2. WHAT ARE AN AIRPORT'S IMPACTS?

2.1 Introduction

This chapter briefly reviews the impacts of airports and aviation. The negative impacts of airports and aviation include land take, noise, air pollution, climate change, water use, and effects on the social structures of local communities. Positive impacts include direct and indirect employment, and social (and economic) benefits to people who fly. These impacts can typically be split into impacts from

- *construction* v. *operation* of airports and associated projects, and possibly *closure* if, say, a runway is relocated;
- the *airport terminal and ground operations*, *flights*, *access to the airport* (cars, buses, trains, parking etc.) and *associated projects* such as hotels and airport-related office developments.

Table 2.1 shows the key impacts typically[1] caused by each of these activities.

Table 2.1. Key impacts caused by airport and aviation activities

	terminal & ground operations		**flights**	**airport access**		**associated projects**	
Key impacts - negative impact + positive impact	construction	operation	operation	construction	operation	construction	operation
air pollution			-		-		-
biodiversity impacts	-	-	-	-	-	-	
climate change		-	-		-		
employment and economic benefits	+	+	+			+	+
heritage	-		-	-	-	-	
land take	-			-		-	
landscape	-	-		-		-	-
noise		-	-	-	-		
risk and public safety zones			-				
social costs to nearby communities	-	-			-		
traffic	-	-		-	-	-	-
water pollution		-			-		
water use		-					-

The rest of this chapter discusses each of these impacts in turn.

[1] Not every airport development will have all of these, and a given airport development may also have other impacts.

2.2 Air pollution

Airports and aviation generate air pollution through a range of sources:

- Combustion of aviation fuel – which is mostly composed of kerosene - produces nitrogen oxides (NOx), carbon monoxide (CO), sulphur oxides (SOx), hydrocarbons and particulates. It also releases the greenhouse gas carbon dioxide (CO2) which is discussed at Section 2.4.
- As engines are working inefficiently on approach (as they only use about 30% of the available power) a certain amount of unburnt kerosene is released. These unburnt fuel droplets are a source of volatile organic compounds (VOCs) and give rise to odours.
- As aircraft tyres get worn and burnt during take-off and (especially) landing, they release particulate matter (PM).
- Fuel dumping by aircraft releases unburned aircraft fuel into the air. This is a rare occurrence and usually only takes place in emergencies. In these circumstances, aircraft are expected to dump fuel over water where possible, and at an altitude where they are likely to evaporate before reaching the surface.
- Vehicles travelling to and from the airport, and ground service equipment (tugs for aircraft and baggage, fuel and catering lorries, buses and vans that transport passengers etc.) generate NOx, CO2, particulates and (indirectly) ozone through the burning of petrol and diesel fuel.
- Fuel storage tanks and transfer facilities can lead to the release of VOCs.
- Aircraft and airfield maintenance (painting, metal cleaning, de-icing etc.), and emergency and fire training use complex chemicals which can release VOCs.
- Construction of airport-related projects can lead to dust, emissions from asphalt laying etc. (Kenney, 2006).

http://www.photographersdirect.com

Air pollution can affect the health of people, animals and plants. It can promote eutrophication (essentially over-fertilisation) of water, leading to excessive plant growth and decay. It can also deteriorate buildings and materials and smell bad. Table 2.2 summarises the main impacts of air pollution.

The UK standards are derived from EU Air Quality Framework Directive 1996 and a range of 'daughter' Directives. Each of these Directives has a set timetable for implementation. Table2.2 shows relevant standards. In the UK, the NO2 standards which must be achieved by 2010 are the most problematic. Several Member States are currently seeking an amendment to issue derogations for non-compliant sites.

Table 2.2 Impacts of, and standards for, air pollutants

Pollutant	Background	Impacts on human health, habitats and species	UK air quality standard[2]
Carbon monoxide (CO)	CO is produced when fuels are burned at too high a temperature or where there is too little oxygen.	When inhaled by people and animals, CO bonds to the haemoglobin in the blood, and reduces the oxygen-carrying capacity of the red blood cells. The resulting lack of oxygen in the body causes cells to die.	10.0 mg/m^3 maximum daily 8 hour mean
Nitrogen oxides (NO_x), nitrogen dioxide (NO2)	Nitrogen oxides (NOx) comprise nitric oxide (NO) and nitrogen dioxide (NO2). NO is oxidised in the atmosphere to form NO2. NO2 is acidic and highly corrosive.	NO has no significant human health impacts. NO2 can increase a person's susceptibility to, and the severity of, respiratory infections and asthma. Long-term exposure to high levels of NO2 can cause chronic lung disease. High NO2 levels damage foliage, decrease plant growth, and reduce crop yield. Deposition of nitrogen compounds can lead to soil and water acidification. NOx can cause eutrophication of soils and water, which alters the species composition of plant communities and can eliminate sensitive species. NOx is a component of photochemical smog.	NOx 30 µg/m^3 for vegetation NO2 200 µg/m^3 1 hour mean not to be exceeded more than 18 times per year; 40 µg/m^3 annual mean by 1 Jan 2010
Ozone (O_3)	Ozone is generated by photochemical reactions from NOx and volatile organic compounds, and is an indicator of photochemical smog.	Ozone can irritate the eyes, nose, throat and lungs. At high levels it can increase death rates due to lung and heart problems. It can reduce visibility. High ozone levels can be toxic to wildlife, and can lead to a reduction in growth of forests and crops, and altered species composition in semi-natural plant communities. Ozone can damage materials such as rubber, fabric, masonry, and paint.	100 µg/m^3 running 8 hour mean. Daily maximum of running 8 hr mean not to be exceeded more than 10 times per year
Particulate matter	Particulate matter is a complex mixture of organic and inorganic substances. Particulates are described by their size in micrometres (µm), e.g. PM10 are those smaller than 10µm. PM2.5 typically contain	Of the air pollutants, particulates are worst for human health. They are responsible for up to 10,000 premature deaths through respiratory problems in the UK each year. PM10 can penetrate deep into the lung and cause more damage, whilst larger particles are typically filtered out through the airways' natural mechanisms.	PM10: 50 µg/m^3 24 hour mean not to be exceeded more than 35 times per year; 40 µg/m^3 annual mean

[2] From UK Air Quality Archive (no date). The World Health Organisation's (2005) air quality guidelines are also often cited.

Pollutant	Background	Impacts on human health, habitats and species	UK air quality standard[2]
	aerosols, combustion particles and re-condensed vapours. Larger particles usually contain dust.	Particulates can damage surfaces and materials.	
Sulphur Dioxide SO_2	SO2 is a gas, but when it combines with water, it forms sulfuric acid, which is the main component of acid rain.	SO2 can cause coughing, make people more prone to respiratory infections, and aggravate asthma and chronic bronchitis. SO2 can attach itself to particles (see above) and, if these particles are inhaled, they can cause more serious health effects. Acid rain acidifies soils and water. This can affect aquatic life, cause deforestation, and alter the species composition of plant and animal communities. Acid rain can corrode building materials and paints.	266 µg/m^3 15 minute mean not to be exceeded more than (NE) 35 times per year; 350 µg/m^3 one hour mean NE 24 times per year; 125 µg/m^3 24 hour mean NE 3 times per year; 20 µg/m^3 annual mean for vegetation; 20 µg/m^3 winter mean (1 Oct – 31 March) for vegetation
Volatile organic compounds (VOCs), hydro-carbons	VOCs include a wide range of organic chemicals such as hydrocarbons (e.g. methane, benzene, toluene), halocarbons and oxygenates. VOCs have no colour, smell or taste, and they easily vaporize at room temperature.	Hydrocarbons can be hazardous to human health even at low levels, particularly if the exposure is long term. For instance, long-term exposure to benzene has been linked to an increased incidence of anemia and leukemia; toluene can affect the central nervous system; and moderate levels of formaldehyde can lead to irritation of the eyes, nose and upper respiratory track. Some VOCs can cause cancer. Odours from hydrocarbons are often annoying. Some hydrocarbons play a role in the formation of photochemical smog.	Benzene 16.25 µg/m^3 running annual mean; 5 µg/m^3 annual mean by end 2010 1,3-Butadiene 2.25 µg/m^3 running annual mean Polyaromatic hydrocarbons 0.25 ng/m^3 B(a)P annual mean by end 2010

