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An Economic Valuation of Noise Pollution – developing a tool for policy appraisal

First report of the Interdepartmental Group on Costs and Benefits, Noise Subject Group

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Executive Summary

1. Across Europe, increasingly, attention is turning to noise pollution and the detrimental impacts it has been suggested to have on the population. The rapidly growing literature surrounding noise pollution highlight a wide range of costs including loss of amenity, adverse health impacts, slower learning rates in children, irritation and effects on local ecology. In response to these considerations there has been a significant movement across the EU towards systematically managing noise with the first stage being the creation of detailed noise maps and the development of localised action plans.

2. However, the available research and evidence is fragmented and there is no established long term system to allow the verification of particular endpoints, such as adverse health effects or environmental degradation. As a result the economic valuation tools that have been developed have had to focus on a subset of the total cost. Within the UK, valuations have centred around amenity values, with the key piece of research being the DfT study of house prices in Birmingham, from which the Webtag values were developed and are applied in transport policy appraisal. Across Europe, some other member states have taken a different approach to estimate and value of health impacts, with it being standard practice in Denmark, France, Lithuania, Poland and Switzerland.

3. Based on the existing evidence, initial estimates of the cost of noise pollution suggest that it is currently imposing a cost in excess of £7 billion per annum[1]. This estimate is made up of between £3 - £5 billion in annoyance costs, adverse health cost of around £2 - £3 billion and productivity losses of another £2 billion. Therefore, even where best practice is being observed this means monetised impacts could be around half their true value.

4. To address this gap, the Interdepartmental Group on Costs and Benefits (IGCB) established a sub-group to develop a robust economic methodology to value noise across all government policies. This note sets out the general framework to this task and an outline on how they will look to progress in the short medium and long term.

5. The framework that has been agreed for this work is to apply the impact pathway approach that has been implemented successfully on local pollutants, most notably in relation to air quality. This approach involves following the pollutant from its source (such as a vehicle), to the general levels (in this case the volume), onto a receptor (such as the general population). This is then used to estimate a range of endpoints (such as adverse health effects) before finally being monetised.

6. The long term objective for this group is to apply this framework to include all the many different impacts associated with noise simultaneously, providing a comprehensive evaluation tool. However, given the range of potential outcomes this is not plausible in the short term. To develop this work in a pragmatic yet credible way four broad groups of impacts have been identified as[2]:

- Health impacts, this includes the most severe health effects such as changes in cardiovascular mortality;

[1] The process of developing this estimate is provided in Annex A.

[2] It is recognised that there are significant overlaps between these areas. Therefore in starting analysis on any of these areas there will be need for a clear delineation and any overlaps will need to be recognised. This paper has purposely chosen not to rigidly define each of these areas to allow some flexibility in the resultant research.

- Effect on amenity, which reflect consumers' conscious annoyance from noise exposure;

- Productivity, which relates to areas such as reduced work quality through tiredness or noise acting as a distraction; and

- Environmental, where noise levels may impact on the functioning of the ecosystems, such as through birds breeding patterns.

7. As the evidence base underpinning each of these areas has developed independently they are all at different stages of development Therefore to decide how best to pursue each of these areas and which areas to prioritise a detailed scoping analysis has been undertaken on each of these areas identifying the opportunities and challenges associated with each of these areas. Chapters 3 – 6 contain a more detailed examination of each area.

8. To prioritise when and how to pursue each of these areas four areas each has been considered against four criteria of:

9. The decision to make health the priority for research was based upon four criteria:

- Importance – potential scale of the negative impacts for each area resulting from noise pollution.

- Value added – how much the development of a tool would add to the existing policy framework and enable a more comprehensive analysis of the costs and benefits.

- Quality of existing evidence – the strength of the existing evidence base and current methodology for estimating a dose response function;

- Potential for success – how realistic is the deliverability of the target, in terms of the time and cost needed to reach the target. Are there any serious risks to success?

10. As a result of this exercise the IGCB(N) have identified research into the health impacts of noise as a priority area for further research. As this area was seen to have major potential value added covering annual impacts of between £2-3bn that are completely excluded from the current evaluation framework. It was also seen as the most viable area for research with a wide existing evidence base to draw upon.

11. Further work will be carried out by IGCB(N) into the other three areas. In relation to productivity the key drawback was the lack of robust evidence of a link to noise therefore IGCB(N) will continue to look for evidence on this link. For amenity values there were considerations on the value added of this work given that the DfT values cover the majority of environmental noise. Therefore IGCB(N) will work to estimate the scale of the potential gap. Finally in relation to ecosystems impacts, while ecosystem valuation has made major progress recently with the release of the Ecosystems Services Approach[3] there was also a lack of comprehensive and robust causal links to noise. IGCB(N) will therefore continue to monitor developments in this area.

[3] For further details on the Ecosystems Services Approach, see http://www.defra.gov.uk/wildlife-countryside/natres/dea.htm or http://www.defra.gov.uk/wildlife-countryside/natres/eco-value.htm

12. Following agreement of the priorities, the group will immediately focus resources on estimating dose response functions between noise exposure and a range of health outcomes. The broad timetable for this work is:

- Summer 2008 - Initiate research into dose response functions for health effects;
- End 2008 - Finalisation and publication of research
- Spring 2009 – Publish IGCB(N) guidance to quantify the health impacts of noise.

Chapter 1. Introduction

Issue

13. At present there is no standardised comprehensive approach to the valuation of the impacts of noise. The guidance for appraisal (the Green Book) recommends a case by case approach to valuing and including all impacts of policy. This flexible approach has the advantage of allowing appraisal of different sources to be approached differently. This approach has been a success in some areas, of particular note being the approach taken by the Department of Transport (DfT) to impacts on amenity from road and rail transport.

14. However, given growing importance of noise pollution and the considerable complexity and uncertainties surrounding noise impacts, a need has been identified to develop standardised evaluation tool for noise pollution across government. The key benefits of this are seen to be: the creation of a comprehensive evaluation tool including all the impacts of noise; the opportunity for a more strategic approach to noise management across sources; and finally as a means to inform and influence international noise policy. However, to retain the flexibility of the existing scheme this approach is intended as a minimum standard so that more detailed analysis can be undertaken beyond its remit to address particular circumstances.

15. The objective of this paper is to set out the approach employed by the IGCB(N) noise subject group (IGCB(N)) to develop a robust and consistent tool to the impacts of noise pollution. Following this objective this paper has three key tasks to:

- Set out the general framework that the IGCB(N) will employ to develop evaluation tools to value noise pollution;
- Setting the research priorities between the different outcomes and how each will be progressed; and
- Establish a realistic timetable for taking forward the work of the IGCB(N).

Background

16. Noise is generally defined as “any unwanted sound.” It is particularly important to note that it is not just sound, but reliant upon the subjective perception of being unwanted or harmful.

17. This definition identifies a key issue in addressing noise pollution which is the difficulty in setting a precise definition. While it is possible to measure and define sound extremely accurately, the subjective nature of noise makes a formal definition much more problematic. For example what may be an acceptable level of sound in an urban area may be considered an unacceptable level of sound in a rural area.

18. Noise policy is broadly split into two areas, work noise and non-work noise[4]. Non-work noise can be further broken down into two key categories, environmental noise and neighbourhood noise. Environmental noise is noise emitted by transport or industrial activities. Other forms of noise normally fall under the scope of neighbourhood noise, which is generally defined as noise caused by people in or around their homes.

19. Despite the lack of a strong definition of noise, and arguably because of this problem, what is clear is that noise is a pervasive and growing problem both within the UK and across Europe. A survey by Ipsos Mori, commissioned by Environmental Protection UK, found that noise has a negative effect on the quality of life of 39% of the population, with 10% stating that the effect was either a fair amount or a great deal. Meanwhile, figures from the Office for National Statistics indicate that noise complaints to local government offices have more than doubled over the past decade[5].

