result, action is potentially disincentivised at a national level.

Based on national experiences across Europe, the EEA's network of noise experts (Eionet) has identified several common challenges in reducing noise pollution (see Box 7.1).

Box 7.1

Key challenges in reducing population noise exposure across countries — insights from the Eionet

Countries across Europe encounter several common challenges in their efforts to mitigate harmful noise exposure from road, rail and air traffic:

High population density	• Urban areas have significant population densities near major noise sources, which limits the feasibility of noise mitigation measures. • Ongoing urban development and population growth contribute to increasing noise exposure
Limited funding	• Many countries struggle to secure sufficient investment for effective noise control measures. • Austerity policies have further constrained available resources for noise abatement.
Public resistance to traffic measures	• Initiatives such as restricting car use, implementing low-emission zones, or enforcing stricter noise regulations often face opposition from the public and stakeholders. • Regulatory complexities and conflicting interests hinder the enforcement of stronger noise control measures.
Dependence on older vehicles	• A higher prevalence of older, noisier vehicles in some countries exacerbates noise pollution levels. • There is a dependence on private car use, particularly in areas with inadequate public transportation systems.
Lack of awareness	• A general lack of awareness regarding noise as a public health issue leads to its low prioritisation in policymaking. • Without recognition of noise as a significant health concern, political support for action and investment in long-term solutions diminishes.
Source-specific challenges	• Some countries face challenges related to specific noise sources, such as airports located in densely-populated areas, making it difficult to limit exposure. Emerging sources like drones are also a concern (Peeters and Schwanen, 2024)

Source: Based on an Eionet TG Noise Survey.

7.1.2 Findings from the EC's 2023 END implementation review

The 2023 implementation report on the END, prepared by the EC (EC, 2023c) reviews the status of implementation since the publication of the previous report in 2017. It highlights several key findings including progress in implementation and opportunities for further improvements:

- All 27 MSs correctly transposed the amendments to the directive related to the health and noise assessment methods. The directive has delivered improved harmonisation and digitalisation of noise management processes across the EU.
- More action is needed at a national level, with MSs needing to accelerate their compliance efforts in areas such as the content of noise action plans. Better cooperation between national, regional and local authorities is also required.
- In relation to the setting of source-specific limit values, the report notes that while the END does not set binding limits, MSs may themselves choose to apply limits. However, it is noted that while a significant number of MSs have set source-specific limit values at a national level, there is limited evidence that these limits are being enforced effectively.
- In the implementation report, the EC commits to assessing possible improvements to the directive, including applying noise reduction targets at the EU level.
- A study commissioned by the EC found that the maximum technically-feasible reduction in health burden from noise between 2017 and 2030 would be 45%.
- The application of the measures identified in action plans was found to be cost effective, with EUR 10 in social benefits for every EUR 1 spent on implementing measures.
- In relation to the designation of quiet areas, this has mainly taken place in urban areas and more progress is needed in rural areas. The implementation report indicates that this may be related to the lack of a consistent definition of quiet areas in the directive.

These findings show that while the EC's END implementation has seen significant progress — particularly in the correct transposition of amendments and improvements in the harmonisation of noise management processes — there are still some gaps that require attention. The EC's commitment to exploring further improvements presents significant opportunities for reducing the negative noise impacts in the EU.

7.1.3 Challenges identified by the European Court of Auditors (ECA)

In a recent report assessing the implementation of the Air Quality Directive and the END in selected EU cities (ECA, 2025), the ECA highlights several challenges in the EU's efforts to reduce noise pollution from transport.

One of the key findings highlighted by the ECA is that, in contrast with the EU legislation on air quality, there are no EU limit values or reduction targets for noise. The ECA considered that the lack of targets disincentivises MSs to prioritise actions to reduce noise pollution effectively.

The ECA also highlights delays and gaps in noise mapping and reporting, which hinder understanding of the scale of the problem and citizens' exposure to harmful levels of noise.

Furthermore, the report finds that cities struggle with implementing effective local measures. In some cases, actions only slightly reduce noise, or they shift the problem to surrounding areas. Poor planning, low public support and a lack of awareness often lead to measures being scaled down or postponed.

The ECA also points out the weak coordination between national, regional and local levels of governance, which undermines the effectiveness of noise-management strategies. Moreover, the ECA found that it is difficult to evaluate the impact of EU-funded projects aimed at reducing noise, due to a lack of clear indicators and monitoring mechanisms. This makes it challenging to assess whether such projects deliver measurable and lasting improvements.

7.1.4 Challenges identified by the WHO Regional Office for Europe

Although the WHO Regional Office for Europe has not specifically assessed challenges in reducing population exposure to noise, it has identified several barriers to achieving its health-based noise recommendations (WHO, 2023b). These barriers are listed below.

- One of the main challenges identified is that many countries view the WHO guideline values as too ambitious and difficult to achieve under current conditions. The wide gap between existing national noise limits and WHO-recommended levels, combined with a lack of interim targets, makes it difficult for authorities to pursue gradual, realistic implementation pathways.

- The economic costs of achieving the WHO recommendations are regarded by the end users as too high considering the impact on other areas such as transport, housing and infrastructure. The perception that implementation may be too costly or disruptive can reduce political and practical momentum.

- There is a need for more practical support and tools to aid implementation. End users of the guidelines have called for best-practice examples of effective noise mitigation, user-friendly tools to assess local health impacts and clear, long-term roadmaps that governments and cities can follow to gradually lower noise exposure levels. Without these supporting resources, turning the WHO recommendations into national policy and local action remains a challenge.

In addition to this, in 2023, the *Declaration of the Seventh Ministerial Conference on Environment and Health*, known as the Budapest Declaration (WHO, 2023a), recognised the challenges posed by noise pollution and the need for urgent action to reduce the associated BoD. The declaration includes specific commitments in relation to noise:

- developing and implementing policies and actions to reduce exposure to environmental noise and exploring the benefits of interventions that target both air quality and noise;

- using the WHO guidelines on environmental noise as evidence-informed references for standard setting or actions/interventions;

- reducing environmental pollution, including noise exposure.

7.2 Examples from countries on actions to reduce population exposure to noise

European countries are implementing a diverse range of measures to mitigate noise pollution from transportation sources. In many instances, these measures are linked to the noise action plans that national competent authorities are required to prepare under the END. Action plans for the round of strategic noise maps of 2022 have not yet been compiled as the deadline was 18 January 2025 and there are still many action plans to be reported. Therefore, this section focuses on case studies from countries and information reported through the Eionet. A previous analysis of action plans can be found in the *Environmental noise in Europe report 2020* (EEA, 2020).

There are several common trends and initiatives that have emerged across various countries. While traditional measures such as the use of low-noise asphalt and installing noise barriers in high-traffic areas remain prevalent, new and emerging strategies are also being adopted. The following is a compilation of actions being taken by various countries, as reported through the Eionet.

7.2.1 New policy initiatives

Countries are increasingly implementing new policy initiatives to address noise pollution. For instance, Czechia has established legally-recognised noise limits, creating a framework that includes stricter regulations for noise produced by vehicles and construction equipment. Portugal is developing a new national strategy for environmental noise, aiming to expand on existing noise management and mitigation efforts. Furthermore, in Türkiye, comprehensive national regulations focusing on noise limits specifically related to environmental impacts from transportation have been introduced.

7.2.2 Tackling high noise emitters

Several countries are implementing innovative strategies to address high noise emissions, particularly from motor vehicles. This approach aims at not only monitoring excessive noise levels, but also at mitigating their impact.

In Austria, authorities have introduced a seasonal ban on loud motorcycles in Tyrol as a direct response to public complaints about noise pollution from these vehicles. Assessment of the effectiveness of this measure reports an average reduction of 36%. This figure corresponds to a noise level reduction of 2dB, demonstrating its effectiveness (Lechner and Schnaiter, 2021).

In France, authorities are experimenting with noise radar technology that can issue penalties for excessive noise. This initiative is part of a broader 2-year project involving local governments, aimed at enhancing overall noise management.

In Geneva, Switzerland, a noise radar system is currently being tested to detect and measure excessive noise generated by vehicles. This technology not only identifies peak noise levels as vehicles pass by but also automates the monitoring process for large volumes of traffic. By pinpointing vehicles that exceed noise emission regulations, authorities can design targeted measures based on the most prominent sources of noise pollution. Preliminary findings from the project reveal that the majority of vehicles exceeding the noise threshold are motorised two-wheelers, accounting for approximately 70% of the offenders. Other noisy vehicles include cars and vans (17%) and heavy trucks and buses (13%) (Magnin and Thomson, 2024).

Box 7.2

Assessing and mitigating noise pollution from high emitters in urban areas

The EU NEMO project focused on assessing and mitigating noise pollution from high emitters, particularly in urban areas. The key findings are as follows:

- Specific categories of vehicles that contribute significantly to noise pollution were identified, including freight trucks, buses and motorised two-wheelers.
- Comprehensive measurements revealed that noise levels from high emitters often exceed regulatory limits, particularly in densely-populated urban settings. Peak noise levels were frequently recorded during specific times, such as rush hours.
- Based on the findings, the project proposed several policy measures, including the establishment of stricter noise emission standards for high emitters, incentive programs for using quieter vehicles and improved urban planning to minimise noise exposure in residential areas.

Source: NEMO EU Project (Nemo-cities EU, 2025).

7.2.3 Public engagement

There is a growing commitment among countries to engage and involve residents in the fight against noise pollution, recognising the importance of public input and cooperation in formulating effective noise management strategies and increasing the level of acceptance and support for these strategies.

In Germany's Ruhr area, a digital public participation tool was developed to improve noise management action planning. This program specifically targets noise pollution and the identification of quiet areas in urban settings like Bochum, Dortmund and Gelsenkirchen. It aims at encouraging public engagement by allowing residents to contribute geo-referenced data on noisy and quiet locations through an accessible online platform (Stadt Bochum and HS Gesundheit, 2023). The data collected inform municipal noise action plans, successfully involving the public.

In Slovenia, a 'dialogue forum' between Ljubljana airport and the community has been established to address the environmental impacts of airport operations, particularly noise pollution (ANIMA, 2020). The dialogue forum promotes open communication and collaborative problem-solving between airport authorities and affected communities and was initially organised within the framework of the European ANIMA project. Meetings occur biannually, resulting in policy changes such as restricting flight hours over Kranj and fostering awareness of mutual benefits through cooperation.

Malta has also implemented campaigns to educate citizens about the effects of noise pollution, aiming to foster community involvement (ERA Malta, undated). These efforts are complemented by initiatives to integrate noise considerations into urban planning and align them with broader policy goals.

7.2.4 Road speed reduction

Several countries, such as Luxembourg, Sweden, Ireland and Switzerland, are increasingly adopting road speed reductions which have benefits to noise pollution by implementing lower speed limits on roads. This shift has gained traction because of numerous benefits associated with reducing vehicle speeds, especially in densely-populated areas. Lowering speed limits not only reduces noise pollution from traffic but also contributes to road safety by reducing the likelihood and severity of traffic accidents.