Sources: US EPA (2007), Environment Agency (2007)

Overall in the UK, emissions of air pollutants decreased between 1990 and 2004: NOx by 45%, particulates by 48%, and sulphur dioxide by 77%. However, even with improvements to aircraft, the rapid growth of aviation means that its contribution to air pollution is increasing overall. Aircraft typically generate between 8 and 50 kg of NOx per landing/take-off cycle (depending on aircraft type) and the number of aircraft movements in the UK has increased from 3.1 million in 1996 to 3.6 million in 2006. The local impacts of aviation-related air pollution can be significant. Air quality at Heathrow is particularly bad, and Government has stated that it will only permit the development of a third runway at Heathrow if it is confident that air quality limits can be met. Overall, the area of sensitive ecological habitat where acid deposition and eutrophying pollutants exceeded critical loads have also fallen over time; however in 2003, 56% of these habitats still received too much acid deposition, and 59% too much eutrophying pollution (Defra, 2006).

It is very difficult to reduce the air pollution impacts from aircraft except through more efficient operations and technology. The use of the most polluting chemicals is covered by pollution prevention and control regulations. The air pollution impacts of ground traffic can be reduced by switching to less polluting forms of transport (bicycle, train and bus rather than private vehicles). Dust from construction can be controlled by soil damping and wheel washing. Some airports compile emissions inventories and carry out air quality assessments to help identify how air pollution can best be tackled.

Some of the measures that have been proposed or carried out to mitigate the effects of air pollution include measures to control the emissions or to penalise non-compliance. Measures proposed in airport master plans and environmental statements for minimising air pollution impacts are:

- Working towards a reduction if the total number of vehicles that commute to and from the airport
- A system of penalties for polluting vehicles
- Introduction of charges to promote the use of lower emission aircraft
- Minimising dust emissions by wheel washing, damping down and employing the use of covered vehicles for transportation
- Conducting a Code of Construction Practice relating to air emission
- Carrying out air quality assessments periodically

2.3 Biodiversity (or nature conservation, or flora and fauna) impacts

Biodiversity impacts refer to impacts on plants and animals. These include reduction in the type and extent of habitats; bird strike and road kill; disturbance from light pollution, noise and aircraft/vehicle movements; and air pollution.

Habitat loss occurs when previously ‘green’ areas[3] are built on, destroying the habitats of the plans and animals that live there. *Habitat fragmentation* happens when a larger area of habitat is split into smaller areas, for instance if it is split by a road or fence. This can make it difficult for animals to forage for food, breed and migrate. Animals with very consistent foraging patterns (like badgers) or breeding patterns (like toads) may continue to move from one habitat fragment to the other, and may be hit by cars. Some animal species have large land requirements, and may be affected by habitat loss or fragmentation even if these reduce the animals’ habitat a little bit.

Habitat degradation reduces the attractiveness of the habitat for the plants and animals on it. This could result, for instance, from the ground being churned up and/or compacted, vegetation clearance, replacement of one type of vegetation by another (e.g. herb-rich grassland by turf), storage or disposal of rubble on the site, litter, or land contamination.

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[3] These ‘green’ areas can include previously developed land that provides biodiversity benefits, for instance disused industrial areas that have been recolonised by *bodleia*, brambles, rabbits and foxes. Rare and unusual plants and animals often thrive on previously developed areas.

Bird strikes occur when aircraft hit birds during take-off and landing. Roughly 85% of bird strikes involve aircraft below 800 feet, and up to 40% of bird strikes take place beyond the airport perimeter (CAA, 2001). The number of bird strikes at a given airport is a function of:

- The number of birds near the airport: airports in an area of high bird density are likely to have more bird strikes than airports in areas of low bird density.
- The types of birds near the airport: the likelihood of a bird being struck by an aircraft depends in part on the height at which it flies and its flight patterns. For instance, oystercatchers and starlings are much more likely to be hit by an aircraft than pheasants and grey herons (DfT, 2006a).
- The number of aircraft landings and takeoffs at the airport: the greater number of aircraft movements, the greater the likelihood of a bird strike.


http://oopslist.com/Heli%20Bird.jpg

The Civil Aviation Authority (2006) suggests that, in the UK, 1000 air traffic movements lead, on average, to roughly 0.54 bird strikes. In 2001, the CAA predicted that the risk of a catastrophic accident due to bird strike would be 2.5 times higher in 2010 than 2000 due to a large increase in the population of large flocking birds and the forecast growth in air traffic (CAA, 2001).

Because birds are a significant hazard to aircraft, control measures are used at many airports to reduce bird strike. These measures can include landscaping, waste management measures, use of noise and flare guns, and use of falcons. The whole purpose of these measures is to disturb birds – there is a clear conflict between aircraft safety and large bird populations.

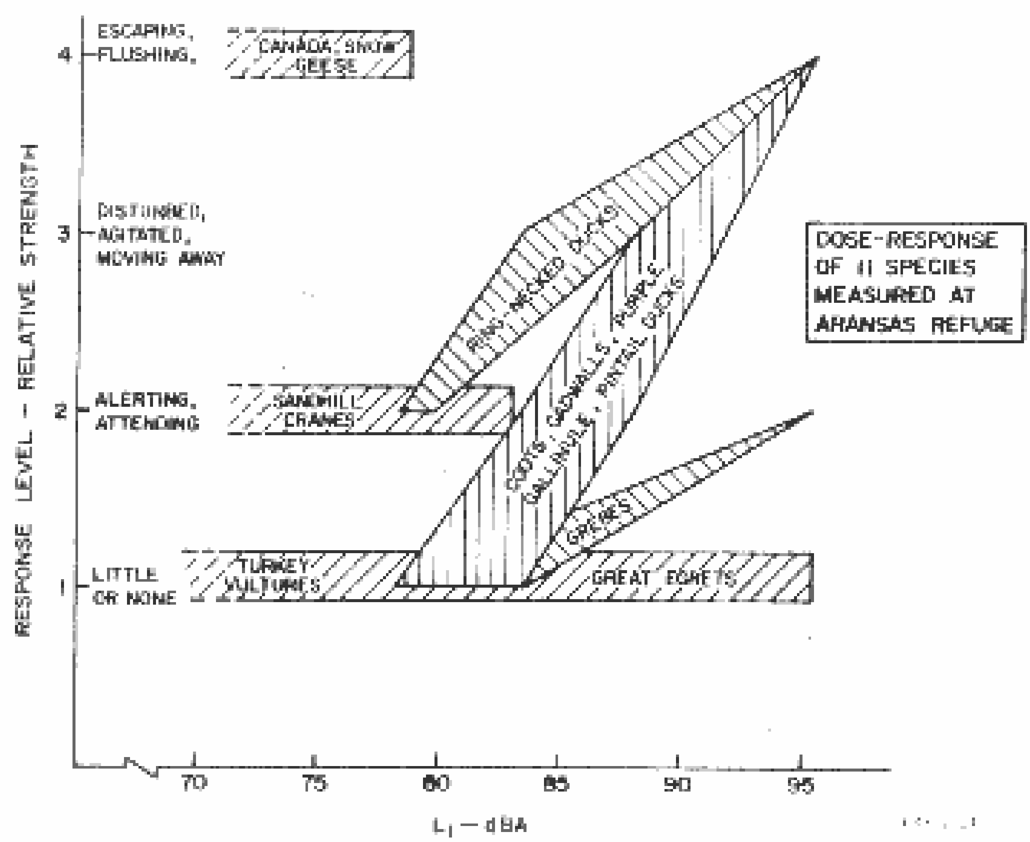
Measures to control birds also extend beyond the airport boundary. 13km radius safeguarding zones have been established around 27 airports, and 8 mile radius zones around military airfields. Within these zones, planning authorities must consult the owner or operator of the airport before giving planning permission for any development that could attract birds (DfT, 2003a). Typically such developments are landfill and mineral extraction sites. Several applications to create new water environments have been rejected by the CAA unless the applicant can demonstrate that the area can be successfully netted. A report by the British Geological Survey identified that 44% of England's land area falls within such safeguard zones (Henney et al., 2003).

