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NEED OF A NATIONAL NOISE STRATEGY IN SPAIN AND APPROACH TO DEVELOP IT.

Miguel Ángel González García^{1*} Ignacio Soto Molina¹

Carlos Soriano Pastor¹

¹ Ministerio para la Transición Ecológica y el Reto Demográfico, España

ABSTRACT

The last decade made us aware of the importance of environmental noise as cause of disease and life quality loss for the population. Since the entry into force of END and Spanish legislation on noise progress has been made, especially in noise evaluation, even with difficulties. Nevertheless, reaching objectives of noise reduction nowadays on the table (ZPAP) seems a difficult goal.

To afford this challenge it is needed a correct overview of noise problems at a macro scale and a strategic approach of what the causes are and the possible ways to work to solve it effectively. This work reviews why this strategical vision is needed, what are the works in course for developing it and which could be, at the State level, the main axes that guide the action of the different administrations to address environmental noise.

Keywords: Environmental noise, Public health, Noise management, Strategic approach, National noise strategy



***Corresponding author:** maggarcia@miteco.es
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1. INTRODUCTION

The impact of noise on health is a key concern for several international bodies. The World Health Organization (WHO) has published guidelines recommending safe noise levels to protect public health, as noise exposure has been linked to sleep disturbances, cardiovascular diseases, and other health problems. Additionally, global institutions like the World Bank and the United Nations Environment Programme (UNEP) have incorporated noise pollution into their sustainable development agendas.

Within the framework of the United Nations Sustainable Development Goals (SDGs), noise pollution is directly related to SDG 3 (Good Health and Well-being) and SDG 11 (Sustainable Cities and Communities). Reducing noise not only minimizes non-communicable diseases but also enhances the overall quality of urban life by creating healthier, more livable environments.

At the European level, Directive 2002/49/EC plays a central role by establishing a common framework for the evaluation and management of environmental noise. This directive requires member states to develop strategic noise maps for urban areas, major transport infrastructures, and densely populated regions, along with comprehensive action plans aimed at reducing noise levels.

In addition to the Directive, the European Green Deal and its Zero Pollution Action Plan integrate noise management into broader sustainability strategies. These initiatives aim to transition the EU towards a sustainable, climate-neutral economy, with noise reduction being a key element in improving both environmental quality and public health.

The European Environment Agency (EEA) plays a pivotal role in tracking and assessing noise pollution across Europe. The report, "Environmental Noise in Europe —



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2020," illustrates that noise exposure remains a significant issue, affecting millions of people.

Despite the importance of the problem, we are far from achieving a sound environment aligned with what, according to science, would be adequate for citizens. Some challenges for more progress on this path are:

- A complete picture of the problem is lacking. Based on the best possible technical approach, it would shed light on the true severity of this form of pollution. This work can help administrations and the public better understand the significance of noise pollution for the country's society and economy.
- Despite the existence of long-standing regulations, their application is not always efficient or easy, and there is a significant gap in their implementation.
- This form of pollution has generally been considered a local problem, to be addressed locally. However, this has not led to an improvement in the situation and does not always help address the issue in a coherent and appropriate manner.
- Many times there are no comprehensive policies that are sustained over time.

2. WHY IS A NOISE STRATEGY NECESSARY IN SPAIN?

In Spain, a noise strategy is needed, as the current approach to assessing noise pollution only provides a partial view of its impact on both citizens' quality of life and terrestrial habitats. While strategic noise maps are developed for urban areas with more than 100,000 inhabitants and significant noise sources—such as busy roads, railways, and airports, as defined by the Environmental Noise Directive—this methodology leaves many areas and sources unexamined. For example, while higher noise levels ($Lden > 70$) are reasonably well represented in current noise maps, initial estimates indicate that, at medium noise levels ($Lden 55-70$), approximately 50% of the exposed population is not adequately studied. This significant data gap underscores the limitations of the existing framework.

Spain's National Information System on Noise Pollution (SICA) currently only reports data from a limited number of urban agglomerations and infrastructure, including 64 large cities, 21,000 km of main roads, 1,800 km of major railways, and 13 major airports. Consequently, numerous small municipalities and diverse noise sources—from industrial activities, wind farms, and port facilities to

local disturbances from leisure activities, neighborhood events, urban services, and construction noise—remain unassessed. This narrow focus means that a large segment of the population and numerous sensitive receptors in the natural environment are not considered in current assessments.

