The economic value of aircraft noise effects: a UK perspective

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ABSTRACT

The quantification of the effects of aircraft noise on health and quality of life and the associated monetisation of those effects has taken on significance as a major field of study with important implications in policy making and business management. Good quality studies have been conducted in this matter. Although these studies have enriched the understanding of the magnitude and complexity of this matter, several gaps remain, challenging decision making on aircraft noise management at macro and micro levels. This paper is part of a series of papers on understanding and communicating the exposure to, and impacts from aviation noise and developing a balanced scorecard for informed decision-making. In particular, this paper aims to provide an overview of the most up to date and robust monetisation methodologies and the context for its application to UK aviation policy. It presents some estimates for London Airports to show the change in the cost of aircraft noise effects on health and annoyance over 5 years. We suggest a set of principles and a process that can guide monetisation efforts of aircraft noise effects. We argue that monetary values should be considered as indicative and should only be used to understand trends rather than quantify the effects in an absolute sense.

Key words: Aircraft Noise Effects, Monetisation, Sustainability. I-INCE Classification of Subjects: 62.5, 66.1, 67.4

1. INTRODUCTION

The monetisation of the effects of aircraft noise on health and quality of life is a recently new area of study that has been developed independently for each type of effect analysed. It has emerged as a key issue in the sustainable aviation policy agenda as the industry continues to growth. Our latest research explores this same issue [1].

Monetisation of the effects of aircraft on health is a recent field of research, which has partly been driven by the need of adequate public policies that minimize the potential adverse effects from noise on health. Nevertheless, limitations on the scientific evidence base to establish causal relationship and thresholds have prevented the calculation of accurate monetary values [2].

Despite the complexities and limitations there is an increasing need for a better understanding of the various effects of aircraft noise on health, their relative significance and the communication of this information to communities. Monetisation of the effects of aircraft noise on health and quality of life plays a key role in this effort.

This paper aims to provide an overview of the most up to date monetisation methodologies and the context for its application at the UK aviation policy. We suggest a set of principles and a process that can guide monetisation efforts of aircraft noise effects. Also, we present monetary estimates for selected London Airports as a reference for future calculations. We argue that these should to understand trends rather than to quantify the effects absolutely. This paper is part of a series of papers on understanding and communicating the exposure to, and impacts from aviation noise and developing a balanced scorecard for informed decision-making [3].

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2. RELEVANCE OF MONETISATION AND UK AVIATION POLICY

The worldwide air transport industry is expected to grow from 5% to 6% over the next 20 years. In the UK, forecasts predict a significant growth in demand for aviation between now and 2050, bringing the London airport system under very substantial pressure in 2030 and exceeding capacity by 2050 [4].

This forthcoming growth leads to important economic benefits that will continue to boost UK economic prosperity and the local economy of surrounding airport communities. However, it will also leads to negative side-effects on the environment and local people.

Noise has been identified as the most important issue by far for local communities above safety, air pollution or local employment [5].This has put noise on the top of management and political agenda, urging a better understanding of the extent of aircraft noise effects and the role it plays within a sustainable aviation policy. Monetary values seem to appear as a useful tool in balancing the cost and benefits of airport operations and their externalities.

In 2012 the UK Government set up an Independent Commission tasked with identifying and recommending options for expanding UK airport's capacity. Three shortlisted options were announced at the end of 2013, two at Heathrow and one at Gatwick Airports as possible locations for a new runway. The objective of the Government is to strike a fair balance between the negative impacts of noise and positive economic impacts of flights [4].

For this, the Commission is undertaking a Sustainability Appraisal [6] for those three options, which incorporates monetising effects from aircraft noise on annoyance, sleep disturbance and cardiovascular diseases. After consultation, the Commission recognised the limitations of their initially proposed methodologies, in particular relating to hedonic pricing for monetising aircraft noise annoyance. In turn, it determined to follow the Disability-adjusted life years (DALY) approach presented in the latest WHO report [7].

Monetary values of aircraft noise effects can provide a common language to assist sustainability appraisal and policy making and analysis. They also enable comparison and contextualisation of noise in sustainability policy and management, by helping to understand the balance between benefits and negatives effects of aviation.

3. AIRCRAFT NOISE EFFECTS – OVERVIEW

Human response to noise is very complex and varies between people and places. The extent of the response is influenced by many elements, besides the pure acoustical ones, such as personal, attitudinal and social factors.