Road kill occurs when animals get hit by vehicles, for instance on access roads to airports. No formal data are collected on road kill numbers, but evidence suggests that they can be significant. For instance, Naturewatch (2007) suggests that more than 10% of the badger population is killed on Britain's roads each year; and Mead (1997) suggests that 10-30% of many bird species are killed by cars each year, with owls being particularly badly affected. Road kill due to airport traffic is unlikely to be a major impact over and above existing levels of road kill, but could be major if the airport requires a new road.

Light pollution from airports and roads can attract animals either directly or indirectly (e.g. they attract insect prey which, in turn, attract bats and birds – and their predators). This can affect migration patterns where animals travel off-course because they are attracted to light. Once they arrive at the light source, birds may circle the source, become disoriented and exhausted, and collide with structures or other disoriented birds. Light pollution can also affect animals' rhythms of waking, sleeping and hibernation (Rich and Longcore, 2006).

The sensitivity of wildlife to the *noise* of aircraft, airport ground operations and airport access roads varies greatly from species to species. Such noise can cause some wildlife – notably a range of grassland and woodland birds - to avoid areas near them, reducing the density of those animal populations (Kaseloo and Tyson, 2004). Animals' breeding success can also be reduced by noise. Studies have shown that some birds are disturbed by noise affecting noise and migration, although other species can tolerate exposure at the same level: see Figure 2.1.

Figure 2.1



Source: U.S. Federal Aviation Administration, 1985

Animals can be *disturbed by the movement* of aircraft and vehicles. For instance, a study of birds near the Liverpool John Lennon Airport found that aircraft movement had limited effect on the birds, but the cumulative impact of multiple sources of disturbance, including dog walkers and vehicles, was significant (Peel Airports, 2006).

Biodiversity impacts are particularly significant if they affect sites of nature conservation importance:

- at the international level: Special Protection Areas (for birds), Special Areas of Conservation (for habitats) and Ramsar sites (wetlands)
- at the national level: Site of Special Scientific Interest
- at the regional level:
- at the local level:

If the project could have a significant on an international level site, then 'appropriate assessment' of the project is required. This is a strong planning tool and is discussed at Chapter 7.

Measures proposed in airport master plans and environmental statements for minimising impacts on biodiversity are:

- Minimising intrusion
- Translocation, restoration and creation of habitats
- Rescue of important species
- Pond replacement and refurbishment
- Hedge restoration and improvement
- Designing river channels to minimise hydrological and ecological changes
- Mitigating the loss of mature trees as a result of height restrictions by substituting small trees and shrubs and hedge thickening

2.4 Climate change

The so-called 'greenhouse effect' occurs when sunlight passes through the atmosphere, warming the earth; heat from the earth's surface is re-emitted; and this heat is partly absorbed by the atmosphere, trapping the heat. Higher atmospheric concentrations of greenhouse gases - notably carbon dioxide (CO2)[4] but also methane, NOx and others - cause the atmosphere to absorb more heat from the earth's surface, and lead to higher levels of warming, or climate change.

The UK has already warmed by 0.6-0.7°C since the Industrial Revolution. Because of the inertia of the climate system, average global temperatures are expected to rise by about another 0.5°C simply as a result of emissions to date. On current trends, global average temperatures will rise by 2-3°C within the next 50 years (Stern, 2006). This will worsen droughts in the summer, floods in winter, and extreme events such as storms.

[4] CO2 emissions are sometimes expressed in terms of carbon (C). One tonne of C is equivalent to 3.67 tonnes of CO2.

Planning Policy Statement 1, *Delivering Sustainable Development,* places climate change issues firmly in the remit of local and regional planning bodies. It charges these planning bodies with the task of *'addressing the causes and potential impacts of climate change – through policies which reduce energy use, reduce emissions..., and take climate change impacts into account in the location and design of development"* (Communities and Local Government, 2005). About half of all local authorities in the UK have also signed the Nottingham Declaration on Climate Change (2000), which pledges that they will actively tackle climate change in their area and work with others to reduce greenhouse gas emissions country-wide.

Airports and aviation generate greenhouse gases in three main ways:

- *Flights* are by far the largest source. Aircraft emit large quantities of CO2 and NOx during flights, particularly during take-off and landing. NOx emissions at altitude react to either increase ozone concentrations or decrease methane concentrations in the atmosphere. While this leads to global warming and cooling respectively, the two occur in different regions and latitudes and do not cancel each other out. Water vapour from combustion also contributes to the formation of contrails, and persistent contrails are also thought to cause additional cirrus cloud formation (although the scientific certainty of the precise impact is less compared to other greenhouse gases);
- *Ground traffic* is the second largest source. Vehicles (including construction vehicles) travelling to and from the airport, and around the airport generate CO2;
- *Airport buildings* require electricity and heating. Unless this comes from sources that do not use fossil fuel (e.g. hydro- or wind power), the energy production will generate greenhouse gases. Airport construction also generates CO2 through 'embodied energy'[5].

Flights International aviation is not included in the UK's climate change inventory (or the Kyoto Protocol) as there is no agreed method for allocating such emissions between countries. In 2005, emissions from domestic flights plus international aviation departing the UK accounted for 6.3% of UK CO2 emissions (Directgov, 2007).

The overall climate change effect of all aircraft emissions is roughly 2-4 times the effect of CO2 alone: as such, aviation accounts for roughly 13% of current climate change impacts in the UK. This 'radiative forcing' multiplier accounts for some of the differences between statements about aviation's climate change impacts. The aviation industry typically do not use the multiplier; this accounts for some of the discrepancies between different organisations' statements about the impact of greenhouse gas emissions from aviation. The aviation minister used a factor of two in a recent answer to Parliamentary Questions, concluding that aviation accounted for approximately 13% of climate change impacts attributable to the UK (Merron, 2007).

Emissions from aviation fuel use more than doubled between 1990 and 2004 (Defra 2006). On the most favourable (to the industry) credible projections and assumptions,

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[5] Embodied energy is the energy needed to produce and transport materials, and is typically measured as megajoules per kilogrem (MJ/kg). The more energy is needed, the more greenhouse gases will typically be used in the production of the material. Steel, aluminium, and glass – much used in airport construction – all have high embodied energy. Concrete has relatively low embodied energy, but because such large quantities of concrete are used in the construction of a typical airport, this adds to the project's embodied energy. Typically embodied energy accounts for about 10% of the energy used in a building.

by 2050 aviation's CO_2 emissions alone will equal a quarter of the UK target for greenhouse emissions. On other projects and assumptions from peer reviewed scientific literature, in 2050 emissions from aviation alone would significantly exceed all of the carbon permitted under the UK's climate change targets (Levett, 2007).

Modern aircraft generally produce fewer CO_2 emissions per passenger kilometer than older ones, and the aviation sector has adopted a target to improve fuel efficiency per seat-kilometre by 50% by 2020 compared to 2000 (DfT, 2006). Improvements to the air traffic control system are also thought to offer one-off improvements in the region of 8-18% (IPCC, 1999)

It is possible to work out an 'economic cost' for greenhouse gas emissions, which quantifies the cost of the emissions on society as a whole, and suggests how much the airlines (or their passengers) should pay under the 'polluter pays principle'. The official 'cost of carbon' is currently £77 per tonne. (This is the source of much debate – the Stern report in Nov 2006 suggests the cost could be much higher.) The cost of X tonnes of CO_2 is thus X × £77 × 2.7 / 3.67 (the 2.7 multiplier is for radiative forcing, the 3.67 divider for the CO_2 to C conversion).