The Environmental Noise Directive's approach, which determines study areas based on noise sources rather than the distribution of affected receptors, results in many affected communities and natural habitats being overlooked. While the European Environment Agency has made efforts to use statistical methods to fill the gaps, these methods can be significantly biased due to a lack of comprehensive data and do not yet identify all areas requiring corrective action.

For these reasons, the Ministry for the Ecological Transition and the Demographic Challenge (MITECO) emphasizes the urgent need for a comprehensive noise strategy. A comprehensive assessment of noise pollution is essential to clearly understand the various problems, analyze the potential impacts on public health and natural environments, and develop synoptic documents that facilitate access to this information for monitoring and evaluating the effectiveness of policies. MITECO is developing global noise models for key sources, especially road traffic, which has the greatest impact on environmental acoustic quality, in addition to promoting assessment methodologies for other noise sources. This strategy would ensure the identification and addressing of all affected areas, thus protecting both the health of the population and the integrity of natural habitats.

3. STRATEGY OBJECTIVES

The National Noise Strategy aims to serve as a benchmark document that not only meets the regulatory requirements set by the European Union but also identifies national priorities and establishes effective measurement indicators to assess progress. This strategy is designed to guide specific policies for mitigating noise across various economic sectors and social environments, ultimately protecting public health, preserving the acoustic quality of natural surroundings, and enhancing the overall well-being of Spanish society. In doing so, it aligns with international commitments and promotes a more livable and healthy environment for current and future generations. The objectives pursued are the following:

- Analyze the information generated, identifying the needs for action to improve current noise pollution levels and reduce its adverse effects on health and the





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environment. To this end, the most appropriate tools will be used for this analysis (SWOT).

- Identify those elements with the greatest potential to improve the noise environment but that may still be less developed, such as Quiet Zones, Soundscapes, or Sound Reserves, etc.
- Identify the strategic axes and lines of work that can help gradually improve the noise environment.
- Identify the stakeholders with the greatest responsibility for improving the noise environment to increase the positive impact of the actions that this document may lead to.
- Set achievable objectives for the different strategic axes/lines and define policies and actions that will help the Competent Authorities make progress in reducing noise pollution problems.
- Assess the potential costs and impact of such policies and actions, as well as the best way to implement them.
- Establish formulas to keep the diagnosis of noise pollution in Spain up-to-date, in the simplest and easiest way possible, to evaluate trends and identify potential emerging problems in noise pollution, and to monitor the implementation of the Strategy.

Together, these objectives and guiding principles provide a robust framework for the National Noise Strategy, laying the groundwork for comprehensive actions that protect public health, sustain natural environments, and contribute to the overall quality of life in Spain.

4. METHODOLOGY FOR STRATEGY DEVELOPMENT

4.1 General Methodology

The methodology for developing the National Noise Strategy is structured around a comprehensive index that ensures a thorough analysis of all aspects of environmental noise and its impacts.

The process begins with the justification and objectives of the Strategy. This initial phase examines the nature of environmental noise, its causes, and its effects on both public health and the environment. It also identifies potential for improvement and highlights the need for a strategic approach to noise management.

The Strategy's development is then based on a review of the national, European, and international legal context for noise management. This involves analyzing previous approaches to environmental noise in Spain, examining the

international and European frameworks that have influenced current practices, and considering how Spanish national, regional, and local regulations interact with broader environmental policies. This phase also explores the relationship between noise pollution and other environmental issues to identify potential synergies with existing plans and strategies.

The next step is a detailed diagnosis of the current situation. This assessment employs a multifaceted methodological approach that includes both quantitative and qualitative analyses. Quantitative methods involve the collection and processing of noise level data from various sources, the application of standardized noise modeling techniques, such as CNOSSOS-EU, and the use of Geographic Information Systems to assess noise exposure in different population segments and sensitive natural areas.

Complementary semi-quantitative and qualitative approaches help fill data gaps and provide insight into public perception, regulatory compliance, and the effectiveness of existing noise management tools.

Particular attention is paid to assessing significant noise sources—from road traffic, rail, and air transport to industrial activities, port operations, and even local events—allowing for a comprehensive evaluation of both modelable and non-modelable noise sources.

Once the current status has been diagnosed, the synthesis of the findings identifies key needs and challenges that need to be addressed.



