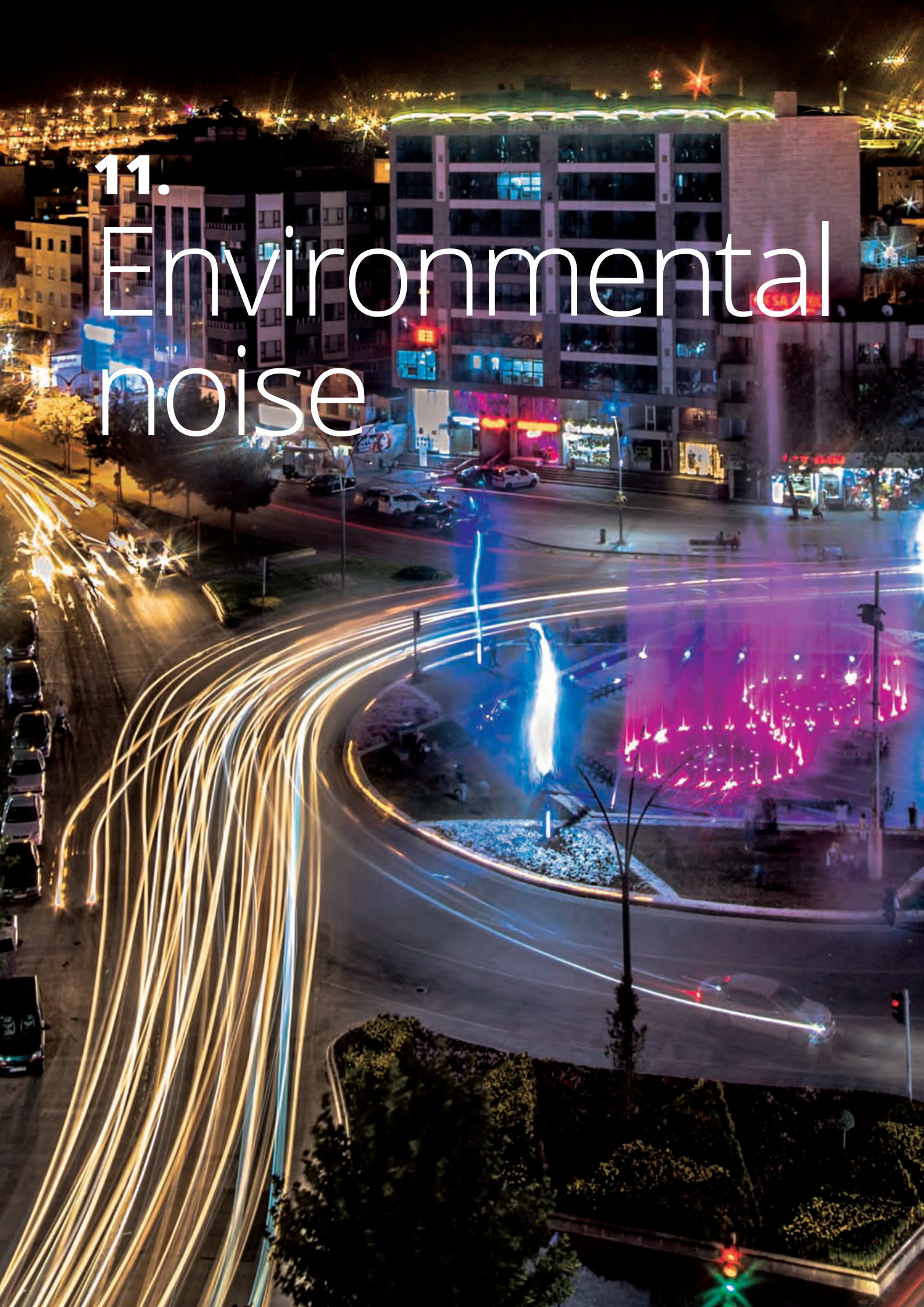

# 11. Environmental noise

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# Key messages

- Environmental noise remains a major environmental health problem in Europe with at least 20 % of the EU's population living in areas where noise levels are considered harmful to health.

- Road traffic noise is the most dominant source of environmental noise, with an estimated 113 million people affected by long-term daily average noise levels of at least 55 dB(A) and 79 million people affected by night-time noise levels of at least 50 dB(A).

- Exposure to noise pollution harms health. Long-term exposure is estimated to contribute to 48 000 new cases of heart disease per year in Europe and to 12 000 premature deaths. In addition to this, it is estimated that 22 million people suffer severe annoyance, 6.5 million people suffer severe sleep disturbance and 12 500 school children may suffer learning impairment due to aircraft noise.

- The number of people exposed to high levels of noise since 2012 has broadly remained stable. The objective of the Seventh Environment Action Programme — to significantly reduce noise pollution in the EU and move closer to World Health Organization recommended levels by 2020 — will not be achieved.

- An increase in the numbers exposed to environmental noise is projected as a result of future urban growth and increased mobility demands. Therefore reducing noise pollution will require further efforts.

- The implementation of the Environmental Noise Directive, introduced in 2002, has not yet achieved its full potential. It would be achieved if Member States implemented it fully, particularly with respect to completeness, comparability and timeliness of reporting, as well as implementing action plans that include the protection of quiet areas.

**Thematic summary assessment**

| Theme | Past trends and outlook | | Prospects of meeting policy objectives/targets |
|---|---|---|---|
| | Past trends (10-15 years) | Outlook to 2030 | 2020 |
| Population exposure to environmental noise and impacts on human health | Trends show a mixed picture | Deteriorating developments dominate | ☒ Largely not on track |
| Preservation of quiet areas | Trends show a mixed picture | Developments show a mixed picture | ☒ Largely not on track |

**Note:** For the methodology of the summary assessment table, see the introduction to Part 2. The justification for the colour coding is explained in Section 11.3, Key trends and outlooks (Tables 11.3 and 11.4).

# 11. Environmental noise

## 11.1 Scope of the theme

Environmental noise is a pervasive pollutant that adversely affects the health and well-being of Europe's citizens as well as wildlife. Although noise is a product of many human activities, the most widespread source of environmental noise is transport. To this effect, noise caused by transport is considered to be the second most significant environmental cause of ill health in western Europe, after fine particulate matter pollution (Hänninen et al., 2014; WHO and JRC, 2011). According to the World Health Organization (WHO), prolonged exposure to environmental noise is associated with an increased risk of negative physiological and psychological health outcomes (WHO, 2018). These include cardiovascular and metabolic effects, reduced cognitive performance in children, and severe annoyance and sleep disturbance. As a result of projections of rapid urban growth and increased demand for transport, a simultaneous increase in exposure to noise and the associated adverse effects can be anticipated (Jarosińska et al., 2018). Furthermore, there is also increasing evidence regarding the harmful effects of transport noise on wildlife (Shannon et al., 2016). The effects of noise vary depending on the species, although, in general, noise interferes with animals' feeding, hunting and breeding behaviour.