The link between noise effects and potential impacts is neither simple, nor linear, as commonly presented. It depends on how one effect can modify another, the cumulative exposure and individual sensitivity to noise, the risk factors associated with health conditions and the influence of modifiers and cofounders factors [8]. This results in a complex web of pathways between noise and health and means that there is no simple cause-effect model between aircraft noise exposure and health impacts.

The evidence base that supports a link between each particular health outcome and noise exposure has developed independently. Table 1 presents the strength of evidence of effects of aircraft noise on health, in terms of specific cause-effect pathways. This table is based on author's reviews of key international guidelines from WHO and European Commission [2, 7, 9, & 10]. The standardised evidence categories are those used by the WHO.

While the literature on non-auditory effects of aircraft noise exposure is extensive, the scientific evidence to establish a causal relationship and associated thresholds is limited for some effects. Conclusions from the 2014 ICBEN Conference highlight that future research should focus on large-scale cohort studies that investigate causality, since there is enough evidence to indicate a link. There is a need to improve understanding on mechanism of co-exposures, influence of modifiers and confounding factors, habituation, role of annoyance in health pathways and the short and long term effects from noise exposure. No agreement exists on the robustness of dose – response relationships and the definition of thresholds [2].

Table 1- : Summary of strength of evidence that supports an association

Health Effect		**Strength of evidence**	**Issues**
Annoyance (indirect; psychological, psychosocial)		Sufficient	Complex interaction with other health effects and non-acoustic factors. Debate on metrics and scope of analysis
Sleep disturbance (indirect; psycho-physiological)	Awakenings	Sufficient	A number of awakenings are normal. No agreement on threshold levels
	Self-reported	Sufficient	Subject to bias
	Long term effects and performance	Inadequate / Lacking	Complex mechanisms underlying long-term effects. No conclusive evidence of decrements in chronic objective long term effects
Cardiovascular (indirect; physiological)	Acute Myocardial Infarction – AMI Hypertension Coronary Heart Disease	Sufficient	Aircraft noise may be a risk factor for CVD, but not causal link has been conclusively proven. No evidence of effects on children Importance of confounding factors
Cognitive development (indirect; physiological)	Adults	Inadequate / Lacking	Lack of data; no firm conclusions can be drawn
	Children	Sufficient	Evidence from primary school reading age and recognition memory in the short term. Uncertainties on the existence of long term effects. The scale of effect is relatively small compare with other "life events"
Mental health (indirect; psychological)		Lacking	Some evidence of symptoms, but not of severe clinical disorders
Hearing impairment (direct; physiological)		None	No effects at environmental noise levels <75dB (A)

4. MONETISATION OF AIRCRAFT NOISE EFFECTS

In the UK, the Interdepartmental Group on Cost and Benefits Noise subgroup- IGCB(N), a DEFRA led group, was established to provide advice on the economic evaluation of noise and ensure that noise impacts are appraised consistently. The IGCB(N) has provided guidelines on effects can be part of a valuation methodology [11]. However, some gaps still remain on how to address:

- The multiple uncertainties in dose-response relationships
- The identification of the most appropriate economic valuation methods; and
- The interpretation and application of results into public policy.

The following sections of this paper outline a general framework for monetising aircraft noise effects and provide specific in depth analysis for each particular effect.

4.1 What do we need for monetisation?

In order to define whether or not is possible to include specific noise related effects as part of an economic valuation framework it is fundamental to have:

- ✓ A sufficient strength of evidence that supports the link between each particular health outcome and noise exposure
- ✓ Robust dose-response relationships to quantify the link and ideally accounts for causality
- ✓ A monetisation methodology appropriate for each effect
- ✓ Analysis and interpretation of results