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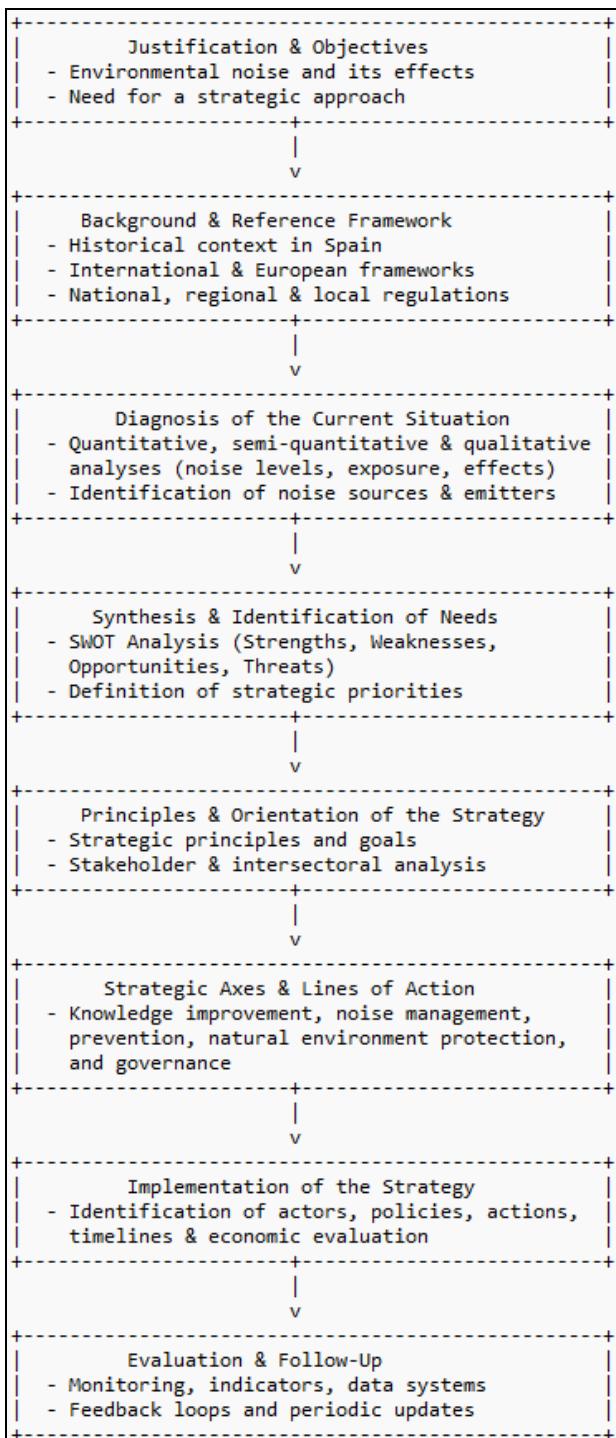


Figure 1. Methodological diagram.

This summary lays the groundwork for defining the Strategy's principles and strategic directions. It includes an analysis of the strengths, weaknesses, opportunities, and threats (SWOT analysis) related to noise management in Spain, as well as an assessment of how various sectors, such as urban planning, environmental protection, and public health, can be integrated into a coherent strategic framework.

The Strategy will define the strategic axes and lines of action. These include improving citizen knowledge and awareness, noise management in different sectors, preventing noise pollution, improving the quality of the acoustic environment, and improving intervention and regulation tools. Each strategic axis is detailed in terms of specific actions, such as capacity building, intersectoral cooperation, and the development of clear policy objectives.

The Strategy's implementation will be planned through a detailed roadmap that identifies key stakeholders, defines specific policies and actions, sets measurable objectives, and includes an economic evaluation of the proposed interventions. This stage also addresses the need for planning, programming, and periodic reviews to ensure the Strategy maintains its effectiveness over time.

Finally, the methodology incorporates an evaluation and monitoring phase. This phase is designed to periodically update the noise pollution assessment, monitor the effectiveness of the implemented measures using defined indicators, and ensure the availability of robust information systems and data sources. This continuous feedback loop is essential for adapting the Strategy to new challenges and technological advances.

