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Discussion

Supportive soundscapes are crucial for sustainable environments

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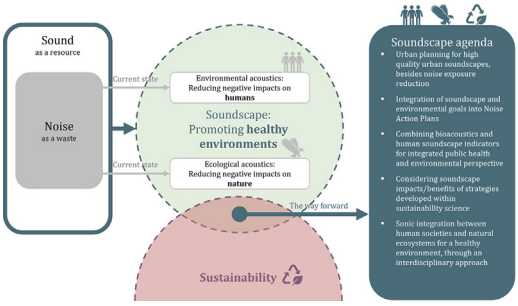
HIGHLIGHTS

- Ecoacoustics, noise pollution and sustainability have so far been mainly independent.
- Soundscape approach is crucial in the light of global heating and urbanisation.
- Integration of soundscape and environmental goals into Noise Action Plans is advocated.
- Integrating bioacoustics and soundscape indicators for public health and environmental goals.

GRAPHICAL ABSTRACT



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1. Noise is a public health issue

The human production of noise has increased dramatically since the industrial revolution, with demonstrated and wide-ranging impacts on environments and human well-being, which are exacerbated in densely populated urban areas. According to the World Health Organization (WHO), in European countries, at least one out of five people are exposed to noise levels which are directly harmful to health, and the social cost of transportation noise alone is 0.2–2 % of the gross domestic product (World Health Organization, 2018). Noise pollution is acknowledged as a major public health issue by international agencies and regulatory bodies, such as the WHO, the United Nations Environment Programme (2022), and the European Environment Agency (2020). This form of environmental pollution is linked to expanded physical and psychological problems for both adults and children, ranging from increased risk of sleep disturbance and cognitive impairment to psychiatric disorders and cardiovascular diseases, and even early death.

2. Noise is disrupting nature

Human-generated noise pollution also has important ramifications for the natural world, both terrestrial and aquatic, and for wildlife more broadly. The term “environment” is often used interchangeably with the

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ecological term “ecosystem”, as in a community of interacting organisms together with their physical surroundings (i.e., environs). Sound phenomena form a critical part of this interaction, with humans both contributing to, and degrading the soundscapes of the natural world. R. Murray Schafer once wrote that the “healthy give and take between sounds in the natural soundscape is disappearing from the modern urban world” (Schafer, 1994). Anthropogenic noise, in both urbanized and non-urbanized contexts, interferes with animals' communication and their ability to detect important sounds (Francis and Barber, 2013). Such mechanisms became even more obvious during the lockdowns due to COVID-19 around the world, because of the sudden reduction of human activity. For instance, research recently published in Science (Derryberry et al., 2020) found that traffic noise reduction in the San Francisco Bay Area of California led to change in white-crowned sparrows songs as they reclaimed frequency ranges previously occupied by traffic noise.

3. Soundscape: a sustainable approach to bridge the gap

This knowledge has, for the most part, originated from the realm of environmental and ecological acoustics and noise pollution (epidemiological) studies, with little attention given from the field of sustainability. This represents a major blind spot and leaves key questions unanswered and unlikely to be addressed without a step-change in policy, research, and practice. In a world of increasing urbanisation and looming climate change, urban soundscapes will continue to deteriorate and new challenges in noise pollution will arise – challenges which will require sustainable solutions and new ways of thinking beyond a traditional noise reduction approach. The soundscape framework does this by abandoning the view of noise strictly as a waste and considers sound holistically as a resource which forms a key component of healthy environments. The modern development of the soundscape concept was recently standardized by the International Organization for Standardization (ISO), where soundscape is defined as an “acoustic environment as perceived, experienced or understood by people in context” (International Organization for Standardization, 2014). Putting this approach into practice means engaging communities, interdisciplinary researchers, and policy makers towards providing soundscapes which support quality of life and enhance the efficiency and sustainability of cities and natural environments.