Noise remains a major cause of environment-related health problems in Europe.

The state of the knowledge presented in this chapter is based on data reported by the EEA 33 member countries excluding Turkey (EEA-33) in accordance with the Environmental Noise Directive (END) on a 5-year cycle (EU, 2002) and submitted up to 1 January 2019. The data cover noise sources such as roads, railways and airports, inside and outside urban areas as well as industry inside urban areas. The results presented in this chapter show the number of people exposed to noise levels of 55 dB or higher during the day-evening-night period, as well as to night-time noise levels of 50 dB or higher for the three rounds of noise mapping in 2007, 2012 and 2017 (see Box 11.1). Throughout the chapter, and according to the Seventh Environment Action Programme (7th EAP), those are referred to as 'high noise levels'. However, even levels below these thresholds have been found to have negative health effects (WHO, 2009, 2018). The impact of noise on health is assessed in terms of annoyance, sleep disturbance, cardiovascular effects, cognitive impairment in children, and annual premature deaths caused by heart disease.

Identifying and protecting areas undisturbed by environmental noise is also a requirement under the END. Therefore, a spatial assessment of noise exposure data combined with land use cover data for areas potentially unaffected by noise pollution in European

**TABLE 11.1 Overview of selected policy objectives and targets**

| Policy objectives and targets | Sources | Target year | Agreement |
|---|---|---|---|
| Noise reduction | | | |
| Significantly reducing noise pollution in the EU moving closer to WHO recommended levels. | 7th EAP (EU) | 2020 | Non-binding commitment |
| Implementing measures to reduce noise at source and including improvements in city design | 7th EAP (EU) | 2020 | Non-binding commitment |
| Decreasing noise levels below the values specified in the WHO noise guidelines is strongly recommended | WHO (2018) | N/A | Non-binding commitment |
| Member States must prepare noise maps every 5 years to determine exposure to environmental noise from transport and industry sources. These noise maps serve as the basis for adopting action plans designed to prevent and reduce harmful exposure in areas affected by noise from roads, railways, airports and industry. The plans should also aim to protect quiet areas against an increase in noise | Directive 2002/49/EC | N/A | Legally-binding |
| Impacts on human health and well-being | | | |
| By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being | SDG 3 | 2030 | Non-binding commitment |

**Note:** SDG, Sustainable Development Goal; N/A, non-applicable.

cities is presented for 2012 and 2017. Quiet areas are not only beneficial for human health but are also consistent with the need to protect species vulnerable to noise and areas of valuable habitat.

## 11.2 Policy landscape

The EU 7th EAP (EU, 2013) recognises that a large number of people living in major urban areas are exposed to high levels of noise at which adverse health effects frequently occur. To address this environmental impact, it sets out the objective that by 2020 noise pollution in the EU needs to be significantly decreased, moving closer to WHO recommended levels. To meet this objective, the 7th EAP identified the need to implement an updated EU noise policy aligned with the latest scientific evidence as well as measures to reduce noise at source, including by improving urban design.

In the EU, the END is the primary legislative tool for achieving noise reduction. The Directive offers a common approach to avoiding and preventing exposure to environmental noise through the reporting of noise mapping and action planning, thereby reducing its harmful effects as well as preserving quiet areas (EU, 2002). Accompanying the END, there are a number of other legislative measures that aim to address or control noise at source, such as by imposing noise limits on certain vehicles or equipment or their components or by restricting their operation (EEA, 2014).

Quiet areas are beneficial for human health and wildlife.

Table 11.1 presents an overview of selected policy targets and objectives on environmental noise addressed in this chapter.

Although, as shown in Box 11.2, health and well-being can be affected at levels below the END reporting thresholds, there is a significant lack of data on the number of people exposed to noise

**BOX 11.1**
**EU noise indicators**

The Environmental Noise Directive (END) defines two important noise indicators to be used for noise mapping and action planning:

$L_{den}$: Long-term average indicator designed to assess annoyance and defined by the END. It refers to an A-weighted average sound pressure level over all days, evenings and nights in a year with an evening weighting of 5 dB and a night weighting of 10 dB.

$L_{night}$: Long-term average indicator defined by the END and designed to assess sleep disturbance. It refers to an A-weighted annual average night period of exposure.

High noise levels are defined in the 7th EAP as noise levels above 55 dB $L_{den}$ and 50 dB $L_{night}$. ■

**BOX 11.2**
**The 2018 Environmental noise guidelines for the European region (WHO, 2018)**

In 1999 and 2009 the World Health Organization (WHO) published guidelines to protect human health from exposure to community noise and night noise. Since then there has been a substantial increase in the number and quality of studies on environmental noise exposure and health outcomes. Following the Parma Declaration on Environment and Health, adopted at the Fifth Ministerial Conference (2010), the Ministers and representatives of Member States in the WHO European Region requested WHO to develop updated guidelines on environmental noise. To this end, WHO commissioned systematic reviews to assess the relationship between environmental noise and health outcomes such as cardiovascular and metabolic effects, annoyance, effects on sleep, cognitive impairment, hearing impairment and tinnitus, adverse birth outcomes, and quality of life, mental health and well-being. These reviews are the basis for the development of the recommended noise levels above which negative effects on health begin according to our best knowledge. ■

**Reducing noise below these levels is recommended (WHO, 2018).**

| | Road | Rail | Aircraft |
|---|---|---|---|
| $L_{den}$ | 53 dB | 54 dB | 45 dB |
| $L_{night}$ | 45 dB | 44 dB | 40 dB |

levels below 55 dB $L_{den}$ and 50 dB $L_{night}$, as reporting at such levels is voluntary.