20. Two pieces of research commissioned by Defra in 1990 and 2000 have looked at changes in the incidence of noise and attitudes towards noise. The National Noise Incidence Study[6] investigated the exposure of the population to noise. This found that 55% of the population were exposed to daytime noise levels above WHO guideline values of 55dB and 68% were exposed to night noise levels above the night noise WHO guideline values of 45dB. An interesting finding was that short term noise indicators had fallen, although night time background levels had increased[7]. The National Noise Attitudes Survey[8], found that between 1990 and 2000, there was an increase in the proportion of the population who reported hearing noise from both traffic sources and neighbours.

21. The evidence suggests that while noise emissions have not increased significantly across the board, and in some areas the actual level of noise may have fallen, complaints have increased. This result suggests that any reductions have been outweighed by a greater sensitivity to noise and a growing perception that noise is a problem affecting people's lives.

Policy context

22. Noise regulation of some form has been existent in UK law for over 100 years, initially in the form of anti-nuisance laws. These laws now cover many different aspects, including nuisance, workplace, transport, planning and industry

23. The UK approach to noise regulation is split by source between environmental noise, neighbourhood noise and noise in the workplace. The regulation of noise has evolved over time as noise has become a more significant public issue and awareness of negative impacts of noise has grown. To address all the sources, a wide range of approaches have been employed including: limit values on noise emissions, planning restrictions, requirements for compensation for insulation where noise has an adverse effect and advice and guidance on how to minimise the impacts of noise. A list of the key regulations are provided in Annex B.

[4] Noise in the workplace is currently regulated by the Health and Safety Executive (HSE) and is not considered in any detail in this paper.

[5] http://www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7295&Pos=1&ColRank=1&Rank=272

[6] http://www.defra.gov.uk/environment/noise/research/nis0001/index.htm

[7] A likely explanation for this is an increase in the volume of traffic, coupled with a fall in the noise emitted by individual vehicles due to improving standards.

[8] http://www.defra.gov.uk/environment/noise/research/nas9900/index.htm

24. The key new piece of legislation is the European Noise Directive (END)[9]. This directive follows the 1996 green paper, "Future Noise policy"[10] which commented on the low prioritisation of noise outcomes relative to other environmental issues such as air and water pollution.

25. The END seeks to create a uniform means to define noise for the purposes of mapping, and then, in the first round, to generate noise maps of major agglomerations (over 250,000 inhabitants) and major roads, railways and airports to be used for the purposes of action planning. The action plans are expected to set out plans for reducing the impacts of noise where necessary and for maintaining designated quiet areas. The second round is expected to take place between 2008 and 2012, extending the methodology of the first round to smaller agglomerations, roads and railways.

26. This is a major step forward for noise policy as this mapping will help to underpin evaluation of policy measures to reduce noise pollution. These maps will effectively set a baseline against which policy options can be compared and thereby enabling analysis to identify the most cost effective means of achieving a desired standard, known as cost-effectiveness analysis (CE-A). While CE-A is a useful tool to inform the achievement of a given standard it can only inform target setting by providing cost information. The aim of the IGCB(N) evaluation tool is to value noise based on the outcomes to estimate the benefits of any targets and allow a full cost benefit analysis. The advantages of cost benefit analysis are discussed in more detail in Chapter 2.

The IGCB Noise sub-group

27. The IGCB(N) noise sub-group is a Defra led group of government economists and other experts that provides economic analysis and advice relating to the evaluation of noise. The remit of the group is to develop, maintain and disseminate a robust and comprehensive approach to noise evaluation.

28. The noise group was established in Autumn 2007 with Noise having been identified as a key cross cutting area where there was potential for an interdepartmental approach to add value. The key reasons an interdepartmental approach was favoured were:

- Noise is a cross cutting issue with implications for a number of government departments and policy areas;
- Noise is a complex issue therefore evaluation requires an interdisciplinary approach including experts in economics, mapping, acoustics, psychoacoustics, health, and public policy; and
- The interdepartmental approach will strengthen the advice available by pooling resources and knowledge from a range of sources and aid dissemination.

29. The group consists of government economists and other experts from all relevant government Departments and associated institutions. Annex D gives details of the current members of the group, there is however still potential for additional members to join the group.

[9] Available at http://ec.europa.eu/environment/noise/directive.htm

[10] Available at http://europa.eu/documents/comm/green_papers/com96_540/summary_en.htm

Chapter 2: Methodology

Introduction

30. This chapter looks to set out the general framework that is being employed by the IGCB(N) to develop a evaluation tool for noise. In doing so, it first sets out the general objective of moving towards cost benefit analysis, discusses the impact pathway approach that has been adopted and a number of the key sensitivities which will be kept under consideration by the group.

Cost Benefit Analysis methodology

31. Cost-benefit analysis (CBA) provides a framework to evaluate policies. In its simplest form, the costs and benefits of each policy are quantified and valued in monetary terms. The costs are subtracted from the benefits and those policies with a positive net benefit are supported by this analysis. Also in comparing different policies the higher net benefit are considered preferable to those with a lower net benefit. In practice, undertaking a CBA of policies related to noise involves considerable complexity and uncertainty, including the consideration of impacts which have not been monetised, and there are a number of possible methodological approaches.[11]

32. Cost benefit analysis has a major advantage over cost effectiveness analysis (CEA) of presenting costs and benefits in the same metric i.e. money. It therefore facilitates comparison both of differing impacts within the same measure (e.g. the technology costs and health savings) and of differing potential policy measures themselves. In a broader context, monetary cost benefit results can also be compared with the CBA of measures in other policy areas to assess where limited resources can best be used.

33. At present, IGCB(N) are focusing predominantly on the development of quantifying the impacts associated with changes in noise. This does not diminish the need for robust analysis on the other impacts to carry out a full CBA. However, generally such impacts are more readily estimated for example the cost to reduce noise by installing double glazing can be observed directly in the market.

The Impact- pathway approach

34. To develop a robust approach to evaluating the impacts of noise pollution, the IGCB(N) have adopted the impact-pathway approach. This approach follows the logical progression from emission through to noise level, exposure and finally to a range of endpoints that can be valued. The main steps are outlined below and are discussed in more detail in the remainder of this section:

- Quantification of emissions of noise from point and diffuse sources;
- Conversion of projected noise levels into noise maps to estimate population and environmental exposure to noise;

[11] Further information on how to select between options where there is uncertainty and costs or benefits which have not been monetised can be found in the Green Book, notably “Selecting the Best Option” http://greenbook.treasury.gov.uk/chapter06.htm#selecting

- Quantification of end points associated with the change in noise, for example, using dose-response functions that estimate the relationship between changes in noise and health outcomes;

- Valuation (monetisation) of health and non-health impacts; and

- Description and analysis of uncertainties associated with the quantification and valuation of impacts.

35. The first two stages of this process will be undertaken for major agglomerations and transport routes in 2008 as part of the noise mapping exercise to comply with Environmental Noise Directive, as set out above. IGCB(N) therefore is primarily focusing on developing a methodology for the latter two stages used to value noise by estimating health and non-health outcomes and then valuing them.

36. Once estimates of the level of noise are available they must then be translated into the relevant endpoints that can be valued. Recent evidence has suggested a link between noise and a wide range of potential impacts. For practical purposes, the range of impacts has been split into four broad groups, namely:[12]

- Health impacts, this includes severe health effects such as changes in mortality and temporary effects including tinnitus;

- Effects on amenity, which reflect consumers' conscious annoyance from noise exposure;

- Productivity, which relates to areas such as reduced work quality through tiredness or noise acting as a distraction; and

- Environmental, where noise levels may impact on the functioning of the ecosystems, such as through birds breeding patterns.