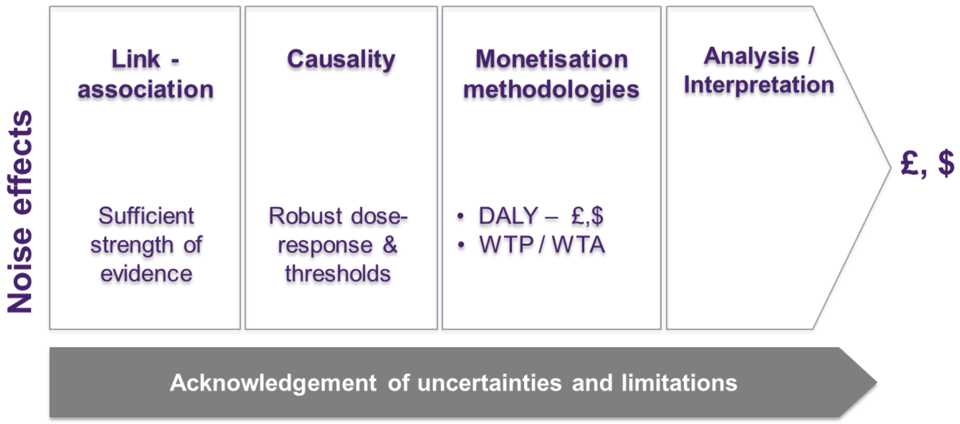

Figure 1: Monetisation Process

This can be understood as the basic process to follow when planning and undertaking monetisation of noise effects. In order to responsibly orient noise management or policy decisions, it is important that policy makers are aware of the many limitations and uncertainties that results may have. It is important to note that this is complex field of work that requires the interaction of academics, practitioners and policy makers.

4.2 Approaches for monetisation

The monetisation of aircraft noise effects can be split in two types of approach.

One approach relates to the cost of lost productivity caused by exposure to aircraft noise, which commonly requires the estimation of the Disability Adjusted Life Years (DALY) as suggested by the WHO. The DALYs combines mortality and morbidity into a single numerical unit. The IGCB(N) recommends the UK monetary cost per DALY to be £60,000 [11], which represents the economic value in terms of loss in productivity (due to either early mortality or due to disability).This is an approach used for quantification and associated monetisation of aircraft noise effects on health.

The other approach relies on the estimation of the willingness to pay to avoid (WTP) or to accept (WTA) a certain level of noise, which can be undertaken using either revealed preference (e.g. hedonic pricing, HP) or stated preference - SP (e.g. contingent valuation) techniques. HP uses house market prices as a proxy of the preference that consumers revealed for noise. SP uses questionnaires in which people state their preferences based on hypothetical situations. This approach is commonly used to monetise the "cost of aircraft noise", without a specific reference to any particular effect.

Figure 2 summarises the above-mentioned approaches for monetising the effects of aircraft noise on health and quality of life.

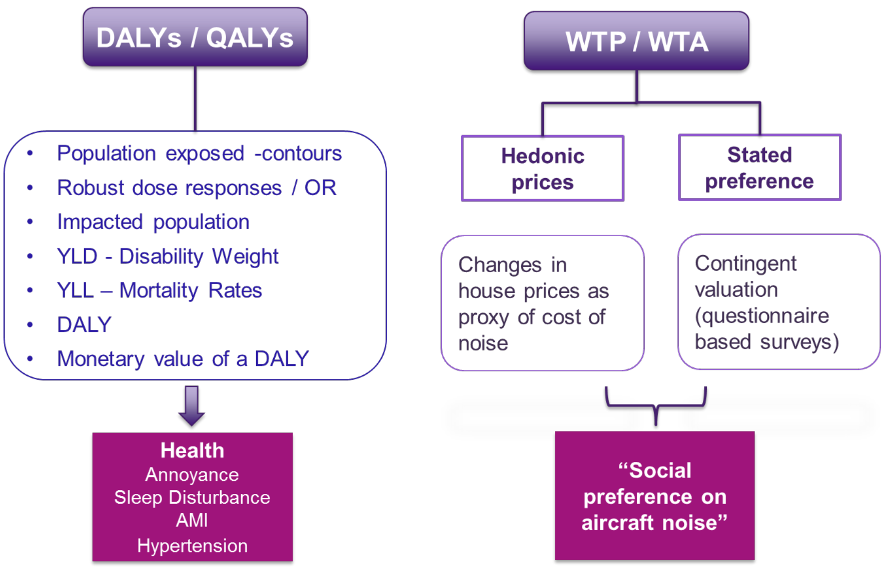

Figure 2: Approaches for monetisation

The following sections illustrate how relationships can be applied in economic valuation for the aircraft effects in which sufficient evidence supports a link. Limitations for each approach will be addressed for each particular effect.

