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IMPACT OF AVIATION NOISE ON HEALTH

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Abstract: Noise has always been a significant issue in airport areas, affecting residential dwellings, or even wildlife and ecosystems in areas surrounding airports. Aircraft noise in airport areas refers to aircraft generated noise during various phases of flight, including take-off and landing. The aim of this article is to highlight the impact of aviation noise on public health. The basics of aviation noise, the noise perception and context for the noise annoyance are presented, as simply as possible in this research article. This study also includes the aviation noise source that imply annoyance, as well as the relationships between physical mechanisms of noise and noise perception in order to describe and highlight aviation noise issues.

Keywords: noise, noise perception, annoyance, aviation noise source, health risks

INTRODUCTION

Acoustics is a scientific branch that studies sound, how it propagates and how it interacts with the environment. These include aspects such as the production, transmission and reception of sound, as well as phenomena associated with it, such as resonance, absorption and diffusion of sound. Sound is the result of the vibration of a solid, liquid or gaseous body. These vibrations locally induce a variation in atmospheric air pressure, which propagates and which the ear mechanism converts into information that is analyzed by the brain and perceived as sounds [1].

As a result, acoustics combines the description of mechanical phenomena with the physiological aspects related to the auditory sensation. Therefore, the mechanics and physiology of the auditory apparatus are inseparable for understanding and interpreting noise-induced auditory perception [1] [2].

Noise is defined as an unpleasant sound and excessive or prolonged exposure can lead to negative effects on human health, such as hearing damage, stress or sleep disturbances [1]. An important characteristic of noise is its intensity, which refers to the loudness of noise and is measured in dB (decibels) [3]. A louder noise corresponds to a higher intensity level of noise. Another property is spatial distribution [3]. Noise can be produced from various sources, e.g.: industrial machinery, construction, electronic devices, traffic and environmental factors such as wind or rain, that can damage the environment. This article deals only with air traffic – generated noise.

MECHANISM OF PRODUCTION OF AVIATION NOISE

Noise has always been a significant issue in airport areas, affecting residential dwellings, or even wildlife and ecosystems in areas surrounding airports. Aircraft noise in airport areas refers to aircraft generated noise during various phases of flight, including take-off and landing [4] [5].

Some of the important aviation noise sources include:

- Engine noise: The engines of an aircraft produce significant amounts of noise during all phases of flight, particularly during takeoff. This noise is generated by the combustion of fuel within the engine, as well as the interaction of the engine's moving parts, such as turbine blades and compressor fans, with the surrounding air. Jet engines, in particular, produce a characteristic high-pitched noise known as "jet noise." Each engine sub-component that contributes to engine noise is highlighted in Figure 1.
- Aerodynamic noise: As an aircraft moves through the air, it generates aerodynamic noise due to turbulence and airflow disruptions around the airframe, wings, control surfaces, and other components. This noise can be particularly pronounced during takeoff and landing, as well as at high speeds during cruise.
- Airframe noise: Various components of the aircraft's structure, such as landing gear, or detached high-lift devices (Figure 2), can also contribute to overall noise levels. For example, the extension and retraction of landing gear

and flaps produce noise, especially during approach and landing phases.

- Auxiliary systems: Other aircraft systems, such as air conditioning, hydraulic pumps, and auxiliary power units (APUs), can also generate noise. Even though these sources may be less significant than engine and aerodynamic noise, they can still have an important contribution to overall noise levels, especially on the ground.

The interaction of these sources of noise can result in complex acoustic characteristic of different aircraft types and operating conditions.

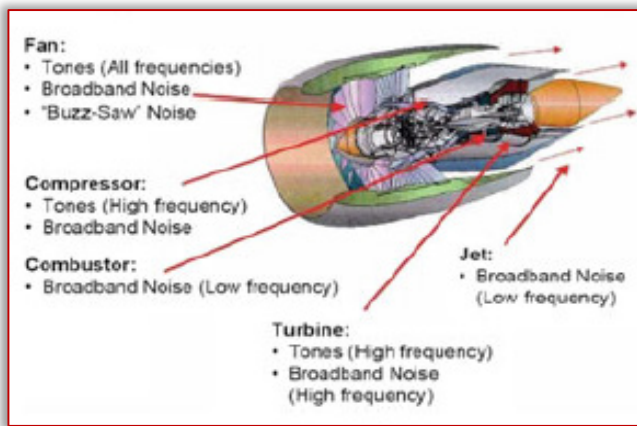


Figure 1. Engine noise source identification [5]

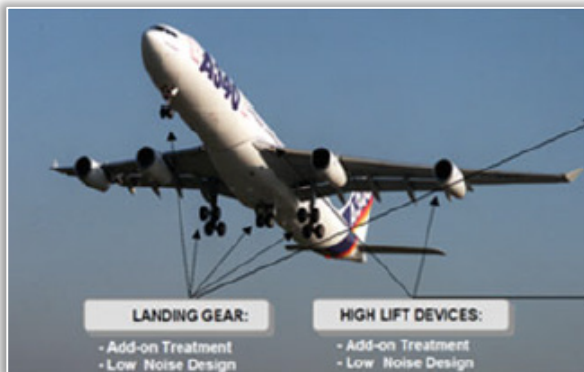


Figure 2. Airframe component noise contributions to total aircraft noise [5]

CONSEQUENCES OF AVIATION NOISE ON PUBLIC HEALTH IN EUROPE

According to the Environmental noise guidelines for the European region excessive noise exposure above noise levels of 45 dB Lden and 40 dB Lnight is an important environmental issue causing various health risks [6]. The relationship between health outcomes and aviation noise exposure has been evaluated by European Environment Agency (EEA), using exposure-response functions illustrated in Environmental noise guidelines for the European region [6]. According to World Health Organization (WHO) health statistics, aviation noise prolonged exposure can lead to:

- Hearing Loss: Prolonged exposure to high levels of noise, such as those generated by aircraft engines, can lead to hearing loss.
- Annoyance: Aviation noise can cause annoyance and dissatisfaction with the living environment, leading to reduced quality of life for individuals living in affected areas. Chronic exposure to noise-related annoyance can have detrimental effects on mental and emotional well-being [7].
- Sleep disturbance: Aviation noise, particularly during nighttime operations, can disrupt sleep patterns and lead to sleep disturbances such as difficulty falling asleep, frequent awakenings, and decreased sleep quality [7].
- Ischaemic heart disease (IHD), known as coronary artery disease (CAD) or coronary heart disease (CHD): Exposure to chronic noise, including aviation noise, has been associated with an increased risk of cardiovascular problems such as hypertension (high blood pressure), ischaemic heart disease, stroke and heart attacks. The stress response triggered by loud noise can rise blood pressure and heart rate, contributing to cardiovascular strain over time [7].
- Reading and oral comprehension issues for children: Living in noisy environments, including those affected by aviation noise, can contribute to increased levels of stress, anxiety, and depression. Persistent exposure to loud noise may also impair cognitive function and interfere with concentration and productivity, such as reading and oral comprehension for children [7] [8].
- Premature mortality due to IHD [7] [8].

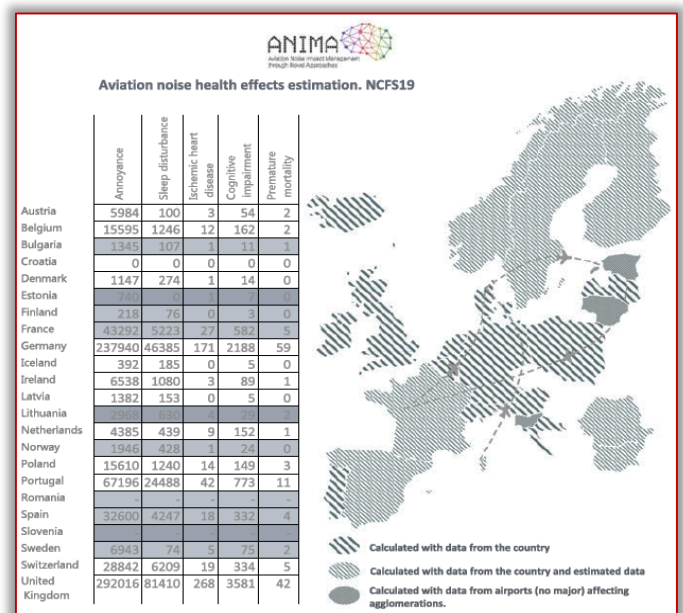


Figure 3. People affected by aviation noise in Europe [6]

All these consequences of aviation noise on public health in Europe are highlighted in Figure 3, which shows the estimated number of people affected by aviation noise across several European countries, based on calculations with data from the country, with data from the country and estimated data, or with data from airports affecting agglomerations.

These data are available in EEA 2019 Noise country fact sheets (NCFS).

ATTEMPTS AND REGULATIONS TO REDUCE AVIATION NOISE

Since the beginning of aviation, noise has been a major environmental problem that mostly affects the residential areas that surround airports. In general, environmental noise is a clear illustration of the unintended social and technological consequences of ongoing human growth, with clear negative behavioral and health effects on those who are exposed.

In Europe in particular, urban areas account for one-third of reported noise exposure problems (14–51% in EU States), which are primarily related to noise-related annoyance among the population [5].

A comprehensive and systematic approach developed by the International Civil Aviation Organization (ICAO) to address aircraft noise issues around airports is ICAO Balanced Approach [9]. Its main goal is to achieve an equitable balance between the need for aviation services and the desire to minimize the impact of aircraft noise on communities surrounding airports [9].

The ICAO Balanced Approach consists of four main components:

- Noise Reduction at Source (focuses on reducing aircraft noise emissions through technological advancements in aircraft design, engine technology, and operational procedures),
- Land Use Planning and Management (which involves land use planning and zoning regulations to minimize the exposure of communities to aircraft noise),
- Noise Abatement Operational Procedures (focuses on the implementation of operational measures to minimize aircraft noise during takeoff, landing, and taxiing) and
- Operating Restrictions (involves the establishment of operating restrictions and limitations on aircraft operations to manage aircraft noise impacts effectively) [5] [9].

The ICAO Balanced Approach highlights the importance of cooperation among national

governments, aviation authorities, airport operators, airlines, local communities, and industry stakeholders, to develop and implement effective noise management strategies.

It recognizes that no single measure can fully address aircraft noise issues and that a balanced combination of measures is necessary to achieve meaningful noise reduction while maintaining the viability and growth of the aviation industry [10] [11].

CONCLUSIONS

Aviation noise is an unpleasant sound produced by aircraft during various phases of flight, including take-off and landing. It is a significant source of environmental noise pollution, particularly in areas surrounding airports and along flight paths.

Aviation noise can have several adverse effects on communities and environment, including health impact and environmental concerns. Efforts to mitigate aviation noise include implementing reducing noise procedures, by using quieter aircraft and engine technologies, optimizing flight paths, and implementing land use planning measures to minimize noise impacts on surrounding communities.

Overall, reducing aviation noise is essential for protecting public health, improving quality of life, mitigating environmental impacts, promoting social equity, and ensuring regulatory compliance.

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