37. Having estimated the different end points, the final stage is to value the quantified end points of the level of noise. Each of these values are then summed to provide a total estimate of value of a level or change in noise pollution.

38. The long-term objective for the noise evaluation tool to include valuations of all the impacts of noise. However, practically it is not possible to carry out all of the research required concurrently and a tool will not develop uniformly. Therefore it will be necessary to continually update the tool over time to reflect the best available evidence.

39. Because of the constraints on resources it has been necessary to prioritise one of the endpoints. This priority areas define the research programme undertaken by the IGCB(N) and consequently the development of the evaluation tool.

[12] It is recognised that there are significant overlaps between these areas therefore in starting analysis on any of these areas there will be need for a clear delineation. This paper has purposely chosen not to rigidly define each of these areas to allow some flexibility in the resultant research.

40. To inform this the next four chapters (chapters 3 – 6) provide the results of the scoping exercise that has been undertaken to evaluate the potential for further work in each of these groups of endpoints to move forward the valuation. Each of these endpoints are presented in a consistent manner of:

- Impact, precisely defining the end point under consideration;
- Evidence, setting out the latest research into the links between this outcome and noise;
- Benefits, making the case for why additional research in this area should be a priority area for the IGCB(N);
- Obstacles, this section sets out the problems that have been identified in undertaking additional research in each of the areas; and
- Research, based on the above evidence it sets the aims of further research in each area that will be conducted by the IGCB(N) and an associated timetable

Key Sensitivities

41. This section outlines a number of specific sensitivities and uncertainties related to each stage of the impact pathway approach. A key aspect of the group's work will be to minimise any risks and ensure that there are no inherent biases in the methodology employed. The key sensitivities identified include:

42. The metric for measuring noise. The mandatory metric used in the END is L_{den} which weights noise according to the time of day and includes noise over a 24 hour period. As this is the metric with the most widely available data, where possible the group will apply dose response functions which measure noise exposure using Lden. However, there are other metrics such as L_{day}, L_{night}, L_{10} and L_{max} which can also be collected and used as an indication of exposure to noise. Different measures have different strengths depending on the type of noise impact being examined. For example, L_{night} can be useful when looking at sleep disturbance or L_{max} can provide a useful indication of intermittent noise. [13] The group will adopt a flexible approach, seeking to use Lden or adjustments to Lden where possible, but using alternative metrics if necessary.

43. The noise mapping for END was based upon GIS modelling backed up with some validation of the predicted noise exposures. This combined available data and assumptions regarding factors including traffic flows, noise emissions, urban mapping, road surfacing and population data. Due to the number of different data sources and assumptions, there is a degree of uncertainty regarding the results of the noise mapping so the results must be treated with caution.

[13] For further details on the different metrics for measuring noise, see http://noisemapping.defra.gov.uk and go to the help section.

44. It is very expensive to take primary measurements of noise exposure for large numbers of the population. As a result, the noise mapping which was carried out for the END was based upon GIS modelling which combined a number of pieces of data included traffic flows, noise emissions, urban mapping and population data to give an estimate of the noise exposure in the mapped areas. Some validation was carried out to ensure that the predicted noise exposures were relatively accurate, however, there is a degree of uncertainty regarding the results of the noise mapping so the results must be treated with caution.

45. There is a substantial and growing evidence base which looks to quantify the relationship between noise and a number of impacts. One part of this research is an improvement in how uncertainties are taken into account and the work done on confounding factors, especially air pollution. However, there is no single approach to estimating noise impacts and there are uncertainties associated with different studies. The group will seek to only use high quality research that has been peer reviewed by experts and has robust methodological underpinnings.

46. Dose response functions provide an average response to noise for the whole population. Noise studies generally take a sample from across the population and include control areas where noise exposure is low to ensure that the sample is representative. Care is usually taken to ensure that there is not any inherent bias, however, as the link between noise and impacts is often not homogenous. A number of other factors can have an impact such as:

- Habituation – there is evidence of partial habituation to noise over time, and that the level of annoyance can diminish with prolonged exposure. However, studies have found that complete physiological habituation rarely occurs, with individuals still displaying elevated blood pressure, if lower reported levels of annoyance over time.

- There is not a homogenous response to noise across the population. The sensitivity of individuals varies widely and can be dependant on a number of factors. For example, individuals who have grown up in rural areas may be far more sensitive to modest noise levels to those who have grown up in urban areas.

- The heterogeneous response of individuals to noise can lead to a self-selection question and potential lead to biases in the estimated valuation of noise. For example, individuals with a high sensitivity to noise are less likely to live in noisy areas and so estimates of annoyance in noisy areas may be affected by the fact that residents are less likely to be sensitive to noise.

47. Within the impact pathway approach, a number of approaches are likely to be taken to estimate different aspects, and it is necessary to ensure that the use of different approaches does not lead to double counting of effects. For example, as annoyance is a reaction which people are aware of, it is possible to elicit a willingness to pay to reduce noise levels, whereas we assume that people are unaware of health impacts and so these impacts are valued through the effect on health and quality of life indicators. It is necessary to ensure that similar impacts are not counted twice through different calculations.

48. Although this section does not go into great detail on the sensitivities, a number of these are discussed at relevant points in later chapters. They will also be continually considered by the group in the development of a valuation framework to ensure that the methodology is robust.

Chapter 3: Health Impacts

49. This section covers the health impacts of noise, research which has linked these outcomes to noise and studies where a tool has been defined and applied to data to give an indication of the potential scale of impacts. Proposed further research is then outlined, with some discussion of the advantages and potential obstacles to pursuing this avenue of research.

50. It has long been recognised that there is a link between noise and adverse health impacts, although the quantification of the link is an ongoing process. There is a growing body of evidence which has sought to quantify the relationship and ensure that the link is robust.

51. The adverse health impacts include cardiovascular disease, hypertension, cognitive development and sleep disturbance. The current evidence suggests is that higher levels of noise can act as a trigger through higher blood pressure and other physiological outcomes, with prolonged exposure leading to more cases of adverse health issues, affecting quality of life and mortality.

52. A joint DH and Defra research project, co-ordinated by the Ad-Hoc committee on Noise and Health is currently preparing a report on the evidence of environmental noise and health impacts in the UK which is expected to be published later in 2008.

53. Dose response functions define a direct quantitative link between the exposure (i.e. the dose) and the effect that it has on the organism. These have been developed in robust studies for some of these outcomes and has been applied to data for the populations of Germany and Netherlands to give an indication of the scale of the health impacts of noise. The dose response functions were based upon a number of major primary studies into the relationship between noise and health[14].

54. This area has been identified as the key priority area for additional research by the IGCB(N) on the basis of its high value added and the significant existing evidence base. The initial project proposes to use the best available evidence to develop a dose response relationship across a range of health outcomes that could be applied in the UK and use that to estimate the adverse health impacts of noise. These outcomes could then be valued as appropriate.

Impact

55. There is evidence of a higher risk of adverse health outcomes associated with exposure to high levels of noise. Although a causal link has not been conclusively proven, the strongly supported hypothesis is that higher levels of noise can lead to higher blood pressure levels. Persistently high blood pressure can in turn lead to adverse health effects such as hypertension and cardiovascular infraction and ischaemic heart disease.

[14] The meta-analysis contained a total sample of over 10,000 individuals and was only based upon robust primary studies which met certain criteria.

56. There are a number of other adverse health impacts which have been investigated include hearing impairment, tinnitus, sleep disturbances and impairment to cognitive development. These are unlikely to be associated with mortality outcomes, however, their impact could be monetised through the effect on quality of life, as measured using DALYs.

57. The evidence of a link between noise and adverse health impacts is widely accepted, however, there is continued uncertainty regarding the quantification of the relationship. There is ongoing work to develop a robust dose response relationship with agreed and defensible coefficients.