The Government is supporting the inclusion of aviation in the European Union's emissions trading scheme (DfT, 2006). The scheme essentially allocates greenhouse gas emission allowances to different industrial emitters: companies can buy more allowances/credits from other sectors or sell their credits if they reduce their emissions. However, aviation has not yet been included in this scheme; whether the scheme will actually secure real emissions reductions is highly dependent on how (and whether) some highly controversial questions about its implementation and design are finally resolved; and it is not credible to hope that other sectors and other countries will be able to offset the impacts of the UK's proposed growth in aviation (Levett, 2007).

The Government is also proposing that decisions about major increases in aviation capacity should be informed by an emissions cost assessment, which would 'consider whether the aviation sector is meeting its external climate change costs' (DfT, 2003). However it is not suggesting how the results of such assessments would inform planning decisions. The DfT (2007) has consulted on an emissions cost assessment. This develops scenarios for whether the industry is meeting its external costs based on a range of carbon costs (from £83 - £207) and a radiative forcing index of 1.9 or 4. The DfT has said that the emissions cost assessment would not inform decisions on individual applications.

Airlines (or air passengers) can also sign up to a range of 'carbon offset' schemes, where the carbon impacts of flying can be offset, for instance through tree planting or support for renewable energy in developing countries. However, the schemes vary widely in terms of the assumptions they make and price they charge; there is concern about their 'additionality' (whether they lead to new action or simply support action already taking place anyway); and arguably they simply make people feel better about their unsustainable behaviour rather than encouraging people to fly less.

Ground traffic generates CO_2 through the burning of fossil fuels. As with air pollution, this can be reduced by switching to cycling, trains and buses. Electric vehicles can be used on-site, but they still generate greenhouse gases indirectly, since their power comes from power stations, most of which burn fossil fuels. Car use can be discouraged by making parking at airports expensive (although care needs to be taken that this does not lead to parking in nearby neighbourhoods instead); provision of bus lanes; and locating public transport terminals more conveniently to the airport than car access points.

Airport buildings can be made very energy efficient, or even ‘energy negative’ if they incorporate renewable energy technologies such as photovoltaics. Energy plants can be made more efficient, and electricty supplies to airports can come from ‘green’ sources. However airports use only a small proportion of the energy used for flying, so any gains here are minor in the overall scheme of things.

Few if any measures for reducing the effect of aviation on climate change are proposed in airport master plans and environmental statements. Mitigation measures are usually aimed at reduction of air emissions and improvement in ground transportation rather than directly targeting climate change as an issue on its own.

2.5 Employment and economic benefits

Airports and aviation often generate much employment and many economic benefits. However they can also have economic costs.

The employment generated by airports and aviation can be split into direct, indirect, induced and catalytic employment, as shown in Table 2.3. A study by Oxford Economic Forecasting (1999) – mostly funded by the aviation industry – found that, in 1998, aviation and airports in the UK directly and indirectly generated approximately 550,000 jobs.

Table 2.3 Types and amount of employment generated by airports and aviation (based on York Consulting, 2002; Oxford Economic Forecasting, 1999)

Impact category	Definition	Examples	UK aviation-related employment in 1998
Direct	Employment wholly or largely related to the operation of airports or airlines	Airport operator, airlines, handling agents, control authorities, concessions, freight agents, flight caterers, hotels, car parking, aircraft servicing, fuel storage	180,000
Indirect	Employment supported in the chain of suppliers of goods and services to the direct activities	Utilities, retailing, advertising, cleaning, food, construction, IT, fuel	75,000 in travel agencies plus 200,000 others
Induced	Employment supported by the spending of incomes earned in the direct and	Retailing, restaurants, entertainment	100,000

	indirect activities		
Catalytic	Employment supported by the attraction, retention or expansion of economic activity as a result of access by air	Inward investors, exporting companies, visitor attractions	

The study also noted that aviation supports the UK's large and growing tourism industry, which in turn directly employed 1.75 million people in 1998; and contributed £10.4 billion to the Gross National Product (1.4% of the total). It concluded that, if passenger numbers were not allowed to increase beyond 1998 levels, £30 billion would be lost to the economy by 2015.

Government used these figures in its Aviation White Paper (DfT, 2003) to help justify the need for the continued growth of aviation. The White Paper also notes that airports can act as a focal point for 'clusters' of business development and thus act as a focus for the development of local and regional economies.

Generally, increased employment is a good thing. There is a clear link between unemployment and low satisfaction with life, although the link between employment and high life satisfaction is less clear[6]. Employment also improves people's personal wealth, which again contributes to life satisfaction, although relative income (individuals' income compared with that of other people) is a clearer contributor (Dolan et al., 2006).

However, many environmentalists claim that the basis of many of these calculations of economic benefits, including that by Oxford Economic Forecasting, is flawed:

- The environmental costs of aviation are not included, which makes comparisons between investment costs and the impact on GDP nonsensical;
- All the people employed in the aviation sector would not become unemployed if the aviation sector did not grow. The economy would develop in different ways: budgets and investment may well be spent elsewhere, leading to employment and contributions to GDP in other areas of the economy; and
- Relating indirect, induced and catalytic jobs to a country's overall employment is essentially double counting. These jobs arise in other sectors. If all industries made the same claims, the number of jobs created would exceed the total workforce (CE Delft, 2005).

Jobs directly and indirectly related to aviation are typically relatively low-paid. Airlines are cutting back jobs where possible, for instance by promoting e-ticketing and getting passengers to carry their own luggage to the aircraft. Catalytic jobs are typically a mixture of relatively poorly paid (e.g. tourism industry) and well-paid (many of the knowledge-intensive industries that rely on air travel).

Where aviation-related employment is in areas of high unemployment, it is an undoubted benefit. However where it occurs in areas of already high employment , then it can lead

[6] For instance, casual work has been found to be detrimental to men's mental health and women's life satisfaction.

of poaching of workers from other companies and contribute to over-heating the economy.

The links between increased air travel and regional regeneration are also not as clear as suggested in the Air Transport White Paper. The government's Standing Advisory Committee on Trunk Road Assessment examined the link between transport provision (of all forms) and economic activity, and found that:

- there is no simple link between the provision of transport infrastructure and regional regeneration;
- non-transport factors in a region (such as the availability of skilled labour) are usually a more critical factor in regenerating a region than transport infrastructure;
- in a mature economy with an already well-developed transport system (as in the UK) any increase in economic growth from improved transport is likely to be modest (SACTRA, 1999).

Aviation also has significant economic costs which were not acknowledged in the Air Transport White Paper (DfT, 2003). Air passenger duty – essentially a tax on flying - does not make up for the *tax breaks* that the aviation sector benefits from. Air passenger duty was £0.9 billion in 2003. However airlines do not need to pay taxes on jet fuel: if such taxes were paid at the same level as those paid on petrol, they would have raised £5.7 billion in the UK in 2003[7]. The aviation industry also does not pay VAT in the UK: this would have raised £4.0 billion in 2003. As such, the aviation industry essentially received a government subsidy of around £9 billion in 2003 (Sewill, 2003). This subsidy, which could be spent on other services such as education and hospitals, will increase further as air passenger numbers rise (though not as fast as the growth in air passengers, because of the significant recent increase in air passenger duty and the increasing efficiency of aircraft).

Aviation also contributes to the *trade deficit* in two main ways. First, the difference between what UK residents spent abroad (£35.1 billion) and what foreign residents spent in the UK (£16.1 billion) was £19 billion in the 12 months ending July 2007 (National Statistics, 2007). This deficit has been consistently increasing: it was £2.6 billion in 1995, £9.1 billion in 2000 and £15.7 in 2005 (Ross, 2007). London is the only region in the country with a small net benefit; all the other regions show large tourism deficits.

