

## Transport noise and public health



### Editorial

Road, rail and air traffic: there are many noise sources, particularly in the densely urbanised Paris metropolitan area.

Numerous scientific studies have shown that exposure to environmental noise is associated with non-auditory effects, primarily sleep disturbance, annoyance, cardiovascular diseases and learning difficulties.

However, despite increasingly advanced knowledge, noise and its associated effects are still insufficiently taken into account by both authorities and the general public.

In order to guide public action in this area, Bruitparif, in association with the Regional Health Observatory in Île-de-France (ORS ÎdF), has, for the first time at this scale, quantified the health impact of transport noise for the population of the Paris metropolitan area.

To do this, teams used population noise exposure data from the strategic noise maps produced for the implementation of the first deadline of European directive 2002/49/EC and applied the DALY (Disability-adjusted life-years) quantification method proposed by the World Health Organization (WHO). This method assesses the burden of disease through the 'healthy life years lost' indicator.

This issue of Francilophone is devoted to presenting the extremely insightful results of this study, which are the outcome of a particularly enriching collaboration between the teams of Bruitparif and ORS Île-de-France.

I hope you enjoy reading this report.

**Julie Nouvion**  
Chairperson



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# Environmental noise, a real public health issue

**Environmental noise is a serious health problem. Noise pollution is the second highest cause of morbidity among environmental risk factors in Europe, behind atmospheric pollution.**

According to the WHO report of March 2011[1], more than one million healthy life years are estimated to be lost every year in Western Europe because of noise caused by transport, making noise the second highest environment-related cause of morbidity, behind air pollution.

The health effects of exposure to environmental noise are mainly what are referred to as "non-auditory" effects as they do

not directly impact hearing (hearing effects are generally due to exposure in the working environment or during recreational activities to noise levels exceeding 85 dB(A), which is considered to be the threshold for risk of hearing loss). Over the last two decades, many publications have established a direct link between exposure to environmental noise and the following health problems:

## Disturbed sleep

One of the main non-auditory effects of noise is disturbed sleep, which may occur when average night-time noise exposure exceeds 40 dB(A). Sleep disturbances can mean taking longer to get to sleep, more fragmented sleep, a reduction in the total duration of sleep, changes to the sleeping pattern with a reduction in deep sleep and REM sleep.

This fragmentation caused by noise results in lower quality sleep, reducing our body's capacity for recovery. Poor quality sleep has a serious impact on everyday life, causing tiredness, loss of attention, and reduced performance, thereby exposing sufferers to a higher risk of road accidents and occupational hazards. According to the WHO report of 2011, 1 in 5 people in Europe sleeps badly because of transport noise.



## Annoyance

According to the WHO's definition, annoyance is "a feeling of inconvenience or displeasure caused by an environmental factor (noise, for example) known or believed by the individual or group to adversely affect their health".



Every individual has their own perception of noise. The level of annoyance they feel is the result of factors related to the noise: noise intensity, noise peaks compared to background noise, the repetitive nature of the noise, and frequency, as well as other factors related to the context and individual: the time of day, whether the individual chooses to hear the noise or it is inflicted on them, the positive or negative image that the person has of the noise source, personal history and socio-cultural habits, age, etc. According to the report published by WHO in 2011, 1 in 3 people in Europe claim to be annoyed by transport noise.

## Cardiovascular risks

Noise nuisances can cause non-specific physiological stress reactions and lead to cardiovascular problems in the case of chronic noise exposure. Stress can provoke the production of certain hormones (adrenalin, catecholamine, cortisol, etc.) that can have side-effects like high blood pressure. Over an extended period of time, these effects can, in turn, increase the risk of cardiovascular disease.



[1] Burden of disease from environmental noise - Quantification of healthy life years lost in Europe, WHO 2011

## Learning difficulties

Children exposed to noise can have difficulty concentrating and suffer from impaired cognitive functions, causing learning difficulties and behavioural problems.



## Tinnitus

Tinnitus is a subjective noise, heard "in the ear" or "in the head," without any outside sound stimulus. It can be the symptom of a pathology of the hearing system or the aftermath of a traumatic accident. However, tinnitus very often appears simultaneously with hearing loss. Hearing loss can occur for noise exposure at 8-hour equivalent continuous levels (LAeq 8h) of above 75 dB(A), or LAeq 24h levels above 70 dB(A). Environmental noise which is loud and constant, such as in some cases of road noise exposure can therefore have a significant impact on the potential incidence of tinnitus. Due to the limited number of available studies, the relative fraction of tinnitus related to environmental noise has been estimated at 3%, by an expert consensus.



## Focus on sleep

Noise nuisances are truly detrimental for sleep and therefore for our health. Noise is indeed today considered as the most important environmental factor affecting sleep. It decreases the quality of sleep (fragmenting and shortening certain sleep phases) making it less restful than it should be, which results in fatigue, decreased alertness, lower performance at work or learning difficulties. In the long term, poor quality sleep makes us more irritable or bad-tempered. There is also an increased risk of cardiovascular and metabolic diseases.

In France, 52% of people are disturbed by noise when trying to go to sleep and 60% consider it to be the prime cause of nocturnal awakenings (INSV-MGEN survey, 2013). Both during the week and at weekends, 31% of people are disturbed by noise when sleeping and 76% of this group say they are disturbed throughout the whole night. In the vast majority of cases (92%), the most disturbing noises come from outside the home. Transport noise (61%), especially from cars, is the most commonly cited source, followed by noise from neighbours and aircraft.

It is important to be aware that the body does not become accustomed to noise. There is always a biological reaction and the quality of sleep deteriorates. As we all know, ears do not have «ear-lids»!

Even during deep sleep, the ear continues to hear; the brain constantly analyses the nature of perceived noises and the body reacts to the slightest sound, be it consciously or unconsciously. Noise can cause a person to consciously wake up, depending on their sensitivity and the type of noise. Mothers are awoken by even the softest cry of a baby, for example. Unconsciously, sounds awaken the brain for a few seconds (micro-awakenings) and jog the neurovegetative system. Unknowingly to us, this triggers the production of adrenaline, noradrenaline and cortisol. At cardiovascular level, the heart rate accelerates and blood pressure increases slightly. And with this, the quality of our sleep suffers.