Figure 1: Severity of (noise) effects

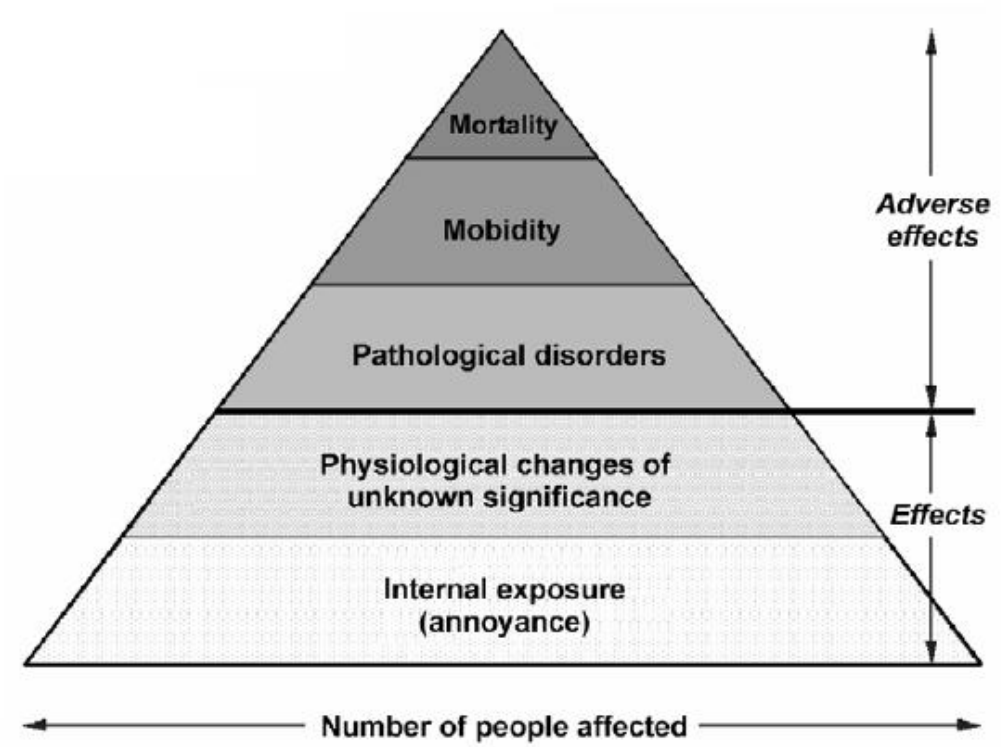


Figure 1, above, is an adaptation from Wichmann, (1992)[15]. This shows a pyramid of effects, ranging from amenity effects which affects the largest group of people to mortality (such as cardiovascular disease), which is the most severe effect but affects a smaller group of the population. The effects in the top three layers of the table are described as adverse under World Health Organisation (WHO) criteria (Babisch (2002)).[16]

Dose-response function

[15] This originally referred to chemical exposure, but has been adapted to noise. The main difference is that internal exposure, which is directly measurable in the organism, with annoyance which is a subjective measure of effect.

[16] An adverse health effect is defined by WHO criteria as: "Change in morphology, physiology, growth, development or life span of an organism, which results in impairment of the functional capacity to compensate for additional stress, or increase in susceptibility to the harmful effect of other environmental influences." WHO (1994)

58. Dose response functions define a direct quantitative link between the exposure (i.e. the dose) and the effect that it has on the organism (i.e. the response). For example, in the context of health, these can applied to noise exposure data to estimate the risk of certain health outcomes. Depending on the relationship between the exposure and effect, dose response function can take any function form or threshold above which there is an effect. For example certain impacts may only occur above a given threshold or may not increase linearly across volumes.

59. For the purposes of policy appraisal, dose response functions are a valuable tool, allowing for a flexible approach which considers the marginal effects of a policy. It can be used to directly transform any change in exposure which is useful for assessing different policies which are expected to have different effects. This is particularly useful for economic appraisal where evaluation is undertaken on marginal changes in response to policy options.

60. In a number of primary studies, dose response functions have been estimated for the relationship between noise and certain adverse health impacts. These studies have examined local data where it is possible to separate the adverse health effects on a local population based upon their exposure to noise.

61. The development of dose response functions for adverse health impacts is an area of continuing research. A current research project being undertaken by the World Health Organisation (WHO), “The environmental burden of disease” has brought together a group of experts in the field of noise and health. The study is seeking to develop robust dose response functions for a range of adverse health impacts such that they can be applied to population data to estimate the overall impacts of noise on health in Europe.

62. The WHO report is due to be published in late 2008, however the table below gives preliminary results on the incidences of health outcomes and the implications given in terms of potential years of healthy life lost in Europe through noise-related death or disability, as measured in Disability Adjusted Life Years (DALYs), which can be used to measure reduced quality of life impacts as well as mortality impacts (such as in the case of tinnitus).

Table 2: Health effects from noise (WHO 2008)

Type of noise exposure	**Impact**	**Proportion affected, per annum**	**Potential years of healthy life lost in Europe through noise-related death or disability (DALYs)[17]**	**Monetised UK Impact[18] (£ million per annum)**
Daytime traffic	Heart disease	3% of all heart disease cases across EU	211,000	£1,183
Night-time background noise	Severe Sleep disturbance	2% of all Europeans	No figure	No figure
24-hour background noise	Severe Annoyance [19]	15% of all Europeans	278,000	£1,571
Traffic/leisure noise	Tinnitus (ringing in the ears)	3% of all tinnitus cases (0.75% of all Europeans)	9,300	£52
Daytime and night-time noise	Slower learning by children	0.01% of all Europeans	45,000	£252
Loud music	Hearing loss from 'leisure noise'	1.8% of 7 to 19 year olds in Europe	6,800	£38

63. Two recent meta-analyses (Van Kempen, (2002) and Babisch (2006)). combined a number of suitable primary studies to estimate dose response functions based upon the best available evidence. These have then been applied to population level data on noise exposure to estimate the health impacts of noise in the Netherlands and Germany.

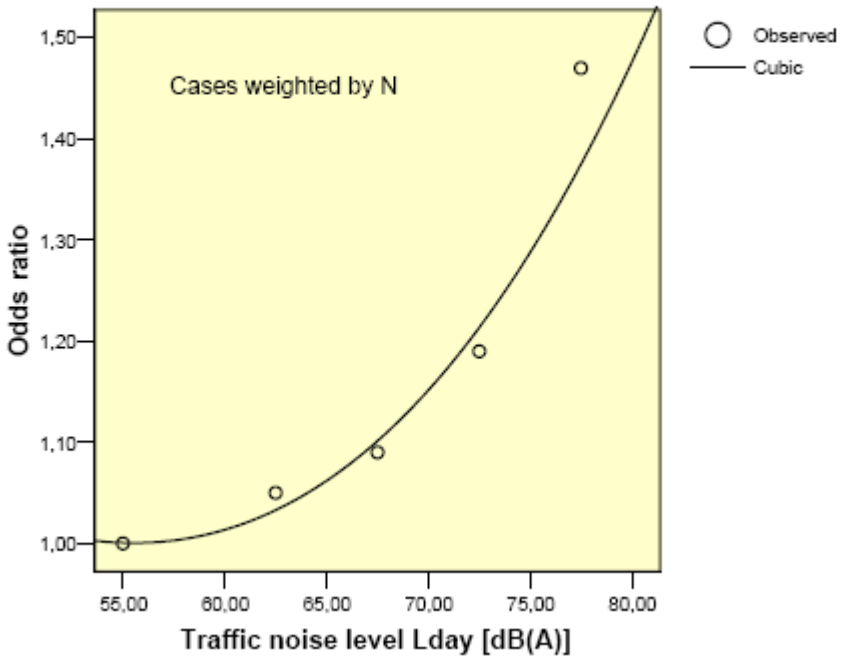
[17] DALYs are a good tool to use here as noise exposure has both morbidity and mortality effects which can be analysed using just DALYs. Therefore, even if an impact has no mortality effects, such as tinnitus, it nevertheless contributes to a reduced quality of life and can be valued using DALYs.