## 11.3 Key trends and outlooks

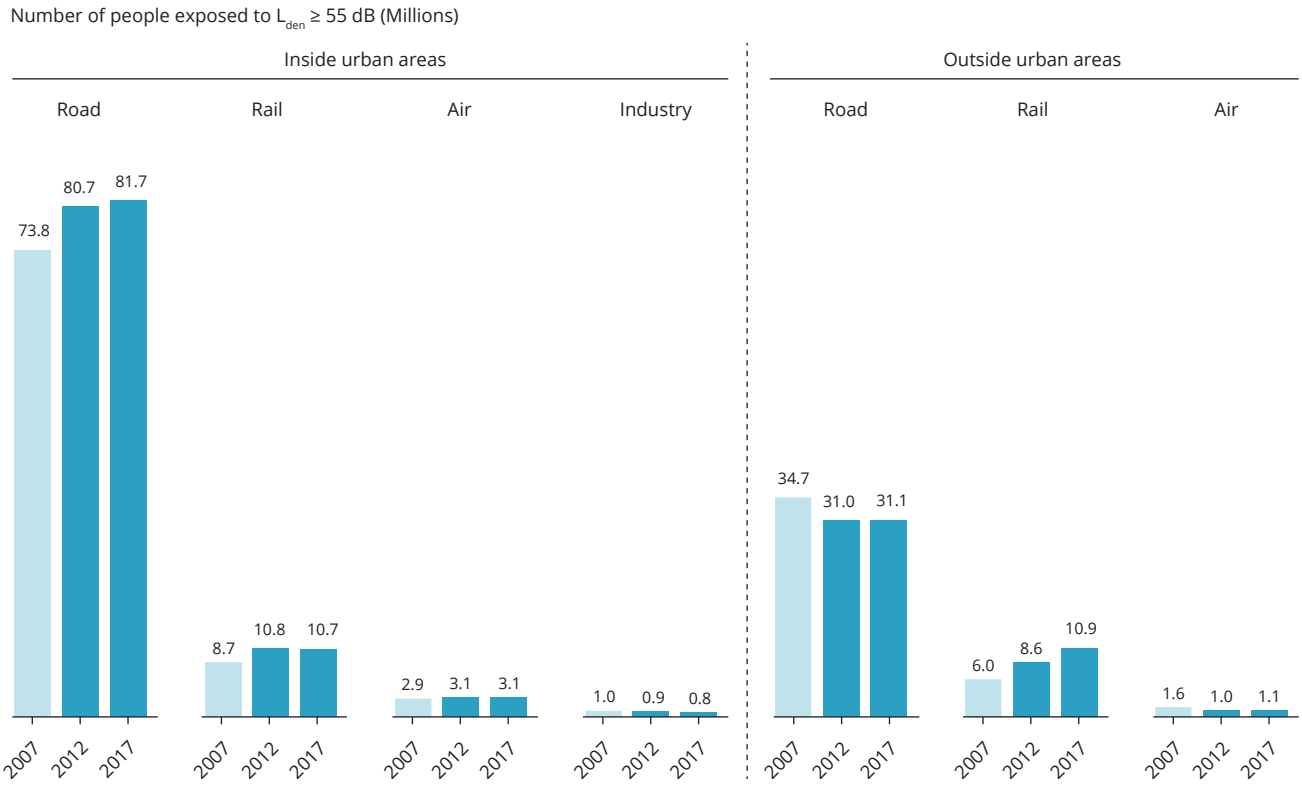
### *11.3.1 Population exposure to environmental noise and impacts on human health*

►*See Table 11.3*

To support the implementation of the END (EU, 2002), the EEA gathers population exposure data from its 33 member countries (EEA-33). The current state of knowledge on noise sources and population exposure in Europe is largely based on this database. According to the latest data, the overall number of people exposed to day-evening-night average sound levels of 55 dB or higher is estimated to be 113 million for road traffic noise, 22 million for railway noise, 4 million for aircraft noise and less than 1 million for noise caused by industry. Similarly, road traffic is by far the biggest source of environmental noise during night-time, followed by railway, air and industrial noise, respectively. These results indicate that at least 20 % of Europeans are exposed to long-term average day-evening-night noise levels of 55 dB or more and more than 15 % to night-time noise levels of 50 dB or more — levels at which adverse health effects can occur (Figures 11.1, 11.2, 11.3).

Trends between 2012 and 2017 suggest that the number of people exposed to levels considered harmful to human health has generally remained stable across most of the noise sources, with the exception of railway noise outside urban areas for which there was a significant increase of 27 %. Efforts to reduce exposure to noise from individual sources may be being offset by continuing migration to urban areas, which implies a growth in population, activity and traffic. Increased demand for passenger and goods transport across cities, regions and countries can also negatively influence efforts to reduce the number of people exposed to high noise levels. There are regulations related to noise action plans that have come into force recently but that have not yet clearly reduced the reported number of people exposed to noise. This is the case, for example, for Regulation 598/2014 on noise

**FIGURE 11.1 Number of people exposed to $L_{den}$ ≥ 55 dB in Europe, based on areas covered by strategic noise maps, EEA-33 (Turkey not included)**




**Note:** There are comparability issues between 2007 and the other reporting years because of different reporting requirements. There may be comparability issues between 2012 and 2017 because of a lack of common assessment methods or incomplete reporting of exposure assessments. Due to gaps in the reported data, a gap-filling procedure was used to estimate the number of people exposed to high noise levels in 2012 and 2017, introducing a degree of uncertainty into the assessment.

**Source:** EEA (2019a).

20 %

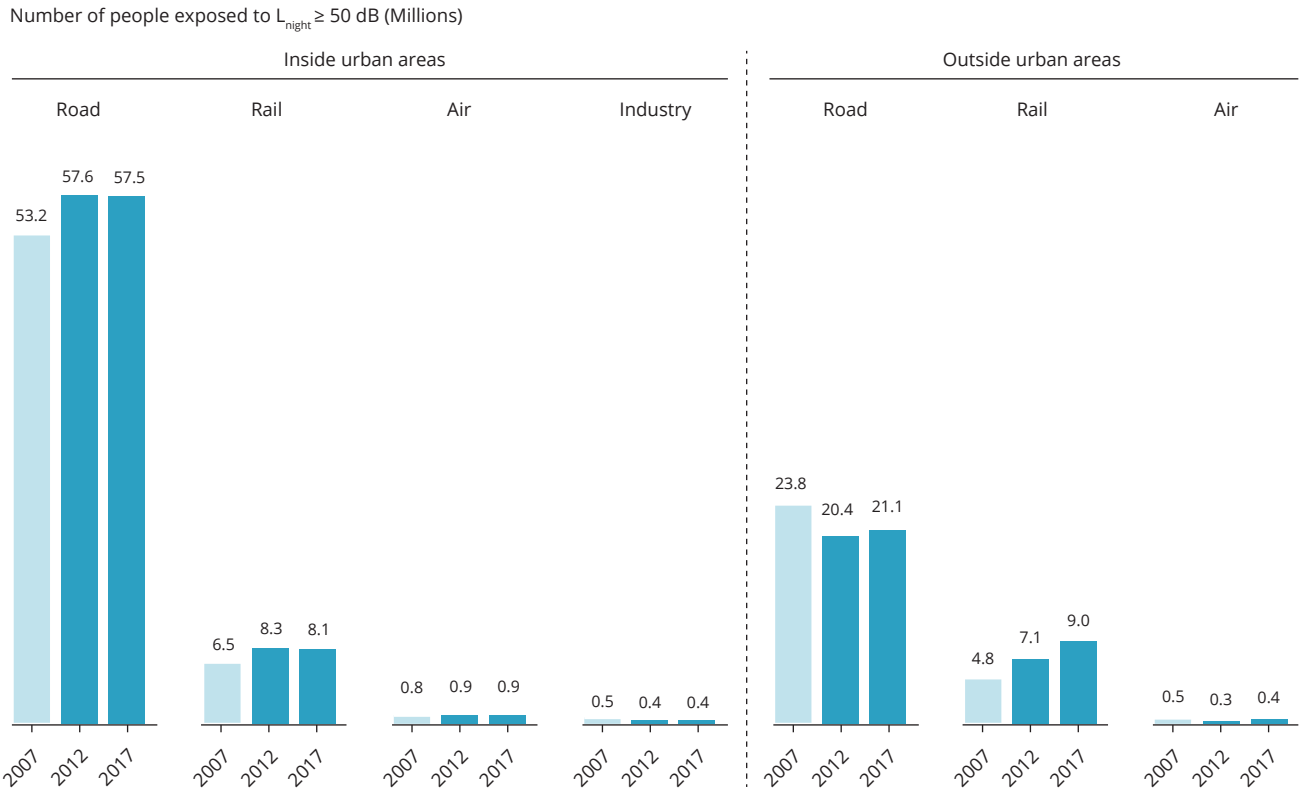
of the EU's population lives in areas where noise levels are considered harmful to human health and well-being.

management at airports, which calls for cutting noise levels by deploying modern aircraft, careful land use planning, quieter ground control operations and restrictions on night-time flying (EU, 2014).