For instance, Zurich has successfully implemented speed limit reductions and closely monitored the outcomes related to noise annoyance and sleep disturbances both before and after the changes. The reduction in traffic speeds significantly decreased the levels of noise annoyance and sleep disruptions attributed to road traffic noise. Notably, the observed improvements in public health outcomes (see Box 7.3 below) exceeded what could have been anticipated based solely on measurable reductions in noise levels.

Applying similar speed limit reductions across Europe could lead to reductions in annoyance and sleep disturbance, as outlined in Box 7.3.

Box 7.3

Quantifying the potential impact of reducing urban speed limits from 50km/h to 30km/h in Europe

A study by the City of Zurich and the Federal Office for the Environment in Switzerland found that reducing speed limits in Zurich from 50km/h to 30km/h led to a decrease in the average noise levels — 1.6dB during the day and 1.7dB at night (Stadt Zürich, Umwelt- und Gesundheitsschutz and Bundesamt für Umwelt, Abteilung Lärm und NIS, 2022). However, the reduction in perceived annoyance and sleep disturbance was even greater, corresponding to 2–4dB for annoyance and around 4dB for sleep disturbance. This suggests that lower speed limits not only reduce noise but also enhance perceived safety and neighbourhood liveability, potentially improving residents' reactions to noise intervention (Brink et al., 2022). Based on these findings, additional health benefits — such as improved mental and cardiometabolic health and fewer premature deaths — may also be expected (Rossi et al., 2020).

Applying these relationships at a European scale, residents living near roads with a speed limit of 50km/h in urban areas could see a 30% reduction in baseline annoyance if the speed limit is lowered to 30km/h. Similarly, sleep disturbances could decrease by approximately 40%. Assuming that around 30% of urban roads currently have a speed limit of 50km/h, the potential overall impacts could lead to a 9% decrease in the number of residents reporting high levels of annoyance and a 12% decrease in those experiencing high sleep disturbances. When considering the entire population currently affected by road traffic noise in Europe, this translates to a 7% reduction in highly annoyed (HA) individuals and a 12% reduction in those suffering from high sleep disturbances. These reductions may vary significantly depending on various factors including the local context, the infrastructure, the types of vehicles and also baseline noise levels.

Table 7.1 **Estimation of annoyance and sleep disturbance reduction based on speed reduction**

Scenario — reducing urban speed limits from 50km/h to 30km/h		
	Benefits of implementing this measure in Europe	
	% reduction in HA	% reduction in HSD
People affected by major roads in urban areas	30%	40%
People affected by road noise in urban areas	9%	12%
People affected by road traffic noise across Europe	7%	9%

Notes: Approximations based on the assumption that in urban areas, the total number of people currently affected by roads of 50km/h is 30%.

7.2.5 National rail noise reduction programmes

A number of countries are implementing national rail noise reduction programs to reduce the impact of railway noise on nearby residents. For instance, Switzerland retrofitted all trains with silent brakes, significantly reducing braking noise and improving noise quality in affected areas. Poland also has a national program for rail grinding, which smooths track surfaces to minimise noise from train wheels, benefiting residents near rail lines. In Belgium, the focus is on renewing the railway fleet with trains that meet the technical specifications for interoperability — noise (TSI NOI) standards, ensuring new vehicles are quieter. Similarly, Germany and France are also investing in and modernising their railway lines to reduce noise emissions.

7.3 Actions taken at the EU level to reduce environmental noise

In recent years, a range of measures have been adopted at the EU level to strengthen the legislative and regulatory framework on transport noise pollution, increase the accuracy of collected data and reduce negative impacts on citizens.

7.3.1 Legislative developments

Since the last reporting period, some amendments have been made to the END. In 2020, the EU adopted a common approach to calculating the health effects of noise by updating Annex III of the directive (EU, 2020a). This update ensures that countries take health into consideration when drawing up action plans.

Further progress was made in 2021 through the adoption of a new implementing decision on noise data reporting (EU, 2021). This decision introduced a more harmonised format and methodology for submitting data under the END, improving the quality of noise data across Europe.

7.3.2 Strategic initiatives

The establishment of a non-binding target to reduce the number of people exposed to noise pollution under the zero pollution action plan (see Chapter 4) also brings increased focus and pressure on the need to accelerate actions to reduce transport noise. While this target is non-binding, it signals a growing recognition of the health impacts of environmental noise at the EU level.

7.3.3 Making freight trains quieter

The EU is taking significant steps to reduce railway noise through a combination of updated regulations and targeted rolling stock measures.

The TSI NOI, developed by the EU Agency for Railways (ERA), was updated in 2023 (EU, 2023). It now requires special railway vehicles — such as track maintenance and inspection machines — to comply with noise standards. It also formally integrates the use of composite brake blocks, which must meet specific performance and assessment criteria. These low-noise brake blocks significantly help to reduce noise emissions from freight wagons.

In parallel, the EU has designated sections of the network as 'quieter routes'. These are stretches of railway at least 20km long where more than 12 freight trains operate nightly on average. In total, 23,429km of quieter routes have been identified — covering more than 11% of the EU rail network. Only vehicles that comply with TSI NOI limits are permitted to operate on these routes. This designation is instrumental in reducing noise exposure, particularly along major freight corridors. It also benefits other routes used by freight trains.

So far, the share of newly-built freight wagons compliant with the TSI NOI increased from 14% in 2017 to 24% in 2023. At the same time, the proportion of wagons still requiring retrofitting dropped from 57% to 24%. At present, at least 60% of Europe's freight wagons are equipped with silent brake blocks and this number continues to grow (ERA, 2024).

The full impact will be better understood in the coming years through continued monitoring and evaluation.

7.3.4 New aircraft noise standards

The International Civil Aviation Organization (ICAO) has recently agreed on updated noise standards for new commercial aircraft. From 2029, all newly-certified aircraft will need to be at least 6dB quieter than current models (EC, 2025b). This corresponds to an estimated 30% reduction in perceived noise under standard conditions.

If effectively implemented, these stricter standards can contribute to reducing the aviation sector's environmental impact, particularly in noise-sensitive areas such as around airports. Fewer people living near airports will be exposed to harmful noise levels, thus helping to improve the overall quality of life and public health in affected communities. The benefits of this measure will be dependent, amongst others, on ongoing renewal of the aircraft fleet.

7.3.5 Tyre noise labelling

The EU introduced tyre noise labelling under Regulation (EU) 2020/740 (EU, 2020b) to provide consumers with information about tyre noise performance, alongside fuel efficiency and wet grip. The label indicates external rolling noise in dB and classifies tyres into three categories: low, medium, or high noise.

This system aims to help consumers make informed choices while encouraging manufacturers to develop quieter tyres.

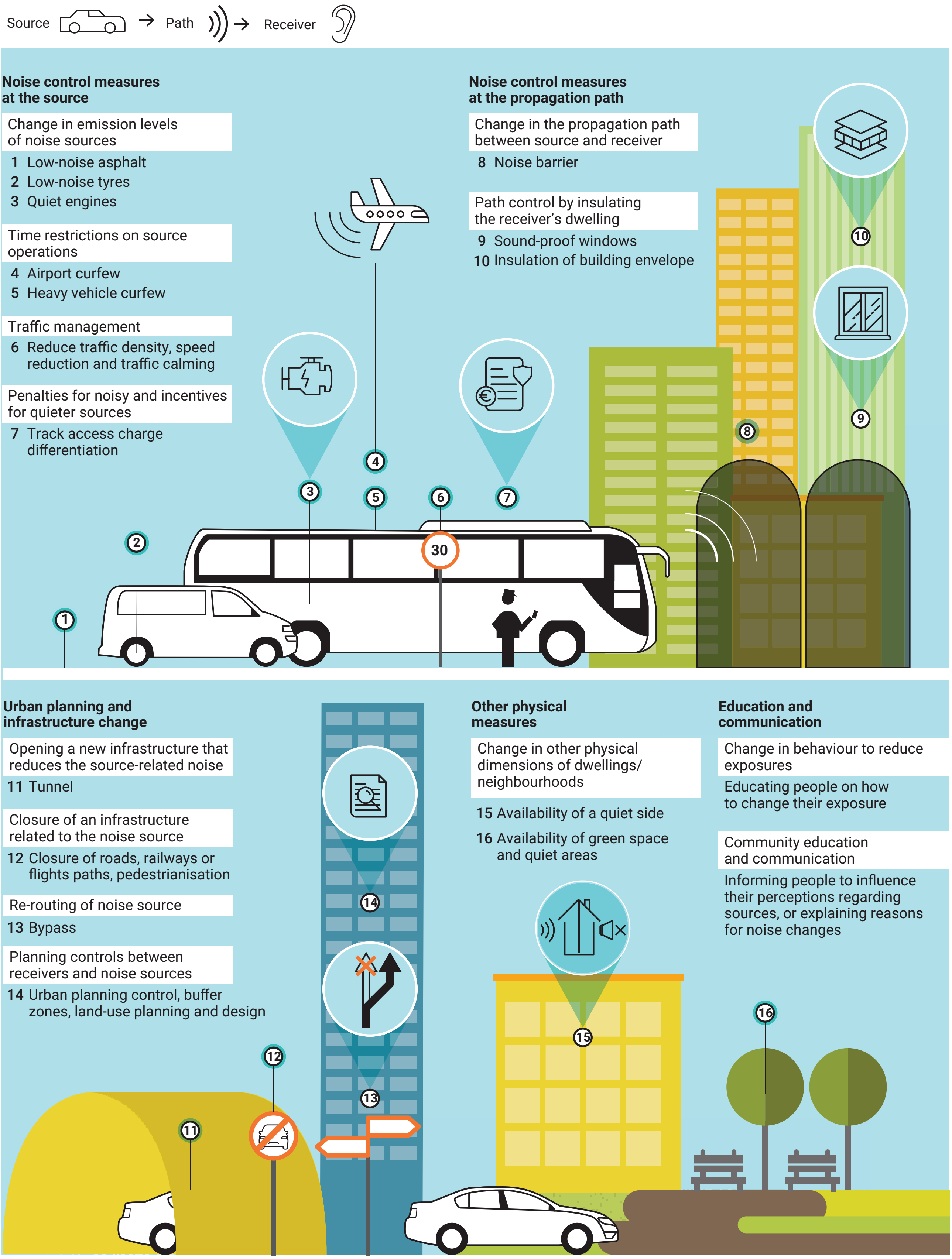
7.4 Opportunities for reducing population exposure to noise

Europe has an opportunity to continue to improve health and well-being as well as protect natural ecosystems by addressing environmental noise. As highlighted in Chapter 3, environmental noise poses a significant health burden across the continent. It is estimated that approximately 1.3 million healthy life years are lost annually in Europe due to noise exposure, with associated economic costs estimated to be around EUR 95.6 billion each year. These figures show the need for effective action to address noise pollution, resulting in human health and quality of life improvements, healthier ecosystems and economic savings.

Environmental noise is a major issue that demands attention and action as a stand-alone problem. However, within the current EU policy landscape, there are also synergies with other initiatives that, if leveraged effectively, could further support noise reduction efforts. This section outlines interventions and key cross-cutting areas that are considered critical for making meaningful progress in reducing population exposure to environmental noise (see Figure 7.1 for terminology and an overview on types of noise measures).