### The impact of noise varies according to the phase of sleep:

- **During light sleep**, even a slight auditory input provokes an unconscious micro-awakening and can even cause a conscious awakening. The time it takes to fall back to sleep varies depending on the person and their sleep environment. In the worst case, the individual is not able to fall asleep again after being awoken in the early hours of the morning and the night is significantly shortened.
- **During deep sleep**, it takes a louder noise to awaken us. However, even when we do not wake up, noise interferes with our sleep

pattern, resulting in a return to light sleep or a micro-awakening.

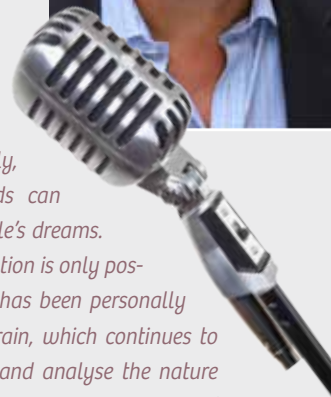
- **During REM sleep** (which is typically when we dream), the noise levels required to wake sleepers vary greatly, especially as sounds can become part of people's dreams. However, this integration is only possible once the noise has been personally interpreted by the brain, which continues to process information and analyse the nature and origin of the sounds it hears. The call of a sick child is thus quickly distinguished from the habitual drone of traffic.

Whether a noise fully awakes us, unconsciously awakes us (micro-awakening) or sends us into light sleep, it reduces the duration of the most restful phase.

It is therefore crucial that all stakeholders, authorities, and the public take action to reduce night-time noise pollution. We must respect the body's natural curfew to preserve our own and other people's sleep.

## The opinion of Professor Damien Leger

*APHP, Sleep and Alertness Centre at Hôtel-Dieu Hospital, Paris, Honorary member of the French National Institute of Sleep and Alertness (INSV)*



# Quantification method

The WHO relied on a corpus of epidemiological studies conducted by various research teams to assess the health risks of environmental noise and suggest a method[1] to quantify the health impact of the different environmental noise sources through an estimation of the number of disability-adjusted life-years (or healthy life years lost).

This estimation, which has been carried out for the scientifically recognised health impacts of noise, can be broken down into three steps:

## STEP 1

### Estimation of exposure to noise

This step is performed using population noise exposure data classed into noise-level categories with a 5 dB(A) range, as presented in the strategic noise maps for the Lden indicators (Level day-evening-night) and Ln (Level night) indicators for each of the main sources of transport noise: road traffic, rail traffic and air traffic[2]. The Lden indicator (Level day-evening-night) represents the weighted average noise level over a 24-hour period divided as follows: day: 12 hours, evening: 4 hours, night: 8 hours.

## STEP 2

### Estimation of the number of cases attributable to each health effect and each noise source

For sleep disturbance and annoyance, the exposure-response relationships obtained from epidemiological studies and given as guidelines by WHO, give an estimate of the percentage of people affected according to the distribution of exposure within the population to each transport noise source.

For myocardial heart attacks, the relationship indicates a relative risk.

For tinnitus, there is no exposure-risk relationship. However, an estimation of the overall fraction attributable to environmental noise is suggested.

## STEP 3

### Estimation of the burden of noise

The overall burden of disease from noise can be expressed with the indicator DALY (disability-adjusted life-years), which is equivalent to the years of potential life lost due to premature death and healthy years lost due to disability.

The notion of disability expresses a more or less significant deterioration of the health state, quantified by the disability weight (DW). For each health outcome, the DW can vary from 0 (non-deteriorated health state) to 1 (death). It usually comes from expert opinions gathered by WHO.

For a given calendar year, DALYs represent the number of healthy life years lost by a population in a given area. They are the sum of years of life lost (YLL) due to premature death and healthy years lost due to disability or disease (YLD). Premature death only applies to heart attacks.

### Formula for calculating disability-adjusted life-years (healthy years lost)

$$DALY = YLD + YLL$$

$$YLD = I * DW * D$$

$$YLL = (\sum N * L) * PAF$$

Where "I" is the number of cases attributable to noise within the population (for each health outcome considered), DW is the disability weight determined for the health outcome and D an average duration of disability expressed in years. For the calculations, the duration was considered equal to 1 as the assessment was over one calendar year.

Where "N" is the number of deaths for each age group distinguished by sex, L is the life expectancy at the time of death, and PAF (population attributable fraction), the fraction of deaths that occur after a myocardial infarction attributable to noise.

[1] - Burden of disease from environmental noise - Quantification of healthy life years lost in Europe, WHO 2011  
- T. Hellmuth, T. Classen, R. Kim, S. Kephelopoulou, 'Methodological guidance for estimating the burden of disease from environmental noise', WHO Regional Office for Europe (2012).

[2] The Lden indicator (Level day-evening-night) represents the weighted average noise level over a 24-hour period divided as follows: day: 12 hours, evening: 4 hours, night: 8 hours. The average levels for evening and night have 5 dB(A) and 10 dB(A) penalties added to them respectively, to reflect people's extra sensitivity to noise during these periods.



# Exposure to different types of transport noise

Bruitparif has aggregated the noise maps published by the 209 municipalities or federations of municipalities involved in implementing the 2002/49/EC directive for the Paris metropolitan area[1]. Using this initial consolidation completed in 2014[2], it has been possible to quantify noise exposure problems. 22% of the population of the Paris metropolitan area, i.e. 2.2 million people, are potentially exposed to noise levels in front of their homes that exceed the regulatory thresholds.



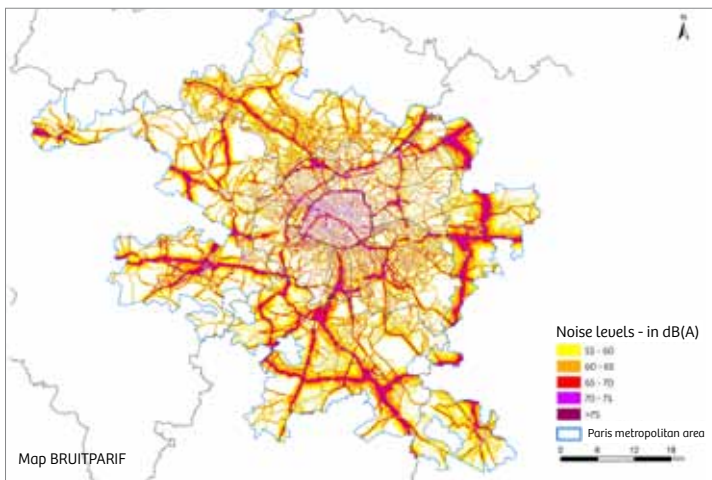
## Exposure to road noise

Road traffic is the main source of noise pollution in the outdoor environment in the Paris metropolitan area.

