



Review of environmental noise policies and actions in 2017-2020

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ABSTRACT

This report provides a continuation of the review of environmental noise policies and economics in 2014-2016, published in the proceedings for the ICBEN 2017 Congress. The report addresses the international progress on noise mitigation policies and strategies, best practices and guidelines for environmental noise management. It focuses on developments in evidence and policy by international bodies and in selected countries. There is a considerable amount of new relevant documents in many countries on these topics since the last ICBEN Congress in 2017. Much of this progress was made in the European Union, the Russian Federation, the United Kingdom and Switzerland. Developing countries in Latin America, especially Chile, Costa Rica, Mexico, Paraguay, and Perú are increasingly committed to improve environmental noise policies.

INTRODUCTION

Environmental noise has intensified in densely populated urban areas as a result of urbanization and associated growth in population mobility. International organizations, governments and other agencies in developed and developing countries are now taking action to enhance their institutional and technical capabilities to monitor and control noise exposure and implement preventive actions to reduce the risks that environmental noise poses to their citizens. This review provides an update on international progress on noise mitigation policies and strategies, best practices and guidelines for environmental noise management in recent years

INTERNATIONAL BODIES

In 2018 the **World Health Organization** Regional Office for Europe (WHO/Europe) published the Environmental Noise Guidelines for the European Region (ENGER) [1] as a regional update to the WHO Community Noise Guidelines (CNG) published in 1999 [2] and a supplement to the Night-Noise Guidelines for Europe (NNGE) [3]. The main purpose of these new environmental noise guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. Leisure noise in the ENGER refers to noise sources such as at nightclubs, pubs, fitness classes, live sporting events, concerts or live music venues and when listening to loud music through earphones. The guidelines focus on the WHO European Region and provide policy guidance to EU Member States that focus on the most used noise indicators L_{den} (the day-evening-night-

weighted sound pressure level) and/or L_{night} as defined in the Environmental Noise Directive (END). The L_{den} and L_{night} indicators are those generally reported by Member States to the European Union (EU) and are widely used for exposure assessment in health effect studies in the EU and elsewhere.

The evidence on the health outcomes of exposure to environmental noise that emerged since 1999 was systematically reviewed in the ENGER, including: cardiovascular and metabolic effects; hearing impairment; cognitive impairment; quality of life, mental health and wellbeing; sleep disturbance; annoyance; tinnitus and adverse birth outcomes.

The process of developing these guidelines applied a rigorous methodology following the WHO approach of Grading of Recommendations Assessment, Development and Evaluation [4]. The recommended guideline values for transport noise (road, railways, aircraft), leisure noise and wind turbine noise are rated as strong, i.e. adoptable in most situations, or conditional, i.e. performing a policy-making process with substantial debate among all stakeholders.

The 2018 environmental noise guidelines state that the the ENGER “supersede the CNG from 1999”. The document, however, also recommends “that all CNG indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) should remain valid.” It should be noted that both statements are slightly incompatible. In the author’s opinion the new Environmental Noise Guidelines do not supersede the Guidelines for Community Noise, but rather complement them.

Since 2010 the **International Civil Aviation Organization** (ICAO) regularly updates the ICAO Global Environmental Trends by developing a range of scenarios to assess future noise trends [5]. The total contour area and population inside the yearly average day-night level (DNL) of 55 dB contours of 315 airports worldwide are used as noise indicators. The four scenarios are described in Table 1 and their results depicted in Figure 1 [6].

Table 1: Scenarios on aircraft technologies or operational improvements after 2015.