In addition, Section 4.7 also references specific measures and actions which could be applied to accelerate progress in reducing transport noise exposure in Europe.

Figure 7.1 Terminology and examples of types of noise management and mitigation measures



Source → Path → Receiver

Noise control measures at the source

Change in emission levels of noise sources

1 Low-noise asphalt
2 Low-noise tyres
3 Quiet engines

Time restrictions on source operations

4 Airport curfew
5 Heavy vehicle curfew

Traffic management

6 Reduce traffic density, speed reduction and traffic calming

Penalties for noisy and incentives for quieter sources

7 Track access charge differentiation

Noise control measures at the propagation path

Change in the propagation path between source and receiver

8 Noise barrier

Path control by insulating the receiver's dwelling

9 Sound-proof windows
10 Insulation of building envelope

Urban planning and infrastructure change

Opening a new infrastructure that reduces the source-related noise

11 Tunnel

Closure of an infrastructure related to the noise source

12 Closure of roads, railways or flights paths, pedestrianisation

Re-routing of noise source

13 Bypass

Planning controls between receivers and noise sources

14 Urban planning control, buffer zones, land-use planning and design

Other physical measures

Change in other physical dimensions of dwellings/ neighbourhoods

15 Availability of a quiet side

16 Availability of green space and quiet areas

Education and communication

Change in behaviour to reduce exposures

Educating people on how to change their exposure

Community education and communication

Informing people to influence their perceptions regarding sources, or explaining reasons for noise changes

Source: EEA, 2020.

7.4.1 Legislative and regulatory measures to tackle noise at source

The scenario analysis presented in Chapter 4 indicates that, without additional regulatory or legislative measures, achieving a 30% reduction in the number of people chronically disturbed by noise is unlikely. New EU regulations, as well as legislation at a national level, tackling noise at source and setting out obligations to act upon critical levels could help to reduce the number of people affected by noise.

Additional measures that ensure EU-wide application would provide large benefits in terms of noise pollution. For example, implementing a binding requirement to use quieter tires by 2030 could potentially decrease the number of people affected by noise by approximately 9% in a conservative scenario and by 5% in a more optimistic one (EEA, 2022a). Based on approximations, a wider application of reductions in road speed limits in urban areas could lead to a decrease of around 7% in the number of people highly annoyed by road traffic noise (see Box 7.3 for details).

A previous study on potential measures capable of delivering significant reductions to health burden due to environmental noise also concluded that achieving a reduction of 20% or more in health burden by 2030 is feasible only through the implementation of combined noise abatement solutions that are supported by revised and strengthened EU environmental policies. These include the END, source directives, the European Green Deal as well as other legislative measures with a strong environmental impact (EC, 2021c).

The most effective strategies identified in the study emphasise addressing noise directly at its source and necessitate broad application through national or supranational legislation. For instance, regulations that limit vehicle noise — whether from engines, tires, or components like train brakes — can significantly mitigate transport noise pollution. Such regulations are particularly effective as they target noise at its origin and are legally binding, ensuring broad and consistent enforcement across affected populations.

7.4.2 The role of effective urban planning in reducing noise exposure

Exposure to noise pollution is of particular importance in more densely-populated urban areas and cities (see Box 7.4). Data collected by Eurostat through population surveys show that 24% of the EU population living in cities consider noise pollution as a problem for their household, compared to 16.9% in towns and 10.5% in rural areas (Eurostat, 2025b).

Box 7.4

Challenges to reduce noise in cities

Cities face rising noise levels driven by urban growth and increasing transport demand, yet noise-reducing mobility solutions – such as walking, cycling and public transport – remain under-promoted and underutilised.

Urban areas also face emerging noise challenges, including the growing use of drones in city airspace. These devices are not yet comprehensively regulated, raising concerns about their long-term impact on the acoustic environment.

Electric vehicles are often seen as a promising development in reducing road traffic noise. However, current EU legislation requires them to emit artificial sounds to ensure pedestrian safety. As a result, their noise levels can be comparable to conventional vehicles, potentially limiting their overall benefits on reducing urban noise from traffic.

Sources: Eurocities, 2020, 2025.

Preventing noise pollution or preventing people from being exposed to noise is the most effective approach to protecting public health in the long term. While mitigation measures like noise barriers and insulation are important, they often come with high costs (EC, 2021c) and are reactive by nature. A more sustainable strategy is to integrate noise prevention into urban and transport planning from the outset (see example in Box 7.5). This includes creating buffer zones between transport corridors and residential areas and orienting buildings to minimise exposure. It is also useful to design noise-sensitive indoor layouts, such as placing bedrooms on the quieter side of a building. Land-use planning that separates noisy infrastructure from vulnerable sites like schools and hospitals can also significantly reduce exposure. Some measures, like the creation of quiet green areas, may have clear co-benefits in terms of air quality improvement, climate change adaptation and wellbeing.

In addition, promoting sustainable mobility options — like public transport, walking and cycling — not only lowers emissions but also reduces urban noise. By embedding prevention into planning and design, cities can limit future noise impacts and reduce the need for costly interventions, thus creating healthier, quieter environments by design.

Box 7.5

Health benefits of reducing noise through health-promoting urban planning strategies

The adoption of a health-promoting approach to urban planning provides benefits in mitigating the adverse effects of noise pollution from transportation, as demonstrated by a recent study conducted in Malmö.

This study explored various densification scenarios designed to increase residential space for approximately 12,000 new residents, alongside the inclusion of diverse building types in a specific area. The research assessed the advantages of implementing a health-centred approach, particularly in terms of reducing noise pollution and its negative impacts on the community. Key components of this approach and its associated benefits are summarised below.

Table 7.2 Example of health-promoting approach

Key components	Description
Informed land use planning	Thoughtful placement and design of new residential buildings to minimize noise exposure, controlling height and density.
Road network modifications	• Narrowing roads: reduced width of main streets to limit traffic volume. • Burying main streets: separated residential areas from traffic noise. • Reduced speed limits: lowered speed from 40 km/h to 30 km/h to decrease noise from traffic.
Establishment of green areas	Increased vegetation coverage (approx. 313,829m^2 or 48.4% of study area) to serve as a natural noise buffer and improve air quality.
Focus on community well-being	Spaces designed to foster social interactions and enhance quality of life through quieter, more inviting environments.

▼

- A 50% reduction in the number of individuals reporting high levels of annoyance from noise and experiencing high sleep disturbance.
- Approximately a 35% decrease in the incidence of ischemic heart disease (IHD) cases and premature deaths attributed to IHD.

Source: Flanagan et al., 2023.

7.4.3 Maximising synergies with other environmental policies

Reducing noise pollution offers a valuable opportunity to align with and enhance the objectives of multiple EU policy areas. One such opportunity lies in the recent revision of the Ambient Air Quality Directive. Measures aimed at reducing air pollution can also reduce overall road traffic noise. As cities adapt to meet stricter air quality standards, many interventions likely have the potential to create quieter urban environments as a secondary benefit. In addition to this, the success of the European Air Quality Directive in facilitating downward trends offers lessons for environmental noise (EC, 2020c).

Some actions under the EU climate policy also offer important synergies. Efforts to decarbonise cities and transport systems, promote active mobility and reduce dependence on car travel — through investments in walking, cycling and public transport — can lead to lasting reductions in urban noise. This is especially true in densely-populated areas.

The EU biodiversity strategy and Nature Restoration Law also present emerging opportunities to reduce noise exposure. Creating and restoring green and blue spaces — such as urban forests, wetlands, parks and green corridors — not only improves ecological resilience but also increases the availability of quiet areas for recreation and restoration (see Chapter 5).

In this broader policy context, integrating noise considerations into environmental, climate, transport and nature-based strategies can help to deliver substantial benefits.

7.4.4 Strategic relevance of addressing noise pollution in Europe

Addressing environmental noise is relevant for supporting various EU goals. Table 7.3 presents the relevance of reducing noise pollution within the framework of other key EU strategies and policies.

Table 7.3 Summary of relevant policy documents related to quiet areas in Europe

EU policy/ strategy	Main objective	Relevance
EU competitiveness compass	Strengthen Europe's economic base, including health and resilience.	Mitigating noise pollution can significantly enhance quality of life and reduce premature deaths, making it an important preventive health measure. By decreasing stress-related illnesses and risks associated with CVDs and mental health issues, noise reduction supports the mission outlined in the EU competitiveness compass to foster a more resilient population.
Sustainable and smart mobility strategy (from Green Deal)	Make the European transport system more sustainable, smart and resilient.	Noise mitigation measures can contribute to green innovation, accelerating activities to produce and deliver cutting-edge solutions by EU manufacturers and industries.
One Health approach	Integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems.	Holistic approaches, such as the 'One Health' concept, recognise the interconnected challenges of human, environmental and animal health. Integrating noise considerations can enhance policy coherence, improving health outcomes for people while also benefitting wildlife and biodiversity.
Just Transition (from Green Deal)	Ensure fairness in environmental and climate policies.	Equity is central to the EU agenda. Vulnerable and low-income communities can be disproportionately affected by noise pollution. Addressing noise pollution promotes healthier living conditions for all, ensuring that the benefits of environmental and mobility improvements are shared equitably.

Sources: EC, 2020a, 2021a, 2025d, 2025a.

7.4.5 Recognising noise as a key environmental health risk

In their paper, *Noise Causes Cardiovascular Disease: It's Time to Act* (Münzel et al., 2025), the authors emphasise the need for greater recognition among healthcare practitioners of noise as a significant health risk. They point out that noise pollution is often under-recognised in medical and public health practices compared to air pollution and chemical exposures. Given its substantial contribution to the Global Burden of Disease, the authors argue that noise should be acknowledged as a critical environmental risk factor and its exposure should be integrated into medical education and clinical prevention guidelines.

This presents a clear opportunity to elevate the profile of noise within health systems by increasing awareness among health professionals. As the connections between environmental stressors and non-communicable diseases become increasingly evident, addressing noise in a medical context can lead to more comprehensive and effective disease prevention strategies. Furthermore, it can foster stronger collaboration between the environmental and health sectors, ultimately enhancing public health outcomes.

In addition to recognition within the health and medical community, raising public awareness that noise harms health is needed, as many remain unaware of its serious effects. Greater awareness can promote healthier behaviour and community action, and increase support for policies that create quieter, more liveable cities.

8 Conclusions

The *Environmental noise in Europe* report is the largest European assessment of noise pollution and its health impacts, comprising data from 31 countries — including all 27 Member States and additional EEA member countries. Published every 5 years, this report presents key data on the number of people exposed to harmful levels of noise, the associated health effects and the progress made in mitigating these impacts. It also explores broader issues, such as the effects of noise on biodiversity and the importance of protecting quiet and green areas. This information is important to understanding the scale of the problem and identifying effective strategies to protect public health.

As scientific understanding evolves, so too does the evidence base linking noise pollution to a growing number of health conditions. This year's report reflects these advancements by including new health outcomes in the analysis. These include all-cause natural mortality, a broader range of CVDs, type 2 diabetes, various adverse health effects on children and also preliminary estimates of emerging impacts like depression and dementia. This expanded scope provides a more complete and nuanced picture of the burden noise pollution places on both adult and child health.