This assessment (2012-2017) takes into account gap-filled data from urban areas with more than 100 000 inhabitants as well as major roads with more than 3 million vehicles per year, railways with more than 30 000 trains per year and airports with more than 50 000 movements per year. The data shown for 2007 have to be treated with caution, as the reporting requirements for urban areas, major roads and railways in 2007 were different from those in 2012 and 2017. The 2007 data refer to noise in urban areas with more than 250 000 inhabitants, major roads with more than 6 million vehicles a year and railways with more than 60 000 trains a year. Therefore, the results from 2007 are not fully comparable to those from 2012 and 2017.

As shown in Figure 11.3, there is a considerable variability in the percentage of the population

**FIGURE 11.2 Number of people exposed to $L_{night}$ ≥ 50 dB in Europe, based on areas covered by strategic noise maps, EEA-33 (Turkey not included)**




**Note:** There are comparability issues between 2007 and the other reporting years because of different reporting requirements. There may be comparability issues between 2012 and 2017 because of a lack of common assessment methods or incomplete reporting of exposure assessments. Due to gaps in the reported data, a gap-filling procedure was used to estimate the number of people exposed to high noise levels in 2012 and 2017, introducing a degree of uncertainty into the assessment.

**Source:** EEA (2019a).

exposed to high noise levels within individual countries — from 9 % of the population exposed to road traffic noise in Slovakia to 54 % in Cyprus. The variability between countries may be due to several factors. One of them is the way in which countries define agglomerations. The END states that data need to be reported for all agglomerations with a population in excess of 100 000 and a population density such that the Member State considers them urbanised areas. Therefore, it depends how countries define density and how they delimit agglomerations in their territories. For instance, Switzerland may have a high percentage of people exposed to road noise inside urban areas, as it reports 13 agglomerations according to its own agglomeration criteria. Conversely, countries with a similar population such as Portugal or Norway report six and five agglomerations, respectively. Another reason may be the density of transport networks in the country. For instance, in the central part of Europe (e.g. Austria, Belgium, France, Germany, Luxembourg and Switzerland), where the railway network is denser and well

Road traffic is the main source of noise with about 113 million people affected by daily average noise levels of 55dB or higher.

**FIGURE 11.3** **Country comparison — percentage of the total country population exposed to $L_{den}$ ≥ 55 dB in 2017, EEA-33 (Turkey not included)**

| | | | | | Outside urban areas | | |
|---|---|---|---|---|---|---|---|
| | Road | Rail | Air | Industry | Road | Rail | Air |
| Austria | 24.2 | 6.6 | 0.1 | 0.1 | 8.2 | 5.7 | 0.1 |
| Belgium | 14.0* | 1.0* | 0.6* | 0.2* | 8.6 | 2.2 | 0.6* |
| Bulgaria | 28.8* | 0.6* | 0.1* | 0.0* | 1.5 | | |
| Croatia | 7.7 | 0.6 | 0.0 | 0.0 | 2.8 | 0.0 | |
| Cyprus | 49.2* | 3.2* | 0.9* | 1.0* | 4.7* | | |
| Czechia | 16.7 | 0.7 | 0.1 | 0.0 | 6.9 | 1.8 | 0.1 |
| Denmark | 18.5 | 0.5* | 0.1* | 0.0* | 5.0 | 1.5 | 0.0* |
| Estonia | 22.7 | 0.5 | 0.2 | 0.5 | 0.5 | | |
| Finland | 8.8 | 1.6 | 0.1* | 0.0* | 2.1 | 0.6 | 0.4 |
| France | 23.5* | 3.6* | 0.7* | 0.2* | 9.8 | 3.9 | 0.0* |
| Germany | 6.9* | 3.7 | 0.7 | 0.1* | 3.3 | 4.0 | 0.4 |
| Greece | 7.9* | 1.3* | 0.4* | 0.1* | 0.2* | 0.0* | 0.0* |
| Hungary | 16.4 | 1.3 | 0.0 | 0.0 | 1.8 | 0.9 | 0.3 |
| Iceland | 16.6 | | 0.5* | 0.2 | | | 0.5 |
| Ireland | 14.4 | 0.6 | 0.6 | | 4.8 | 0.3 | 0.0 |
| Italy | 13.7* | 0.9* | 0.7* | 0.1* | 12.0* | 3.3 | 0.3* |
| Latvia | 27.0 | 2.0 | 0.0 | 0.7 | 1.2 | 0.1 | 0.1 |
| Liechtenstein | | | | | 11.4* | | |
| Lithuania | 26.3 | 0.4 | 0.4 | 0.3 | 0.8 | 0.0 | |
| Luxembourg | 24.5 | 1.5 | 10.1 | 0.0 | 11.2 | 3.3 | 1.1 |
| Malta | 22.4 | | 1.9 | 0.0 | 3.7 | | |
| Netherlands | 19.3 | 1.3 | 0.4 | 0.3 | 1.0 | 0.5 | 0.0 |
| Norway | 15.2* | 2.2* | 0.2* | 0.0* | 2.6* | 0.2 | 0.1* |
| Poland | 11.6 | 0.6* | 0.1 | 0.1* | 5.7 | 0.5 | 0.0 |
| Portugal | 5.2 | 0.4 | 0.9 | 0.0 | 8.6* | 1.0 | 1.3 |
| Romania | 13.3* | 1.5* | 0.2* | 1.2* | 1.6* | 0.1* | 0.0* |
| Slovakia | 6.7* | 2.4* | 0.0* | 0.0* | 2.9* | 2.0* | |
| Slovenia | 9.8 | 1.2 | | 0.0 | 5.5 | 1.1 | |
| Spain | 24.8* | 1.1* | 0.2* | 0.2* | 4.2* | 0.7* | 0.3 |
| Sweden | 12.3 | 2.9 | 0.2* | 0.0 | 3.3 | 2.7 | 0.2 |
| Switzerland | 30.6 | 3.4 | 1.1 | 0.2* | 5.1 | 2.4 | 0.0 |
| United Kingdom | 14.5 | 1.9 | 1.5 | 0.2 | 6.5 | 0.7 | 0.2* |