4.3 Cardiovascular disease: Acute Myocardial Infarction and Hypertension

According to Babisch [12], the hypothesis that chronic long-term exposure to environmental noise increases the risk of cardiovascular diseases has been confirmed in large epidemiological studies. However, the relationship specifically to aircraft noise is much less well understood. Recent studies indicate links to increased risk rather than causal relationships, but there are many confounding factors that have not been isolated at this time [13, 14].

Babisch [12] points out that the relevance of cardiovascular effects over annoyance and sleep disturbance should drive future research and noise policy efforts. Although in terms of scale and numbers of people affected, CVD effects are lower than annoyance or sleep disturbance effects; their severity is greater since they include risk of mortality.

In the UK, the work done by IGCB(N) suggests that noise effects on cardiovascular diseases can be applied into monetary valuation using DALYs. This has been updated with recent research, specifically related with hypertension effects [15]

4.3.1 Acute Myocardial Infarction – AMI

Cardiovascular effects related with Acute Myocardial Infarction- AMI can be monetised by using the 2006 Babisch relationship derived from road traffic exposure. At the present, no other alternative exists than to take the AMI risk curves derived from road traffic noise studies as an approximation for aircraft noise [7, 11, 16]

There are multiple uncertainties and sensitivities associated with the use this curve, most of them related with the variability on responses across population due to differences in individual noise sensitivities, the role of habituation, effects from air pollution and other non-identified confounders.

4.3.2 Hypertension - HT

The latest study from Harding [15] has contributed to IGCB(N) work, by identifying three noise-related hypertension (HT) outcomes (AMI, stroke and dementia) and proposing a method for monetisation of those effects using the quality adjusted life years (QALY) approach.

In their methodology, Harding used van Kempen & Babisch 2012 [17] pooled estimate as a first step in quantifying the link between environmental noise and HT. To quantify each outcome, the risk of HT associated with an increase of noise levels above 55dB $L_{Aeq\ 16\ hours}$ was combined with the risk associated with HT for AMI, stroke and dementia.

Monetisation was undertaken using the “QALY loss” approach. This is a similar measure to DALYs, which instead of disability weights (DW) uses health weights. The monetary cost of a QALY lost was estimated as £60,000, which represents the value of a life recommended by the Department of Health and used across UK government.

This study estimated that the cost of additional HT-related cases due to environmental noise exposure in the UK was around £1.09bn, providing and insight into the scale of health impacts due to environmental noise exposure.

This study shows that if substituting van Kempen & Babisch risk estimates with Babisch & van Kamp 2009 [18], the total impact of environmental noise on HT in the UK increases to £2.53 billion. This is because Babisch & van Kamp 2009 estimates used L_{den} rather than $L_{Aeq\ 16\ hours}$ and proportion of UK population exposed to noise above the recommended level is greater for Lden (67%) than for L_{Aeq} (54%)

The main limitations of this methodology are the use of non-aircraft risk rates (van Kempen & Babisch) and uncertainties on availability of data.

4.4 Sleep Disturbance

The scientific community appears to agree that noise-induced sleep disturbance responses vary significantly from one individual to another. There is no agreement on a single relationship to inform an economic valuation methodology [11,19]

A recent paper presented by Basner [20] in ICBEN 2014 Conference showed half of the variance in response is due to inter-individual differences, meaning that the relationship between night- time aircraft noise and sleep disturbance depends on individual noise sensitivity. The same study developed different dose-response relationships for each noise sensitivity levels. This may have important consequences on night noise regulation, which should not be based on average responses. Policy makers should include these findings when reviewing and updating policy.

In the UK, the CAA developed a methodology to evaluate the loss of productivity resulting from sleep disturbance [21]. This uses the percentage highly sleep disturbed function (%HSD) for L_{night} from the EU Position Paper on night time noise [22], derived from Miedema work [23] and used by the WHO in the calculation of the Burden of Disease [7]. The basic principle is to determine the additional cost or net benefit of a proposed policy measure compared with a baseline, for these health outcomes using DALYs and its associated monetary value.

A major limitation relies on the use of a unique relationship to all airports and cases. There are also uncertainties associated with the high degree of unexplained variance and bias that results poses. This is due do the large uncertainty interval for the disability weight (which ranges from 0.04 to 0.1) and because the %HSD is based on self-reported studies. How to weight universally a subjective and self-reported impact comes again as one of the most concerning issues around these methodologies.

4.5 Annoyance

Quantification and monetisation of effects of aircraft noise on annoyance is currently one of the most debated issues regarding aviation impacts in Europe and UK in particular.