This report reaffirms findings from previous EEA assessments, which state that noise pollution — primarily from road, rail and air traffic — is an increasingly serious environmental risk factor contributing to premature death and long-term illness in Europe. The data present the scale of the problem: over 20% of Europe's population is currently exposed to harmful levels of transport noise, a figure that could rise to 30% with more comprehensive data. In 2021 alone, over 66,000 premature deaths were attributed to noise from transport sources, as well as more than 48,000 new cases of CVDs and 22,000 new cases of type 2 diabetes. Altogether, transport noise accounted for a loss of 1.3 million healthy life years (measured in DALYs), establishing it among the leading environmental health risks in Europe.

When compared to other environmental health risks, transport noise ranks among the top three — just behind air pollution and temperature-related stress — posing a greater burden on health than second-hand smoke or lead exposure.

Despite these significant public health impacts, the report reveals that much work remains to be done to reduce both noise pollution and its toll on population health in Europe. Historical data have been limited by methodological changes over time and differences between countries. Nevertheless, current evidence indicates that progress in decreasing the number of people exposed to harmful noise levels has been slow. If no additional measures are taken, the situation is expected to remain largely unchanged by 2030.

The report also highlights the need to preserve quiet and green spaces both in urban and non-urban environments as these areas play a dual role in supporting public well-being and biodiversity. Regarding noise impacts on areas of natural interest, the report finds that at least 29% of the surface area of Europe's Natura 2000 network is affected by high noise levels from transport, posing a threat to conservation goals. In urban environments, an analysis of 233 cities shows that only 34% of residents have access to green and quiet areas within 400 meters of their homes. Additionally, nearly half (49%) of urban green spaces are exposed to noise levels of 55dB L_{den} or more, reducing their potential to serve as restorative, health-promoting environments.

However, there are opportunities to make progress in curbing noise pollution and its impacts. By implementing additional measures — including stronger regulatory and legislative actions — and by leveraging synergies with other environmental initiatives, it is possible to significantly reduce noise pollution and improve public health outcomes and ecosystems. This report provides a comprehensive and robust evidence base, strengthening the call for urgent and coordinated action at a European, national and local level and highlighting the critical need for collaboration among policymakers, public health authorities and communities to effectively address the growing challenge of environmental noise.

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List of abbreviations

BoD	Burden of disease
CBD	Convention on Biological Diversity
CII	Carbon intensity indicator
CNOSSOS-EU	Common noise assessment methods for Europe
Corine	Coordination of information on the environment
CO_2	Carbon dioxide
CVD	Cardiovascular disease
DALY	Disability-adjusted life year
dB	Decibel
DW	Disability weight
EBP	Experience-building phase
EC	European Commission
ECA	European Court of Auditors
EEA	European Environment Agency
EEA-32	32 EEA member countries: the 27 EU MSs plus Iceland, Liechtenstein, Norway, Switzerland and Türkiye
EEDI	Energy efficiency design index
END	Environmental Noise Directive
ERA	The European Union Agency for Railways
ETC HE	European Topic Centre on Human Health and the Environment
EU	European Union
GBD	Global burden of disease
GDP	Gross domestic product
HA	Highly annoyed
HPA	Hypothalamic-pituitary-adrenal
HIA	Health impact assessment
HSD	Highly sleep disturbed
HRA	Health risk assessment
ICAO	International Civil Aviation Organization
IHD	Ischaemic heart disease
IUCN	International Union for Conservation of Nature
IMO	International Maritime Organization
L_{den}	Day-evening-night noise level
L_{night}	Night noise level
LAU	Local administrative units
MSs	Member States
MSFD	Marine Strategy Framework Directive
NOISE	Noise Observation and Information Service for Europe
NO_X	Nitrogen oxides
NUTS	Nomenclature of territorial units for statistics
$PM_{2.5}$	Fine particulate matter
QSI	Quietness suitability index
RR	Relative risk
SOx	Sulfur oxides

SDGs	Sustainable development goals
SNS	Sympathetic nervous system
SPL	Sound pressure level
TSI NOI	Technical specifications for interoperability — noise
URN	Underwater radiated noise
WHO	World Health Organization
YLL	Years of life lost
YLD	Years lived with disability

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Annex 1 Data completeness by country

Table A1.1 **Data completeness of L_{den} values in 2022 by country, 32 EEA member countries (excluding Türkiye) as of 18 November 2024**

Country	Completeness of reported L_{den} value in %							
	Inside urban areas				Outside urban areas			Total
	Road	Rail	Air	Industry	Road	Rail	Air	All
Austria	100	100	100	100	100	100	100	**100**
Belgium	100	100	100	100	100	100	100	**100**
Bulgaria	0	0	N/A	0	0	N/A	N/A	**0**
Croatia	100	100	N/A	100	100	100	N/A	**100**
Cyprus	100	N/A	100	100	0	N/A	100	**100**
Czechia	100	100	100	100	100	100	100	**100**
Denmark	100	100	N/A	100	100	100	100	**100**
Estonia	100	100	100	100	100	N/A	N/A	**100**
Finland	100	100	100	N/A	100	100	100	**100**
France	86.71	84.71	92.12	94.57	100	100	100	**89.9**
Germany	100	100	100	100	100	100	100	**100**
Greece	0	N/A	N/A	0	0	0	0	**0**
Hungary	0	0	N/A	0	0	0	0	**0**
Iceland	0	N/A	N/A	0	0	N/A	0	**0**
Ireland	100	100	100	100	100	100	100	**100**
Italy	93.84	67.24	73.01	98.4	63.72	100	100	**88.2**
Latvia	100	100	100	100	0	100	100	**94.5**
Liechtenstein	NP	NP	NP	NP	NP	NP	NP	**NP**
Lithuania	100	100	100	100	100	100	N/A	**100**
Luxembourg	100	100	100	100	100	100	100	**100**
Malta	100	N/A	100	100	100	N/A	N/A	**100**
Netherlands	96.47	67.86	83.3	98.22	100	100	100	**94.6**
Norway	100	0	N/A	0	100	N/A	89.38	**87.1**
Poland	100	100	100	100	100	100	100	**100**
Portugal	52.82	26.16	78.8	100	23.45	0	100	**44.9**
Romania	69.61	54.03	0.55	61.38	60.72	0	100	**66.3**
Slovakia	0	0	N/A	0	0	0	N/A	**0**
Slovenia	0	0	0	0	0	0	N/A	**0**
Spain	49.4	9.14	11.68	49.59	34.06	14.37	100	**44.7**
Sweden	100	100	100	N/A	100	100	100	**100**
Switzerland	100	100	100	N/A	96.96	100	100	**99.5**
Total	**82.30**	**79.15**	**91.12**	**90.78**	**87.26**	**94.30**	**95.49**	**84.2**

Notes: The completeness was calculated using the following formula: (sum of the reported number of people exposed to a L_{den} ≥55dB/sum of the expected number of people exposed to L_{den}≥55dB) × 100.
N/A means not applicable, source not existing in the country.

Source: EEA, 2025.

Table A1.2 Data completeness of L_{night} values in 2022 by country, 32 EEA member countries (excluding Türkiye) as of 18 November 2024

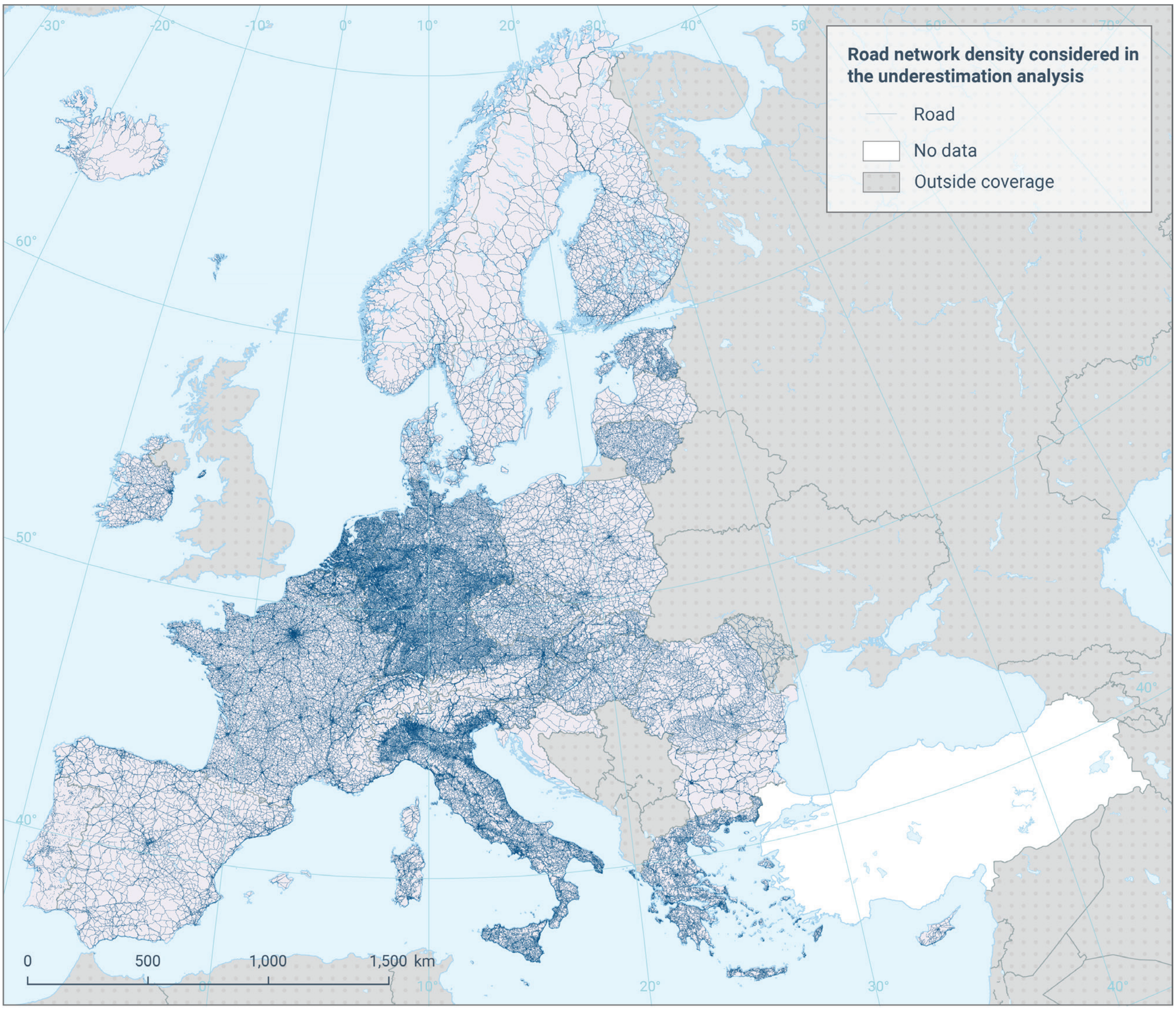
Country	Completeness of reported L_{den} value in %							
	Inside urban areas				Outside urban areas			Total
	Road	Rail	Air	Industry	Road	Rail	Air	All
Austria	100	100	100	100	100	100	100	**100**
Belgium	100	100	100	100	100	100	100	**100**
Bulgaria	0	0	N/A	0	0	N/A	N/A	**0**
Croatia	100	100	N/A	100	100	100	N/A	**100**
Cyprus	100	N/A	100	100	0	N/A	100	**100**
Czechia	100	100	100	100	100	100	100	**100**
Denmark	100	100	N/A	100	100	100	100	**100**
Estonia	100	100	100	100	100	N/A	N/A	**100**
Finland	100	100	100	N/A	100	100	100	**100**
France	86.71	84.71	92.12	94.57	100	100	100	**89.9**
Germany	100	100	100	100	100	100	100	**100**
Greece	0	N/A	N/A	0	0	0	0	**0**
Hungary	0	0	N/A	0	0	0	0	**0**
Iceland	0	N/A	N/A	0	0	N/A	0	**0**
Ireland	100	100	100	100	100	100	100	**100**
Italy	94.54	71.91	82.29	99.19	68.68	100	100	**90.8**
Latvia	100	100	100	100	0	100	100	**95.9**
Liechtenstein	NP	NP	NP	NP	NP	NP	NP	**NP**
Lithuania	100	100	100	100	100	100	N/A	**100**
Luxembourg	100	100	100	100	100	100	100	**100**
Malta	100	N/A	100	100	100	N/A	N/A	**100**
Netherlands	96.27	63.26	70.54	98.1	100	100	100	**94.0**
Norway	100	0	N/A	0	100	N/A	77.11	**86.4**
Poland	100	100	100	100	100	100	100	**100**
Portugal	52.12	26.11	93.56	100	20.56	0	100	**43.0**
Romania	69.61	54.03	0.55	61.38	60.72	0	100	**66.3**
Slovakia	0	0	N/A	0	0	0	N/A	**0**
Slovenia	0	0	0	0	0	0	N/A	**0**
Spain	48.09	5.67	0	65.28	35.5	8.35	100	**43.5**
Sweden	100	100	100	N/A	100	100	100	**100**
Switzerland	100	100	100	N/A	96.53	100	100	**99.5**
Total	**82.15**	**79.99**	**97.29**	**92.80**	**89.36**	**94.63**	**94.30**	**84.7**