Scenario No.	Technology	Aircraft noise level reduction [EPNdB/a]	Reduction of affected population due to rerouting of aircraft [%]
1	Baseline (BAU)	0	0
2	Low	0.1	2
3	Moderate	0.2	2
4	Advanced	0.3	2

BAU = Business as usual. EPNdB = Effective Perceived Noise measure of human annoyance to aircraft noise

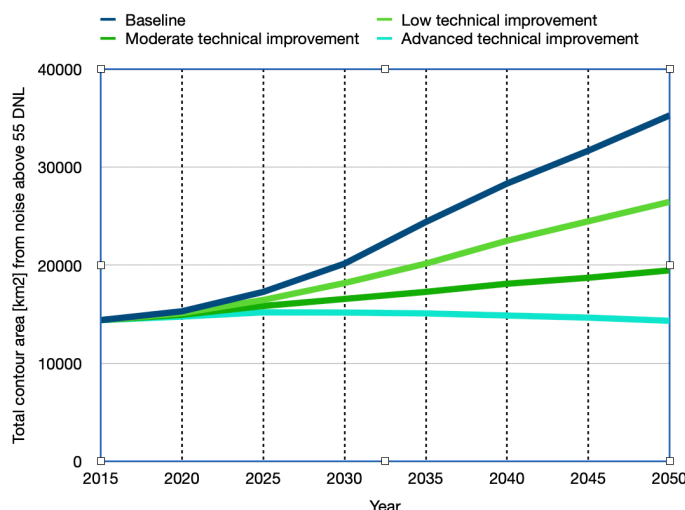


Figure 1: Scenario estimates of 55 dB noise contour areas 2015-2050

In 2015, the total 55 dB DNL noise contour area of Figure 1 was 14,400 km², and the population inside that area was approximately 30 million people. By 2050, the area is estimated to grow by a factor of approximately 2.5, 1.8, and 1.4 times for baseline (BAU), low technical improvement, and moderate technical improvement scenarios, respectively. The advanced aircraft technology scenario has a maximum area at 2025 and decreases to slightly less the 2015 value.

To foster the development of new technologies, ICAO regularly sets technology goals, with the purpose of providing targets for industry research and development, in cooperation with States [7]. The latest set of noise goals, integrated with goals for air quality and carbon dioxide emissions, is detailed in ICAO Doc 10127 [8] and in a paper by Cumpsty et al. [9].

In order to reduce the aircraft industry's environmental footprint while the capacity demand of the flying public is increasing, ICAO strives to mitigate the noise impacts associated with aircraft operations. The tool developed to improve the management of air traffic ('airspace modernization') is called "Performance Based Navigation" (PBN). For the realization of PBN ICAO considers engagement of all aviation stakeholders as a necessary ingredient. In consequence, the ICAO has published two reports on the role of community engagement for aviation environmental management [10] and for PBN [11]. Circular 351 highlights lessons learned and good practices from case studies; The PBN report reviews and assesses States' implementation of PBN action plans, complementing ICAO's Balanced Approach to Aircraft Noise Management.

On 30 March 2017, the **European Commission** published a report on the implementation of Directive 2002/49/EC (END). This report observed [12]:

- The implementation of the Directive is significantly delayed as more than 20% of the required noise maps, and around 50% of the action plans have not yet been reported.
- EU citizens are not always aware of the noise situation and their related health effects.
- Comments given in stakeholder consultations have not necessarily been taken into account in action plans.
- Reasons for the observed implementation delays include lack of priority setting; centralized and consistent input data; effective co-ordination among responsible authorities, and comparability of noise maps among jurisdictions.
- Recommendations for activities to reduce the delay in implementation of the END include among others to reconsider implementation arrangements; to better inform policy options in the area of transport; to have a common approach to avoid, prevent or reduce harmful effects of noise; to implement noise mitigation measures within their action plans; and to raise awareness of all stakeholders on the adverse effects of transportation noise.

On 24/04/2017 the **European Commission** organized the "Noise in Europe Conference" to raise awareness on the adverse impacts of noise from transport on human health [13]. The conference participants recommended among other issues to strengthen stakeholder involvement; broaden the scope of the END beyond transport and industry sources; lower the thresholds for noise mapping, i.e. below 55 dB L_{den} and 50 dB L_{night}, by including currently excluded significant sources of noise; raise public funding for noise reduction measures, covering the full life cycle costs; avoid operating restrictions at airports but considering citizens' requests for undisturbed sleep; and enhance interconnections between noise and urban planning actions.

