

Overview of aviation noise impacts and the recent work of CAEP's Impacts and Science Group (ISG)

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Opinions, findings, conclusions and recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of ASCENT sponsor organizations.



Outline



- Overview of Aviation Noise Impacts
- The CAEP Impacts and Science Group
 - What it is
 - Current work and current literature
- Noise mitigation recommendations

Primary Reference

- M. Basner, C. Clark, A. Hansell, J. Hileman, S. Janssen, K. Shepherd, V. Sparrow, "Aviation noise impacts: State of the science," *Noise and Health*, 2017; 19: 41-50, doi: 10.4103/nah.NAH_104_16.

Results will primarily be discussed in terms of *associations* and not *correlations*.



- The statistical finding of an **association** means that two variables are related.
 - Whereas, the statistical finding of a **correlation** indicates the *strength* of the relationship between the variables
- For research investigating links between noise and impacts, **correlation** is usually too strong of a term to use
- **Associations** are the best we have since it is difficult to have large enough *sample sizes* in this type of research to obtain *highly statistically significant* findings
- NOTE: associations do not necessarily mean **causation**.

Community Annoyance [Basner, et al., 2017]

- An average evaluation of the annoyance across a community
- Must distinguish ***annoyance*** vs. ***complaints***:
 - Annoyance: a privately held opinion
 - Complaints: an overt action (but does not represent a cross-section of the community)
- Main indicator: Percentage of individuals highly annoyed (%HA)
- Exposure response relationship: Usually “day night average noise exposure level,” L_{DN} .
- It may or may not be true, but **equal energy hypothesis** is assumed: many quieter events can equal fewer loud events



<https://acousticsresearchcentre.no/predicting-aircraft-noise-annoyance-2/>

Non-acoustical Factors [Basner, et al., 2017]

- Only a portion of annoyance is directly linked to sound exposure!
- Remember, annoyance is an opinion.
- Non-acoustical factors include:
 - Noise sensitivity
 - Age
 - Fear
 - Necessity of the noise source
 - Ability to cope with the noise
 - Trust in authorities
 - Previous experiences of noise
 - Future expectations of noise



<https://www.hearlink.com.au/industry-news/new-study-says-noise-sensitivity-dependent-your-brain>

Children's Learning [Basner, et al., 2017]

- Aircraft noise exposure at school OR home is associated with poorer reading and memory skills.
- Performance on standardized achievement tests is poorer for students exposed at school.
- Research findings indicate that even small reductions in noise levels will likely improve reading comprehension.
- Regarding interventions, aircraft noise effects on cognitive performance seems reversible, if noise stops.



Sleep Disturbance [Basner, et al., 2017]

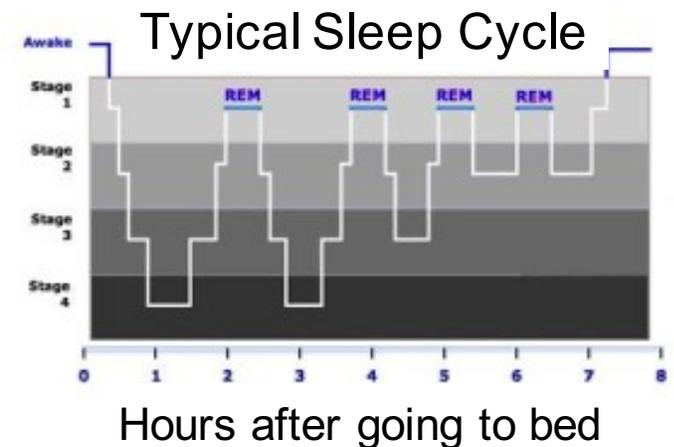
- Sleep is a biological imperative.
- Evidence clearly shows chronically disturbed sleep is associated with negative health outcomes such as obesity, diabetes, or hypertension (high blood pressure).
 - Sleep disturbance is considered the most deleterious non-auditory effect of environmental noise.



chittagongit.com/icon/sleep-icon-png-11.html

- Mechanism is noise-induced arousals that change the sleep structure:

- Delayed onset
- Early awakening
- Less deep and REM sleep stages
- More time in superficial sleep



pipelineperformancegroup.com/blog/the-sleep-cycle/

- More at risk: elderly, children, shift-workers, chronic illness
- SPLs as low as ~ 35 dBA can induce physiological reactions.

Health Impacts [Basner, et al., 2017]

- Mechanisms:
 - Physiological response via the nervous system
 - Stress from annoyance
 - Disturbed sleep
- Clear associations between noise and both heart disease and stroke occurrence
- Also association between noise and hypertension
 - A number of studies have linked increased blood pressure to nighttime aircraft movements, but some studies have high bias.



www.healthline.com/health/high-blood-pressure-hypertension

- **Very difficult to quantify these impacts at this time.** There are not enough high-quality studies for aircraft noise.