[18] Using the assumption that 1 in 8 EU residents lives in the UK. http://www.statistics.gov.uk/cci/nugget.asp?id=1314. A DALY is valued here at £46,000 per life year. For further details on this figure, see Annex C.

[19] We have included severe annoyance in the health impacts in line with the methodology employed by the WHO. However, there is a strong potential for overlap with the valuation of annoyance using the Webtag values. As the health effects are adapted for application to the UK, the difference between severe annoyance as included here and annoyance as measured using the Webtag values will be considered to ensure that there is not double counting.

64. Van Kempen (2005) found that up to 1,100 people in the Netherlands may die annually as a result of hypertension attributable to noise[20]. Babisch, (2006), found that up to 9,400 people may die annually in Germany due to road traffic noise as a result of myocardial infarction and ischaemic heart disease.[21] Although the papers do not attempt to monetise the impacts, initial estimates have been included here based upon the life years lost approach, with an assumption that each life lost is equivalent to their life expectancy being reduced by three years. Under these assumptions, hypertension in the Netherlands has a cost of £96m, and myocardial infractions and ischaemic heart disease in Germany have a cost of £817m[22]. The chart below shows the dose response function from Babisch (2006)[23].

Figure 2: Dose Response Function for myocardial infraction (Babisch 2006)



Benefits of this route

65. There are a number of benefits of pursing further research in the UK into the effects of noise on health, such as a high potential for value added by filling a gap in the current appraisal framework and the potential to build on existing research and tailor it to the UK.

66. The health impacts of noise are currently not valued in policy making in the UK. Estimates suggest that potential health costs from noise are in the region of £2 -£3 billion per year, potentially more than a third of the total disutility of noise in England.

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[20] The meta-analysis found a relative risk per 5dB(A) of 1.26. This relative risk was combined with population level data on incidence of health outcomes and mortality rates to estimate that a maximum of 1,100 people may die annually due to noise attributable hypertension.

[21] More detailed results from Babisch, (2006), were that 3.2% of myocardial infarctions in Germany are due to road traffic noise, accounting for approx. 4,289 cases per year, of which approx 66% are lethal. The respective numbers of ischaemic heart disease for would 27,376, with approx. 24% lethal

[22] A cost per life year lost of £29,000 has been applied, based upon IGCB methodology.

[23] The graph shows the risk of myocardial infraction associated with different levels of traffic noise. The odds ratio refers to the elevated risk associated with certain noise levels, for example an odds ratio of 1.1 implies that the risk of myocardial infraction is 10% higher than the risk to the general population.

67. Any research would be of value added, addressing a gap in the evidence base and helping policy makers to take into account a wider range of impacts of noise. The aim of research into this area would be to provide a tool, capable of accounting for the health impacts of noise in policy appraisal.

68. The existing body of evidence acts a valuable starting point to develop a framework, with the potential to build upon research methods and dose response functions. By building on this research and applying it to the specifics of the UK it will enable a robust tool to be developed.

69. This research would link into current and likely future European policy objectives. One of the key aims of the END is to "achieve a high level of health and environmental protection and one of the objectives to be pursued is protection against noise." The position paper (2003) of the working group on health and socio-economic aspects highlighted the need to monetise costs and benefits of noise measures for the purposes of appraisal, although at the time it noted that "there is uncertainty surrounding the economic estimates of the social costs of these health related effects" and as such only provided recommended values for annoyance.

70. It ties in with UK policies on preventative medicine as it enables policy makers to better understand a potentially significant cause of adverse health outcomes. This means that measures can be targeted at mitigation of noise effects to prevent the health outcomes, reducing the costs of healthcare as well as the disutility arising.

Challenges of this route

71. Although the evidence of a link between noise and adverse health impacts has become stronger in recent years, there is still uncertainty regarding the exact nature of the dose response function. This is in terms of both the functional form and the coefficients of elevated risk to be applied. There is also a concern in relation to confounding factors and how these should be accounted for, especially the case of air pollution which tends to be strongly linked to high levels of noise.

72. The evidence base is both complicated and likely to change over time. However, in the absence of an expert committee (such as exists for air pollution in the form of COMEAP[24]) there may be difficulties in agreeing best practise and future risks that any work done will become outdated as the evidence base develops.

73. This research could potentially require significant resources to achieve the target outcomes. WHO analysis has highlighted six dose response functions to date, any research would need to cover a number of areas whilst ensuring that each dose response function is robust.

74. There exist potential overlaps between both health and amenity and between health and productivity. One aspect of any research must be to set clear definitions of the health impacts covered and ensure that the risk of double counting is minimised.

[24] COMEAP (Committee on the medical effects of air pollutants) is an advisory committee of independent experts which provides advice to government departments and agencies on all matters concerning the potential toxicity and effects upon health of air pollutants.

75. It will necessary to ensure that the results of European research are transferable to the UK and that cultural differences are not a major factor.

Research

76. To progress with this area, the research will aim to estimate dose response functions across a range of adverse health outcomes which could be applied to the UK. The dose response functions could be combined with noise mapping data and monetised to give a monetised cost of noise on health in the UK.

77. It is envisaged that this research would use an impact pathway approach as outlined earlier, using the best available evidence of dose response functions, combined with noise mapping data. This could then be monetised using DH values for DALYs to give a monetised cost of noise on health in the UK.

78. The IGCB(N) expects to start this research in Summer 2008 with the aim to release guidance on health impacts in Spring 2009.

Chapter 4 Amenity Effects

79. Amenity effects are the direct impact of noise causing annoyance or dissatisfaction. Amenity effects can occur in any context or situation, where noise acts as a distraction or disturbs conversations or activities. This type of valuation has been the primary focus of current valuation studies that have informed government evaluations.

80. In recent times, the effects of noise on amenity have increased, as measured by surveys and statistics regarding complaints. A survey by Ipsos Mori, commissioned by Environmental Protection UK, found that noise has a negative effect on the quality of life of 39% of the population, with 10% stating that the effect was either a fair amount or a great deal. Meanwhile, figures from the Office for National Statistics indicate that noise complaints to local government offices have more than doubled over the past decade[25]

81. Currently, amenity impacts are the only monetised impact of noise for policy appraisal in England, with DfT's Webtag values used for appraisal of road and rail projects[26]. This gives a cost of noise above 45dB, on a per household and per decibel level (with the marginal value of noise varying according to the level). For the recent Heathrow expansion consultation, the Webtag values were combined with the values found by ANASE (attitudes to noise from aviation sources in England).[27]

82. Monetisation has been carried out by two main means. The Webtag values are based upon the impact of noise on house prices, using hedonic pricing methods[28]. The ANASE study was carried out using stated preference techniques, whereby surveys are carried out to elicit the WTP of consumers to reduce their exposure to noise.

83. Current values are available and are applied to road, rail and air transport by DfT. Given the relatively advanced state of this area it is felt that more work is needed to be undertaken by the IGCB(N) to estimate the potential for added value by expanding these values to other areas.

Impact

84. Amenity effects are a subjective measure of people's responses to levels of noise. It can occur in any context, for example where excess noise causes annoyance by distracting from conversations or activities.

85. This is the most widely recognised impact of noise, due to the fact that people can perceive it. As a result, it receives significant public attention for different types of noise, such as the concern over increased exposure due to the Heathrow expansion proposal and TV programmes about the negative effects of noisy neighbours.