Regarding its quantification, results from EU COSMA study concluded that no annoyance curve can represent the annoyance situation of all airports, highlighting the validity of official curves used in the EU and US for such a process [24]. This is due to the increasing role of non-acoustic factors for predicting annoyance. Research has shown that when including those factors into the prediction model, the percentage explaining aircraft annoyance increases from 20 % to over 50% [25].Cultural differences and variation on noise sensitivity are shown to explain variances of aircraft noise annoyance among airports [26].Variations in individual annoyance reactions to the same noise level shows that annoyance may be a local issue [27].

There have also been important developments in recent years with the emerging concept of Community Tolerance Level [28]. This concept is currently being applied in a major revision of the International Standard ISO 1996, expected to be published at the end of 2014 [ref to be supplied]

These findings could have important consequences for current Noise Aviation Policy, at least in the EU, where one might expect that the annoyance curve could be updated in line with recent research.

Generally there are two approaches for monetising the effects of aircraft noise on annoyance; one is the estimation of the Burden of Annoyance and other is the calculation of the WTP / WTA [1]. Nevertheless, the UK Airports Commission established the Burden of Annoyance as the approach to follow for policy appraisal of annoyance effects from aircraft noise [6]. This paper updates previous publications and follows the same approach to that suggested by the Commission in the UK.

The Burden of Annoyance combines exposure data, with the EU Position Paper on dose-response relationship between aircraft noise and annoyance and a disability weight (0.02, with a large uncertainty interval of 0.01 -0.12), to estimate the number of DALYs.

The main limitations of this approach are the use of a unique relationship to explain annoyance situations across all airports and the high degree of uncertainty due to the large range for the DW; results present a difference of 12 times between the highest and lowest value. There are questions on whether or not annoyance significantly contributes to disability and it should be considered in the noise induced burden of disease. There are doubts about the extent to which monetising annoyance make sense to noise policy making.

4.6 Social preference on aircraft noise: WTP or WTA

The Willingness to Pay or to Accept (WTP / WTA) has been used as a common method to help determine the price of intangibles, such as noise effects on people to support cost benefit analysis and further decision-making. Strictly, this approach does not value the cost of noise; what it does measure is the individual preferences for improvements or avoidance of noisy environments, in which case, money becomes the measuring rod that permits aggregation of preferences [29].

It is accepted that the WTP/ WTA will vary across population and locations. Studies that transfer WTP/WTA estimates have a huge uncertainty and variability and could be hazardous in terms of advising policy making [29].

The WTP/WTA approach seems to be inappropriate in valuing health effects, since monetary estimates are based on preference, which are not always self-interest (people could prefer something that goes in detriment of their health), and could be uninformed (people might be not aware of the implications that aircraft noise might have on health).

Most of the literature on this matter refers to the monetisation of the "social cost of aircraft noise" based on the disturbance or annoyance it causes on people, without an explicit quantification of that link. Nevertheless, a comprehensive definition of the social cost of noise should go beyond annoyance and include all the effects that aircraft noise has on health and quality of life. This raises questions on how to aggregate the different cost and its interpretation and use within noise policy making.

Two common techniques are used for the estimation of the WTP/WTA. One is Hedonic Pricing (HP) that uses house market prices as a proxy of the preference that consumers revealed for noise. The other is Stated Preference (SP) which uses questionnaires in which people state their preferences based on hypothetical situations.

In particular, HP techniques can't account for the complexity of people's preferences, specific socio-economic, local conditions and the benefits that people living nearby airports enjoy in terms of transport links and employment. SP solves some of those limitations, but still has issues relating people's understanding on what a noise reduction means and the unfamiliarity with placing monetary values on intangibles such as noise.

5. ESTIMATION OF MONETARY COSTS FOR SELECTED UK AIRPORTS

We have estimated the change in the monetary cost of aircraft noise on cardiovascular disease (AMI), sleep disturbance and annoyance using DALYs estimation for selected London Airports: Heathrow (LHR), Gatwick (GTW) and Stansted (STN) between 2011 and 2006.

Due to limitations on the availability of information, it wasn't possible to undertake estimates for other London or UK Airports.

5.1 Noise exposure data

For all three airports, we have used $L_{den\ (24hour)}$ and $L_{night\ (8hrs,\ 2300\ -0700)}$ 2006 noise maps contours produced and published by DEFRA according to the Environmental Noise Directive, END, and English Regulations [30].