Notes: The completeness was calculated using the following formula: (sum of the reported number of people exposed to a L_{night} ≥55dB/sum of the expected number of people exposed to a L_{night} ≥55dB) × 100.
N/A means not applicable, source not existing in the country.

Source: END, 2025.

Annex 2 Underestimation of people exposed to noise based on road and rail networks not included in the END

Map A2.1 Road network density considered in the underestimation analysis of Box 2.3

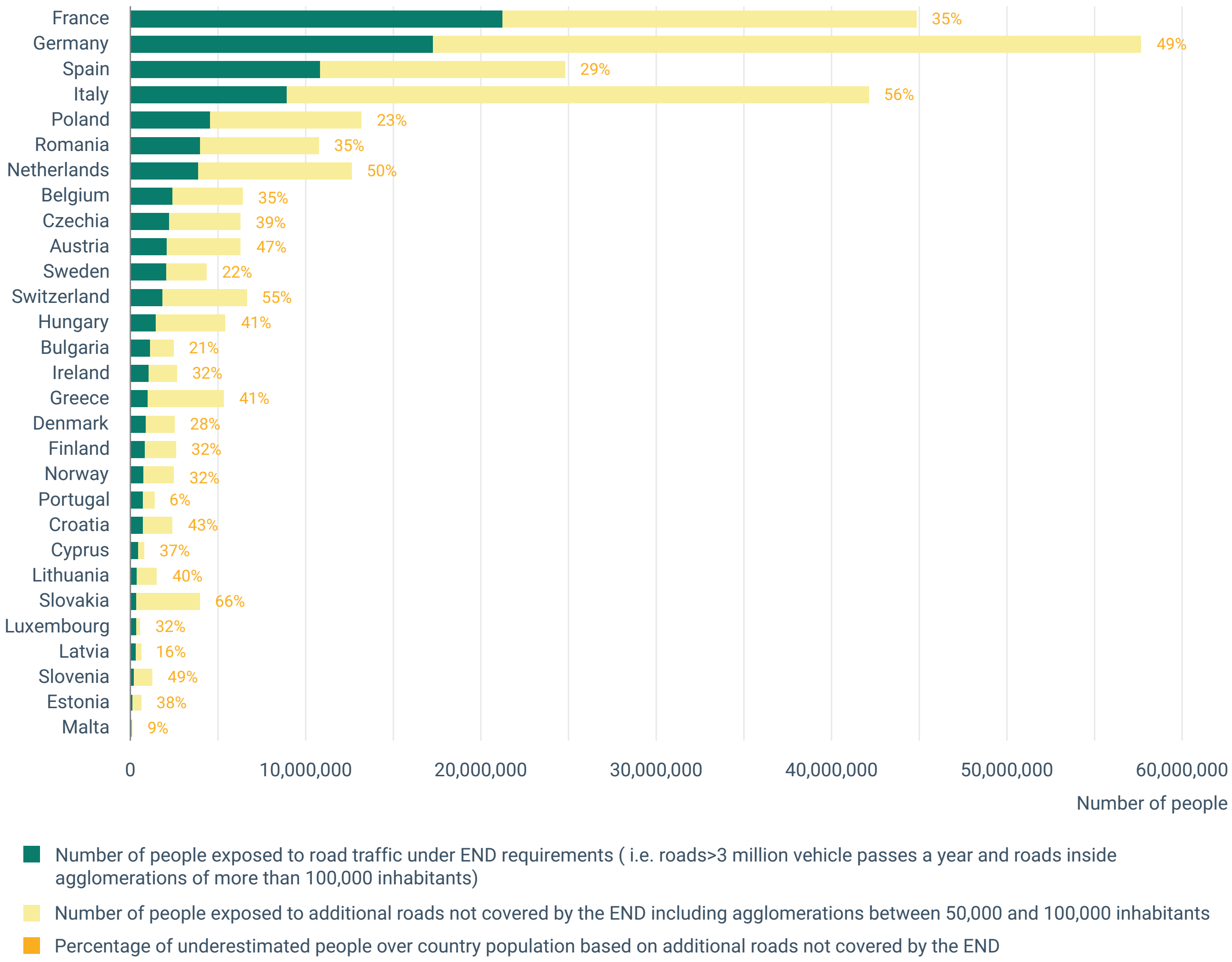


Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: This is 75% more than the road segments considered under the END.

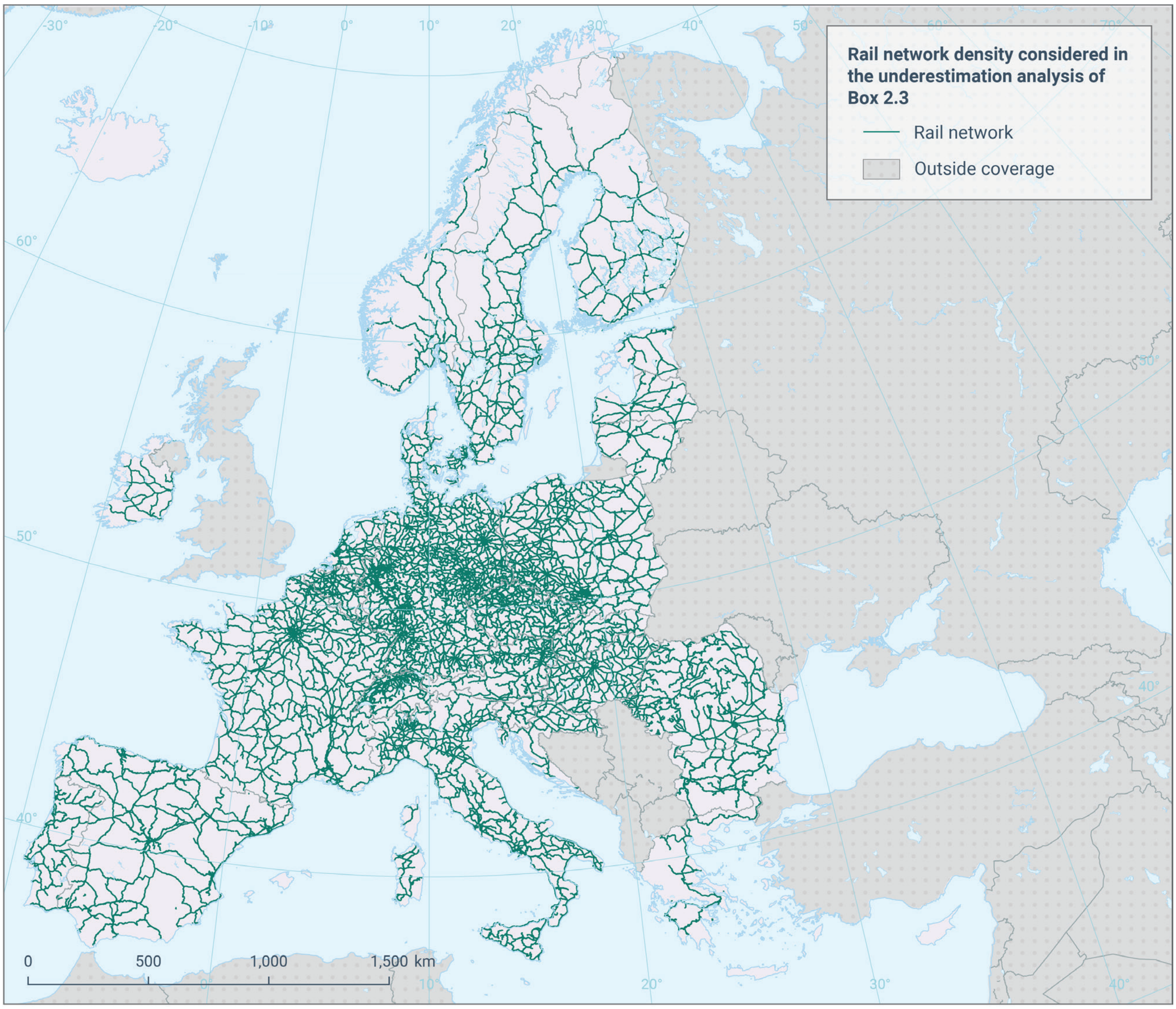
Source: ETC HE internal data analysis.

Figure A2.1 **Reported and underestimated number of people equal or above 55dB L_{den} to road traffic noise in EEA-32 (excluding Türkiye)**



Source: ETC HE internal data analysis.