* Data totally or partially estimated


**Note:** Based on areas covered by the END.

**Sources:** EEA (2019b); ETC/ATNI (2019b).

**TABLE 11.2 Estimated number of people suffering from various health outcomes due to environmental noise in 2017, EEA-33 (Turkey not included)**

| | High annoyance | High sleep disturbance | Ischemic heart disease | Premature mortality | Cognitive impairment in children |
|---|---|---|---|---|---|
| **Inside urban areas** | | | | | |
| Road | 12 525 000 | 3 242 400 | 29 500 | 7 600 | |
| Rail | 1 694 700 | 795 500 | 3 100 | 800 | |
| Air | 848 300 | 168 500 | 700 | 200 | 9 500 |
| Industry | 87 200 | 23 400 | 200 | 50 | |
| **Outside urban areas** | | | | | |
| Road | 4 625 500 | 1 201 000 | 10 900 | 2 500 | |
| Rail | 1 802 400 | 962 900 | 3 400 | 900 | |
| Air | 285 400 | 82 900 | 200 | 50 | 2 900 |

**Note:** Premature mortality calculated as premature mortality due to ischaemic heart disease.

**Source:** EEA (2019a).

developed, a higher percentage of people are exposed to railway noise outside urban areas than in other countries.

Exposure to environmental noise is associated with an increased risk of negative physiological and psychological health outcomes. Widespread exposure to noise from transport (road traffic, railway and aircraft) is of major concern, affecting the health and well-being of millions of people in Europe. In particular, long-term exposure to environmental noise can lead to a number of adverse health outcomes such as annoyance, sleep disturbance, negative effects on the cardiovascular and metabolic systems, and cognitive impairment in children. Sleep disturbance and annoyance, mostly related to road traffic noise, are the most prevalent effects (Jarosińska et al., 2018).

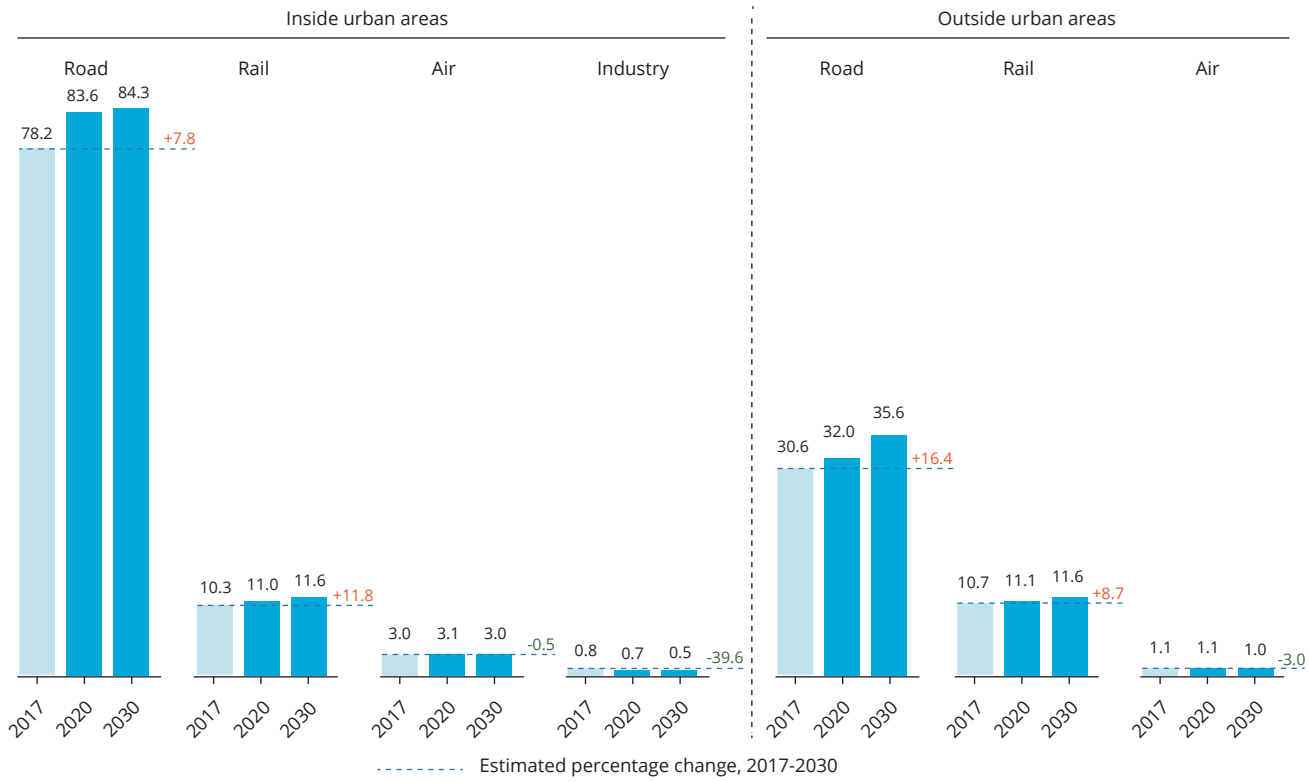
Based on the latest health impact assessment of the 2017 round of noise mapping (EEA, 2019a), around 22 million adults living in agglomerations or near major sources with noise levels of 55 dB $L_{den}$ or more are estimated to be highly annoyed by noise from road traffic, railways, aircraft and industry. Moreover, it is estimated that 6.5 million adults suffer high sleep disturbance due to night-time noise levels of 50 dB $L_{night}$ or more. Exposure to environmental noise from road traffic, railways, aircraft and industry contributes every year to about 48 000 new cases of ischaemic heart disease, and 12 000 premature deaths (Table 11.2). Aircraft noise has also been associated with a decrease in children's cognitive performance in schools that are affected by flight paths. As a result, it is estimated that around 12 500 children in Europe aged 7-17 years old have a reading impairment as a result of exposure to aircraft noise.

48 000 new cases of heart disease and 12 000 premature deaths are estimated to occur annually due to long-term exposure to noise pollution.

In terms of the individual noise sources, road traffic noise, as the most prevalent source of environmental noise, not surprisingly has the largest contribution to the burden of disease due to noise (75 %) followed by railways (20 %), aircraft (4 %) and industry (0.5 %). The major part of the burden of disease, including annoyance, sleep disturbance, heart disease and cognitive impairment due to noise, occurs inside urban areas of more than 100 000 inhabitants (EEA, 2019a).

**FIGURE 11.4 Outlook for 2020 and 2030, EU-28**

Number of people exposed to $L_{den}$ ≥ 55 dB (millions) and estimated percentage change, 2017-2030




**Source:** ETC/ATNI (2019a).

Instead of just assessing the number of premature deaths, the WHO (2011) developed methods to quantify the burden of disease from environmental noise using disability-adjusted life-years (DALYs), which combine years of life lost due to premature mortality and years of life lost due to time lived in any state of less than full health. The DALYs lost due to noise-induced health outcomes were estimated to be equivalent to 437 000 years for sleep disturbance, 453 000 years for annoyance, 156 000 years for cardiovascular heart disease and 75 years for cognitive impairment in children (EEA, 2019a).