Directives 2002/49/EC Environmental Noise Directive, (END) and 2000/14/EC (Noise emission by outdoor equipment) have both been amended with respect to adaptation to technical and scientific progress by Regulation (EU) 1219/1243 [14]. In addition, a supporting

study for an evaluation and impact assessment of Directive 2000/14/EC was completed in October 2018 [15].

The **European Environment Agency (EEA)**, in collaboration with the European Union Aviation Safety Agency (EASA) and the European Organisation for the Safety of Air Navigation, published the second European Aviation Environmental Report (EAER) [16]. The EAER provides an updated assessment of the environmental performance of the aviation sector published in the first report of 2016. It found that the number of people inside $L_{den} 55$ dB noise contours at 47 major EU airports increased to 2.58 million people, an increase by 14 per cent and 12 per cent as compared to 2014 and 2005, respectively, while the passenger kilometres flown by commercial flights, departing from member states of the EU28 and the European Free Trade Association increased by 20 per cent and 60 per cent, respectively. Similarly, the average noise energy per flight decreased by 14 per cent compared to 2005 and 1 per cent compared to 2014.

Technological improvements, fleet renewal and increased operational efficiency have been able to partially counterbalance the impact of recent growth, but there has still been an increase in overall noise and emissions since 2014. In 2011, aviation accounted for 3.2 per cent of the total population exposed to $L_{den} > 55$ dB from all sources covered by the END.

The EAER observes that the average noise level of the twin-aisle aircraft category in the European fleet has significantly reduced since 2008 due to the introduction of the Airbus A350 and Boeing 787.

Jet and heavy 4 propeller-driven aircraft must comply with noise certification requirements and the associated noise limits prescribed in ICAO Annex 16 Volume 1 Chapters 2, 3, 4, and 14. In order to demonstrate the influence of the various noise limits, the EAER has estimated for four hypothetical 75-metric ton jet aircraft the noise contour areas in which people are exposed to noise levels greater than 80 dB during one landing and take-off. The contours illustrated in Figure 2 show the reduction over time from the first Chapter 2 limit applicable before 1977 to the latest Chapter 14 limit applicable in 2018.

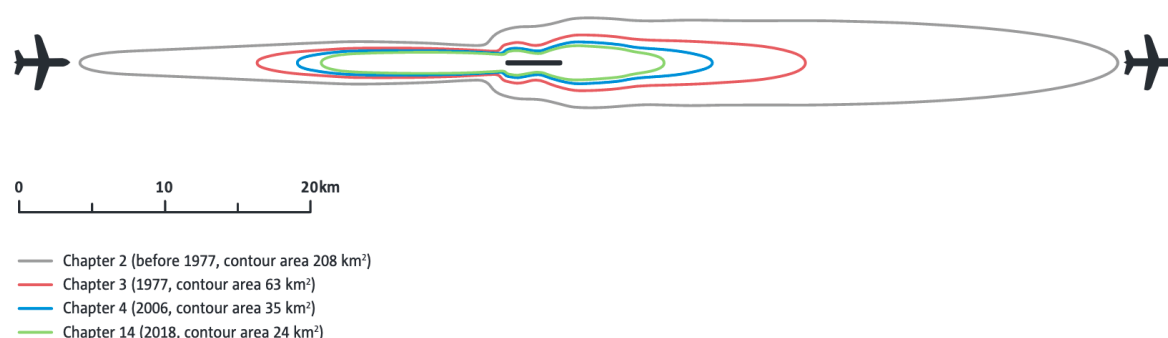


Figure 2: Single landing and take-off 80 dB noise contours for four hypothetical aircraft that just meet the noise limits of the various ICAO Annex 16 Volume I Chapters

Source: [16]

The latest database under the END on noise exposure information (number of people exposed to each of the noise sources inside and outside urban areas to 5 dB bands $L_{den} \geq 55$ to >75 dBA and $L_{night} \geq 50$ to >70 dBA) published by the **EEA** covers member country data

until 1 January 2019 [17]. Correspondingly, EEA's Noise fact sheets exist for 21 EU Member States and 3 non-EU countries: Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Spain, Sweden, Switzerland, United Kingdom [18].