Map A2.2 Rail network density considered in the underestimation analysis of Box 2.3

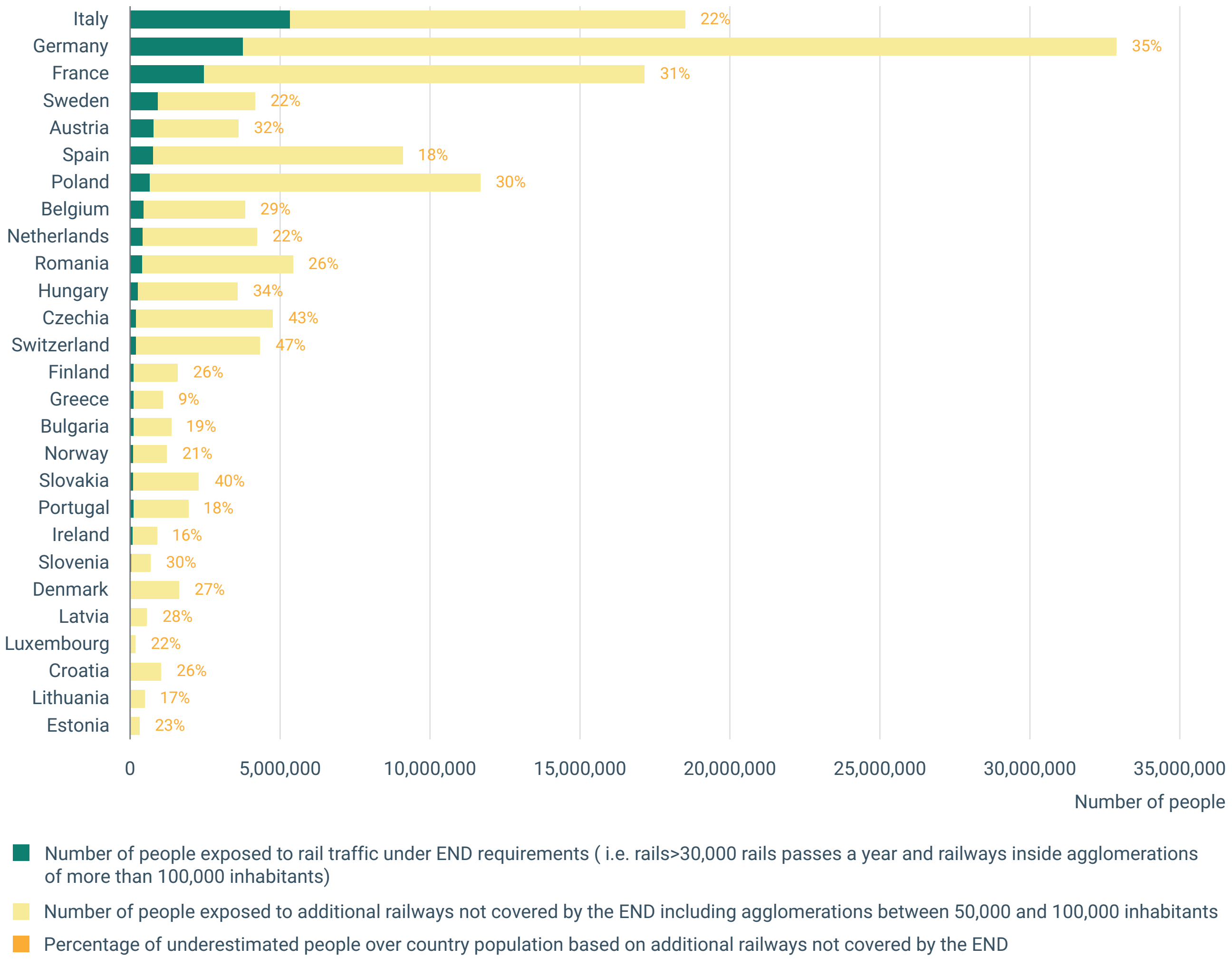


Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: This is 75% more than the road segments considered under the END.

Source: ETC HE internal data analysis.

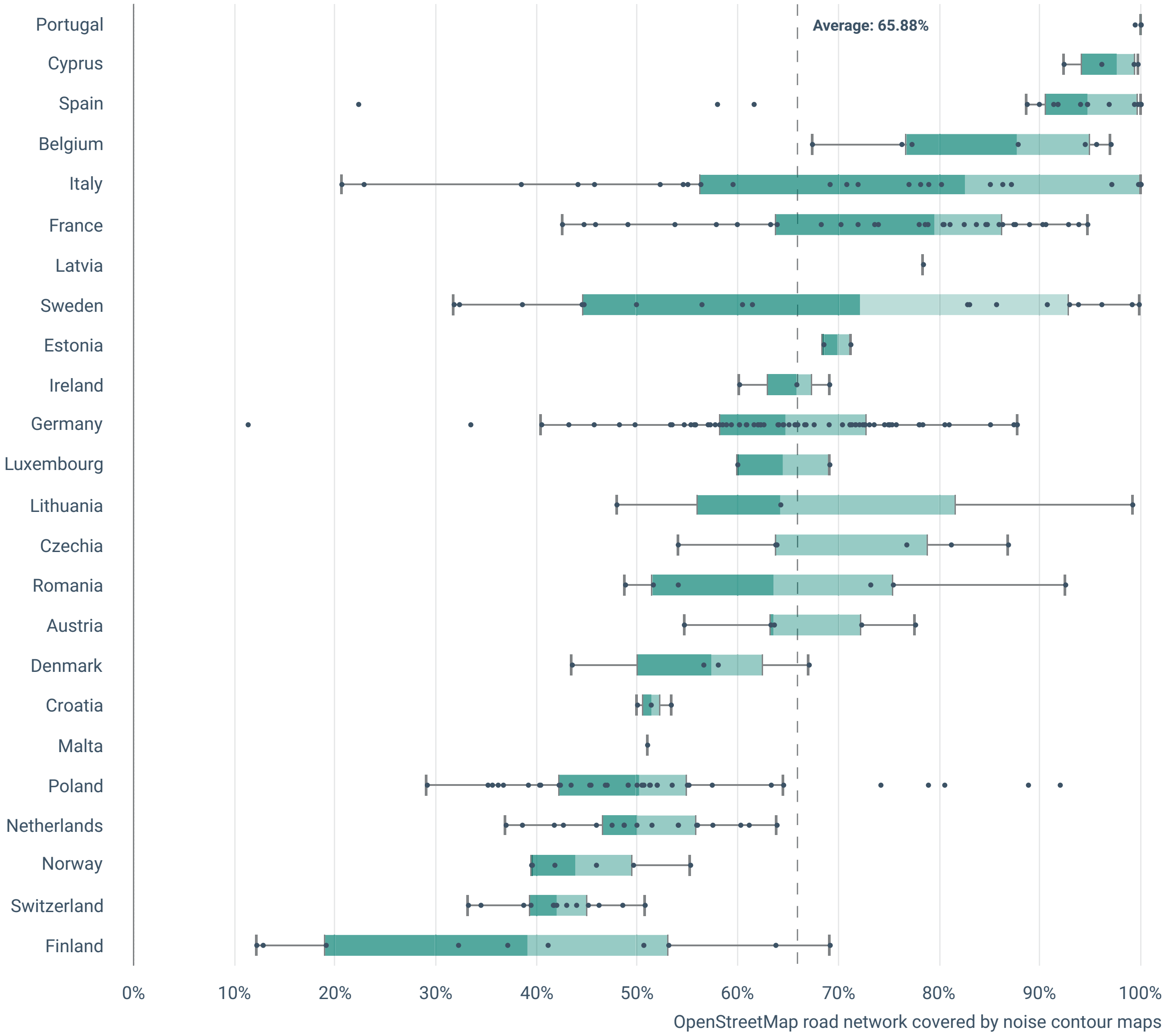
Figure A2.2 **Reported and underestimated number of people equal or above 55dB L_{den} to rail traffic noise in EEA-32 (excluding Türkiye)**



Source: ETC HE internal data analysis.

Annex 3 Extent of road and railway coverage in urban areas

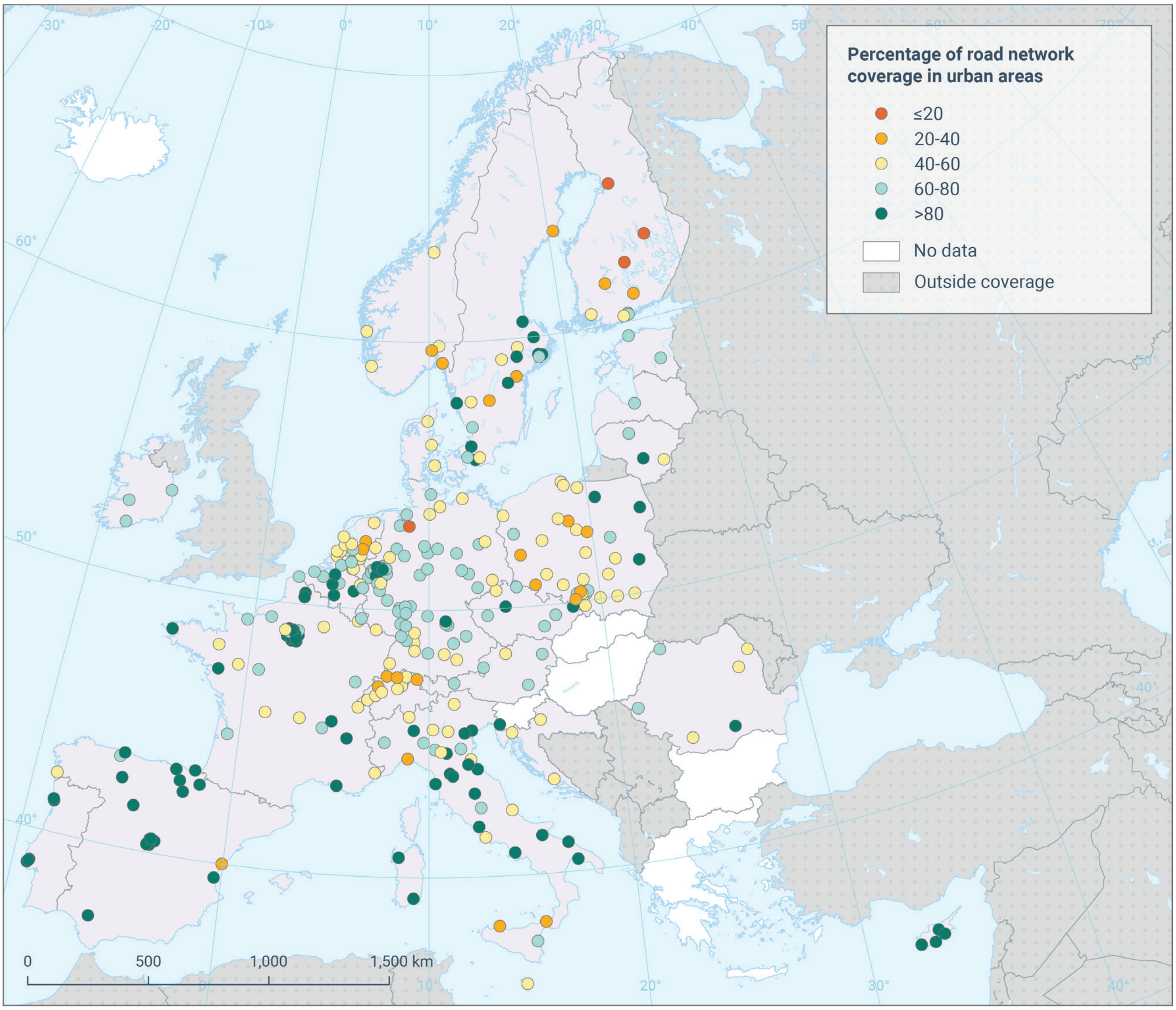
Figure A3.1 **Percentage of road coverage with road traffic noise contour maps in urban areas across the EEA-32 countries (excluding Türkiye)**



Notes: The assessment includes only those END agglomerations submitting L_{den} noise contour maps for road noise inside agglomerations. Data completeness of L_{den} values in 2022 by country, as of 18 November 2024.