Second, the difference between the amount spent by UK residents purchasing airline tickets from foreign airlines (£7.1 billion) and that spent by foreign residents purchasing tickets from UK airlines (£4.1) was £3 billion in 2005. This deficit has also been steadily increasing, from a £0.6 billion surplus in 1995 (Ross, 2007).

Aviation also imposes *external costs* on society which it does not pay for. These include the reduction in home values due to airport noise; the costs of treating respiratory diseases caused by increased particulates; and the cost of cleaning buildings eroded by air pollution. The Department for Transport (2003) estimated that, in 2000, the external costs of aviation included:

[7] In 2003 air passenger duty was £5 or £10 per ticket. It is now (autumn 2007) £10 for economy travel to most EU destinations (£20 for business) and £40 for all other destinations (£80 for business). This is projected to raise almost £2billion but still leaves a significant shortfall.

- £1.4 billion due to global warming, expected to rise to £4.8 billion in 2030, assuming no demand or supply side responses;
- £25 million due to noise impacts;
- depending on the methodology used, either minimal costs or between £119 and £236 million due to air pollution; and
- additional costs due to congestion in the skies and from surface transport around airports.

The DfT (2004) subsequently estimated that accounting for the costs of noise and climate change alone would add between £3 and £20 to the cost of an airline ticket.

2.6 Heritage / culture

Heritage (or cultural) assets include archaeological remains, both above ground and buried; historic buildings and sites such including listed buildings, cemeteries, parks, village greens, bridge and canals; historic areas and landscapes; and other structures of architectural or historic merit. Heritage designations include, at the international level World Heritage Sites (e.g. Blenheim Palace); and at the national level Scheduled Ancient Monuments, Areas of Archaeological Importance, listed buildings of different grades (in decreasing order of importance Grades I, II* and II), conservation areas, and parks and gardens of historic interest. Ancient woodlands are often valued and protected for their biodiversity, but their sheer age also gives them heritage value.

The county archaeologist and local conservation officer(s) will normally keep a list and map of heritage assets, including areas with potential but not yet confirmed archaeological remains.

Heritage assets can be affected by aviation and airports several ways:

- They can be razed or built over to make way for airport-related development. This would happen to a number of listed buildings, for instance, if a second runway was built at Stansted;
- Their structure can be affected by vibrations from aircraft or road traffic: there are concerns, for instance, that this could happen at Speke Hall, a Tudor building situated near Liverpool John Lennon Airport;
- Their building materials can weather faster due to air pollution;
- The vegetation of historic parks and landscapes can be harmed by air pollution: this is the case, for instance, with Hatfield Forest, a medieval forest near Stansted;
- Their curtilage (the enclosed area of land surrounding a house) or geneal landscape setting can be eroded, so that one can no longer view them in context.

Ideally, heritage assets should be preserved in their context, including the wider landscape in which they are seen. Mitigation (as opposed to avoidance) measures include digging up archaeological artefacts, recording them, and moving them to a museum; preserving buildings or archaeological remains in a different setting (e.g. as part of the open space in an office development, or under a car park with a raised ground floor); and taking them apart and moving them to a different location. However it is impossible to replace the sheer *age* of heritage assets. Often it will not be possible to mitigate impacts on them.

Measures proposed in airport master plans and environmental statements for minimising impacts on heritage/ culture include the following:

- Carrying out archaeological surveys to reduce the loss of possible earthworks during construction
- Rerouting of construction traffic
- Geological survey, evaluation and excavation where necessary
- *In situ* preservation of archaeology
- Design amendments and sensitive landscape works
- Keeping a careful record of details of character and construction
- Dismantling and reconstruction of timber-framed sections of some buildings

2.7 Land take and urbanisation

Land take refers to how much new land is required for the project. Depending on the type of land that is built on or fenced in, land take can lead to:

- Wildlife habitat loss and fragmentation. This was discussed at section 2.3;
- Loss of land that could otherwise be used for housing, community facilities, open space and playing fields etc.
- Loss of agricultural land. Agricultural land is an important resource that allows the UK to be more self-sufficient, thus reducing the 'food miles' needed to transport food from the producer to our tables. Agricultural land is classified from grade 1 (excellent) to grade 5 (very poor). The Department for Environment, Food and Rural Affairs (2003) promotes the protection of the 'best and most versatile' land, namely grades 1, 2 and 3a.
- Loss of entire communities, such as Sipson at Heathrow third runway.

Guardian Unlimited,
http://www.guardian.co.uk/

More generally, land take for airport-related development can add to a drip-feed of development in an area which adds up to a change from a rural to a more urban atmosphere.

The re-organisation of farm units has been proposed in airport masterplans and environmental statements for the use of land that would otherwise have been used for farming.

2.8 Landscape and visual impacts

Airports and airport-related developments affect the *landscape* by removing existing landscape features such as trees and hedges and replacing them with buildings and tarmac. At night, the lights of the runways, aircraft and terminals increase light pollution.

The following components of the landscape can be affected by development:


http://photolibrary.baa.com

- physical factors: geology, landform, climate and microclimate, drainage, soil, ecology
- human factors: archaeology, landscape history, land use, buildings and settlements
- aesthetic factors: proportion, scale, enclosure, texture, colour views as well as sounds, smells, tastes and touch
- associations: historical (e.g. history of settlements, special events) and cultural (links to well-known personalities, literature, painting and music) (Countryside Council, 1993).

Airports and airport-related development can also change the overall character of an area to make it look harder and more urban. Natural England has divided England into 159 'joint character areas', described their landscape[8], and summarised whether countryside quality in these areas is getting better or worse[9] (Natural England, 2007). This can be used as a starting point for discussion about urbanisation and impacts on landscape character.

The less developed and more attractive the original landscape was, the bigger the landscape impacts of an airport or airport-related development is likely to be. National Parks, Areas of Outstanding Natural Beauty and (to a lesser extent) Heritage Coasts are areas designated because of their attractive landscapes and managed so as to ensure that these landscapes are preserved.

Airports and airport-related developments can also have *visual* impacts. These refer to the impacts of landscape change on people: on the views that people have from their homes, offices, footpaths, cars as they drive past etc. All developments have a 'zone of visual intrusion' from which they can be seen, and an environmental statement will often show this on a map. The more people can see the development, the closer they live and work to the development, and the clearer their lines of sight are (rather than, say, their views being blocked by high hedges), the bigger the visual impact will be.

The landscape and visual impacts of developments often change over time. For example hoardings or bunds (long low hills made out of spare soil) may be put up during construction and taken down during operation. Plantings will grow over time, softening the features of the development. Deciduous plantings will shed their leaves in autumn so that the development will be more visible in winter than in summer.

Landscape and visual impacts are closely related to other impacts, particularly noise. For instance people tend to think that the noise from a development is louder if they can also see the development. The Campaign to Protect Rural England has compiled maps of 'tranquillity', which very roughly equates to a combination of lack of noise and lack of visual impacts[10].

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[8] Natural England, http://www.countryside.gov.uk/LAR/Landscape/CC/jca.asp.
[9] Natural England, http://www.cqc.org.uk/publications/CQC_HeadlineIndicator_A1.pdf and http://www.cqc.org.uk/publications/CQC_TrackingChange_A4_4pp.pdf.
[10] Campaign to Protect Rural England, http://www.cpre.org.uk/campaigns/landscape/tranquillity

Landscape and visual impacts often occur on a cumulative, drip-feed basis: deaths of the landscape by a thousand cuts. The Campaign to Protect Rural England has produced striking maps of how light pollution has increased between 1993 and 2000[11].

Typical mitigation measures include good design of buildings, possibly including green roofs; the erection of some kind of screen (wall, planting, bund) between the viewer and the development; locating parts of the development further away from viewers or hiding taller buildings behind shorter ones to soften their impact; and careful use of colours, choice of street furniture (lamps, benches, waste containers) etc. Light pollution can be reduced by keeping lighting (e.g. of parking lots) to the minimum levels needed for safety, and through the careful choice of light fixtures such as the use of flat-glass lanterns in car parks. Some buildings, particularly airport terminals, can be very attractive, and many people prefer the aesthetics of a well-designed and well-managed development to those of derelict, scrubby areas. In such cases, the development is a visual improvement. Other measures may include landscape engineering, tree planting and ground modelling.

