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

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

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.

• 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

• 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.

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

[www.healthline.com/health/high-blood-pressure-hypertension](http://www.healthline.com/health/high-blood-pressure-hypertension)
Future Supersonic Aircraft [Basner, et al., 2017]

• 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:
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

  – 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

• 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!
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Thank you!

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