Source: ETC HE internal data analysis.

Map A3.1 **Percentage of road and street coverage with road traffic noise contour maps in urban areas**

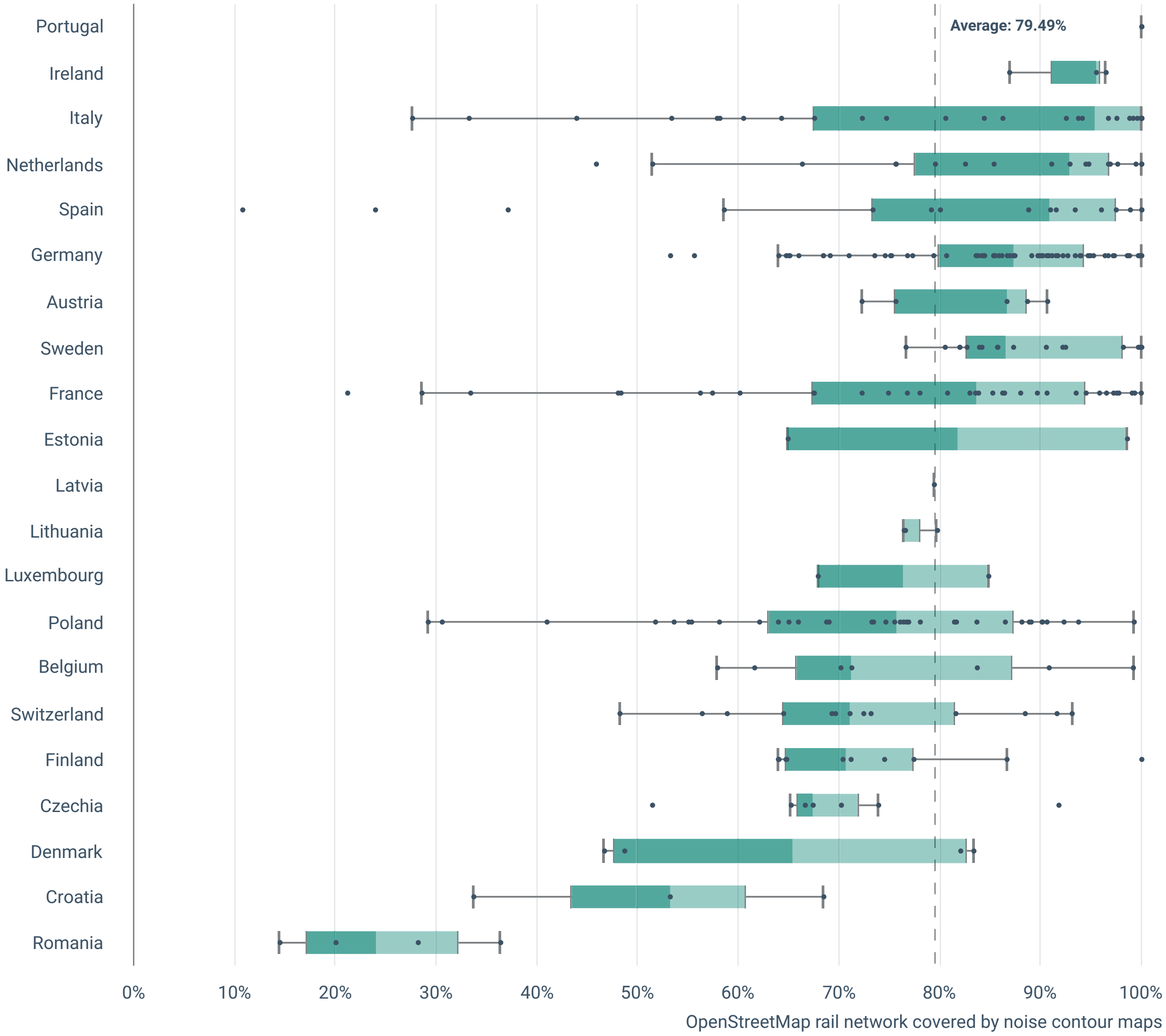


Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: The assessment includes only those END agglomerations submitting L_{den} noise contour maps for road noise inside agglomerations. Data completeness of L_{den} values in 2022 by country, as of 18 November 2024.

Source: ETC HE internal data analysis.

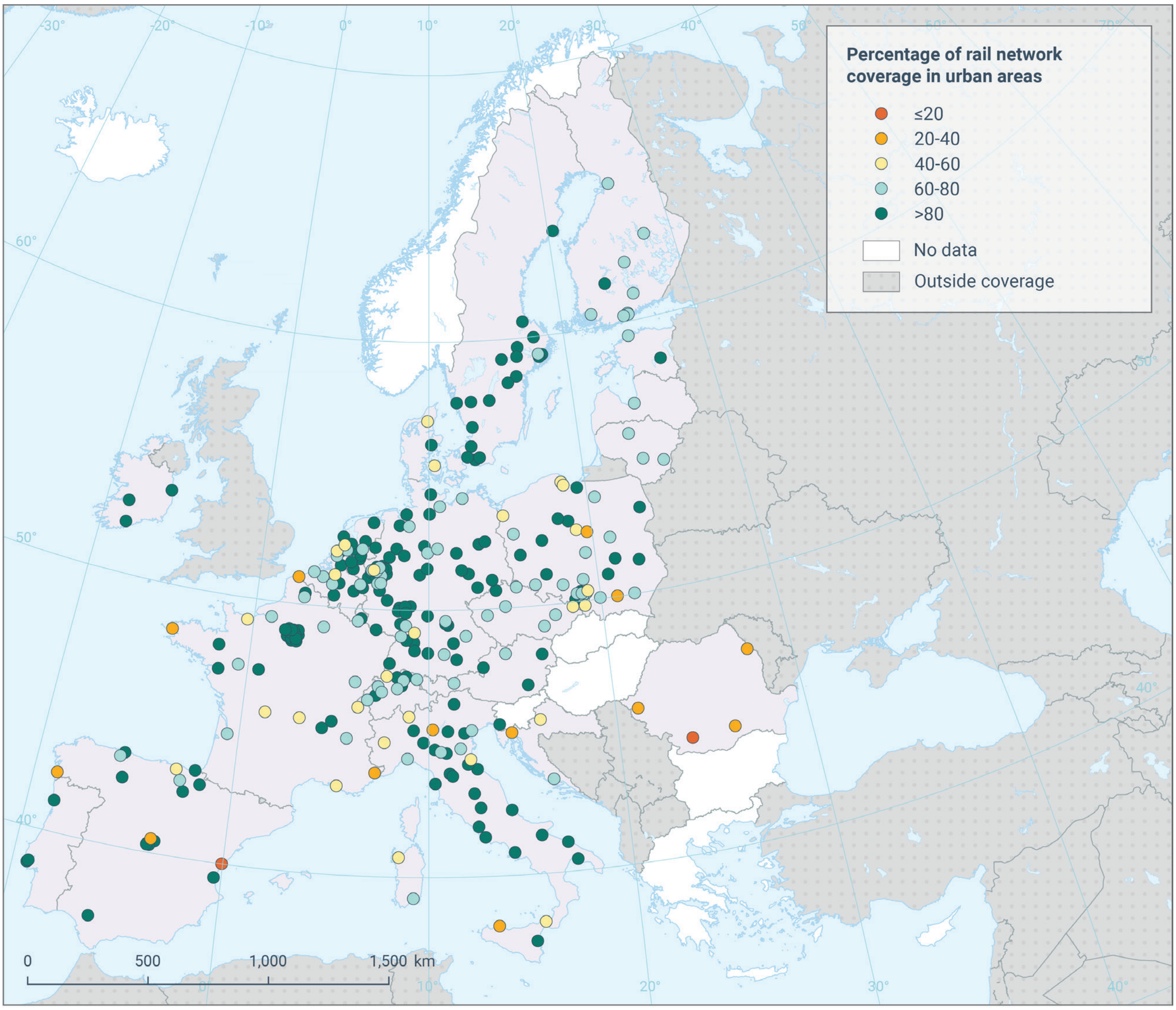
Figure A3.2 **Percentage of rail network coverage with rail noise contour maps in urban areas across the EEA-32 countries (excluding Türkiye)**



Notes: The assessment includes only those END agglomerations submitting L_{den} noise contour maps for rail noise inside agglomerations Data completeness of L_{den} values in 2022 by country, as of 18 November 2024.

Source: ETC HE internal data analysis.

Map A3.2 Percentage of rail network coverage with rail traffic noise contour maps in urban areas



Reference data: © EuroGeographics, © FAO (UN), © TurkStat Source: European Commission – Eurostat/GISCO

Notes: The assessment includes only those END agglomerations submitting L_{den} noise contour maps for rail noise inside agglomerations. Data completeness of L_{den} values in 2022 by country, as of 18 November 2024.

Source: ETC HE internal data analysis.