2.9 Noise

Noise from aircraft and from traffic going to and from airports is probably the most obvious environmental impact of the aviation industry because it is easily perceived and annoying, especially where this occurs frequently. Aircraft noise is generated by both the engine and the airframe and is most evident during landing and take-off and under frequently-used flightpaths. Other sources of noise include noise generated from taxiing aircrafts, the application of reverse-thrust (an optional braking aid on landing), engine tests and on-site vehicular traffic. Also, noise impacts can extend to vehicular and rail traffic to and from the airport, and construction noise.

The effects of noise pollution include:

- Loss of concentration
- Sleep disturbance
- Anger, frustration and powerlessness to control the noise
- Fear of accidents and of potential increase in frequency of noise
- Cardiovascular effects (not well established)
- Mental health (may affect but not cause it)
- Diminished educational achievement (due to either direct effect or loss of teaching time due to noise disruptions) (Parliamentary Office of Science and Technology, 2003)
- Prolonged or excessive exposure to noise can cause hypertension and ischaemic heart disease.
- Adverse effect on performance, for example in reading, attentiveness, problem solving and memory. Deficits in performance can lead to accidents.
- Noise above 80dB may increase aggressive behaviour.
- The main social consequence of hearing impairment is the inability to understand speech in normal conditions, which is considered a severe social handicap (WHO, 2001).

[11] Campaign to Protect Rural England, http://www.cpre.org.uk/campaigns/landscape/light-pollution/light-pollution-in-your-area

Noise also affects the breeding and feeding habits of birds and also encourages unnecessary expenditure of energy as the move towards or away from the sound source, thereby exposing them to predators (White Young Green Planning, 2006)

The significance of noise impact depends on a variety of factors such as volume, duration, location (e.g. countryside vs busy street), time of the day and frequency of noise (deep low noise travels longer distances and can be felt in buildings) (Defra, 2004).

Government defines the noise impact around UK airports by reference to the area covered by the 57dB(A)Leq contour (measured between 7am and 11 pm). The 57 Leq contour was chosen by Government as being representative of high levels of annoyance based on social survey work undertaken in the 1980s. The Government has recently published the results of a consultant's report that aimed to review whether this relationship between noise and annoyance was still valid. *Attitudes to Noise from Aircraft Sources in England* was published in December 2006 and showed two significant changes: that people were very much annoyed at much lower levels than 57 Leq, and that people were very sensitive to the frequency of aircraft noise events. Peer review comments, published at the same time, highlighted some methodological concerns, leading Government to announce that it would be undertaking further work and not revising policy at this stage. Nevertheless, most of the findings are robust and it should be regarded as an important commentary on aircraft noise in the UK today. .

To try and minimise these effects, Government has stated in the 2003 ATWP that:

"3.11 Our basic aim is to limit and, where possible, reduce the number of people in the UK significantly affected by aircraft noise. This is a challenging objective, and meeting it will require a combination of measures, including:

- *promoting research and development into new low noise engine and airframe technologies. We support the research target set by the Advisory Council for Aeronautics Research in Europe that perceived noise should be reduced to one half of current average levels by 2020;*
- *implementing the regulatory framework agreed by the International Civil Aviation Organisation (ICAO)[12]. The key elements of this framework have now been incorporated into UK law by the Aerodromes (Noise Restrictions) (Rules and Procedures) Regulations 2003. These regulations currently apply at ten UK airports, but we expect the underpinning principles to be applied at all significant UK airports;*
- *implementing EU Directive 2002/49/EC, which requires periodic noise mapping at many airports from 2007 to identify day and night noise problems and, from 2008, action plans to deal with them;*
- *retaining and, where necessary, strengthening the current regulation by central Government of noise at Heathrow, Gatwick and Stansted airports. We will also consider exercising similar powers at other airports if there is evidence that a major noise problem is not being dealt with adequately through local controls. However, the Government's preference remains that local solutions should be*

[12] The ICAO framework is referred to as the balanced approach to noise management. It comprises reducing noise at source; land-use planning and management; noise abatement operational procedures, and; operational restrictions.

devised for local problems wherever possible, and we expect that airport master plans… will describe the package of measures that an airport operator intends to apply to deal with local noise (and air quality) problems;

- *widening the use of economic instruments, including the use of differential landing charges according to noise levels - for which powers already exist - at all airports where a significant local noise problem exists. Funds from a noise-related element in user charges could be used to finance local mitigation and compensation schemes."*

While this may appear comprehensive, the Government still prefers noise problems to be resolved at a local level. Consequently, while some Government imposed controls exist at Heathrow, Gatwick and Stansted, most airports are subject to planning conditions or obligations.

Noise from aviation may be reduced by:

- Putting strict regulatory constraints on the amount of noise that can be generated by aircrafts and on the flight paths to be followed
- Refusing planning permission where noise levels exceed 66dB(A)Leq at daytime and 57 dB(A)Leq at nighttime
- Making technical adjustments to thrusts, angle of flight decent/ take-off, speed of aircraft accent etc. (POSTNOTE, 2003).

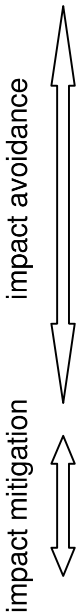
The Government also acknowledges that it may not be possible to reduce noise to a reasonable level. Consequently it states in the ATWP that:

"3.15 Our approach to noise impacts is first, to seek to control the scale of impacts; second, to mitigate remaining impacts; and third, to compensate for those impacts which cannot be mitigated. A variety of measures is available to help reduce noise impacts at source, as described earlier in this chapter, but there is a limit to how far noise nuisance near airports can be reduced… Accordingly, with immediate effect, we expect the relevant airport operators to:

- *offer households subject to high levels of noise (69dBA L_{eq} or more) assistance with the costs of relocating; and*
- *offer acoustic insulation (applied to residential properties) to other noise-sensitive buildings, such as schools and hospitals, exposed to medium to high levels of noise (63dBA L_{eq} or more)."*

As with emissions, the industry has been successful in developing relatively quieter aircraft – the noise footprint of a modern jet is a fraction of that made by the first generation of jet aircraft. Every new aircraft must comply with noise standards developed by the International Civil Aviation Organisation. The most stringent standard to date (known as Chapter 4) came into effect last year, although it had not previously been revised since the Chapter 3 standard was adopted in 1977. Furthermore, EU regulations prevented the operation of Chapter 2 aircraft at EU airports from 1 April 2002 – this encouraged many airlines to speed up their fleet replacement. But while aircraft have become less noisy, noise around many airports is getting worse due to an increase in the number of flights. A DfT analysis of noise levels around UK airports shows that more people will be affected in 2030 compared to 2000.

Noise mitigation measures proposed in various airport masterplans include:



- Incentive and penalty systems to encourage airlines to use quiet aircraft
- Requirements for arriving aircraft to maintain minimum heights above the airport before starting on their descent path
- Use of preferred flight routings and runways where possible, that impose less noise on local properties
- Noise quotas on night flights, with the noisiest aircraft not allowed to land or take off at night
- Ban on aircraft engine testing or training flights at certain times (e.g. nights, weekends) unless in an emergency
- Encouragement of minimum use of auxiliary power units, and of reverse thrust by aircraft on landing consistent with safety constraints
- Design of the airport so that buildings and/or bunds (long low hills made of soil) shield nearby properties from ground noise
- Sound insulation grants: for high specification double-glazing in the noisiest areas, and secondary glazing across a wider area
- Property relocation schemes which cover most of the costs of moving house for those people living in the areas of highest noise
- Public complaint handling services
- Noise monitoring systems that monitor the noise level of each aircraft.