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[25] http://www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7295&Pos=1&ColRank=1&Rank=272

[26] The Webtag values are available from http://www.webtag.org.uk/webdocuments/3_Expert/3_Environment_Objective/3.3.2.htm#014

[27] Further details on the ANASE study can be found at http://www.dft.gov.uk/pgr/aviation/environmentalissues/Anase/

[28] The Webtag values are based upon the results of the Birmingham study which used differences in house prices to estimate consumer valuations (hedonic pricing). This study can be found at http://www.dft.gov.uk/pgr/economics/rdg/birmingham/

86. As it is a subjective and instantaneous response, trends in amenity effects can be measured over time through surveys and complaints. A survey by Ipsos Mori, commissioned by Environmental Protection UK, found that noise has a negative effect on the quality of life of 39% of the population, with 10% stating that the effect was either a fair amount or a great deal. Meanwhile, figures from the Office for National Statistics indicate that noise complaints to local government offices have more than doubled over the past decade[29]

Dose-response Function

87. An impact pathway approach to monetising the amenity element of noise has been developed and applied to policy by DfT. Higher levels of noise lead to lower levels of amenity and as the effect on amenity is directly perceived, it is possible to elicit the willingness to pay (WTP) of people to reduce their exposure to higher levels of noise. For example, at 80dB, the willingness to pay to reduce noise by 1dB is £98 per house hold per year, whereas at 650dB, the WTP for a 1dB noise reduction is £48.

88. The link between noise and the outcome is subjective, and depends on the individual's attitude and sensitivity to noise. This differs from the health outcomes which are based upon physiological effects which can be measured more objectively across individuals. There are two main methods for measuring the value that people place upon annoyance from noise, through hedonic pricing and stated preference techniques.

- Hedonic pricing studies measure the link between house prices and exposure to noise, such as the Birmingham study (2004). This was one of the key inputs into the Webtag values which are currently applied to noise valuation of road and rail by DfT.

- Stated preference techniques elicit WTP values for noise reduction by conducting surveys. Using carefully designed surveys, whereby individuals choose between a number of options relating to noise emissions and monetary outcomes, it is possible to estimate the value people place upon noise reduction. This was applied in the ANASE study with respect to aviation noise.

89. Initial estimates by Defra combined the Webtag values with data on population exposure to road noise in major agglomerations. It was found that the total disutility of current road noise in England is between £3bn and £5bn per year. This figure, however, is likely to be an underestimate as the population data covers less than half of the population (albeit those in major agglomerations) and the data only considers road noise. Defra is currently undertaking work to update these values with more detailed data available from the noise maps prepared for the END. Further details of the estimation can be found in Annex A.

Advantages of this route

90. Amenity effects are a perceived impact and the impacts on the individual are immediate. This means that it is relatively straightforward to measure through revealed or stated preference by eliciting the values that people place upon the amenity effect of noise.

91. There is a significant amount of research already available and established methodological techniques, especially for hedonic prices. Further research would be able to build on existing techniques, tailoring them to specific research requirements..

[29] http://www.statistics.gov.uk/StatBase/ssdataset.asp?vlnk=7295&Pos=1&ColRank=1&Rank=272

92. Amenity effects make up approximately 50% of the disutility of noise, as estimated by Defra, with a cost of over £3bn per year. As well as being the largest, it is also the factor which people are most aware of as they are conscious of the effects.

93. The values applied in aviation have been subject to controversy, so having a cross government agreed approach may give more credence to values and reduce the risk of future challenges.

Challenges of this route

94. As this impact is already measured in policy appraisal, through the Webtag values for road and rail, there is less immediate value added from further research.

95. The policy implications and benefits for appraisal are likely to be more marginal than the development of a new stream in the impact pathway. As monetary values are already applied to transport, any updated values will not lead to wholesale change in the approach taken, although there will be benefits from having more robust values.

96. Although the methodology is well established and a number of studies have been carried out, there is a risk that the results will not be accepted due to questions regarding the methodology. Any work must be robust and defensible.

Research

97. Further research into this area will look to estimate the potential benefits from extending amenity estimates beyond the current transport values to other areas of noise, most notably industrial and neighbourhood noise. The IGCB(N) agreed to conduct more detailed scoping of this area, to estimate the potential impact of noise from non-transport sources and the value that might be added by developing a valuation methodology. This will be taking advantage of DfT expertise and acting as a complement to their research programme.

Chapter 5: Productivity

98. There are economic impacts from noise pollution due to reduced productivity at work resulting from factors including lost sleep and workplace distractions. This is not currently valued in policy appraisal in the UK. While there are no estimates of productivity and noise, if sleep disturbance causes just 0.1% lower productivity per day for 2% of the population, this equates to losses of around £2bn per year.

99. There are potentially many different ways in which noise pollution can lead to losses in productivity. We have identified two routes, due to loss of sleep which leads productivity losses the following day, and as a result of noise in the workplace, leading to concentration losses and losses of productivity. There is not a well developed evidence base for this impact, with a single study, Wicke (1986), which attempts to value the impact of noise on productivity.

100. Research into this area has two key aims, firstly to scope out the potential impact of noise on productivity to investigate if there are other routes which require further investigation. The second aim is to develop a dose response function for valuing productivity losses due to lost sleep, by estimating the link between lost sleep and productivity losses.

Impact

101. Productivity losses can occur via two main routes. Firstly, loss of sleep due to noise can lead to tiredness the next day and thus have a negative impact on productivity. The second hypothesis is that noise in the workplace, especially background conversations can lead to a loss of concentration and result in reductions in productivity.

102. Very little research has been done into the link between noise and productivity. A paper by Wicke (1986) found that productivity losses in Germany due to noise were estimated to be 0.2% of GDP, equivalent to a loss of 3bn Deutschmarks at 1984 prices, equivalent to £3 billion at 2007 prices.[30] We are currently reviewing the evidence underpinning this result to determine if it can be transferred for application in the UK.

Dose response function

103. An impact pathway approach to estimating the effect of noise on productivity through sleep disturbance would contain three main elements, the effect of noise on sleep, the effect of disrupted sleep on productivity and valuation of the effect on productivity.

104. Studies have investigated the first step and quantified the link between noise and sleep disturbance, although there are methodological questions regarding both measuring sleep disturbance and measuring noise (especially accounting for the difference between one off noisy incidents and constant levels of background noise which can have differing impacts on sleep).

105. The second step, the link between loss of sleep and loss of productivity is a key question which research would look to address as very little research has been done in this area.

[30] Adjusted in line with exchange rates and inflation

106. The final link, valuing the effect on productivity can be estimated using gross value added (GVA) per worker or an alternative tool for valuing productivity.

107. The impact pathway for productivity effects resulting from workplace disturbance is clear cut – higher levels of noise result in distraction and a loss of productivity.

108. There are two key issues around quantifying this pathway. The first is that higher noise levels do not necessarily lead to more distraction as the type of sound will affect the level of distraction (for example it has been shown that low level conversation can be highly distracting as individuals strain to pick up more of the content of the conversation). Secondly, the sound is much more heterogeneous and difficult to quantify than environmental noise due to the variability of events and their sound levels.

Advantages of this route

109. This would represent value added as the productivity impacts of noise resulting from a loss of sleep are currently not taken into account in UK policy making. Estimates indicate that the costs of productivity may be around £2 billion per annum.

110. This area would measure a direct welfare loss, as a loss in productivity can be directly linked to a loss in output. This is a tangible loss as opposed to an intangible loss such as a disutility resulting from annoyance.

111. The impacts are short term – a loss of sleep leads to a loss of productivity on the following day, which means that it is comprehendible and people are able to make the connection between the exposure to noise and the resulting impact on productivity.

