Environmental Noise Pollution

Noise Mapping, Public Health, and Policy

Enda Murphy & Eoin A. King

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Dublin and Hartford
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Preface

Noise – The chief product and authenticating sign of civilization
Ambrose Bierce, The Devils Dictionary, 1907

Environmental noise has traditionally been dismissed as an inevitable fact of life and has not been targeted and controlled to the same extent as other health risks. A growing body of research linking noise to adverse health effects coupled with proactive legislation, primarily in the EU, is now driving change. Environmental noise has often been referred to as the 'forgotten pollutant' but is now recognised as an environmental and public health issue which needs to be addressed in modern society. For some people, noise is nothing more than a minor inconvenience, but for others noise exposure can lead to negative health effects varying from annoyance and sleep deprivation to more serious issues such as hearing impairment and cardiovascular diseases. Indeed, excessive exposure to environmental noise has been linked to a series of negative health effects in children including their cognitive impairment. For the first time, clear links between these adverse health effects and noise exposure have been identified, and estimates of their proliferation across the population have been established. The World Health Organization recently estimated that at least 1 million healthy life years are lost every year from traffic-related noise alone in Western Europe while the social cost of noise from road and rail across the EU has been valued at approximately €40 billion per year. Given that dose–response investigations are still relatively under investigated, it is likely we have not yet fully grasped the true extent of the noise pollution problem.

Despite this increase in awareness and the rapidly accumulating evidence pointing to the health issues associated with excessive noise pollution, environmental noise continues to be poorly understood by practitioners, policymakers and the general public. Although environmental noise issues now feature on the policy agenda, there is no adequate reference guide available that is relevant to specialists while also being accessible to policymakers, students and non-specialists. The core aim of this book is to provide such a reference guide. This text is thus intended to serve as a guideline for all stakeholders, ranging from professionals working in the field to members of the general public wishing to learn more about environmental noise. It is also meant as a reference guide for students studying acoustics, civil and environmental engineering, urban planning as well as public health professionals.

The key to driving effective change in environmental noise pollution is to clearly define the problem and then identify appropriate control strategies and actions. In discussions with the general public, it seems that most people can easily relate to the problem of noise pollution – everyone knows someone who is annoyed either by aircraft noise or noise from a busy road or factory. Addressing noise issues requires a deeper understanding of various control strategies and must be sensitive to a range of technical and contextual issues. This book endeavours to provide the material necessary to develop this understanding irrespective of whether the reader is a planner, politician, acoustician, student or member of the general public.

We begin by introducing the fundamentals of acoustics and focus specifically on how they relate to the assessment and management of environmental noise. The aim here is to provide readers who may not have scientific background with technical information that is needed to understand subsequent chapters and to do so in a manner that is accessible to a wide-ranging audience. This is followed by a state-of-the-art review of existing studies linking long-term environmental noise exposure with various adverse health effects. We also detail the chief source mechanisms for the key categories of environmental noise: road, rail, aircraft and industrial sources. Noise prediction/calculation methods for different noise sources used across the world are also outlined and discussed in detail, and this information provides the reader with an appreciation of the technical detail involved in noise prediction modelling. The book concludes with examples of best practice in noise mitigation strategies. The most effective noise mitigation approaches generally take a holistic approach to noise abatement and rarely focus on only one technical initiative. To highlight this, we identify specific initiatives that best emphasis how mitigation measures should form part of an overall noise control policy.

In general terms, this book is aimed at an international audience, and it is intended to act as a robust reference guide for stakeholders globally. After all, environmental noise is a global issue and does not recognise national borders. Europe is undoubtedly the world leader in planning for the management and control of noise pollution. Accordingly, the European Union's Environmental Noise Directive is considered in detail along with an assessment of how various Member States set about achieving the ambitious requirements set down by that seminal piece of legislation. The Directive has probably been the single most progressive step in the battle to control the proliferation of environmental noise. The results from the first round of noise mapping under the Directive (completed in 2007) show that lessons learned from this phase have directly improved the approach towards noise mapping in the most recent second phase (completed in 2012). These lessons may serve to guide all stakeholders on best practice in the assessment of noise. The European

experience can be used to highlight not only best practice but also potential pitfalls that should be should be avoided for noise assessment and management. Throughout the text, we identify both the strengths and weaknesses of the Environmental Noise Directive and the approach to its implementation by Member States.

The successful management and control of environmental noise involves interdisciplinary considerations. When environmental noise is considered at an early stage, for example, by vehicle manufacturers, it can frequently be eliminated at source. This is always the preferred solution because noise control as a retrograde step is usually much less effective and sometimes wholly ineffective. Noise should be a detailed consideration in national planning systems which could be strengthened with appropriate legislative instruments. Indeed, it is considerably easier and cheaper to redesign a road on paper then to subsequently erect noise barriers across hundreds of kilometres of road. Of course, environmental noise considerations should not be limited to planners and engineers. Automobile and tyre manufacturers should consider noise in the design process of vehicles and tyres. Industrial operators should consider noise levels in all site operations and should favour quieter machines and processes where possible. If real change is to be realised, perhaps the most logical, albeit controversial, step is to introduce statutory environmental noise limits that are rigorously enforced. Moreover, there is potential for a psychoacoustic approach towards noise control which might help maximise the impact of mitigation measures. This approach has many attractive aspects but is not yet sufficiently developed to make a real difference in current noise mitigation strategies. However, it is our hope that this book will spark debate and interest in these and related emerging concepts and ideas.