Overall, the methodology for developing the National Noise Strategy is an integrated and iterative process. It combines historical analysis, rigorous data collection and modeling, strategic planning, and ongoing evaluation to create a robust framework aimed at significantly reducing noise pollution and its impacts in Spain, while ensuring the necessary participation of all involved authorities and the public through appropriate public consultations and information periods.

4.2 Considered Noise Sources in Diagnosis

To effectively analyze noise pollution within this Strategy and achieve an accurate diagnosis, it is essential to systematically identify and understand the sources responsible for this type of contamination. These noise sources vary greatly in their characteristics, and their contribution to the overall environmental problem differs significantly. Below, the characteristics of some of the most important sources are described.





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Road traffic is recognized as the primary source of noise pollution in urban and suburban areas, affecting a large proportion of the population. The noise from road traffic primarily results from the contact between tires and pavement, compounded by engine noise and, to a lesser extent, the use of braking systems. Similarly, rail transport is an important contributor, particularly in urban areas. Trains—especially high-speed ones—generate noise due to the contact between wheels and tracks, as well as aerodynamic noise at high speeds. In urban contexts, the passage of trains at level crossings or in proximity to residential areas can adversely affect quality of life, and noise from freight trains can also cause significant issues in the surrounding environment.

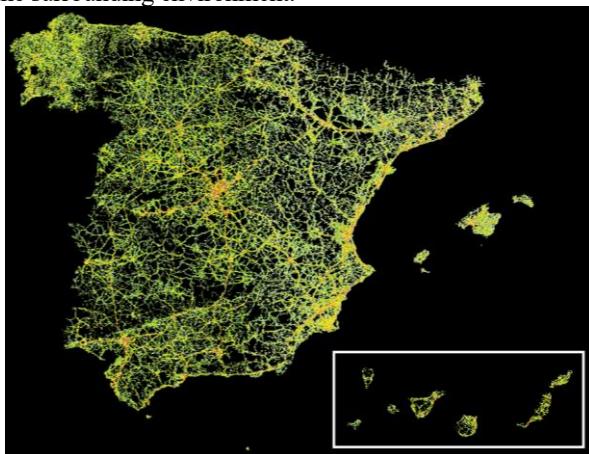


Figure 2. First version of the supra-strategic road map of Spain.

Aviation is another significant source of noise, especially near airports where takeoffs and landings create high noise levels that impact both nearby residents and sensitive natural areas. In a similar vein, maritime transport and port activities are major contributors to noise pollution, even though they are not mandated to conduct noise evaluations and action plans under the Environmental Noise Directive. Operations such as loading and unloading, the movement of heavy machinery, and the vessel traffic within ports generate substantial noise, particularly in port cities.

The industrial sector also plays a key role. Industries contribute to noise not only through manufacturing processes but also via logistics and transportation operations. Noise generated by machinery, material handling, and the movement of vehicles during loading and unloading creates significant issues in industrial areas adjacent to residential zones. Additionally, industrial noise affects rural areas where facilities such as farms, food

processing plants, and other agro-industrial activities are located.