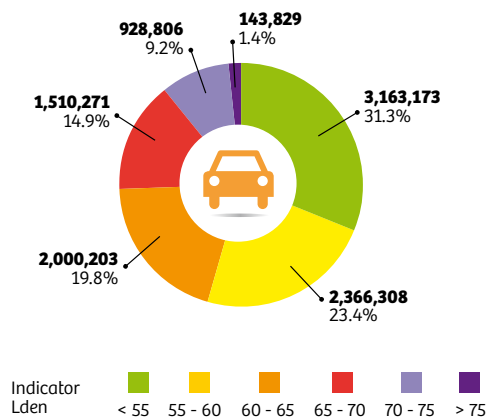
- 25.5% of inhabitants of the Paris metropolitan area are subjected to noise pollution from road noise of  $\geq 65$  dB(A) according to the day-night indicator Lden (Level day-evening-night).
- 28.1% are exposed to levels of  $\geq 55$  dB(A) during the night.
- In total, 17.1% of the population of the Paris metropolitan area, i.e. 1,724,422 people, are potentially exposed to levels exceeding the regulatory threshold of 68 dB(A) Lden (see box, page 6) and 8.5%, i.e. 862,701 people, are exposed to levels exceeding the 62 dB(A) threshold at night.



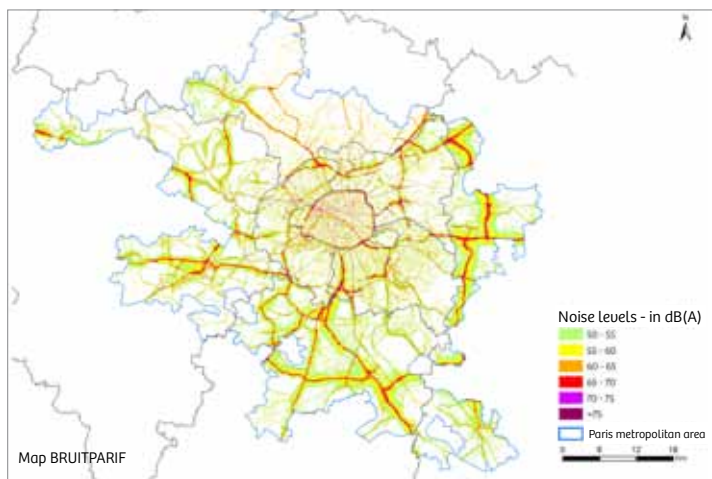
### Lden Indicator



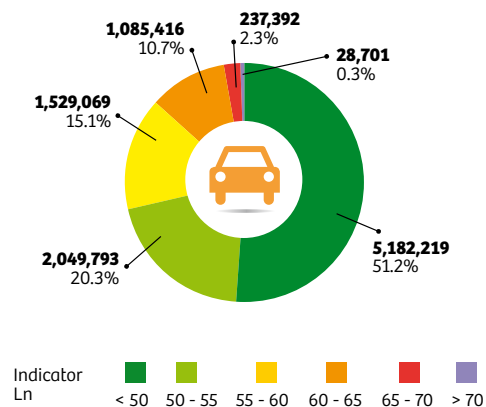
Population exposed in number and in %



### Ln Indicator



Population exposed in number and in %



[1] For this study, the Paris metropolitan area was considered to be the urban unit of Paris as defined by INSEE in 1999. This unit includes 396 municipalities forming a continuously built-up area (no break of more than 200 metres between two constructions)

[2] Assessment of the aggregation of the first strategic noise maps in Île-de-France, Bruitparif, June 2015





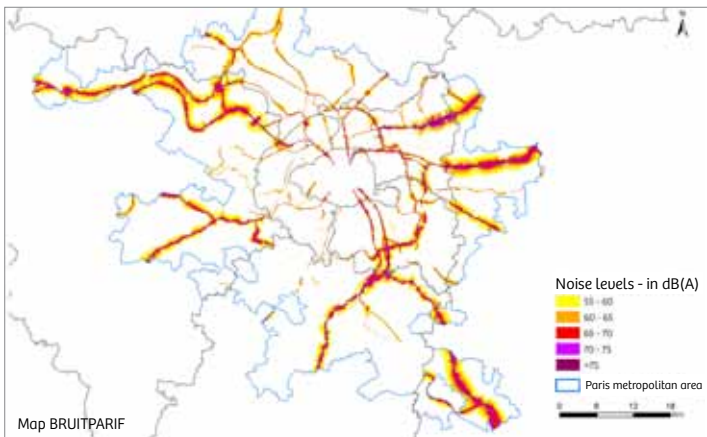
## Exposure to rail noise

For rail traffic:

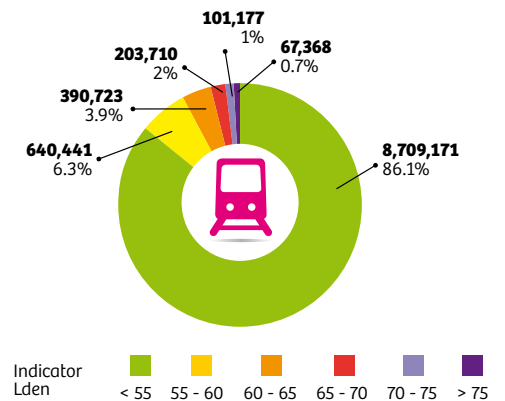
- 3.7% of people living in the Paris metropolitan area are potentially exposed to rail noise of  $\geq 65$  dB(A) according to the Lden day-night indicator.
- 5.6% are exposed to levels of  $\geq 55$  dB(A) during the night.
- 1% of the population, i.e. 100,467 people, are exposed to levels exceeding the 73 dB(A) Lden regulatory threshold (see box below) and 1.1%, i.e. 114,378 people, are above the 65 dB(A) threshold at night according to the Ln indicator.