- 20-30 years from now we may regularly hear low-amplitude sonic booms in addition to today's aircraft noise.
- Have good understanding of noise impact from traditional (N-wave) sonic boom, such as from Concorde.
- **Poor understanding of noise impact from these new quiet low-boom aircraft**
- NASA is building the new X-59 low-boom demonstration aircraft to carry out community noise tests 3 or 4 years from now.
- RUMBLE (RegUlation and norm for low sonic Boom LEvels) is new EU project to study low-boom sonic booms.

CAEP's Impacts and Science Group



- The Committee on Aviation Environmental Protection (CAEP) is a technical committee from ICAO (International Civil Aviation Organization), the UN specialized agency for international civil aviation matters.



- The Impacts and Science Group (ISG) aims to inform CAEP of best consensus external scientific information regarding aviation environmental impacts, including noise.
- CAEP meets every 3 years, and ISG reports to CAEP each cycle.
- ISG was formed as a follow-on to a Feb. 2007 Workshop in Montreal, Canada on aviation environmental impacts:
 - Maurice L. Q., Lee D. S. (eds) 2009. Assessing Current Scientific Knowledge, Uncertainties and Gaps in Quantifying Climate Change, Noise and Air Quality Aviation Impacts. Final Report of ICAO CAEP Workshop, US Federal Aviation Administration and Manchester Metropolitan University, Washington DC and Manchester.

Aviation Noise Impacts Workshops



- Workshops under the auspices of ICAO/CAEP/ISG
 - Invited only to allow for open discussion of sensitive issues
- Feb. 2015 workshop: Washington, DC, USA
 - 4 focused sub-topics:
 - Noise Impacts
 - Air Quality Impacts
 - Aviation Impacts on Climate
 - Climate Impacts on Aviation
- Nov. 2017 workshop: Montreal, Canada
 - 1 sub-topic:
 - Noise Impacts, including additional topics:
 - Helicopter noise
 - More details on supersonics
 - Monetization of aviation noise

Noise Impact White Papers



- 2016 CAEP White Paper became [Basner, *et al.*, 2017].
 - Quoted extensively in this presentation
 - Specific to aviation noise
- 2019 CAEP White Paper will become a similar paper
 - White paper on aviation noise impacts in preparation, not available yet
 - Some contents will be taken from new **WHO evidence reviews** for ALL transportation noise sources, recently published (2017-2018) in *Int. J. Env. Res. & Pub. Health* with titles beginning “WHO Environmental Noise Guidelines for the European Region, A Systematic Review on . . .”:
 - Basner, *et al.*, “Environmental Noise and Effects on Sleep,” doi:10.3390/ijerph15030519
 - Guski, *et al.*, “Environmental Noise and Annoyance,” doi:10.3390/ijerph14121539
 - van Kempen, *et al.*, “Environmental Noise and Cardiovascular and Metabolic Effects: A Summary,” doi:10.3390/ijerph15020379
 - Clark, *et al.*, “Environmental Noise and Cognition,” doi:10.3390/ijerph15020285
 - Nieuwenhuijsen, *et al.*, “Environmental Noise and Adverse Birth Outcomes,” doi:10.3390/ijerph14101252
 - Brown, *et al.*, “Transport Noise Interventions and Their Impacts on Health,” doi:10.3390/ijerph14080873

Mitigating Noise [Basner, et al, 2017]



- Numerous studies agree that mitigation of the noise at the source is best when possible.
- Introducing flight procedures to minimize radiated noise is helpful to alleviate noise from existing aircraft.
 - For sleep: nighttime curfews are also effective (but drastic, so should be carefully considered)
- Passive sound insulation of homes is expensive (last resort), but it can work.

Sparrow's Suggestions for Design:



He once did aeroacoustics, many moons ago. . .

- Decrease the amplitude whenever possible
- Shorten duration for extended high levels of sound
- Minimize distinct tones if possible
- A smoother sound is usually more appealing than a shocked or crackly one
- Lower absolute velocities and relative velocities are quieter

None of this should be surprising . . .

Summary



- Aviation noise impacts are real !
- There is a lot of carefully researched, peer-reviewed information on aviation noise impacts.
- CAEP ISG is trying to encapsulate the consensus science developed worldwide to determine how much aviation noise is too much.
- The work you are doing to alleviate noise is really important. Thank you for your efforts!

Acknowledgments



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Thank you!

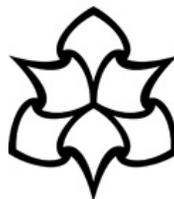
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