Also, we have used the 2006 and 2011 Strategic Noise Mapping Contours for each airport, produced by the Environmental Research and Consultancy Department (ERCD) of the CAA in the UK, in order to meet the requirements of the END and English Regulations [31-36]. These contours are based on air traffic movements over the entire year. Data published at these reports are the same than DEFRA data.

Since data was only available at 5dB steps from 55dBA to 75dBA for L_{den} and $L_{Aeq\ (16hrs,\ 0700\ –\ 2300)}$, and from 50dBA to 70dBA for $L_{night\ (8hrs)}$, midpoints values were chosen for each band in order to undertake estimations.

These reports use different data set for population between 2006 and 2011. For 2006 noise maps, the population data is based on 2001 UK Census, updated in 2005. For 2011, the population data is based on the 2011 UK Census. Although this limitation, this was the only consistent information available across airports that allowed reasonable comparison and aggregation.

5.2 Methodology

We used the methodology proposed in this paper, including the corresponding dose-responses for each effect in the estimation of the DALYs. We have adopted the recommended UK monetary cost per DALY of £60,000 [11, 21].

5.3 Results

Acute Myocardial Infarction

To estimate the number of additional AMI cases resulting from noise exposure, we have used a low threshold of 55dB $L_{Aeq,\ 16hrs}$ which according to Babisch no effects were found below this level [16].

An AMI risk of 0.0596%, based on the UK AMI risk of death (72%) was used. We have assumed that the underlying prevalence of AMI in UK population is the same for each of the populations analysed. To estimate the number of DALYs a disability weight (DW) of 0.405 was considered. An average of 11 years loss of life and a mean disability weighting of 7.94 was used for AMI mortality [7, 11, 21].

The monetary cost due to AMI effects from aircraft noise in the three London Airports was valued at around £133m for 2011 compared with £142m in 2006. There is net change in cost of -£9m (-7%).

Sleep disturbance

Despite the multiple limitations mentioned in the previous section regarding the use of a unique dose-response, we have estimated the monetary cost of sleep disturbance due to aircraft noise from London Airports, using the EU official curve. These estimates can just indicate a trend on cost evolution across years, instead of absolute cost.

Due to limitations on the availability of the data, the lower threshold used for these calculations was 50dBA $L_{night,\ 8hrs.}$

The monetary cost due to sleep disturbance effects from aircraft noise in three London Airports varies in range of £53m to £133m in 2011 and £53m to £132m in 2006 (DW low: 0.04, DW high:0.10). Using the central value of DW at 0.07 as recommended by WHO [7], monetary estimates were valued at £93.4 m for 2011 and £92.1m in 2006. This shows a marginal change of 1.4% in the cost over 5 years, which was mainly due to a decrease in the population exposed to aircraft noise during night.

Annoyance

As in the case of sleep disturbance, in order to have a broad understanding of trends in cost of aircraft noise in London, we have provided calculations using the EU annoyance dose-response curve and Burden of Annoyance methodology. As mentioned above these estimations are full of uncertainties and limitations that must the considered when interpreting and using these results.

Due to limitations on the availability of the data, the lower threshold used for these calculations was 55dBA L_{den}, reason why our results might be underestimated. According to WHO, the lower threshold should be somewhere between 45dBA and 50dBA L_{den} [7].

Due to large uncertainty interval for the DW, monetary cost due to annoyance from aircraft noise in the three London Airports varies in a range of 12 times between the lowest and highest value. There was almost no significant change between 2006 and 2011 estimations. For both years, the monetary cost of aircraft noise annoyance at selected London Airports varies between £77m to £925m (DW low: 0.01, DW high: 0.12). Using the central value of DW (0.02), the cost was estimated at £154m for both years.

This evidences the high degree of uncertainty and variability that should be considered when interpreting and using these results. It also raises questions about the reliability and accuracy in the results and to what extent makes sense to monetising annoyance effects.

Initial estimations of the potential cost of noise pollution in England were presented by the IGCB(N) in their first report [37]. Results indicate that the total disutility of environmental noise in the UK was valued at over £7 billion/year.

The cost of the effects of aircraft noise on cardiovascular disease, sleep disturbance and annoyance in three London airports represent around 4% -17% of the total cost of noise pollution in England. This was done in order to give a context for our estimations and should be considered as indicative only.

