The economic and social value of aircraft noise effects: a critical review of the state of the art

Diana Sanchez – Head of Knowledge Leadership, Anderson Acoustics, UK.
Bernard Berry – Director, Berry Environmental, UK.
Contents

1. What the economic value of noise is?
2. Why it is important?
3. How to undertake monetisation?
4. Approaches for the economic valuation
5. Estimates for London Airports
6. Conclusions
What is the economic value of noise? Is it possible to valuate noise?

- Noise does not have a market price, but it has a value.
- **Value are not the same as prices**
- Values are a measure of benefit, utility, pleasure… provided by a good or service to a human being
- Prices depend on values. Values depend on judgments.
- Values are generally measured relative to a currency (money).
- Need of a monetary value for aircraft noise effects: positive and negative social consequences.
1. Why it is important?

✓ Only acousticians understand all the various metrics and descriptors for sound and its impacts.

✓ Provides a common language across all aspects of sustainable airports management

✓ Enables comparison and contextualisation of noise in sustainability.

✓ Input to inform decisions & policy making (CBA)

✓ Helps us to understand the balance between the benefits and negative effects of aviation.

✓ Pivotal role in ongoing UK Aviation Policy

“The Government wants to strike a fair balance between the negative impacts of noise and positive economic impacts of flights”
3. How to undertake monetisation?

- **Association**
  - Sufficient strength of evidence

- **Causality**
  - Robust dose-response & thresholds

- **Monetisation approaches**
  - DALY – £, $
  - WTP / WTA

- **Interpretation**

---

**Acknowledgement of uncertainties and limitations**
Approaches for economic valuation:...

**DALY: Disability-Adjusted Life Years**

- Economic measure the cost of lost productivity caused by exposure to pollutants
- One lost of “healthy” life
- DALY Includes mortality (YLL) & morbidity (YLD)
- Weighting and discounting

**Social preference: WTP / WTA**

- **Revealed Preference**
  - Hedonic Price
  - Changes in house prices as proxy of cost of noise
- **Stated preference**
  - Contingent valuation / Choice Modelling Questionnaire based surveys

**Health**
- Annoyance
- Sleep disturbance
- AMI
- Hypertension

“Social preference on aircraft noise”
Review of the approach for each effect:

- Cardiovascular disease:
  - Acute myocardial infarction (AMI)
  - Hypertension (HT)

- Sleep Disturbance (SD)

- Annoyance (A)
## Analysis / Interpretation

<table>
<thead>
<tr>
<th>Syndrome</th>
<th>Association</th>
<th>Methodology</th>
<th>DALY</th>
<th>Analysis / Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMI</td>
<td>Sufficient</td>
<td>2014 Babisch OR</td>
<td>DALY</td>
<td>Analysis / Interpretation</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Road traffic</em></td>
<td>• DW: 0.405</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR= 1.08 per 10dB</td>
<td>• 72% of cases is fatal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>55 - 77dB(A) L\textsubscript{den}</td>
<td>• AMI risk: 0.0596%</td>
<td></td>
</tr>
<tr>
<td>HT</td>
<td>Sufficient</td>
<td>2012 WHO pooled curve</td>
<td>Harding 2013 /QALY</td>
<td>Analysis / Interpretation</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Aircraft noise</em></td>
<td>• HT outcomes: stroke dementia &amp; AMI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>OR= 1.06 per 5dB</td>
<td>• OR into relative risk</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>47.5 -67.5 dB(A) L\textsubscript{den}</td>
<td>• HT prevalence &gt;10%</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>Sufficient</td>
<td>%HSD</td>
<td>DALY</td>
<td>Analysis / Interpretation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WHO from Miedema</td>
<td>• DW: 0.04 to 0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>45 - 70dB(A) L\textsubscript{night}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Sufficient</td>
<td>% HA</td>
<td>DALY</td>
<td>Analysis / Interpretation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EU position paper &amp; WHO</td>
<td>• DW: 0.01 to 0.12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>45 – 75 dB(A) L\textsubscript{den}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Multiple uncertainties associated
An example: AMI