Challenges of this route

112. There is an extra link in the chain to other outcomes – noise is leading to a welfare loss via an intermediate step in the form of lost sleep as opposed to having a direct impact. This adds to the complexity required to quantify the link and ensure that it is robust.

113. This is a relatively new research area, so any research, although groundbreaking, would also be risky as there would be more methodological uncertainty to overcome, especially in the form of survey design. It would be necessary to ensure that the research is robust if the values and methodology is to be used in policy appraisal.

114. Productivity loss is likely to be measured subjectively, reliant on the perception of the individual. It is also likely to vary significantly across individuals in terms of the severity of impacts.

Research

115. The focus of IGCB(N) work into productivity is to develop the pathway between lost sleep and productivity losses. This research would seek to quantify a direct link between lost sleep and lost productivity or productivity through other routes such as distractions.

116. By estimating a dose response function for the effect of lost sleep on productivity, this could be combined with evidence on the effect of noise on sleep and the monetisation of productivity loses to provide a tool for valuing the effect that noise has on productivity due to lost sleep

117. Research into this area will also look to identify the routes between noise and productivity losses to determine if there are other routes which should be taken into account in government appraisal.

Chapter 6 - Ecosystems

118. This chapter explores the impact that noise has on ecosystems. The effect of noise on ecosystems has been explored in a number of research projects, especially looking at the impact that man-made noise can have on wildlife.

119. Evidence has been found that noise can have a number of impacts on wildlife such as changing patterns of behaviour and effects on breeding patterns. However, the evidence has been mixed and often has difficulty with transforming results at the individual or group level to population level effects.

120. Preliminary valuation was not carried out due to the timing, awaiting the finalisation of the ecosystems services valuation approach. This is likely to be a key tool in valuing the effects of noise on wildlife and ensuring that any research is up to a high standard. Research into ecosystems would seek to assess the impact of noise on ecosystems using existing evidence and assess the potential for developing dose response functions to value the impacts.

Impacts

121. The primary mechanism by which noise is believed to have an impact on wildlife is that loud noise events lead to raised blood pressure in animals with a startle response and escape behaviour in some cases. For example, the hatching success rates of birds in Florida fell to just 1% in 1969, following the introduction of low-flying supersonic flights.

122. Potential impacts of noise were outlined in Busnel, 1978, as detailed in Radle (1998). “Physiological responses to noise include an increased heart rate, body shifting, trotting short distances, flapping of wings (birds), and panic and escape behaviour. According to the text, the coupling of these effects has the potential to cause bodily injury energy loss, a decrease in food intake, habitat avoidance and abandonment and reproductive losses.”

123. Marine impacts of noise have also been studied, with the finding of impacts on patterns of movement, communication of marine mammals and damage to hearing causing a reduction in the ability of whales to navigate by echolocation. These finding are relatively limited due to the difficulty of studying the behaviour of marine animals.

124. Studies have tended to focus upon the impacts of noise on single species and often noise emissions from a single type of source (such as airplanes). In some cases, studies have found strong evidence of outcomes such as reduced hatchings, panic reactions, extra travel and reductions in foraging efficiency.

125. However, consistent evidence is not found across studies, with other studies finding rapid habituation to noise and effects such as elevated blood pressure only occurring in the short term, with levels returning to normal after the noise has passed.

Advantages of this route

126. The effect of noise on ecosystems is not currently taken into account in policy appraisal so any framework, either on a national level or to apply on a case by case basis, would mean that accounting for noise impacts would be improved.

127. Ecosystems valuation techniques are improving, with the ecosystems services valuation methodology as outlined by Defra.[31] If it is possible to develop a robust method for assessing the impacts on ecosystems, then this can be combined with the ecosystems services valuation approach to value the impacts on ecosystems.

Challenges of this route

128. The evidence surrounding the effect of noise on ecosystems is currently limited and definitive patterns have not emerged – impacts are irregular, varying greatly between different species and different types of noise.

129. Significant amounts of further research into the effect of noise on ecosystems would be required to establish whether a relationship exists and under what circumstances man-made noise has a detrimental effect on ecosystems. As the evidence base develops, it may become clearer if it is possible to put into place an overarching system for valuing the impacts on ecosystems, or is a case by case approach is more reasonable.

130. Further difficulty existing in valuing marginal impacts due to the nature of impacts on ecosystems. This may add difficulty in developing a robust tool which can be used for project appraisal.[32]

Research

131. Further research is needed to establish and prove the effects of noise on ecosystems. The first step would be to carry out a literature review of the evidence base that currently existing for impacts of noise on the environment. This would provide a guide to the current strength of evidence and give a clearer idea of how it might be possible to proceed with developing a valuation methodology.

132. The ecosystems services approach will potentially provide a key tool in the valuation of the impacts on ecosystems. This approach has progressed significantly in recent years and further work is being carried out by Defra to develop a framework for valuing the effects of government policies on ecosystems. The IGCB(N) will continue to monitor research in this area.

[31] For further information regarding ecosystems services valuation http://www.defra.gov.uk/wildlife-countryside/natres/eco-value.htm

[32] Although it may be possible to estimate the cost that noise has on certain ecosystems, it is unlikely to be straightforward to transfer that into a cost of noise on a marginal basis, i.e. what is the benefit of a noise reduction of 1dB

Chapter 7 - Conclusions

133. Based on the evidence presented in this paper, the IGCB(N) have identified research into the health impacts of noise as a priority area for further research. This area was seen to have major potential value added, covering annual impacts of between £2 - £3 billion per year that are completely excluded from the current evaluation framework. It was also seen as the most viable area for research with a wide existing evidence base to draw upon.

134. It was agreed that the IGCB(N) will continue further scoping into the other three areas to identify how best they might be taken forward in future.

135. Research into amenity effects would seek to extend the Webtag values to other areas of noise, most notably industrial and neighbourhood noise. The IGCB(N) agreed to conduct more detailed scoping of this area, to estimate the potential impact of noise from non-transport sources and the value that might be added by developing a valuation methodology. This will be taking advantage of DfT expertise and acting as a complement to their research programme.

136. Research into productivity will focus on estimating the pathway between lost sleep and productivity losses, with the aim of quantifying a direct link. This could be combined with evidence on the effect of noise on sleep and the monetisation of productivity loses to provide a tool for valuing the effect that noise has on productivity due to lost sleep.

137. Research into ecosystems is needed to establish and prove the effects of noise on ecosystems. The IGCB(N) will continue to gather evidence base and review the existing literature, to provide a guide as to the current strength of the evidence base and give a clearer idea of how it might be possible to proceed with developing a valuation methodology. Further work is being carried out by Defra to develop the ecosystems services approach which will be a key tool in developing a framework to value the effects of noise on ecosystems.

138. Following agreement of the priorities, the group will immediately focus resources on health. The broad timetable for this work is set as:

- Spring 2008 - Initiate research
- Year end 2008 - Finalisation of research
- Spring 2009 – Publish central guidance for health

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These papers have been separated into categories based upon the type of impact that they cover, there is crossover in many cases, especially between noise and annoyance. There are also studies cited which are yet to be published, to provide an indication of some of the ongoing research in the field.

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Annex A: Initial Estimate of the Costs of Noise Pollution

1.This annex presents initial estimates of the potential costs of noise in England resulting from health, annoyance and productivity effects. The headline result is that the total disutility of noise is over £7 billion per year. This consists of health costs of £2 - £3 billion, productivity costs of £2 billion and amenity impacts in the range of £3 billion to £5 billion.

2.Due to data limitations and conservative estimates these values are likely to be an underestimate of the total disutility of noise in England.

Health impacts

3.Preliminary results from an ongoing WHO study were combined with population data and monetary valuations from England to estimate the value of adverse health effects in England.

4.The main health effects considered were heart disease, sleep disturbance, annoyance, tinnitus (ringing in the ears), slower learning in children and hearing loss[34].