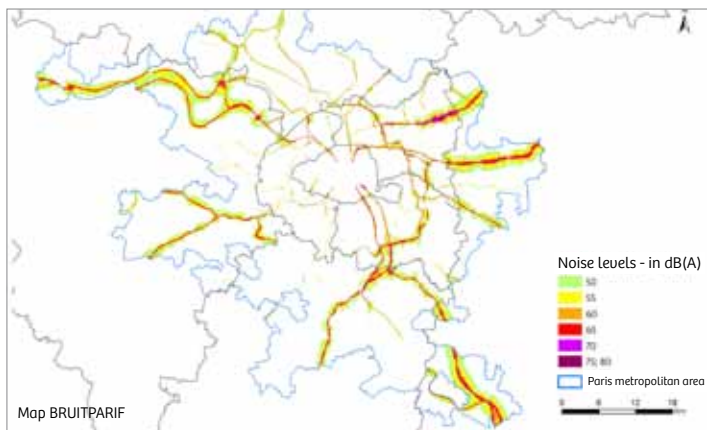
### Lden Indicator



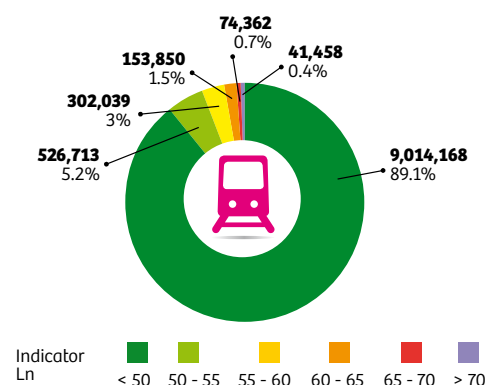
Population exposed in number and in %



### Ln Indicator



Population exposed in number and in %



### Threshold values in the sense of the EU directive

Threshold or values are defined in the European directive 2002/49/EC as "a value of Lden or Lnight, and where appropriate Lday and Levening, as determined by the Member State, the exceeding of which causes competent authorities to consider or enforce mitigation measures; limit values may be different for different types of noise (road-, rail-, air-traffic noise, industrial noise, etc.), different surroundings and different noise sensitiveness of the populations; they may also be different for existing situations and for new situations (where there is a change in the situation regarding the noise source or the use of the surrounding)".

The threshold values set by France under the European directive are outlined in the decrees of 24 March 2006 and 4 April 2006,

relating to the development of noise maps and environmental noise prevention plans.

For transport noise, they are as follows:

Limit values in dB (A)

Noise indicators	Car	Train	Airplane
Lden	68	73	55
Ln	62	65	No limit value

Source: Decree of 4 April 2006 relating to the development of noise maps and environmental noise prevention plans



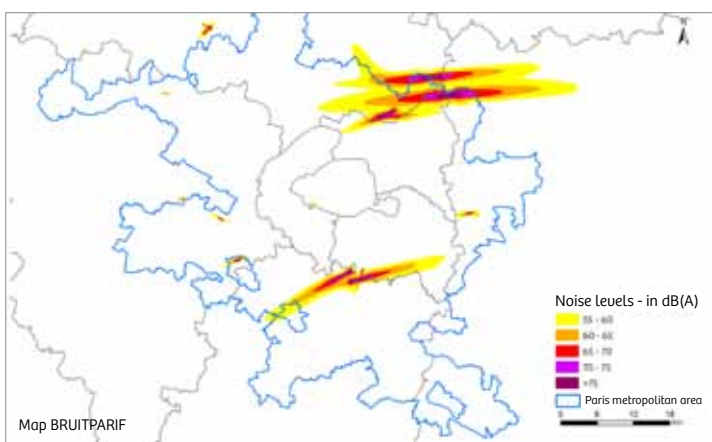


## Exposure to air traffic noise

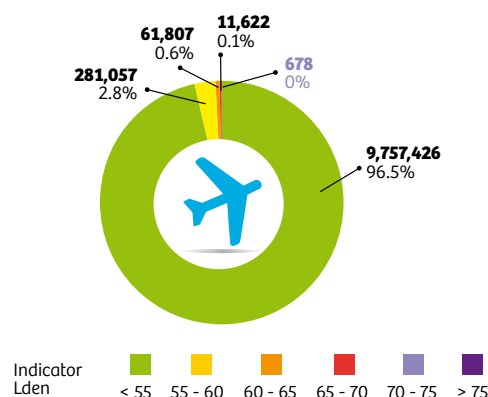
According to the first air traffic noise maps produced under the directive[1], 354,588 people, or 3.5% of the population, are exposed to noise levels from outside the home that exceed the Lden regulatory threshold (see box, page 6) of  $\geq 55$  dB(A). In Île-de-France, the figure is 382,251 people, i.e. 3.3% of the population. These figures were reassessed in updating the noise pollution maps of the Paris-Orly and Paris-CDG airports in 2013, and in producing Paris-Le Bourget's map in 2011. Today 420,000[2] Île-de-France inhabitants live inside areas identified by noise pollution maps and in which noise levels exceed the Lden regulatory threshold of 55 dB(A).