All the results presented in this paper must be used as indicative only and to provide some insight into the scale of the health impacts from aircraft noise exposure at three London Airports. No definitive conclusion can be given on an absolute cost of aircraft noise effects around these Airports. Also, we recall on multiple caveats associated with this process when interpreting these results.

Figure 3 represents the aggregate monetary cost of the effects of aircraft noise for the three London Airports. Figure 4 shows the change between 2011 and 2006 for those monetary estimates.

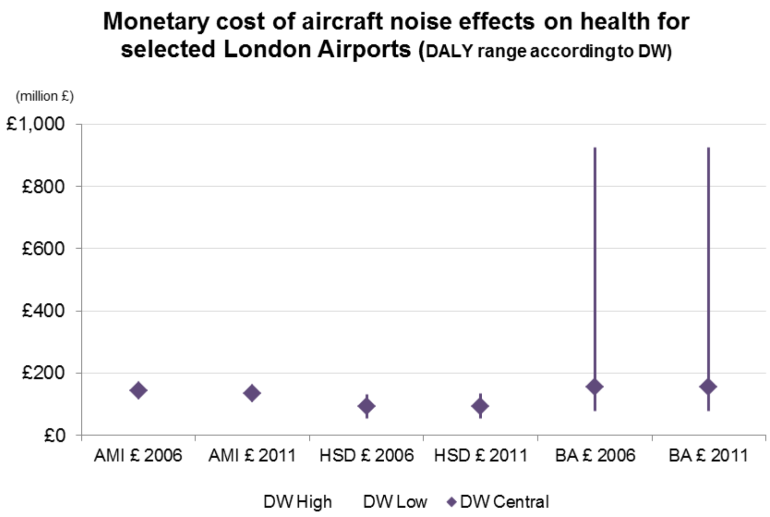

Figure 3

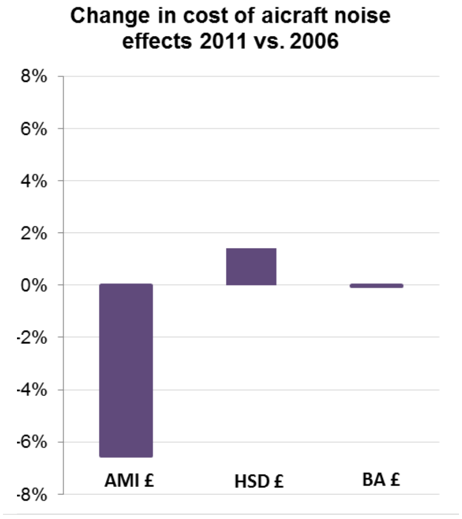

Figure 4

6. POLICY APPLICATION OF MONETARY VALUES

The economic valuation of aircraft noise effects provides a common language to assist noise policy making; it helps to understand how noise can affect human's health and quality of life, and can vindicate the need for policy interventions on this matter. Also, monetary values could provide economic indicators and signals for the design of sustainable and efficient noise policies.

Complex issues, such as aircraft noise effects on health and quality of life, require of complex system of policies. There is no single universal policy tool that can give solutions to all concerns; no size fits all.

In this sense, monetary values can be used to guide the design of multiple policy instruments and noise policy management strategies, as well as support noise policy analysis, help to establish research priorities, raise awareness among policy makers on the noise issue and justify the need for policy intervention.

In particular, monetary values of the effects of aircraft noise can guide policy instruments in terms of the level of investment needed for protection of noise-associated health hazards, noise charges and other market-based instruments. They can also guide noise policy analysis, such as cost benefit analysis as a practical tool for recommending options and balancing between cost and benefits from aviation industry. Monetary values can be used to support sustainable noise management strategies by guiding noise insulation and compensation budgets, prioritising areas of intervention and allowing a contextualised understanding of aircraft noise effects compared with other impacts from aviation industry.

However, the monetisation of aircraft noise effect is a very complex process, due to the complex nature of noise and how it affects people, the difficulty in establishing causal relationships and the multiple uncertainties associated with valuation methodologies. It requires the interaction of scientific experts, practitioners and policy makers.