In 2017 the EEA published an overview report on environmental noise management in Europe, This report and its briefing were last modified in 2020 [19;20;21]. Its key messages include:

- An estimated 113 million people are affected by long-term $L_{den} \geq 55$ dBA traffic noise. In most European countries, more than 50 per cent of inhabitants within urban areas are exposed to road noise levels of $L_{den} \geq 55$ dBA, numbers that are likely increase in future because of future urban growth and increased demand for mobility.
- On the basis of the ENGER, the EEA estimates that such exposure causes 12,000 premature deaths and contributes to 48,000 new cases of ischaemic heart disease per year across Europe. It is also estimated that 22 million people suffer long-term high annoyance and 6.5 million people suffer long-term high sleep disturbance.
- Policy objectives on environmental noise have not yet been achieved;
- More progress is needed on the designation and protection of 'quiet areas' in cities, countries and regions;
- Examples of the most popular measures to reduce noise levels in cities include replacing older paved roads with smoother asphalt, better management of traffic flows and reducing speed limits to 30 kilometres per hour.
- There are also measures aimed at raising awareness and changing people's behaviour in using less-noisy modes of transport like cycling, walking or electric vehicles.

Figure 3 shows the number of people exposed to $L_{den} \geq 55$ dBA and $L_{night} \geq 50$ dBA at inside and outside urban areas in Europe. EEA-33, respectively [22].

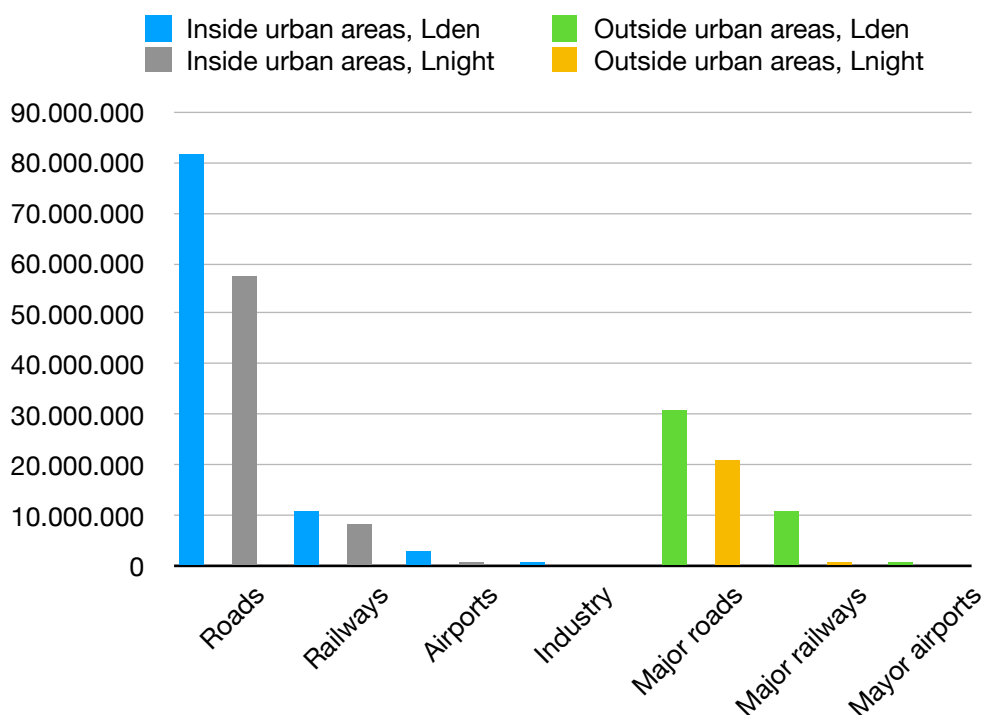


Figure 3: Number of people exposed to $L_{den} \geq 55$ bBA and $L_{night} \geq 50$ dBA in EEA-33

The **International Organization for Standardization (ISO)** published four new and one update of ISO standards: ISO 1996-2:2017; ISO 26101:2017; ISO/TS 12913-2: 2018; ISO/TS 12913-3:2019; and ISO/TR 17534-4:2020.