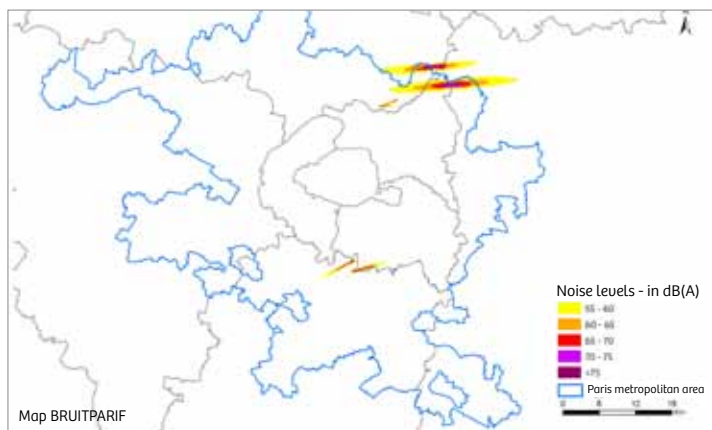
### Lden Indicator



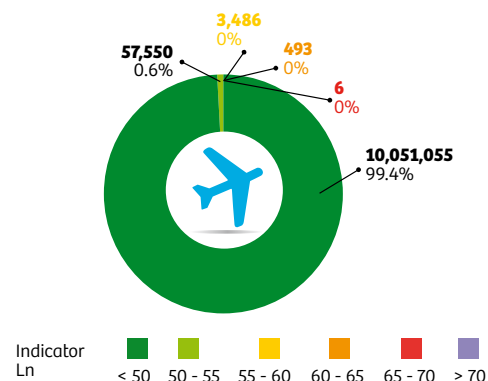
Population exposed in number and in %



### Ln Indicator



Population exposed in number and in %



### Limitation of energy-based indicators for estimating noise levels showing an event aspect

While energy-based indicators such as Lden and Ln are well-suited for continuous noise sources such as road traffic noise, they are not sufficient, when used on their own, to assess the exposure of the population to noise sources with noise peaks, such as air or rail traffic.

In the case of air traffic noise in particular, only considering these indicators in the WHO's DALYs quantification method is likely to mini-

mise the area considered to be affected by air traffic noise as well as the impacts estimated for resident populations. By taking into account the areas with overflights below 1,000 metres in at least one configuration (easterly or westerly wind) or below 2,000 metres all the time, the number of Île-de-France inhabitants potentially impacted by air traffic noise pollution had been assessed by Bruitparif for the SURVOL study[3] at more than 1.7 million people.

[1] Air traffic noise maps were produced at the scale of the Île-de-France region. Air traffic noise exposure data is therefore available for the both the Paris metropolitan area and the Île-de-France region.

[2] Estimated number of inhabitants in Île-de-France concerned by noise pollution maps: Paris-CDG (256,176 people), Paris-Orly (123,902 people), Paris-Le Bourget (40,123 people).

[3] SURVOL Study (Health and Environmental Monitoring of the Paris-CDG, Paris-Orly and Paris-Le Bourget airports) - Noise component, Progress report, Bruitparif, January 2011.



# Health impacts of transport noise

By using the data available at municipal level (for both noise exposure and health outcomes), Bruitparif's teams have obtained a first minimum estimation of the health impacts of environmental noise related to transport within the Paris metropolitan area. Key results are presented below:

## Sleep disturbance

The number of people likely to have highly disturbed sleep (%HSD) according to their night-time exposure to transport noise can be estimated using the curves below based on the work of Miedema *et al.*[1].

In the Paris metropolitan area, 630,953 people, i.e. 6.2% of the population are likely to have highly disturbed sleep (557,519 due to road noise, 65,178 due to rail noise and 8,156 due to air traffic noise).

Given that the disability weight recommended by WHO for sleep disturbance is 0.07, the number of healthy life years lost, or disability-adjusted life-years, due to sleep disturbance caused by environmental transport noise in the Paris metropolitan area is 44,166 per year (39,033 due to road noise, 4,562 due to rail noise and 571 due to air traffic noise).

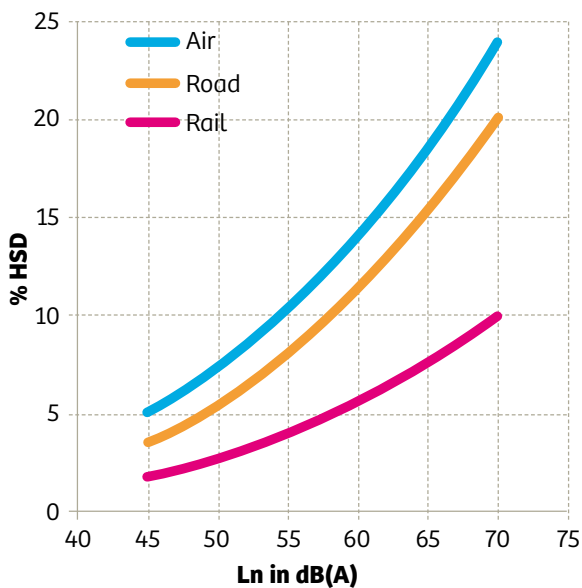
## Annoyance

The number of persons likely to be highly annoyed (%HA) according to their exposure to transport noise assessed with the Lden indicator can be estimated from the curves below published by the European Commission[2].

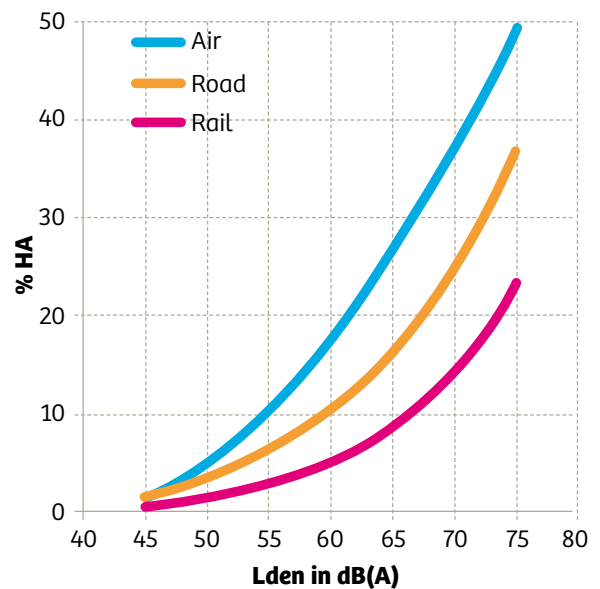
In the Paris metropolitan area, 1.5 million people, i.e. 14.8% of the population are likely to be highly annoyed (1,168,322 due to road noise, 106,519 due to rail noise and 225,157 due to air traffic noise).

Given that the disability weight recommended by WHO for sleep disturbance is 0.02, the number of healthy life years lost, or disability-adjusted life-years (DALYs), due to annoyance caused by transport noise is 30,000 per year within the Paris metropolitan area (23,366 due to road noise, 2,130 due to rail noise and 4,503 due to air traffic noise).