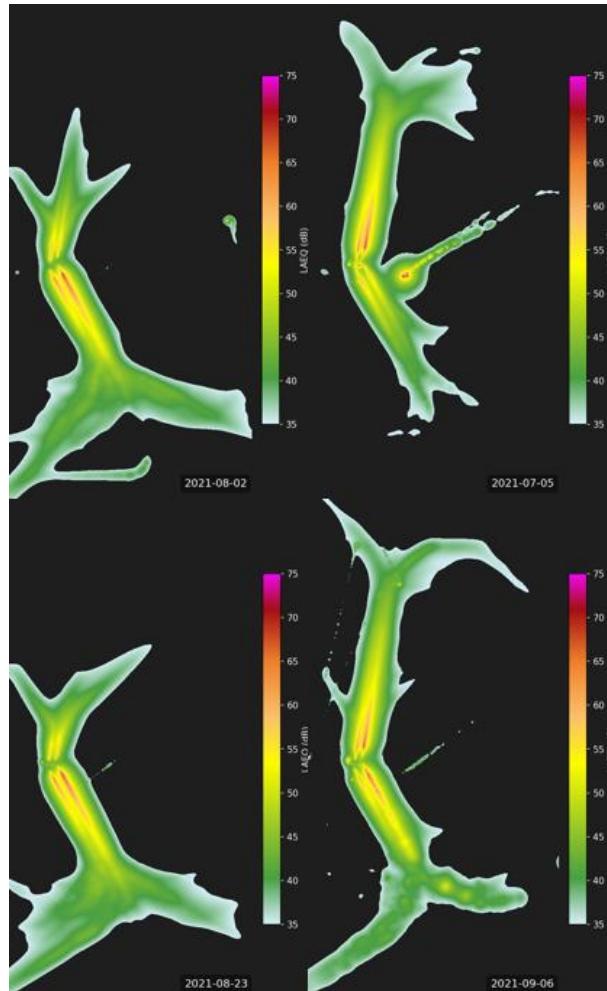


Figure 3. Noise footprints of aeronautical operations on different evaluation days.

The leisure and hospitality sector is a notable source of urban noise, especially in tourist and residential areas with a high density of bars, nightclubs, and restaurants.

Construction, though typically a temporary activity, produces significant noise impact—especially in urban areas where building and renovation projects are continuously underway. These construction activities, which may last for months or even years, can greatly affect residents' quality of life. Moreover, the construction of infrastructures such as roads or rail stations contributes to noise pollution both during the construction phase and in subsequent operational phases.





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Other significant noise sources include local festivities and public events like popular celebrations, which generate temporary yet intense increases in noise levels.

Other sources, such as wind turbines—despite being a renewable and sustainable energy source—can emit significant noise in the areas where they are installed, particularly in rural and mountainous regions.

Based on the diagnosis, a framework of noise sources will be established for consideration in the National Noise Strategy. As said before, for each type of emitter, different methodological approaches will be applied to diagnose their importance and significance, depending on the available information and possible work methodologies. These approaches include a quantitative method, a semi-quantitative method, a qualitative approach at the level of territorial administrative entities, a large-scale analysis, and a normative and management analysis, along with a category for those sources not analyzed.

The quantitative approach involves evaluating the noise generated by all identifiable entities from available cartographic data. This process entails identifying the study entities, processing the available information, characterizing the necessary parameters for strategic input into noise calculation software, generating a calculation model using source data and lidar-derived digital terrain models that include building data, and calculating noise levels using base maps from the National Geographic Institute and tools like CEREMA-FR's Noise Modelling based on the CNOSSOS-EU methodology. The results from this approach will later be used to assess noise exposure and its effects.

In contrast, the semi-quantitative approach employs a mixed methodology by calculating noise levels for typical cases and extrapolating the results. This method starts with approximating the territorial distribution of each type of emitter using available cartographic products, classifying groups of similar emitters into synthetic types, and characterizing the noise each type produces. Noise calculations will then be performed for specific cases or by using available data from such cases (e.g., strategic noise maps of urban agglomerations, environmental procedures), potentially utilizing more tailored methods (such as ISO-9613), before extrapolating these analyses to the broader territory using Geographic Information Systems. The outcomes will again be used to evaluate noise exposure and its subsequent effects.

A qualitative approach will also be undertaken at the level of territorial administrative entities, analyzing the significance of each type of source based solely on statistical data and the most disaggregated local or regional data available. This analysis will be extrapolated to the

entire set of territorial entities and will include an examination of existing management tools and the need for improvements. Additionally, a large-scale state-level analysis will be conducted to assess the overall importance of these noise sources and evaluate the effectiveness of current management tools, potentially supplemented by expert opinions, communications, or relevant literature.

Finally, a normative and management analysis will examine the current regulatory framework and the possible need for additional instruments, focusing on preserving acoustic quality against the noise generated by these sources. For some types, it may be possible to consider the definition of "tolerable limits" for noise pollution.

It is important to note that the list of noise sources included in this framework is not intended to be an exhaustive catalog of all possible sources of environmental noise in urban, rural, and natural areas. Instead, it aims to provide a sufficiently comprehensive approximation that covers the primary contributors to noise pollution for the current Strategy, grouping them into basic typologies that facilitate systematic analysis and diagnosis.

4.3 Main Lines of Action

To structure the National Noise Strategy in Spain and maximize the effectiveness of interventions on acoustic pollution, the main strategic axes need to be identified, for instance through a SWOT analysis.

These axes will serve to orient the Strategy according to both challenges and opportunities, strengthening capabilities in critical areas and improving coordination among administrations and other stakeholders.