<table>
<thead>
<tr>
<th>Association</th>
<th>Causality</th>
<th>Monetisation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Noise can be a risk factor for CVD</td>
<td>• 2014 Babisch OR</td>
<td>• Correlation ≠ causality</td>
</tr>
<tr>
<td>• Studies indicate links form exposure to high levels of AN</td>
<td>• Road traffic</td>
<td>• Confounders</td>
</tr>
<tr>
<td></td>
<td>• OR= 1.08 per 10dB</td>
<td>• Preliminary / indicative results</td>
</tr>
<tr>
<td></td>
<td>• 55 - 77dB(A) L\text{den}</td>
<td>• More research on aircraft noise</td>
</tr>
<tr>
<td></td>
<td>• From meta analysis of 12 studies</td>
<td></td>
</tr>
<tr>
<td>• Confounders and modifiers</td>
<td>• Causal link has no conclusively proven</td>
<td></td>
</tr>
<tr>
<td>• No evidence of effects on children</td>
<td>• Uncertainties in pooling studies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Confounders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• AMI: D-R for road traffic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• DALY inherent limitations (e.g. do not capture other aspects of disease)</td>
<td></td>
</tr>
</tbody>
</table>

- DALY (ERCD)
  - Exposure data
  - Estimate number of AMI cases (using D-R)
  - YLL= Cases * mortality rate * average loss of life per death
  - YLD= Cases * DW * surviving AMI likelihood
  - 1 DALY = £ 60,000 (UK)
Pooled AMI OR Babisch 2006 vs. 2014. Road traffic noise

<table>
<thead>
<tr>
<th>Year</th>
<th>Studies</th>
<th>Exposure range</th>
<th>OR</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>12 studies &amp; 17 estimates Male &amp; female</td>
<td>&lt;50 to 75 dB(A)</td>
<td>1.08</td>
<td>&lt;=55 dB(A) to 77 dB(A) $L_{den}$</td>
</tr>
</tbody>
</table>
AMI cost estimations step by step

- Exposure data = $L_{Aeq}$ 16 Hrs
  
  - Number of AMI cases = $\sum (\text{ORAMI} \times \text{Population}) \times \text{AMI risk}$

  Where:
  - OR means Odds Ratio (Babisch one) estimated for each noise level
  - AMI risk = 0.0596% (for UK estimated from mortality data and risk of death from an AMI)

- YLL = No. of AMI cases * AMI risk of death * average loss of life per death

- YLD = No. of AMI cases * DW * likelihood of surviving an AMI
  
  Where: DW = 0.405 according to WHO.

- Number of DALY = YLL + YLD

- Monetary cost of a DALY = number of DALY * €76,200

- 2006 and 2011 DEFRA and CAA noise maps contours
- Lower threshold depended on availability of data:
  - AMI: $55\text{dB} \ \text{L}_{\text{Aeq}}, \ 16 \ \text{hrs.}$
  - Annoyance: $55 \ \text{dB(A)} \ L_{\text{den}}$
  - Sleep Disturbance: $50 \ \text{dB(A)} \ L_{\text{night}} \ 8\text{hrs}$
- Contours use different data set for population. However, this was the only consistent available information across airports
  - 2006 noise maps are based on 2001 UK Census
  - 2011 are based on 2011 UK Census.
- Since data was available at 5dB steps, mid points values were chosen for each band.
Annoyance cost ranges from €200m to €1.2bn. What does this mean?

IGCB(N) estimated the total cost from environmental noise in England as approx. €7bn; aircraft noise from London Airports represent between 4% & 17%
Change in cost between 2011 & 2006: Net benefit for AMI; marginal net cost for annoyance and sleep disturbance

Change in cost of aircraft noise effects 2011 vs. 2006

-8% -6% -4% -2% 0% 2% 4% 6% 8%

AMI €  Sleep Disturbance €  Annoyance €
5. Conclusions: Monetisation process

- Monetisation of aircraft noise effects on health is a complex process. Consideration of uncertainties and limitations is a key part of it.
- There are no universally accepted methodologies.
- Monetisation should be used to enhance understanding of trends rather than absolutely quantify a value of a specific health effect.
- No definite conclusions can be given on an absolute cost of aircraft noise around airports.

**Challenge:** How to aggregate different cost in relation to understanding the balance between positive and negative effects of aviation?
5. Conclusions: Application of monetary values

- Provide input for decision making, They are NOT a decision itself.
- **Precautionary principle** – deliver responsible airport’s operations
- Analysis of monetary values should be **contextualised** to local conditions
- Could be used to guide **mitigation and compensation** budgets
- Sustainable noise management should be based on a **generous and responsible** approach
- Suggest to have an UK expert group for monetising aircraft noise effects.
Thank you for your kind attention!

**Diana Sanchez** – Head of Knowledge Leadership
Anderson Acoustics
dianasb@andersonacoustics.co.uk

**Bernard Berry** – Director
Berry Environmental
bernard@bel-acoustics.co.uk