Percentage of highly disturbed in their sleep people according to their level of night noise exposure



Percentage of highly annoyed people according to their level of daily noise exposure



[1] Miedema HME, Passchier-Vermeer W, Vos H. Elements for a position paper on night-time transportation noise and sleep disturbance. Delft, TNO, 2003 (Inro Report 2002-59).

[2] European Commission, Position paper on dose response relationships between transportation noise and annoyance, Luxembourg, Office for Official Publications of the European Communities, 2002 ([http://ec.europa.eu/environment/noise/pdf/noise\\_expert\\_network.pdf](http://ec.europa.eu/environment/noise/pdf/noise_expert_network.pdf)).





## Myocardial infarction

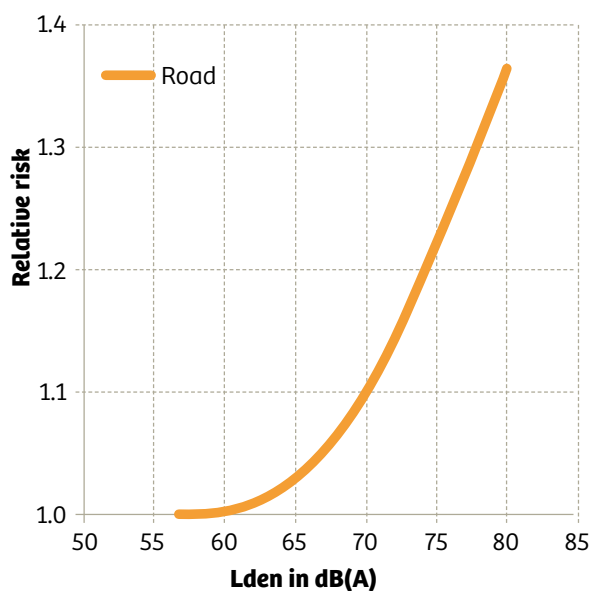
Epidemiological studies carried out during recent years show evidence that road traffic noise increases the risk of myocardial infarction.

For the moment, there is less evidence of this for aircraft noise. Very few studies have been conducted on the cardiovascular effects of other environmental noise sources, such as rail traffic. The exposure-response relationship proposed by WHO for road noise and the incidence [1] of heart attacks indicates a relative risk.

For each municipality of the Paris metropolitan area, deaths from myocardial infarction due to noise were calculated from the number of incident cases of myocardial infarction, the relative risk of myocardial infarction due to exposure to road noise and the population distribution in the various Lden noise-level categories.

Based on the data gathered or estimated for 2008 (6,120 cases of non-fatal myocardial infarction and 1,767 deaths from myocardial infarction within the Paris metropolitan area), the DALY calculation for myocardial infarction due to exposure to road noise gives a result of 755 healthy life years lost (686 due to disabilities resulting from non-fatal myocardial heart attacks and 69 due to premature death).

Relation between road traffic noise exposure and relative risk of incidence of myocardial infarction



## Learning difficulties

The noise exposure data available for the Paris metropolitan area does not allow us to calculate the burden of noise in morbidity or learning difficulties. This would require knowledge of noise exposure patterns for children of 9 to 17 years of age, for which data is currently unavailable.

## Tinnitus

Due to a lack of accurate prevalence data for tinnitus, European figures found in the works of Davis[2] and Hannaford[3] were used. This data relates to the European population aged 15 and over and is presented according to three disease stages:

- **P1:** 3.4% of this population suffer slight or early-stage tinnitus
- **P2:** 1.2% of this population suffer moderate-stage tinnitus
- **P3:** 0.4% of this population suffer severe-stage tinnitus

In a population with 8.18 million people aged 15 and over, it can be estimated that 408,921 people suffer from tinnitus in the Paris metropolitan area (278,066 at the early stage, 98,141 at the moderate stage and 32,714 at the severe stage). This gives a DALY result of 515 healthy years lost due to tinnitus caused by environmental transport noise (the disability weights applied are 0.01 for slight tinnitus and 0.11 for the moderate and severe stages; the attributable fraction of tinnitus caused by exposure to environmental transport noise is 3%).



Modeling of the noise in frontage of the buildings



[1] Incidence is the number of new cases of a pathology observed within a population for a given time period.

[2] Davis A. Hearing in adults, The prevalence and distribution of hearing impairment and reported hearing disability in the MRC Institute of Hearing Research's National Study of Hearing, Nottingham, MRC Institute of Hearing Research, 1995.

[3] Hannaford PC et al, The prevalence of ear, nose and throat problems in the community: results from a national cross-sectional survey in Scotland. Family Practice, 2005, 22: 227-233.



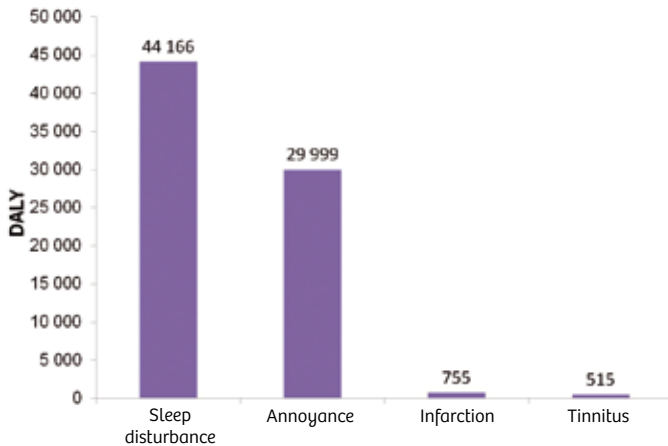
## Summary for the Paris metropolitan area

In total, approximately 75,000 healthy life years are estimated to be lost every year in the Paris metropolitan area due to environmental transport noise.

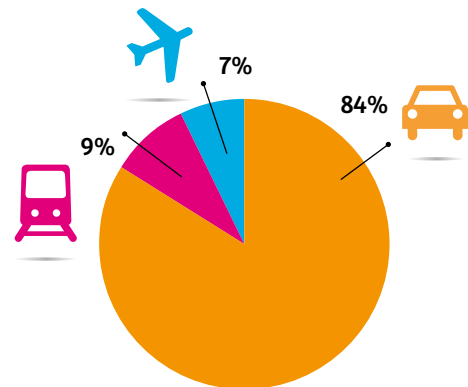
The primary health outcome is sleep disturbance, which on its own accounts for more than 44,000 healthy life years lost or 59% of total DALYs. Annoyance is the second most important health outcome with nearly 30,000 healthy life years lost per year. The remaining DALYs are due to heart attacks or tinnitus.