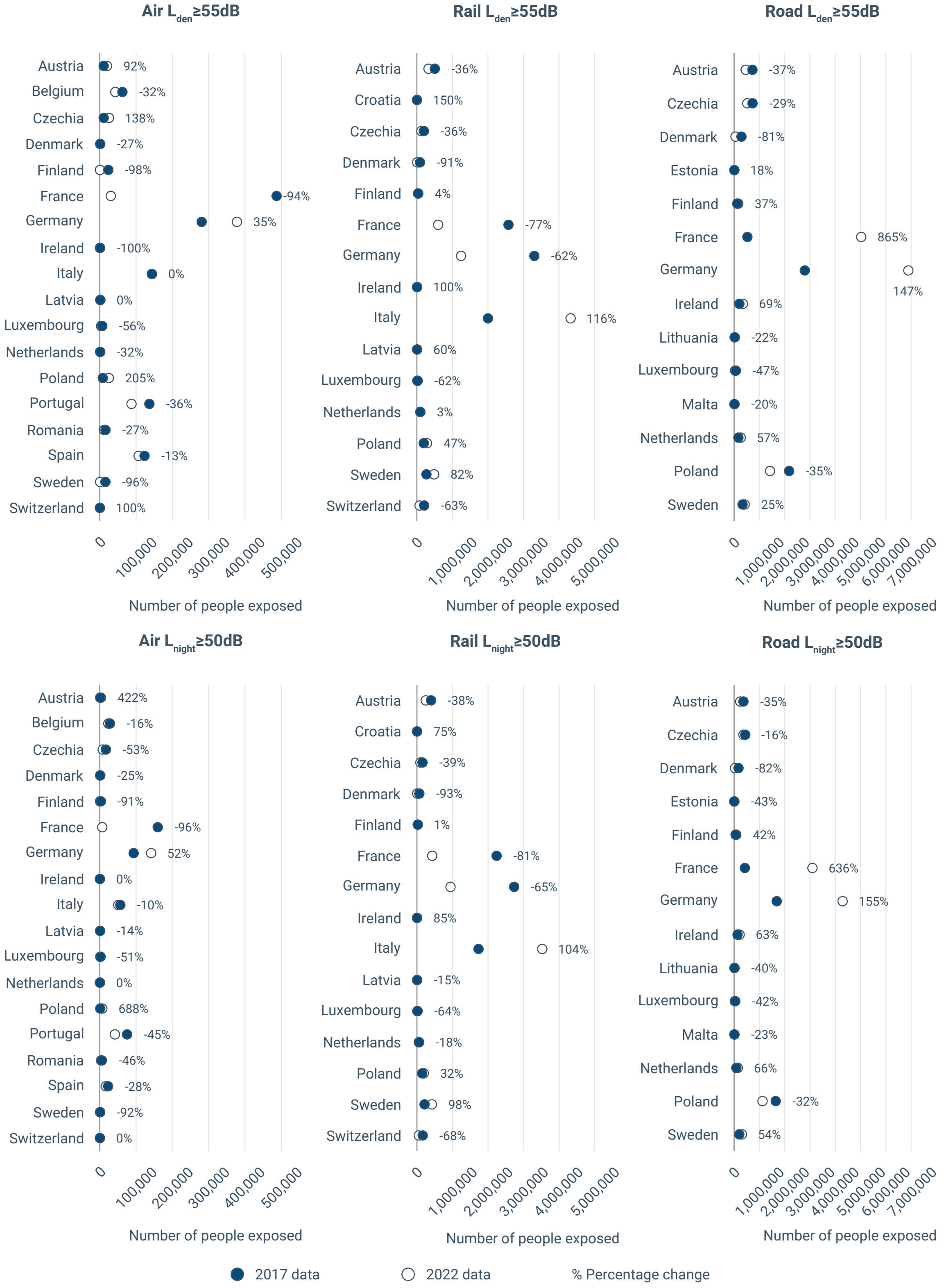
Annex 4 Changes 2017-2022

Figure A4.1 **Changes in people exposed inside agglomerations between 2017 (blue) and 2022 (white) per source**

Notes: Changes represented in logarithmic scale. Asterisks next to the name of the noise source indicate differences in the scale of L_{den} and L_{night}.

Source: ETC HE internal data analysis.

Figure A4.2 **Changes in people exposed outside agglomerations by major sources between 2017 (blue) and 2022 (white)**



Notes: Changes represented in logarithmic scale. Asterisks next to the name of the noise source indicate differences in the scale of L_{den} and L_{night}.

Source: ETC HE internal data analysis.

Annex 5 Methodology used to assess the health risks of transport noise

The full methodology is described in:

- ETC HE report 'Environmental noise health risk assessment: methodology for assessing health risks using data reported under the Environmental Noise Directive' (ETC HE, 2024b);
- ETC HE report 'Health effects of transportation noise for children and adolescents: an umbrella review and burden of disease estimation' (ETC HE, 2025c);
- Up-to-date epidemiological evidence on health effects from transportation noise for BoDs assessment (Röösli et al., 2025).

The health endpoints that are quantified in this assessment are those that have demonstrated a moderate to high-level certainty of evidence for a causal relationship between noise exposure and adverse health effects. These are based on an up-to-date meta-analysis, which builds upon the 2018 WHO environmental noise guidelines. Noise annoyance and sleep disturbance were included using the exposure-response functions from the WHO, 2018 systematic reviews. All-cause natural mortality, CVD encompassing a wide range of cardiovascular outcomes, as well as diabetes type 2 were included following new and updated meta-analyses from ETC HE (2024b). Table A5.1 summarises the relationships between noise and the health effects that were used in this assessment (Chapter 3). Although evidence on the cardiometabolic effects of railway and aircraft noise remains limited, this assessment assumes that the impacts of road traffic noise can be extrapolated to these sources. This assumption is based on the understanding that the biological mechanisms involved are similar, if not more severe, for railway and aircraft noise.

Table A5.1 Relationships between noise and health effects used in Chapter 3

Health effect	Population	Source	Relationship
High annoyance (prevalence)	Adults	Road	Guski et al. (2017) $(78.927-3.1162*L_{den}+0.0342*L_{den}\text{^}2)/100$
		Rail	Guski et al. (2017) $(38.1596-2.05538*L_{den}+0.0285*L_{den}\text{^}2)/100$
		Air	Guski et al. (2017) $(-50.9693+1.0168*L_{den}+0.0072*L_{den}\text{^}2))/100$
High sleep disturbance (prevalence)	Adults	Road	Basner and McGuire (2018) $(19.4312-0.9336*L_{night}+0.0126*L_{night}\text{^}2)/100$
		Rail	Basner and McGuire (2018) $(67.5406-3.1852*L_{night}+0.0391*L_{night}\text{^}2)/100$
		Air	Basner and McGuire (2018) $(16.7885-0.9293*L_{night}+0.0198*L_{night}\text{^}2)/100$
CVD (incidence)	Adults	Road, rail, air	Relative risk (RR) derived from road noise. RR = exp(ln(1.032)/10*(L_{den}-45)) if L_{den}> = 45dB and RR = 1 if L_{den} <45dB.
Diabetes type 2 (incidence)	Adults	Road, rail, air	Derived from meta-analyses (ETC HE, 2024b) RR derived from road noise. RR = exp(ln(1.062)/10*(L_{den}-45)) if L_{den}> = 45dB and RR = 1 if L_{den} <45dB.
All-natural causes mortality	Adults	Road, rail, air	Derived from meta-analyses (ETC HE, 2024b) RR derived from road noise. RR = exp(ln(1.055)/10*(L_{den}-45)) if L_{den}> = 45dB and RR = 1 if L_{den} <45dB.
Reading comprehension impairment (prevalence)	Children aged 6-17	Road, rail, air	Derived from Clark et al. (2006) and van Kempen (2008). Exposure-response relationship derived from aircraft noise at school. 1/(1 + exp(- (ln(0.1/0.9) + (ln(1.38)/10•(L_{den} - 50)))) if L_{den} ≥50dB and 0.1 if L_{den} <50dB.
Behavioural problems (prevalence)	Children aged 6-17	Road, rail, air	Derived from meta-analyses (ETC HE, 2025c). RR derived from residential road traffic noise. RR = exp(ln(1.073)/10*(L_{den}-45)) if L_{den}> = 45dB and RR = 1 if L_{den} <45dB.
Overweight (prevalence)	Children aged 6-17	Road, rail, air	Derived from meta-analyses (ETC HE, 2025c). RR derived from residential road traffic noise. RR = exp(ln(1.063)/10*(L_{den}-45)) if L_{den}> = 45dB and RR = 1 if L_{den} <45dB.
Depression	Adults	Road, rail, air	Derived from meta-analyses (Röösli et al., 2025). Exposure-response relationship derived from aircraft noise at school. RR = exp(ln(1.054)/10*(L_{den}-45)) if L_{den}> = 45dB and RR = 1 if L_{den} <45dB.
Dementia	Adults	Road, rail, air	Derived from meta-analyses (Röösli et al., 2025). RR derived from residential road traffic noise. RR = exp(ln(1.052)/10*(L_{den}-45)) if L_{den}> = 45dB and RR = 1 if L_{den} <45dB.

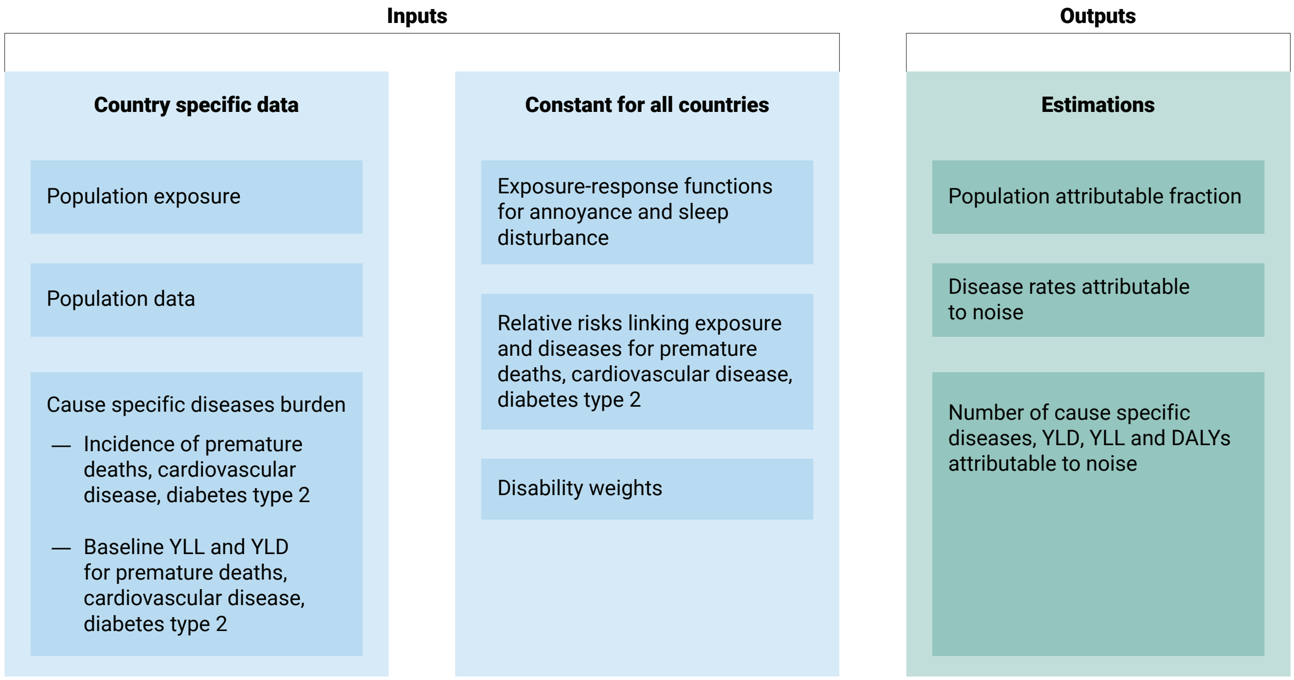
Country-specific incidence rates for those outcomes as well as YLD and YLL rates from the GBD study (IHME, 2021) were used as health input data. A graphic overview of the input and output of the HRA is shown in Figure A5.1.

The health impacts of CVD, premature mortality, type 2 diabetes, behavioural problems, being overweight, depression and dementia were estimated using country-specific baseline incidence or prevalence data from the GBD study (IHME, 2021). Additionally, to assess the BoD attributable to environmental noise, country-specific estimates for these conditions — measured in YLD and YLL — were also obtained from the GBD study. These data were then used to calculate the total impact in DALYs.

Health risks were estimated based on the number of people exposed to noise levels starting at a 55dB L_{den} and 50dB L_{night}, as reported under the END. To improve the accuracy of health risk calculations, a non-uniform distribution was applied across 1dB noise bands, rather than using a mid-point value within broader 5dB bands.

Additionally, population exposure was extrapolated to below the END thresholds following the approach described in ETC HE (2024b). This was in order to undertake the HRA using the source specific lower thresholds recommended by the WHO.

Figure A5.1 **Overview of methodology for calculating the health burden from road, rail and aircraft in this assessment**



Source: Based on the methodology from (ETC HE, 2024b).

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