Where problems exist outside of the planning system, remedies are few and far between. Aviation has been afforded protection from legal action since the 1920s. In its fledgling stages, the Civil Aviation Act (currently section 76) prevented any action in respect of nuisance, but it has never been repealed. Some communities have taken cases to the European Courts of Human Rights but to date, while the Court has accepted that noise can be regarded as an infringement, the government's defense of it being in the national interest has always prevailed.

2.10 Risk to third parties

Airport-related development and aviation pose risks to air passengers and others ('third party risk'). These include road accidents from passengers and workers travelling to and from airports, airplane crashes, terrorism threats, the effects of wake turbulence from aircraft, and health problems of flying for passengers and airline staff. This section discusses only third party risk to people who live and work near airports.

Road accidents related to airport operations. The UK has a good road safety record, and the number of accidents is still decreasing whilst vehicle-kilometres continue to increase. However, increased traffic near an airport is likely to increase the risk of accidents. Increased use of bus and train – both safer forms of travel than the private car – can help to reduce this risk.

Airplane crashes. Flying is a particularly safe form of travel: someone is probably more likely to be involved in an accident when driving to an airport than during the subsequent flight. That said, take-off and landing are the most dangerous phases of aircraft operations, so most crashes occur at or near the ends of runways. Government has responded to this risk by designating Public Safety Zones (PSZs) at many airports, which restrict what new development can be located in these zones.

http://oopslist.com/C90-2.jpg

PSZs are usually triangular-shaped, pointing away from the end of the runway. Their shape and size is determined based on the number of flights at the airport, the likelihood of a crash, where the crash might occur, and the likely consequences of a crash. PSZs have two contours:

- 1 in 10,000 individual risk: nobody should live or work all day in these zones; and
- 1 in 100,000 individual risk: new development in this contour is restricted and existing development should be removed if suitable opportunities arise (Department for Transport, 2002).

There are significant problems with the PSZ policy. For instance, PSZs are based on risk to individuals rather than on total risk (the risk to an individual, times the number of people affected), and so understate risk where many people live within the 1 in 100:000 contour (Aviation Environment Federation, no date). PSZs were also established in 2002, based on predicted air traffic levels in 2015; the Aviation White Paper of 2003 predicted much higher air traffic levels but did not change the PSZs.

The risk of bird strike to aircraft was discussed at Section 2.3.

Terrorism at airports and on aircraft. The tragedy of 11 September 2001 which involved aircraft being flown into buildings in the US, and subsequent attempted terrorist threats in the UK in August 2006 have highlighted the vulnerability of airports and aircraft to terrorist activity. This could directly affect communities living near airports if a terrorism attempt succeeds. It could also affect them indirectly in the form of increased police activity, congestion when there are roadblocks, etc.

Effects of wake turbulence from aircraft. Flying aircraft produce wake turbulence as a result of Newton's Third Law: for every action there is an equal and opposite reaction. Wake turbulence is caused by the 'downwash' caused as aircraft rise in the air, and the vortices (whirlwind) caused at the aircraft's wing tips as the vacuum above the aircraft wing and the pressure below the wing meet. The strength of the wing tip vortices is proportional to aircraft weight, and inversely proportional to aircraft speed, wingspan and air density.

At ground level, wake turbulence causes unusual wind currents, and sometimes small whirlwinds. Wake turbulence may cause tiles to come off roofs. Opponents of an incinerator in Surrey have also suggested that wake turbulence could cause dangerous emissions from the incinerator to be driven towards the ground, "achieving exactly the opposite intention of a chimney stack" (Sage, 2007).

It is possible to avoid some third party risk, for instance through application of the existing PSZ policy, establishment of larger PSZs, traffic control measures that help to reduce road accidents, and efforts to reduce bird strike as discussed at Section 2.4. Repair and re-roofing programmes for damaged properties helps to mitigate for risks from wake turbulence. However ultimately it is impossible to eliminate third party risk altogether: compensation for accidents and loss of life is the only other 'mitigation' measure possible.

2.11 Social / community and equity impacts

Whilst air travellers gain benefits from airport-related development and aviation, residents of nearby communities bear the brunt of the negative impacts. Airport-related development can affect community cohesion in a number of interconnected ways.

Airport-related workers can buy homes in communities close to the airport so that they don't have to commute far to work. However they often work long and unsociable hours, and may not participate in community activities as much as the previous residents did. Airport operators may buy up local homes as a compensation for noise or other impacts. They may rent out these homes, sometimes as houses of multiple occupation. A common complaint at Stansted has been that the rental homes and their gardens are maintained less well than the owner-occupied properties were (Sutton, 2007).

House values may fall due to noise, landscape and other impacts from the airport. Residents may find it difficult to sell their houses at a time and price that they have control over. Airport operators' buy-up schemes may be restricted and divisive.
This drip-feed of factors could result in a greater proportion of empty and neglected properties, further reducing the value of remaining local properties. This could lead to a negative spiral of increased uncertainty about the future of the community, more people moving out of the area, and more houses being rented out or empty. For instance, at Stansted in summer 2007, of 170 properties owned by BAA, 36 (21%) were for sale, and another 36 (21%) were vacant (Rhodes, 2007).

As a result, the number of children attending schools in the area could fall, as could the number of people participating in community activities. This could affect the viability of some community services, such as village halls and shops. Community cohesion may start to erode. Neighbourhood watch schemes could be more difficult to run in areas with a high turnaround of population. Local residents that were previously active in Scouts, church activities or sports may need to divert their time from community activities to fighting against airport expansion. The local planning department may need to put so much time into dealing with the airport expansion that it has difficulty responding to other issues, such as enforcement of planning conditions on other developments.

Although many local residents will benefit from the improved access to overseas (and some UK) destinations that airport development will bring, wealthier people will generally benefit more than poorer people. The Department for Transport's (2006b) most recent travel survey showed that only 21% of respondents in the one-fifth of households with the *lowest* income had made at least one international flight in the last year, whilst 61% of those in the one-fifth of households with the *highest* income had made one or more international flights. Only 4% in the lowest income 'quintile' had made three or more flights in the last year, compared with 23% in the highest quintile. This suggests that wealthier people are gaining more from flying than poorer people. In contrast, people on lower incomes may well gain the most if the subsidies provided to the aviation industry were available to be spent on improving hospitals, schools and public transport.

It is virtually impossible to *avoid* negative impacts on community life. Possible *mitigation* measures include:

- Purchase of housing by airport operators where house values are likely to fall significantly as a result of airport expansion. This is required by Government in response to problems of blight arising from proposals for airport-related development;
- Airport operators now allowing housing that they own to be rented out as houses of multiple occupation;
- Ensuring that airport operator owned housing and their gardens are managed by a good property management company.

Compensation may take the form of funding for local groups, or for improvements to community facilities such as village halls. Airports also bring with them employment opportunities for local residents. However none of these directly tackles the problems of the erosion of community coherence, or the fact that local communities lose whilst travellers win.

Measures proposed in airport master plans and environmental statements for minimising noise impacts are:

- Diverting or closing rights of way could mitigate noise to certain communal areas as well as effects on visual appreciation
- During construction, sound attenuation of plants and noise barriers within a site compound would reduce the ground noise during the construction period
- The access routes of the contractors could be diverted to minimise the impact on the local communities
- Where significant amounts of waste are generated the soil could be re-used or the aggregates recycled
- Keeping construction waste to a minimum

2.12 Traffic

Airports and airport-related development generate traffic on nearby roads from:

- construction workers travelling to and from the site, and haulage of construction and waste materials;
- operational workers travelling to and from the site;
- cargo/freight deliveries and pick up; and
- travellers arriving and departing from the airport.

Within the airport boundary, additional traffic can be caused by airport vehicles such as tugs, fuel lorries, and buses and vans that transport passengers around the site.

Traffic can cause congestion, severance, and environmental problems such as noise and air pollution. The environmental impacts of ground traffic are discussed in other sections. Congestion and severance are discussed here.