Based on a set of systematic literature reviews commissioned by the WHO, noise exposure thresholds at which direct health effects have been recorded have been set for different sources. For instance, the goal has been set to reduce traffic noise to below 53 dB(A) L_{den}[1] and aircraft noise to below 45 dB(A) L_{den}. Contrary to these goals, the Noise in Europe 2020 Report (United Nations Environment Programme, 2022) reports that no agglomerations in Europe have achieved these thresholds and there is a general scepticism in the scientific community about whether this is possible at all in the future, given that no improvement was seen between the 2014 and 2020 reports. It is predicted that the currently affected population of 113 million EU citizens exposed to road traffic L_{den} levels above 55 dB in 2017 will increase by 6.8 % inside urban areas and more than 16 % outside urban areas. This suggests that, realistically, we won't be able to achieve the WHO exposure goals soon, unless some drastic changes happen at societal level, which may include total shifts towards quieter or non-motorized mobility, within and between urban agglomerations. In the meantime, we will have to provide sufficient access to quietness for people and communities- this would require boosting the green infrastructure of cities. It will also be necessary to re-think how buildings work. Indoor space cooling is currently one of the major contributors to climate change, accounting for nearly 5 % of total energy consumption worldwide and around 1 gigaton of CO_2 in 2020 (United Nations Environment Programme, 2021). The proliferation of mechanical ventilation and cooling, as solutions to heat effects, would skyrocket global energy consumption, peak electricity demand, and GHG emissions, while providing new sources of noise inside and outside buildings. Among the principles suggested by the United Nations to reduce the environmental impact of indoor cooling, bio-climatic architecture and passive building design strategies must be implemented to avoid the use of active cooling as much as possible (United Nations Environment Programme, 2021). Natural ventilative cooling (in the simplest case, based on window opening) can overcome the risk of overheating inside buildings with little or no use of active cooling. However, this requires an outdoor environment that is not acoustically polluted in which to open windows to impede the onset of annoyance or other critical noise-related health outcomes identified by the WHO (World Health Organization, 2018).

4. Agenda

When delivering reduced noise exposures is not achievable, proximity and access to high-quality urban soundscapes should be prioritized as it can provide opportunities for stress recovery and restore attentional capacity after cognitive fatigue (Kaplan, 1995), thus leading to improved well-being and quality of life (UNESCO, 2017). But this requires attention to land use and careful urban sound planning. According to the EEA 2020 report, only 9.9 % of Noise Action Plans in Europe consider urban planning and infrastructure measures as potential solutions for noise exposure challenges, while only 7.3 % mandate access to green and quiet areas. These action plans address noise exposure by focusing on noise levels alone. By ignoring measures considering the holistic perception of cities, we reject proven and sustainable methods of action which also promote natural spaces and biodiversity. Current policy frameworks may both decrease biodiversity and fail to achieve their public health goals. To allow for the integration of soundscape and environmental goals into these Noise Action Plans, policy mandates should incorporate a wider array of indicators and targets. By integrating a combination of bioacoustics and human soundscape indicators, urban noise targets and strategies can be identified which provide environmental co-benefits, where a single strategy addresses multiple environmental benefits, both from the public health and environmental perspective. Potential human and bioacoustics indicators which would lead to these co-benefits and lead to a holistic approach to urban noise are currently being discussed in both the urban soundscapes studies and ecoacoustics communities (Kang, 2017; Farina, 2019) and should be incorporated in future policies and plans.

The 2020–2021 biennium marked the International Years of Sound, which coincided with increased public awareness of urban sound because of drastic alterations in soundscapes from the COVID-19 lockdowns. A recent publication by the United Nations Environment Programme listed noise pollution and soundscape quality as one of the main “Emerging Issues of Environmental Concern”, among other problems as serious as wildfires and phenology under climate change (United Nations Environment Programme, 2022). Now is the time to integrate sound into sustainability science, so that it may be considered proactively before it must be addressed reactively. The soundscape approach is the way forward, as it has promoted a healthy sonic integration between human societies and natural ecosystems. For this to happen, starting from the explicit connections that already exists across sustainability disciplines and goals (e.g., related to affordable and clean energy, climate action, life on land), we will need different scientific and practitioners' communities from a broad range of disciplines to come together and draft a more comprehensive and inclusive sustainability agenda.

CRediT authorship contribution statement

Conceptualization: Jian Kang, Francesco Aletta, Tin Oberman, Andrew Mitchell, Mercede Erfanian, Huan Tong, Simone Torresin, Chunyang Xu, Tingting Yang, Xiaochao Chen; Writing- Original draft preparation: Andrew Mitchell, Francesco Aletta, Tin Oberman, Simone Torresin; Supervision: Jian Kang; Writing- Reviewing and Editing: Jian Kang, Francesco Aletta, Tin Oberman, Andrew Mitchell, Mercede Erfanian, Huan Tong, Simone Torresin, Chunyang Xu, Tingting Yang, Xiaochao Chen.

[1] L_{den} is a time-averaged noise indicator over the day-evening-night period.

Data availability

No data was used for the research described in the article.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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