Road noise generates 63,000 DALYs and is thus responsible for 84% of health outcomes, although the method used tends to minimise DALYs resulting from air traffic noise. Sleep disturbance caused by road noise accounts for nearly 52% of the healthy life years lost in the Paris metropolitan area.

Morbidity of transport noise for each studied health outcome



Contribution of the different modes of transport in noise related morbidity



Source	Sleep disturbance	Annoyance	Infarction	Tinnitus	Total
Road	39,033	23,366	755		63,669
Rail	4,562	2,130	Non évalué	515	6,692
Air	571	4,503	Non évalué		5,074
<b>Total</b>	<b>44,166</b>	<b>29,999</b>	<b>755</b>	<b>515</b>	<b>75,435</b>

### Uncertainty factors

Every step of this method of assessing the health impact has its uncertainties. However, the choices made have been systematically guided by the will to minimise the health impact. Some of the key uncertainty factors are presented below:

● **Uncertainty related to noise exposure data**

The estimations for healthy life years lost due to noise are based on data from the first noise maps produced under European directive 2002/49/EC. The quality of this data varies from one municipality to another. To minimise this variability factor, results are expressed at the scale of the metropolitan area in order to average out any estimation errors. By taking account of a potential uncertainty of +/- 3 dB (A) in the exposure levels (which doubles or halves the sound energy) healthy life years lost can be estimated as varying between 58,000 and 97,000 DALYs per year in the Paris metropolitan area. According to legislation, noise maps must be updated every five years and the next deadline for this is June 2017. This update will be carried out as part of the regional noise mapping project being led by Bruitparif and new DALY assessments may be produced based on more representative exposure data once updating is complete.

● **Uncertainty related to choice of disability weights**

The choice of disability weight has a strong influence on the results. This is why, considering the importance of this criterion and the difficulty in reaching an expert consensus for the choice of these values, especially regarding the subjectivity of some outcomes such as annoyance or sleep disturbance, calculations have been done for several DW values and results have been presented for disability weights that give "conservative" estimates, that is to say guided by the will to underestimate the impact on disease.

● **Air pollution, a factor of confusion in the assessment of cardiovascular risks**

Individuals exposed to road noise are usually also exposed to air pollutants. For cardiovascular pathologies, epidemiological studies also show a relationship between this outcome and air pollution. The question remains whether concurrent exposure to noise and air pollution have independent, additive or synergistic effects. Indeed, few epidemiological studies have focused on this question. However, the specific effects of noise have been demonstrated in the case of cardiovascular disease with people working in environments exposed exclusively to noise.

## Lifetime extrapolation of data

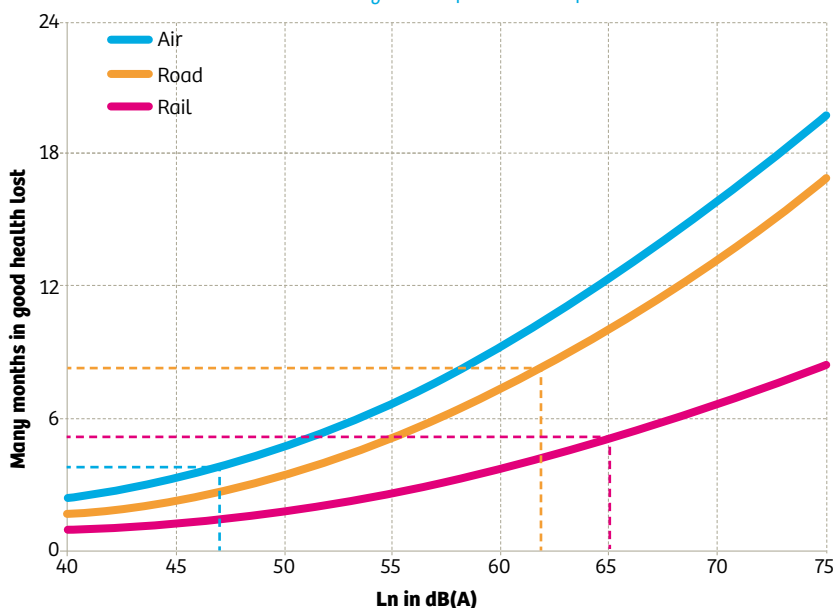
By dividing the annual DALY figure of 75,000 by the population of the metropolitan area (just over 10 million inhabitants) and taking into account an average life expectancy of 81.65 years, it is possible to estimate the total healthy period of life statistically lost because of environmental transport noise for the average person living all of their life in the Paris metropolitan area. The result of this calculation is: 7.29 months.

This figure is of course only an average and results calculated for individuals may vary between 0 and approximately 2 years

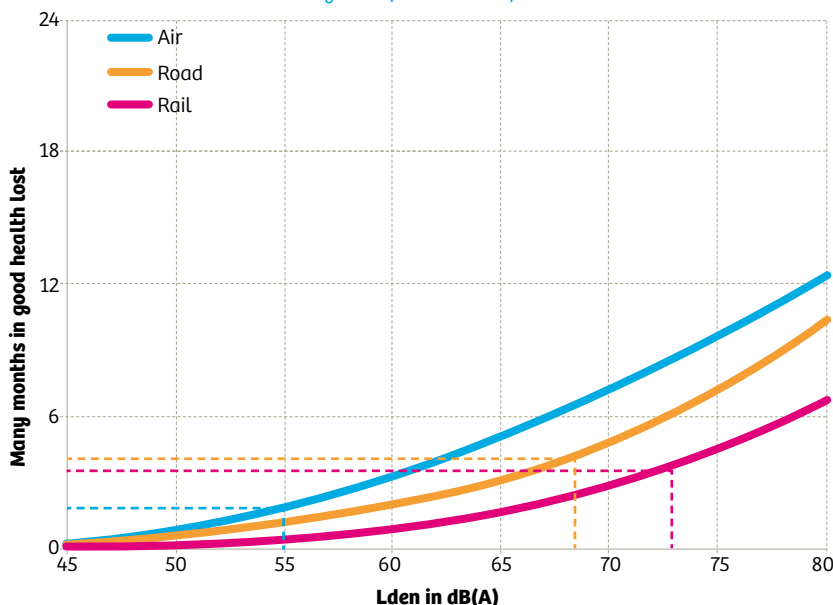
depending on the total exposure to transport noise and each individual's sensitivity to noise.