Preliminary, with the work already done, the following lines of action can be advanced:

- Improvement of Knowledge, Dissemination, and Awareness, emphasizes the need to expand understanding of noise pollution and its impacts on health. It also focuses on training professionals in the sector and raising public awareness about the importance of this issue.
- Management of Acoustic Pollution, advocates for the effective handling of the main sources of noise. This includes addressing major transport infrastructures, industrial and urban activities, and temporary noise emitters, while also targeting interventions in urban spaces to enhance the overall sound environment.
- Prevention of Pollution and Improvement of the Acoustic Environment, is centered on preserving acoustic quality in areas with low pollution levels and preventing noise in urban settings and new constructions. This axis also encompasses efforts to



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improve sound quality in urban areas and in indoor environments, such as residential buildings and workplaces.

- Noise, Biodiversity, and the Natural Environment, underlines the critical importance of preserving biodiversity and natural ecosystems as part of an integrated approach to combating acoustic pollution. It includes managing noise in rural areas, natural settings, and the marine environment to protect vulnerable species and ecosystems.
- Improvement of Management and Intervention Tools, focuses on strengthening the tools necessary for effective governance and compliance. This involves ensuring adherence to regulatory obligations, enhancing the regulatory framework, managing conflicts related to noise, and promoting cross-sector policies that foster synergies and collaboration among various administrations.

Together, these strategic axes will guide the implementation of measures in the areas of management, prevention, knowledge, and regulation of acoustic pollution. They establish a comprehensive framework that contributes to the effective reduction of noise exposure in Spain.

5. EXPECTED RESULTS AND BENEFITS OF THE STRATEGY

The expected results and benefits of the National Noise Strategy are multifaceted, touching on public health, quality of life, environmental protection, and economic gains.

By effectively reducing noise levels, the Strategy is anticipated to lead to significant improvements in public health, lowering the incidence of noise-related issues such as sleep disturbances, cardiovascular problems, and stress. This reduction in noise exposure will enhance urban livability, creating quieter, more harmonious communities that support overall well-being and productivity.

In addition to health benefits, the Strategy aims to preserve and improve the acoustic quality of both natural and urban environments. This will help protect biodiversity and ensure that natural habitats, particularly in rural, coastal, and marine areas, remain less disturbed by excessive noise.

The strengthened regulatory framework and enhanced monitoring tools resulting from the Strategy will facilitate better compliance with European directives and more efficient enforcement of noise standards, leading to a more coordinated and effective noise management system.

Economically, the Strategy is expected to yield benefits by reducing healthcare costs associated with noise-induced conditions and minimizing social costs related to

stress and reduced quality of life. Moreover, improved urban planning and intersectoral coordination can lead to increased property values and a boost in tourism, while encouraging innovation in noise reduction technologies that can spur new business opportunities.

Finally, the Strategy's focus on improving knowledge, dissemination, and public engagement will foster greater awareness and participation among citizens and stakeholders, ensuring that noise management becomes a shared responsibility across communities and administrations.

6. CONCLUSION

The National Noise Strategy will present a comprehensive framework to address the multiple challenges posed by noise pollution in Spain. Through a systematic and integrative approach, the Strategy will address not only the assessment and monitoring of noise sources, but also the development of effective mitigation measures in various sectors, from urban transport and industrial activities to leisure events and natural habitats.

The analysis underpinning this Strategy highlights the need for a detailed diagnosis that encompasses both modelable and non-modelable noise sources, ensuring that the data-driven approach captures the full magnitude of environmental noise and its impact on public health and biodiversity. By integrating robust methodologies, including quantitative, semi-quantitative, and qualitative assessments, the Strategy lays a solid foundation for informed decision-making and policymaking. The strategic axes, ranging from improving public knowledge and awareness to improving noise management, prevention, and regulatory frameworks, guide the plan toward the creation of a cohesive and adaptive system for noise control.

The emphasis on cross-sector collaboration and inter-administrative coordination further strengthens the potential for achieving tangible improvements in both urban acoustic environments and natural ecosystems. Ultimately, the expected outcomes of implementing the Strategy include policies and tools aimed at achieving significant reductions in noise exposure, improvements in public health and well-being, the preservation of acoustic quality in natural areas, and economic benefits through reduced healthcare costs and improved urban livability.

This Strategy will establish a forward-looking agenda that supports the goal of ensuring a healthier, more sustainable, and acoustically harmonious environment for present and future generations.





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