5.The WHO data has been used to estimate monetary values on these impacts. There are two assumptions involved to complete the impact pathway approach, firstly it is assumed that 1 in 8 Europeans live in the UK and secondly that the value of a healthy life year is between £29,000 and £45,000. Under these assumptions the cumulative UK impact of noise pollution on health is around £2 - £3 billion per annum (see table 1).

6.This analysis is based on the WHO methodology, but has been estimated using population exposure data for Europe. This is likely to represent an underestimate of the potential health costs of noise in England due to the higher level of population density in England which means that there is a greater exposure to noise.

[34] http://www.euro.who.int/Noise/activities/20021203_3

Table 1: Health effects from noise pollution[35]

Type of noise exposure	Impact	Proportion affected, per annum	Potential years of healthy life lost in Europe through noise-related death or disability (DALYs)[36]	Monetised UK Impact[37] (£ million per annum)
Daytime traffic	Heart disease	3% of all heart disease cases across EU	211,000	£1,183
Night-time background noise	Severe Sleep disturbance	2% of all Europeans	No figure	No figure
24-hour background noise	Severe Annoyance [38]	15% of all Europeans	278,000	£1,571
Traffic/leisure noise	Tinnitus (ringing in the ears)	3% of all tinnitus cases (0.75% of all Europeans)	9,300	£52
Daytime and night-time noise	Slower learning by children	0.01% of all Europeans	45,000	£252
Loud music	Hearing loss from 'leisure noise'	1.8% of 7 to 19 year olds in Europe	6,800	£38

Annoyance impacts

7.The DfT Webtag values give per decibel values for the loss in amenity due to road noise. These values were applied to data on population exposure to road noise in major cities. This found that the total disutility of current road noise in England is between £3 billion and £5 billion per year. There was found to be a marginal disutility of £311m to £479m per year for a 1 decibel increase in road noise and a marginal disutility of £932m to £1.5 billion per year for an audible increase in road noise[39].

[35] Note that these results are not final and may be adjusted on publication in December 2008.

[36] DALYs are a good tool to use here as noise exposure has both morbidity and mortality effects which can be analysed using just DALYs. Therefore, even if an impact has no mortality effects, such as tinnitus, it nevertheless contributes to a reduced quality of life and can be valued using DALYs.

[37] Using the assumption that 1 in 8 EU residents lives in the UK. http://www.statistics.gov.uk/cci/nugget.asp?id=1314. A DALY is valued here at £46,000 per life year. For further details on this figure, see Annex C.

[38] We have included severe annoyance in the health impacts in line with the methodology employed by the WHO. However, there is a strong potential for overlap with the valuation of annoyance using the Webtag values. As the health effects are adapted for application to the UK, the difference between severe annoyance as included here and annoyance as measured using the Webtag values will be considered to ensure that there is not double counting.

[39] An audible increase in noise is 3dB

8.The two main caveats to this analysis are that they only consider road noise[40], and not other sources of noise such as rail, air or neighbourhood noise, and that they only consider large urban areas, and therefore cover less than half of the UK population. Therefore the numbers represent a substantial underestimate of the annoyance impacts[41].

Productivity impacts

9.There are also economic impacts from noise pollution due to lost sleep and decreased productivity at work. To estimate these impacts we would need some data indicating the incidence of sleep disturbance, the relationship between sleep disturbance and productivity and a measure of productivity in order to monetise the effect.

10.Without this data, we have made some assumptions in order to give an illustrative figure. Taking the assumption that 2% of the UK population are affected by severe sleep disturbance (from table 1), that this disturbance decreases your productivity by 0.1% and that average GVA per capita is an effective measure of productivity per head, expected productivity losses from noise pollution are around £2 billion per year. This again demonstrates the potential significance of noise pollution costs.

[40] Since this was the only population noise exposure data that was available to us.

[41] Note here that there will be a non-linearity effect in the extrapolating of these impacts to cover the whole of the population. This is because the 25% of the population that have already been included in this analysis are those that live in major agglomerations so are more likely to suffer noise pollution.

Annex B Existing Noise Regulations

1.The UK currently regulates noise in a range of ways. This annex provides a brief overview of some of the key pieces of legislation.

2.The Control of Noise at Work Regulations 2005 are designed to protect individuals in the workplace from prolonged exposure to excessive noise that may cause damaging to hearing. The regulations set action levels based upon the daily exposure to noise levels, above which employers must take action to reduce the exposure to which any employee is subject. There is a planned evaluation of this policy taking place during the next two years which will seek to assess the costs, benefits and impact of the regulation. IGCB(N) will look to ensure that the evaluation is joined up and share methodologies and analytical frameworks where relevant.

3.The Land Compensation Act 1973, along with the Noise insulation regulations (1975) provides for compensation to be claimed in instances where house prices have dropped as a result of increased noise levels and for grants to be provided by local authorities to provide noise insulation where road or rail noise has increased and is above certain levels (68dB).

4.Quotas on the number of flights and restrictions on maximum noise levels are placed upon certain airports during the day and at night.

5.The IPPC (Integrated Pollution Prevention and Control) requires the consideration of noise impacts alongside other environmental outcomes for industrial activities.

6.Planning guidance documents include guidelines on acceptable levels of noise and bounds where mitigation measures may be necessary for planning permission to be granted.

7.Neighbourhood noise is subject to a number of pieces of legislation including the Noise and Statutory Nuisance Act 1993, the Clean Neighbourhoods and Environment Act 2005,the Night Noise Act 1996, the Control of Pollution Act 1974 and the Environmental Protection Act 1990.

139. The World Health Organisation (WHO) 1999 published guideline values for specific environments and adverse health effects. These are the views of international experts regarding the levels above which adverse health impacts may occur. However, their nature means that they cannot be directly applied to a valuation methodology as they do not give a dose-response function for marginal effects, but a limit value above which adverse effects may occur. Further work is seeking to address this issue and develop internationally agreed dose response functions for the adverse health impacts of noise.

Annex C: Valuation of a DALY

140. This annex provides detail of the value of £46,000 for a DALY which is applied in Table 2 (page 17). This is applied to data on the number of DALYs lost as a result of the health effects of noise to provide an indicative estimate of the total value of the health effects due to noise.

141. The standard value which is used by the IGCB is £29,000, is based upon a one year extension to life expectancy. This extension is most likely at post-retirement ages. At these ages, QoL scores are typically around 0.78 or 0.73.[42] This implies that £29,000 is for about three quarters of a QALY.

142. This provides a value of a full QALY of about £38,400, at 2004 prices. Inflating this using nominal growth in GDP per capita to 2008 prices gives a value of a full QALY of approximately £46,000

143. This assumes that the value of a QALY is equivalent to the value of a DALY, based upon DH advice that this is a reasonable assumption.

144. There is an Interdepartmental Group on the Value of Life and Health which is involved in developing further work into the value of a QALY or a DALY to be applied to policy appraisal. The IGCB(N) will keep in contact with this group and take on any updated guidance in future.

[42] From http://www.york.ac.uk/inst/che/pdf/DP172.pdf

Annex D: List of IGCB(N) members

The member organisations of the Interdepartmental Group on Costs and Benefits are:

- Department for Environment, Food and Rural Affairs (Defra)
- HM Treasury
- Department of Health (DH)
- Department for Transport (DfT)
- Department of Business and Regulatory Reform (BERR)
- Department for Communities and Local Government (DCLG)
- Environment Agency
- Health and Safety Executive (HSE)
- Health Protection Agency
- Department of Environment for Northern Ireland (DOENI)
- Scottish Environment Protection Agency (SEPA)
- The National Assembly for Wales
- The Scottish Executive
- Better Regulation Executive (BRE)
- HM Revenue & Customs (HMRC)
- Cabinet Office