ISO 1996-2:2017 revises ISO 1996-2:2007 and describes how sound pressure levels intended as a basis for assessing environmental noise limits or comparison of scenarios in spatial studies can be determined [23]. Sound pressure levels can either be directly measured or extrapolated from measurements. The standard can be applied on all kinds of environmental noise sources, such as road and rail traffic noise, aircraft noise and industrial noise. Some guidance is given for indoor measurements as well.

ISO 26101:2017 specifies for a variety of acoustical measurement purposes discrete-frequency and broad-band test methods for quantifying the performance of anechoic and hemi-anechoic spaces, defines the qualification procedure for an omni-directional sound source suitable for free-field qualification, and gives details of how to present the results and describes uncertainties of measurement [24].

ISO/TS 12913-2:2018 and ISO/TS 12913-3:2019 provide requirements and supporting information on data collection and reporting [25] and on analysis of data collected in situ [26], respectively, for detailing the conceptual framework of soundscape studies, investigations and applications developed in ISO 12913-1:2014. Both documents identify and harmonize the collection of data by which relevant information on the key components, people, acoustic environment and context is obtained, measured and reported.

ISO/TR 17534-4:2020 facilitates a standardized interpretation and a verifiably consistent software implementation of the sound propagation part of the Common NOise aSSessment methOdS (CNOSSOS-EU) for road, railway, aircraft and industrial noise according to ISO 17534-1:2015. It provides a set of illustrative test cases along with reference solutions, and an example of a template form for the declaration of conformity for software manufacturers [27]. The Standard does not incorporate the improvement of the calculation method proposed by RIVM in 2019 [28]

ACTIVITIES IN EUROPEAN COUNTRIES

ACTIVITIES IN RUSSIA

The government of Russia now recognizes increased noise as one of the most dangerous and harmful threats for public health. Within the scope of a programme of smart city development the Ministry of Construction and Housing and Communal Services of the Russian Federation implemented in 2017 two national standards for protecting people against noise at residential and public buildings [29]. The standards establish the methods for evaluation of noise sources in building elements, following ISO 717-1:2013 and ISO 717-2:2013, and three codes of rules for sound reduction of air heating, ventilating and air conditioning systems; sound insulation of enclosing structures of residential and public buildings; and protection from road traffic noise (except motorcycles) emitted in the vicinity of residential, public and commercial buildings and recreational areas.

ACTIVITIES IN SWITZERLAND

In 2017, the Government of Switzerland has promulgated the Federal Law on protection of public health against hazards from the use of sound emitting products in conjunction with non-ionizing radiation (NISSG) [30]. It authorizes the Swiss Federal Council to enforce the law by setting limits for sound pressure levels at events using sound emitting products; defining the duties of organisers of such events; setting fees for controls and measures of the executive

organs; imposing penalties for offences and violations [31]. The Swiss Federal Council has established the regulations to implement and enforce the NISSG in 2019. Sound pressure levels at such events must not exceed an equivalent sound pressure level of $L_{Aeq,1h}$ of 100 dBA, never exceed the maximum sound level of 125 dBA, and not exceed the equivalent sound pressure level of $L_{Aeq,1h}$ of 93 dBA, if the audience are persons under 16 years of age.

In 2019, the Federal Office for the Environment (FOEn) published a brief on the situation in Switzerland regarding noise and vibrations [32]. Its main statements include

- Mobility continues to increase in Switzerland as motorized passenger transport has doubled since 1970 and commercial traffic has trebled.
- Road traffic is the source of noise that affects most people in Switzerland.
- Rail traffic is the main source of vibrations and structure-borne noise.
- Protection provided to the population is still inadequate as one in seven people (1.1 million people) are exposed to noise levels that exceed the exposure limit values specified in the Noise Abatement Ordinance

ACTIVITIES IN THE UNITED KINGDOM

The United Kingdom government, in 2019, has published another policy paper on its noise actions plans as a framework to manage environmental noise and its effects in urban areas [33]. This policy document comprises four documents, viz. noise action plans for (i) agglomerations (large urban areas) including (ii) detailed agglomeration data; (iii) for railways; and (iv) for roads. These plans also aim to protect quiet areas in agglomerations (large urban areas) where the sound pressure levels are low.