We suggest a set of principles in the attempt to improve understanding and guide towards a better use of monetised cost of the effects of aircraft noise within public policy and business management. We consider *sustainability* as a core principle for aviation policy making. We include the *precautionary principle*, with the purpose to create an impetus to take decision notwithstanding scientific uncertainty about the nature and extent of the risk [38]. We consider that *protecting human health* should be a maxim to guide decision- making. We advocate for a principle of *transparency* in published data, methodologies and assumptions. We propose a principle of *contextualisation* of results to local conditions and specific needs of location. Finally, we emphasise that these values should be used to enhance understanding of trends rather than absolutely quantify values.

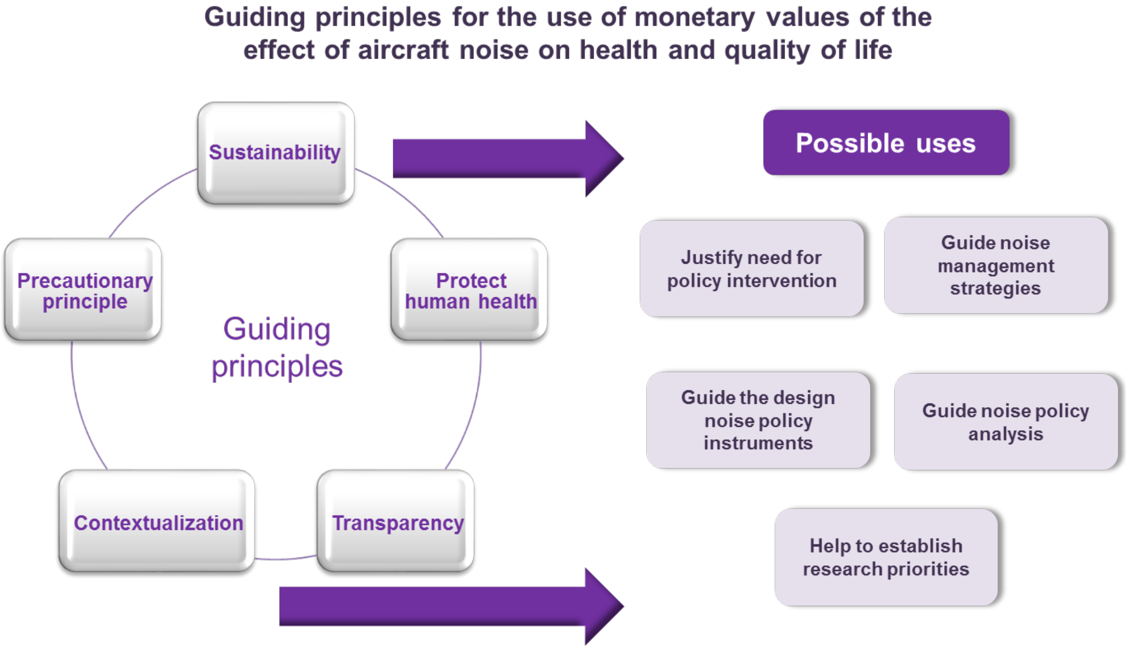

Figure 5: Guiding principles for the use of monetary values of the effects of aircraft noise effects on health and quality of life

However, some challenges remain in the process of understanding and applying monetary values of aircraft noise effect within noise policy. Some of the main questions relate to:

- How to put together the different cost of the effects of aircraft noise on health and quality of life? Is it possible to sum all together?
- What to include in the balance between positive and negative effects from aviation?
- How to integrate this within sustainability principles?
- How to define the social cost of noise?
- Who should pay?

7. CONCLUSIONS

In order to define whether or not is possible to include specific noise related effects as part of an economic valuation framework it is fundamental to have sufficient strength of evidence that supports the link between each particular health outcome and noise exposure; robust dose-response relationships to quantify the link and ideally accounts for causality; and a monetisation methodology appropriate for each effect. It is important bear in mind of the many limitations and uncertainties that results may have.

The monetisation of aircraft noise effect is a very complex process require of complex system of policies. There is no single universal policy tool that can give solutions to all concerns. We have proposed a range of guiding principles for the use of monetary values in noise policy and management.

The cost aircraft noise on AMI, sleep disturbance and annoyance at three London Airports represents between 4% and 17% of the total disutility cost of environmental noise in England. No definite conclusion can be given on an absolute cost of aircraft noise effects in London.

Some challenges remain in the process of understanding and applying monetary values of aircraft noise effect within noise policy, such as how to aggregate the different cost in relation to understanding the balance between positive and negative impacts that aviation can bring.

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