For the first time, this book brings together academic expertise, real-world experience and international computational methods and guidelines for understanding environmental noise. We provide a comprehensive overview of the issue, how it can be assessed according to a number of different methodologies and, most importantly, how it can be mitigated. Our aim is to inform the reader in such a way so that the best solution(s) available on a case-by-case basis might be more effectively understood and identified. We do not intend to offer definitive overage of all problems – the breadth and scale of the topic renders this impossible. Instead, we attempt to educate the reader on the principles of environmental noise in order to provide a sound basis upon which noise issues can be considered. In some ways, the aspiration of the book is similar to the overall objective of the Environmental Noise Directive: to reduce exposure to environmental noise by raising understanding and awareness of its impact. While this has not yet been realised, the tide of understanding and awareness is slowly turning and thus this book represents one more in a series of small steps towards a healthier, quieter society.

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CHAPTER

1

Environmental Noise Pollution

1.1 DEBATES AND CHALLENGES

A recent article in the *New York Times* came with an intriguing headline: 'Behind city's painful din, culprits high and low' (Buckley, 2013). The painful din that is described is the seemingly inescapable background and impulsive noise embedded within major world cites such as New York. As for the culprits – they are the producers of noise being emitted from the very depths below the ground to the skies overhead and seemingly everywhere in between. In the article, the author describes the everyday subjugation of New Yorkers to various sources of environmental noise – road and rail traffic noise, nightly construction activity (underground and over ground), helicopters and airplanes, bars and nightclubs, police and emergency sirens, among others. But more importantly, the piece describes the human experiences of excessive noise – how it actually affects people's everyday lives. Because very often the human impact of environmental noise gets lost in the technical detail: the noise indicators, the decibel scale, the modelling and measurement procedures. The detail is, of course, very important. In fact, it is crucial for understanding and assessing noise pollution as a public health problem. But emphasising only the technical nature of the problem risks normalising noise pollution as an abstract, stoical and somewhat inaccessible experience even though we know it is often viewed as a personnel affront to the people being subjected to it. Rather than noise being an abstract notion then, almost everyone has an intuitive understanding of what it is because we all experience it on a daily basis. In fact, the manifestation of noise exposure as emotion in humans is incredibly subjective even though the physiological impacts are broadly similar. We know from scholarship that human sensitivity to noise is variable – two people exposed to the same sound pressure level can have quite different subjective reactions in terms of their annoyance levels and associated psychological effects. Therefore, understanding

the variable ways in which noise affects its human recipients is a vital accompaniment to technical understanding and problem solving for noise pollution problems.

New York is not exclusive in having a noise problem; rather, it is quite a typical example of the sound environment of modern cities. While European cities are perceived as being somewhat quieter than North American cities, rapid urbanisation and the increased concentration of human settlement and associated activity across relatively small areas typically lends itself to nosier environments. And it is a problem that has plagued cities, in particular, for centuries. Often cited in the literature is the fact that Julius Caesar banned chariots from the streets of Rome during the night because citizens could not sleep. However, it is the Greeks who are credited with the first noise abatement ordinance: in the first century B.C., they banned potters and tinsmiths, as well as roosters, from residential areas of their cities (Goldsmith, 2012). Even in New York, a relatively young city, the fight against noise has been ongoing for over a hundred years. During the Constitutional Convention in Philadelphia (1787) which resulted in the U.S. Constitution, dirt and straw were used to cover the cobblestone streets in front of Pennsylvania State House in an effort to reduce noise levels. In New York (1905), the *New York Times* decried the 'Trolley cars, boiler making, elevated roads, subway trains, harbor sirens, and various steam whistles, riveting machines, trucks laden with slabs of iron and rails of steel, milk wagons banging over the pavements in the small morning hours, hand organs, phonographs with megaphone attachment, fish horns, knife-grinding serenades, yelling junkmen, hucksters and peddlers with cowbell distractions, cracked bells ringing day and night in churches and chapels'.[1] In response to the problem, Julia Barnett Rice founded the Society for the Suppression of Unnecessary Noise in 1906 and this body was largely responsible for the signing into law of New York's first piece of noise abatement legislation prohibiting steamboat captains from unnecessarily sounding their whistles.

In today's cities, the characteristics of the noise have changed with changes in the structure of the economy together with technological change that has been both a force for quieter and nosier cities simultaneously. No longer have we steam whistles or boiler making but these have been replaced by alternative sources of noise such as cars and motorcycles with wider tyres and high-powered engines. The history of noise is not simply a case of being quieter in the past and louder in the present – that is far too simplistic. Noise has always been a problem, particularly for cities. But there is certainly some truth to the suggestion that noise is the forgotten environmental problem. Given its history, there is little doubt

[1]'The noisiest city on Earth', *New York Times*, 2 July 1905.