The set of noise action plans aims to promote good health and good quality of life (wellbeing) through the effective management of noise. It will assist the management of environmental noise in the context of Government policy on sustainable development. It will be relevant to the Department for Transport, to the various highway and rail authorities responsible for transport in the agglomerations, local authorities, including those with environmental, transport and planning responsibilities, and other interested stakeholders.

The UK Ministry of Housing, Communities & Local Government has revised the National Planning Policy Framework of 2012 in 2019. The updated version sets out the government's planning policies for England and how these are expected to be applied [34].

The same Ministry updated the guidance document on noise, published in 2014, in July 2019. This document advises on how planning can manage potential noise impacts in new developments [35]. The questions addressed in the document practically boil down to an environmental impact assessment approach.

The Department for Environment, Food & Rural Affairs has published a document to inform the drafting of noise action plans for road, rail, agglomerations and individual airports by use of the data generated by the noise mapping process required by the END [36].

ACTIVITIES IN LATIN AMERICAN COUNTRIES

ACTIVITIES IN CHILE

The Chilean Ministry of Environment is currently revising the regulation for noise emissions from stationary industrial sources of 2011 with regard to the day and night limits in four urban zones - areas, residential, commercial, and industrial - and rural areas. The revision is

expected to be finalized by December 2020 [37] but it is unknown if this task has been achieved.

A regulation on noise generated from new light and medium vehicles and motorbikes was promulgated in 2015 and implemented in July 2019 [38].

ACTIVITIES IN COSTA RICA

The Presidency of the Republic of Costa Rica and the Ministry of Health were formulating four versions of the Regulation No 39428-S for noise control between January 2016 and January 2019 [39]. The regulation classifies the zones - residential, commercial, mixed residential-commercial, industrial/agricultural and stock farming, and silence areas, for which permissible sound pressure levels are set.

These limits are compiled in Table 2.

Table 2: Permissible sound pressure levels in dBA

Zone	Day (6:00-20:00)	Night (20:00-6:00)
Residential	65	45
Commercial	70	55
Industrial/Agricultural/Stock farming	70	60
Silence area	50	45
Mixed area	70	45

ACTIVITIES IN MEXICO

In November 2019 the Environmental and Land Management Office (PAOT) launched a campaign to reduce the noise generated in commercial establishments such as clubs, restaurants, pharmacies and industries [40]. The objective of this programme is to raise awareness and be able to promote, impel and strengthen compliance with noise regulations on noise in commercial and industrial establishments. PAOT measurements during the first campaign in the Center of Coyoacán have observed sound pressure levels up to 80 dBA from merchant establishments while the maximum limit allowed is 62 dBA. This campaign was intended to be informative, but if in future operations the maximum limit is exceeded sanctions will be applied, which can lead to fines, closures, and even jail.

ACTIVITIES IN PARAGUAY

On 18 September 2019 the Paraguay Chamber of Deputies approved a bill that protects the public from exposure to annoying sound pressure levels [41]. The document establishes that the National Police Command must provide sound pressure monitoring instruments to officers in each police station for noise controls. The action also aims to manage noise emission situations capable of affecting other living beings and the environment and to prevent value deterioration of people's property. In addition, the police must seize noisy equipment, vehicles or machinery, as appropriate, and impose sanctions with fines according to the existing legislation on the prevention against noise.

In January 2020 the National Congress of Paraguay promulgated the Law No 6390, which regulates the permissible emission of sound levels for all kinds of sources [42]. Among other tasks Municipalities are requested to enforce the law by setting emission standards for various source categories, formulating policies to minimise noise, develop low noise emission plans, and establish reference procedures for the monitoring, analysis and evaluation of noise levels.