However, the effects presented here may be underestimated, as new scientific evidence (see Box 11.1) shows that health and well-being can be affected at lower noise levels than those specified under the END (WHO, 2018). Currently, there is a lack of data on the number of people exposed below 55 dB $L_{den}$ and 50 dB $L_{night}$, meaning that the health impact of noise is likely to be greater than that presented in this assessment. Moreover, END data do not cover the full territory within countries, and therefore there are people affected by noise that are not accounted for in the estimations presented. Although not recently quantified, the associated loss to the population's health due to noise has an economic impact in Europe. Monetary costs can also be related to reduced house prices, loss of working days and reduced potential to develop land for certain uses (EC, 2000).

12 500 school children may suffer learning impairment due to aircraft noise.

Noise outlooks for 2020 and 2030 have been projected using current information on transport and urban trends (ETC/ATNI, 2019a) and have considerable uncertainty, as they are based primarily on forecast increases in traffic and on various policy objectives.

The outlook shows that it is unlikely that noise pollution will decrease significantly

**TABLE 11.3 Summary assessment — population exposure to environmental noise and impacts on human health**

| | | |
|---|---|---|
| **Past trends and outlook** | | |
| Past trends (10-15 years) | | The overall number of people exposed to high levels of noise remained rather stable between 2012 and 2017, with the exception of railway noise outside urban areas for which a significant increase occurred.<br>More than one fifth of the population is exposed to high levels of noise likely to have adverse effects on health. Noise remains a major environmental health problem in Europe, causing around 12 000 premature deaths each year. |
| Outlook to 2030 | | By 2030, projected estimates show an increase in the number of people affected by noise from the most prevalent sources (e.g. road and rail). Exposure to air traffic noise is projected to remain relatively stable. |
| **Prospects of meeting policy objectives/targets** | | |
| 2020 | ☒ | Europe is not on track to meet the Seventh Environment Action Programme objective of significantly reducing noise pollution by 2020. Efforts to reduce noise are being offset by an increase in the numbers of people living in urban areas and increases in traffic. Effective action plans to manage and reduce noise are needed. |
| **Robustness** | | The assessment is based on reported and gap-filled noise data from the 33 EEA member countries. The data in this report are based on a data set for 2012 that is approximately 92 % complete and a data set for 2017 that is 66 % complete. A gap-filling exercise was carried out to complete the noise data that were not reported. This introduces some uncertainties into the assessment. There are also some comparability issues between the first and the subsequent rounds of noise mapping due to the use of different assessment methods. The health impacts are calculated using the World Health Organization 2018 Environmental noise guidelines for the European region. The outlook depends on predictions of traffic growth and future policy objectives, and therefore there are considerable uncertainties. |

by 2020, given that road and rail and air transport traffic is forecast to increase, as is the number of inhabitants living in urban areas. As a result, it is likely that the health impacts of environmental noise will be more widespread by 2020 (Figure 11.4).

In the longer term, even if targets for switching to electric vehicles in cities are met, as outlined in the White Paper, *Roadmap to a single European transport area: towards a competitive and resource efficient transport system* (EC, 2011), the number of people exposed to road traffic noise inside urban areas is still set to increase by approximately 8 % in the period 2017-2030. If the objective of halving conventionally fuelled cars in urban areas by 2030 is not achieved, a higher increase can be expected.

Noise outside urban areas will increase by 2030, in particular for road and rail traffic, due to an anticipated increase in the number of passenger and freight road and rail vehicles. Although railway noise inside and outside urban areas presents a considerable increase in terms of number of people exposed (i.e. 12 % and 9 %, respectively), this scenario already takes into account measures to be taken on silent brake retrofitting of freight trains (ERA, 2018).

Europe is not on track to meet the 7th EAP objective of significantly reducing noise pollution by 2020.

Aviation noise will stabilise only if all the anticipated technology improvements stated in the *European aviation environmental report* are met by 2030. Even if the number of flight movements is expected to increase, improvements in aircraft design could stabilise but not significantly reduce overall noise exposure by 2030 (EASA et al., 2016). The noise contribution from industry inside urban areas is projected to decrease. However, the number of people estimated to be exposed to industrial noise is already very small, and overall the number of people impacted by this reduction is very low.

**BOX 11.3**
**Effects of noise on wildlife**

Although the focus of the Environmental Noise Directive is on reducing the harmful effects of noise on human health, noise also affects wildlife. Whether in the terrestrial or the marine environment, many species rely on acoustic communication for important aspects of life, such as finding food or locating a mate. Anthropogenic noise can potentially interfere with these functions and thus adversely affect diversity of species, population size and population distribution.

One of the most studied effects of anthropogenic noise on wildlife is its impact on the singing behaviour of birds (Gil and Brumm, 2013). A study in the forest near Tegel airport in the city of Berlin found that some songbird species started their dawn song earlier than the same species singing in a nearby forest that was less affected by aircraft noise (Dominoni et al., 2016). The authors of the study concluded that the birds in the vicinity of the airport started singing earlier in the morning to gain more time for uninterrupted singing before the aircraft noise set in. In addition, it was found that during the day, chaffinches avoided singing during aircraft take-off when the noise exceeded a certain threshold, 78 dB(A), further suggesting that airport noise can impair acoustic communication in birds. ■

### *11.3.2*
### *Preservation of quiet areas*
▶ *See Table 11.4*

Noise pollution comes from a variety of sources and is widely present not only in the busiest urban environments but also in natural environments. The END recognises the need to preserve areas of good acoustic environmental quality, referred as 'quiet areas', to protect the European soundscape. Quiet areas offer reduced sound levels from traffic and provide a respite from environmental stress and opportunities for rest and relaxation. Apart from the physical and mental health benefits for humans, quiet areas are also important for animals (Box 11.3).

Although the data reported as part of the END currently contain little information on how the countries, regions and cities define and protect quiet areas in their territories, there are indications showing an improvement in the definition and designation of quiet areas in recent years (EC, 2017; Peris et al., 2019). Most countries have criteria in place to define quiet areas, mainly in urban areas. Quiet areas in cities vary in their characteristics, such as noise levels, size of the area and land cover type. However, to date not all of the countries that have a definition of quiet areas in place have designated such areas. Currently, there are at least 15 countries that have designated some quiet areas in their territories (ETC/ATNI, 2019c).

There are currently no data on whether quiet areas in Europe have increased or decreased. However, considering their beneficial health effects, it is important to identify potential quiet areas in places with high population density (Shepherd et al., 2013). A combined spatial assessment of noise exposure, land use and land cover data for areas potentially unaffected by noise pollution in selected cities from the EEA-33 shows a mixed picture (ETC/ATNI, 2019c). While some cities, such as Aalborg, Aarhus,

Quiet areas protect wildlife and human health but their designation and protection are still under development in Europe.