Baseline levels without the proposed development are particularly important for traffic, since general traffic levels in the UK are rising by 1-3% per year and will probably continue to do so for many more years. So traffic that doesn't cause congestion or severance now may do so in the future even without the proposed development. For this reason, transport impact assessments typically predict traffic levels when the proposed project first becomes operational, and then 10-15 years after that.

Congestion occurs when the traffic flow on a road exceed the carrying capacity of the road and its junctions (similar issues pertain to the rail network). Every road and junction has a nominal carrying capacity. This is often shown as a diagram of lines (roads) and nodes (junctions), with numbers next to each line and road showing their capacity. Sometimes different capacities and/or traffic levels are given for the different traffic directions on a road: e.g. north v. south-bound. Traffic levels at key roads and junctions are regularly monitored by local authorities, and these levels may be shown alongside the capacity figures.

Journey times are often discussed in traffic impact assessments. The more congestion, the longer journey times will be. Similarly, the more congestion there is, the more likely it is that traffic will move from the main roads to and from airports, and instead use side roads as rat-runs to avoid the congestion.

Traffic impact assessments try to determine whether, and for how long, roads and junctions are likely to be congested, with and without the proposed development. For this, they generally concentrate on peak traffic levels. Typically peak baseline traffic levels are the rush hour/school run in the morning, and the rush hour in the evening. The peak traffic levels generated by air passengers may, for instance, be 5-6am as people arrive to catch early flights; 9am as other airports' early flights arrive; and a similar double peak in early evening. The peak traffic level for operational workers may occur about an hour before that of travellers in the morning, and an hour after them in the evening. However what is important, in the end, is the total likely future traffic - from the baseline, passengers, operational staff etc. – and whether this will exceed the carrying capacity of roads and junctions.

Typical ways of trying to reduce congestion are to improve public transport provision, use charging regimes such as tolls or high parking charges, provide bus-only lanes, encourage airport workers to car pool, expand roads and junctions so that their carrying capacities increase; and provide new roads. Regional Spatial Strategies and Local Development Documents generally promote some combination of these measures. However the delivery of these measures can be hampered by a range of factors:

- Without subsidies, bus/coach operators will only find it profitable to run frequent, high quality services from a limited number of (primarily urban) areas. Unless bus services are reliable, frequent and attractive, it will be difficult to shift people from their cars to these services;
- Rail infrastructure is very expensive to provide, requires a long lead time, and needs to be approved at a range of central government levels;
- Do we know anything about who operates parking at airports? is there a financial incentive for airport operators to provide lots of parking?;

- If adequate levels of parking are not provided at airports, car drivers may well park at the periphery of the airport (with attendant problems for local communities) and walk or take the bus in.

Severance occurs where communities are split by traffic ('dynamic severance') or transport infrastructure ('static severance'). Dynamic severance occurs when it is difficult to cross a road because there is too much traffic or it is moving too fast. It leads to pedestrian delay, diversion to other crossing points, and accident risk. Static severance is caused when a new road or rail line splits a community, leading to detour journeys and lengthier journeys. Severance is not often discussed in ESs, but can significantly affect the social life of communities, with particular impacts on pedestrians and cyclists.

Typical ways of mitigating for severance include pedestrian bridges or underpasses, toucan and zebra crossings, and traffic lights (pedestrian operated or automatic).

Finally, as well as increasing traffic levels, the *type of traffic* in the local area could change. For instance, residents living near Stansted have noticed a big increase in taxis and buses, "which by their very nature always seem to be in a hurry", and thus could pose more danger to children, horse riders etc. They have also noticed more cars at night, possibly due to the traffic patterns of shift workers, or to travellers or airline staff looking for overnight accommodation (Sutton, 2007).

Measures proposed in airport master plans and environmental statements for minimising traffic impacts are:
- Improve existing rail services
- Promote bus and coach services for staff and minimise the use of single occupancy car trips.

2.13 Water pollution

Airports, airport-related development and aviation affect water quality in several ways.

First, building works can lead to polluted *construction run-off* which can affect nearby water bodies. This is typically dealt with by setting up buffer zones around waterbodies (streams, ponds, estuaries etc.) where machinery is not permitted.

Second, during operation, rainwater that falls on parking lots, building roofs, aprons and taxiways, and other areas with hard surfaces will run off either into drains or (if good drains are not in place) into nearby water bodies or ground water. The de-icing agents used on runways can be particularly problematic. Typically a development will not be allowed to go ahead unless it puts measures in place to treat the chemicals and other pollutants from this *surface water or rainwater run-off*. However during hard rains the drains and their controls can be overwhelmed, and pollution of waterbodies can occur.

Third, airports create a range of potential *pollutants* including de-icing agents, maintenance and painting chemicals, testing of fire equipment, and fuel leakage and spillage from refuelling and storage. These can either be leached into ground water or can contaminate storm water run-off which can pollute nearby water sources. Such instances are monitored by the authorities and fines can be levied. Nevertheless, it is worth considering the height of the water table, whether the airport has an internal drainage system and arrangements for monitoring. In some cases airport development has necessitated the diversion or tunnelling of nearby water sources.

Wastewater (the nice word for sewage) from an airport's operations typically goes to a sewage treatment plant. That can be a problem if the plant is already at or near capacity. In such cases it is often possible to expand the treatment plant or upgrade its equipment to cope with the additional flow. However in some parts of the country, this is not possible (for instance where the treatment plant discharges to a very sensitive environment and is already as technically sophisticated as possible). The Environment Agency's discharge consent programme helps to ensure that developments are not built where their wastewater cannot be adequately treated. The ongoing roll-out of the European Water Framework Directive further strengthens this process.

On a less local level, *fuel dumping* from flying aircraft can cause water bodies to be polluted by kerosene. Aircraft often dump excess fuel before landing as a safety measure: to protect the aircraft's structure and landing gear, reduce the chance of a brake fire, and or to ensure a safe landing. During fuel dumping, jet fuel (mostly kerosene) is ejected from the aircraft's wing tips, tail or aft fuselage. Air traffic controllers are instructed to direct planes dumping fuel away from populated areas, over large bodies of water, and in specified areas where possible. Kerosene evaporates rapidly in the atmosphere and typically little survives in liquid form when it reaches the Earth's surface; at that point it impacts water quality much like an oil or gas spill. Cumulatively fuel dumping may be having a significant impact: it has been estimated that up to 15 million pounds of fuel were released over the world's oceans by commercial and military aircraft during the 1990s (Aerospaceweb, 2005).

Measures proposed in airport master plans and environmental statements for minimising water pollution are:

- Minimise spillage
- Improve environmental management procedures
- Discharge and treat foul drainage and sewage
- Pass run off through oil interceptors
- Expand infiltration systems
- Provide attenuation to impermeable areas
- Use "friendly" de-icing agents
- Ensure the maintenance of equivalent Greenfield runoff rates
- Carry out Flood Risk Assessment
- Follow construction good practice and guidance from Environment Agency PPGs 1,3,5,6 and 21.

2.14 Water use

Construction of airports and airport-related development use water for mixing cement, washing wheels and damping down dust, etc. Operation of such development involve water use for food preparation, toilet flushing, cleaning of the airport and aircraft, fire drills etc.

Over-abstraction of water can exacerbate problems of drought, including impacts on ecological habitats. An airport management plan could thus have a significant indirect ‘in combination’ impact on Special Protection Areas, Special Areas of Conservation or Ramsar sites and require appropriate assessment (see Section 7) because of this.

Generally the amount of water used by a given airport or related development is not significant: figures from Heathrow suggest an average of 30-40 litres of water per passenger. However where a large development is proposed in an area where water resources are already a problem, this could lead to significant impacts.

Ways of reducing water use include dual flush toilets, use of water-efficient rigs for fire drills, and leakage reduction. At Heathrow Terminal 5, rainwater collected from the entire catchment (not just the roof of the terminal building) is used for toilet flushing and irrigation.

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