ACTIVITIES IN PERU

The Ministry of Environment of Perú (MINAM) has established maximum permissible sound pressure levels for national and international aircraft operating over the Peruvian territory [43]. This decree refers to the reduction-at-source element of ICAO's Balanced Approach. The regulation is based on a broad consensus of relevant stakeholders including representatives of private sector entities and from all levels of government. Permissible limits are set for subsonic jet and propeller-driven aircraft type of different dates of certification and different masses, and for helicopters.

The MINAM is now also strongly promoting electric mobility "that goes hand in hand with government and state policy, since electric vehicles do not generate noise emissions" [44].

The National Institute for Quality Assessment has accredited the leading laboratory in inspection, verification, testing, and certification, SGS del Perú, as the first and only laboratory for environmental noise monitoring, analysis, and reporting, according to ISO 1996-1: 2016 and ISO 1996-2: 2017 standards [45].

In 2019, the Municipality of Lima, approved the development of the "Sound Pollution Surveillance and Monitoring Programme" with the aim to supervise noise emissions of the establishments that exist in Lima's historic centre [46] and in the 42 districts [47].

The same year, the Municipality of Lima launched the "Stop the Horn" campaign, which promotes the responsible use of horns by public transport bus companies [48]. The objective of the campaign is to measure the sound pressure levels of the horns and to sensitize operators through informational leaflets on the harmful effects of the indiscriminate use of the horn on health, as well as to inform about the scale of fines .

Based on Law No. 30011/2013, the municipalities of Peru are requested to develop annual plans for environmental protection called "Annual plan for environmental assessment and inspection" (PLANEFA, Plan Anual de Evaluación y Fiscalización Ambiental) [49]. The PLANEFA contains five components [50]:

1. Supervision, including assessment and test of compliance with standards;
2. Performance of the task by the responsible authority;
3. Environmental quality assessments, of various components (air, noise, etc.);
4. Determination of relevant instruments for evaluation, supervision, or sanctions;
5. Summary all environmental control activities to be carried out.

CONCLUSIONS

This report addresses international and national progress on noise mitigation policies and strategies, best practices and guidelines for environmental noise management. A milestone of this progress are the WHO Environmental Noise Guidelines for the European Region, which update and complement the WHO Community Noise Guidelines and the WHO Night-Noise Guidelines for Europe. A lot of work has also been performed by ICAO with respect to lowering noise technology goals and environmental community engagement in aviation issues. The European Commission convened a conference in 2017 with the aim of a better noise policy in the European Union. The European Environmental Agency published an overview report on environmental noise management in Europe, the latest database on noise exposure information under the Environmental Noise Directive, and updated the Noise Fact sheets for 21 EU Member states and three non-EU countries. It also published, the second European Aviation Environmental Report. The International Organization for Standardization published five updates of standards relating to soundscapes, test methods for the qualification of anechoic and hemi-anechoic free-field environments, and a software implementation of the CNOSSOS-EU sound propagation part.

Activities on the national level included normative and technical documents for the protection of people against noise in buildings from both inside and outside sources in Russia; the promulgation of a law and an implementing regulation against hazards from sound and in Switzerland; and a brief on the noise and vibration situation in this country; and noise action plans in the United Kingdom to promote good health and wellbeing. Activities in Latin American countries included regulations for noise control of stationary and mobile sources in Chile; the setting of permissible sound pressure levels in Costa Rica; the creation of a programme to reduce noise generated in commercial establishments in Mexico; a bill to control sound pressure levels in Paraguay; and the setting of maximum sound pressure levels for aircraft following the balanced approach of the International Civil Aviation Organisation in Perú, the promotion of electric mobility, and the accreditation of a centre of excellence for sound pressure level monitoring in this country. Municipalities in Perú increasingly implement the noise pollution surveillance and monitoring programme and develop annual environmental assessment and enforcement plans.

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