Cork, Dublin, Hamburg, Lausanne, Munich and Zurich experienced a significant increase in areas considered to be potentially 'quiet', others, such as Vilnius, Valletta, Prague, Copenhagen, Cologne or Dusseldorf, experienced a loss of quiet areas (Figure 11.5). The increase in quiet areas was mainly in residential areas while the loss was due to a decrease in green and 'blue' space. Although the reason for these results is not known, local noise action plans, nature conservation plans and measures related to urban planning can have an effect on gains or losses of quiet areas in urban settings. However, a change in the modelling methodologies used for traffic could also lead to changes that are not strictly related to an increase or decrease in noise.

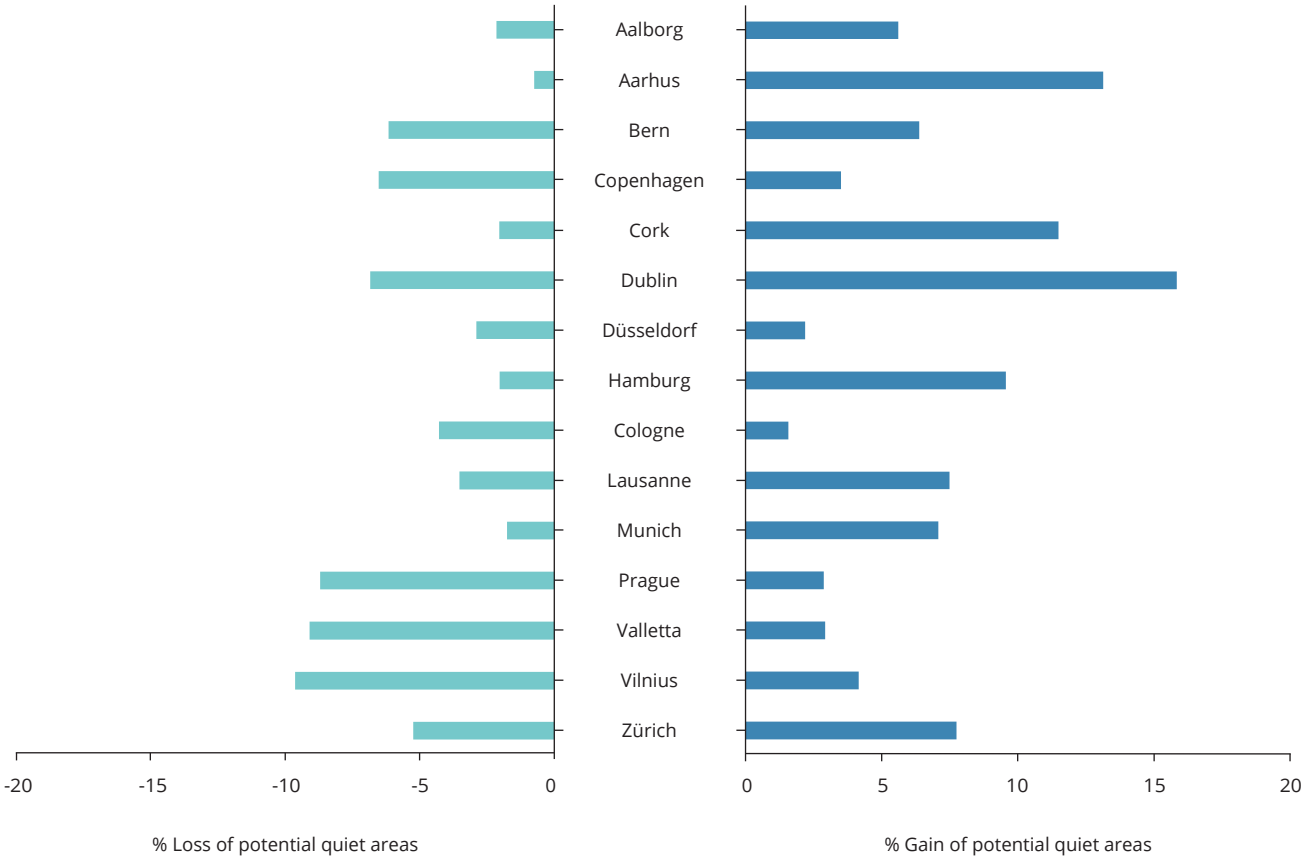
## 11.4
## Responses and prospects of meeting agreed targets and objectives

### *11.4.1*
### *Assessment of policies, and prospects for reaching policy targets and objectives*

#### *Population exposure to environmental noise and impact on human health*

Despite the substantial progress since the END introduced data mapping and development of noise action plans, the Directive remains not fully implemented. For example, noise exposure data from the 2012 and 2017 rounds of noise

**FIGURE 11.5 Change in quiet areas between 2012 and 2017 in selected cities**




**Note:** The city selection was based on the availability of noise data for 2012 and 2017 for all sources. There may be comparability issues between cities due to a lack of a common assessment method.

**Source:** ETC/ATNI (2019c).

**TABLE 11.4 Summary assessment — preservation of quiet areas**

| | | |
|---|---|---|
| **Past trends and outlook** | | |
| Past trends (10-15 years) | | Progress has been made in developing definitions of quiet areas as well as in defining selection criteria for designating them. However, the designation and protection of quiet areas is underdeveloped. There is variability between cities in terms of gains and losses of potentially quiet areas. |
| Outlook to 2030 | | Further progress is expected as current legislation, which obliges countries to protect areas of good acoustic quality, is likely to increase the number of action plans designated to protect quiet areas. |
| **Prospects of meeting policy objectives/targets** | | |
| 2020 | ☒ | The designation and protection of quiet areas in Europe is still under development. There is not a complete designation of quiet areas in countries, and areas identified as quiet are not always protected through action plans. |
| **Robustness** | | This assessment is based on both data reported by EEA member countries, using a questionnaire on the status of the definition, designation and protection of quiet areas, and on an analysis of land cover data and noise data in urban areas in selected cities for which data are available. |

mapping are still incomplete, with only approximately 92 % and 66 %, respectively, of the expected data having been reported. In the 2007, 2012 and 2017 rounds of noise mapping, there was no common method for mapping in place. Therefore, countries may have used different assessment methods across the years. These inconsistencies in the quality and quantity of reported data make the noise situation across Europe difficult to assess. However, there are prospects for improvement. The EU has developed a common method for noise mapping (EC, 2019). As a result, it is expected that noise mapping assessments will be harmonised, making it easier to compare data across countries.

A considerable number of people are still exposed to high noise levels. Despite the efforts to achieve a significant reduction in noise pollution, through the implementation of the END and other EU noise-related regulations, the overall number of people exposed to high levels of noise remained rather stable between 2012 and 2017. Therefore, the objective of the 7th EAP — to significantly reduce noise pollution in the EU and move closer to WHO recommended levels by 2020 — will not be achieved. What is more, in the light of projections of urban growth in Europe and an increased demand for transport, an increase in the population exposed to environmental noise is anticipated by 2020. Similarly, the longer term outlook is not encouraging. For example, even if the objectives outlined in the 2011 White Paper, *Roadmap to a single European transport area: towards a competitive and resource efficient transport system*, of halving conventionally fuelled cars in urban areas by 2030 are achieved, the number of people exposed to road noise, the most prevalent source, is set to increase. Likewise, it is likely that noise outside urban areas will increase by 2030, in particular for road and rail traffic, due to an increase in the number of passenger and freight road and rail vehicles. Aviation noise will be stabilised only if the anticipated technology improvements stated in the *European aviation environmental report* (EASA et al., 2016) are met by 2030.