The charts below concern sleep disturbance and annoyance - the two main health outcomes of noise - and show the total healthy period of life statistically lost due to noise for the average individual over their entire lifetime according to their exposure to transport noise. Estimations are based on chronic transport noise exposure at constant levels throughout a person's lifetime.

Healthy life months lost during a whole life because of the sleep disturbance related to the night transport noise exposure



Healthy life months lost during a whole life because of annoyance related to the daily transport noise exposure



### Interpreting the figures - Examples



#### Example 1 /

For the average individual exposed throughout their entire life to road noise levels close to the regulatory thresholds,

i.e.

**Lden 68 dB(A)**  
and **Ln 62 dB(A)**,

the healthy period of life lost to noise is **13 months** (nearly 9 months due to sleep disturbance and 4 months due to annoyance).



#### Example 2 /

For the average individual exposed throughout their entire life to rail noise levels close to the regulatory thresholds,

i.e.

**Lden 73 dB(A)**  
and **Ln 65 dB(A)**,

the healthy period of life lost to noise is **9 months** (5 months due to sleep disturbance and 4 months due to annoyance).



#### Example 3 /

For the average individual exposed throughout their entire life to air traffic noise levels such as those found at the edge of Zone II of the Paris-CDG airport's noise pollution map,

i.e.

**Lden 55 dB(A)**  
and **Ln 47 dB(A)**,

the healthy period of life lost to noise is **6 months** (4 months due to sleep disturbance and 2 months due to annoyance).



# Questions for ...

## ... Nathalie Sénécals, Director, Regional Health Observatory in Île-de-France (ORS ÎdF)



Why did ORS decide to focus on the issue of noise and work with Bruitparif on this study?

Noise is a major source of nuisance in Île-de-France due to the high population density, the density of transportation infrastructure and high activity levels. ORS began focusing on the health impacts of noise exposure for Île-de-France inhabitants

**in 2009, with the publication of an analysis of the perception of noise in Île-de-France from the 2007 Health and Environment Barometer by the French National Institute for Prevention and Health Education (INPES). The results were striking: 71% of Île-de-France inhabitants said they were disturbed by noise when at home and 26% claimed to be disturbed very often or constantly. A quarter of Île-de-France inhabitants also said that they had already felt the effects of noise on their health.**

**The health impacts of noise are now well and truly established thanks to various studies that have been published on the topic at international level. They go beyond the simple disturbance factor. In addition to the effects observed on the auditory system at high volumes, several extra-auditory effects have been**

**identified, in particular, sleep disturbance, cardiovascular disorders and lower learning capacity. Studies have also shown that noise is a factor that reinforces social inequalities as the worst affected populations are also usually the most disadvantaged. In this sense, the fight against noise also fits fully into the fight against social inequalities in health.**

**In order to raise awareness of this major public health issue, we need to have quantified data for towns and cities and we need to disseminate it. This need for objectified and shared data is especially important as the goal is to inform the development of a regional preventive policy for environmental health. This is why the observatories for noise (Bruitparif) and health (ORS) in Île-de-France decided to work together to assess the burden of transport noise on disease within the Paris metropolitan area. To do this, we used the DALYs synthetic method recommended by WHO, which assesses the health damage attributable to various environmental risk factors. With more than 75,000 healthy life years lost every year in the Paris metropolitan area due environmental transport noise, the results of the study confirm the trends highlighted by WHO at European level. Noise pollution is one of the principal causes of morbidity among environmental risk factors in urban areas, behind atmospheric pollution. Furthermore, noise prevention has a beneficial effect on air pollution.**

## ... Fanny Miettlicki, Director, Bruitparif



Where do you plan to go from here with the study?

This study has shown the significance, in terms of public health, of exposure to environmental transport noise within the Paris metropolitan area. **However, there are many aspects which need improving or which are still to be explored to quantify noise problems even more accurately.**

**First, we need to improve the quality of noise exposure data. We are working on this by updating the noise maps as required under European directive 2002/49/EC. Thanks to the considerable efforts made in terms of coordination and technical consistency throughout the Bruitparif-led regional mapping project, updated transport noise maps will be available for the Paris metropolitan area approximately one year from now and for all of the Île-de-France region by the end of 2017.**

**We then need to improve the relevance of the exposure indicators used. Up to now, most epidemiological studies have used energy-based indicators for noise exposure. However, average noise levels are insufficient to assess biological disturbances caused by occasional noisy events, especially during the night. Bruitparif has been helping to promote event-based indicators which focus on noise peaks and - in the context of the European LIFE project - recently developed the Harmonica index, an indicator for the general public**

**which takes into account the two noise components (background noise and noise peaks). In the future, such indicators could be used in epidemiological studies so that, in time, we can improve the quality of exposure-response curves.**

**We will also need, in the future, to focus on other sources of noise exposure in addition transport. For example, festive or recreational activities in public spaces are sources of noise pollution which are increasing or becoming stronger in some districts. Studies could be launched to improve our understanding of the health impact of exposure to such sources of noise.**

**Finally, as regards further investigation, it is important for us to now work on quantifying the economics of the health impacts of noise, as this information is crucial for decision makers. A first tentative estimation of the economic cost of healthy life years lost due to environmental transport noise in the European Union was proposed by WHO in 2013[1]. To convert DALYs into monetary terms, the number of DALYs due to environmental noise are multiplied by the 'economic value of a statistical life year' (VSLY) estimated at €50,000. The economic costs of the burden of disease of environmental noise published by WHO for the European Union exceed €84 billion per year. By applying this method to the Paris metropolitan area, the bill is approximately 3.8 billion euros. Although this figure should be interpreted with caution and regarded as exploratory, it demonstrates the need to invest in noise reduction policies at the source and appropriate management measures.**

[1] F. Georges, M-E. Heroux, K. Fong, 'Public health and economic burden of environmental noise', Internoise 2013, Innsbruck, Austria (2013).