Achieving the 7th EAP objectives of reducing the impacts of noise on people would have required more effective development and implementation of noise action plans in areas of concern. Although action plans in accordance with the END should have been drawn up for the major transport sources and the largest urban areas, there is a large proportion of countries for which such plans are missing (EC, 2019). The 7th EAP states that noise reduction should be achieved by implementing measures to reduce noise at the source, including improvements in urban design (Box 11.4). Data on action plans submitted by countries under the END show that noise reduction at the source (e.g. improving road and rail surfaces, air traffic management, reducing speed limits, retrofitting, managing traffic flows) is an extensively reported mitigation measure for all sources of noise inside and outside urban areas (EEA, 2017). Land use and urban planning, which are linked to city design (e.g. protecting sensitive receivers using street design and providing quiet zones) are also reported for all noise sources but represent a small percentage of the mitigation measures generally chosen to address noise problems. Other less cost-effective mitigation measures employed to manage noise are those related to the path of the noise, such as introducing noise barriers, or those related to the receiver, such as providing home insulation.

The implementation of such action plans by countries has proven to be cost-effective. The fitness check on the implementation of the END concluded that the Directive has not yet achieved its full potential, although estimations show a favourable cost-benefit ratio of 1:29 (EC, 2017). In other words, in cases in which action plans including measures for noise management have been adopted, the benefits have outweighed the costs. However, in the 2017 evaluation of the END, the completeness of action plans was low, with less than 50 % of required action plans completed for the second round of noise mapping in 2012 (EC, 2017).

It is yet to be seen how national and local authorities will respond to the recent introduction of the *Environmental noise guidelines for the European region* (WHO, 2018), which show that levels below 55 dB $L_{den}$ and 50 dB $L_{night}$ are likely to cause health problems. At the moment, noise reporting and delivering action plans to combat noise levels below the aforementioned END thresholds remains voluntary for countries. National and local noise action plans targeted at levels lower than those outlined in the END could potentially lead to reduced environmental noise levels and subsequent benefits for health.

### *Preservation of quiet areas*

There is a need to preserve areas of good acoustic quality, namely quiet or tranquil areas. Noise policy objectives specified in the 7th EAP can only be achieved if measures are taken to reduce exposure to high noise levels, which also implies preserving areas that are currently undisturbed by noise. If areas of good sound quality are neglected or ignored, more people may become exposed to noise. Likewise, the number of potentially restorative spaces, including parks or quiet urban quarters, could also decrease, resulting in a negative impact on well-being.

Regarding the END, action plans that aim to identify and protect quiet areas within the strategic noise mapping process enable competent authorities to control the sound quality within them. However, the END does not provide a clear definition of quiet areas, leaving countries ample opportunity for interpretation. Therefore, practical

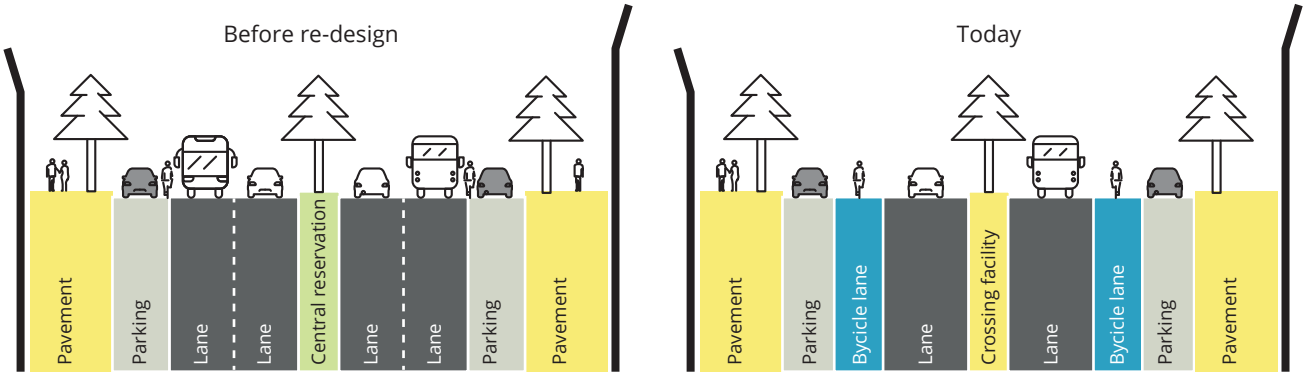
## BOX 11.4 Implementation of noise action plans in Berlin: a success story

The use of the noise maps in accordance with the Environmental Noise Directive (END) helped many cities in Europe detect high noise zones. Berlin, like many other urban areas, is affected by noise pollution, in particular from road traffic.

During the first round of noise mapping in 2007, Berlin found that a considerable number of people were exposed to night-time noise levels considered harmful to health. As a result of these data, and in line with the END, noise action plans were implemented. The mitigation measures consisted of reducing or narrowing the roadway to decrease the traffic levels and concentrate traffic in the middle of the roadway, moving it away from buildings. The traffic area released by this measure provided space for bicycle lanes and pedestrian islands (Figure 11.6). Pilot projects were implemented in four main road sections used by approximately 20 000 motor vehicles per day.

Implementing noise reduction measures by redesigning roadways helped to significantly reduce the number of people exposed to night-time noise levels of 50 dB or higher (Table 11.5). ■

**FIGURE 11.6 Redesign of roadways in Berlin to reduce traffic noise: before and after**




**Source:** Senate Department of Berlin/LK Argus GmbH.

**TABLE 11.5 Night-time noise levels in Berlin, 2007 and 2012**

| Number of people | $L_{night}$ dB(A) | | | | |
|---|---|---|---|---|---|
| | >50-55 | >55-60 | >60-65 | >65-70 | >70 |
| 2007 | 183 000 | 146 000 | 135 300 | 56 300 | 1 400 |
| 2012 | 168 200 | 150 100 | 121 600 | 24 300 | 300 |

guidance in this area needs to be further developed (EC, 2017) to allow countries to fully integrate the protection of quiet areas into their action plans. Countries have indicated that this is an area under development, and so an increase in measures to protect quiet areas may be expected in the future (ETC/ATNI, 2019c). Areas of good acoustic quality can be preserved by implementing measures similar to those used to reduce noise. Moreover, given that a quiet area can also be one with a pleasant soundscape, in cities quiet areas could also be protected by enhancing positive sounds such as those from natural features (Matsinos et al., 2017) (Chapter 17).