European Observatory on Airport Capacity & Quality

Final Report of TASK FORCE
'Economic impact of unaccommodated demand and environmental variables influencing airport capacity'

May 2015

Executive summary

On 28 March 2014, the plenary of the European Observatory on Airport Capacity and Quality met in order to approve the platform's new mandate. The objective of this meeting was also to remind the audience of the context for drafting the new mandate. Indeed, significant work was carried out under the previous mandate of the Observatory that enabled to answer key questions related to airport capacity. Based on this work and on the publication of Eurocontrol's Challenge of Growth 2013 Report, a range of newly identified challenges came up.

The European aviation sector will face a significant shortage of capacity by 2035, thus affecting Europe's competitiveness. How can a European initiative drive national and local decision-makers to take appropriate action and develop much needed ground infrastructure?

This challenge underpins the work of the European Observatory on Airport Capacity and Quality. It was decided to tackle this question from several different perspectives: economic, quality of service and strategic. For each, the objective is to find authoritative arguments that would support decision-making at national and European level for addressing capacity problems at constrained airports. Dedicated Task Forces were created to elaborate these authoritative arguments.

Within this context, the role of Task Force 'Economic impact of unaccommodated demand and environmental variables influencing airport capacity' is to come up with an estimate of the economic costs of not being able to accommodate the additional demand as projected by Eurocontrol in its Challenge of Growth Report by 2035. Since airport capacity is not only about the number of runways available but mostly about the way these runways are operated, it was decided to shed some light on possible capacity restrictions linked to environmental aspects (mostly noise and air quality). The environmental component of the work of Task Force 1 aims at documenting some of the constraints associated with future airport growth in Europe.

The Task Force was made of representatives from Member States, Industry and Civil Society. It is fair to acknowledge that the topic is controversial, and that all participants of the Task Force have accepted to engage in a constructive debate, where the opinions expressed were sometimes diametrically opposed. This document, while not reflecting the individual views of the members of the Task Force, heads towards a consensus and aims to set up common grounds for further policy debates.

The first starting point was that indeed there are economic and environmental impacts. No one has disputed this fact. The second point was that indeed all methodologies – economic or environmental – are worth being reviewed, and that some conclusions would be drawn from that exercise.

Given the timeframe and resources available, the group agreed to proceed via the audition of experts from the group and from outside the group, and through the review of existing methodologies and studies. The work was organised through 3 work streams:

1. Identifying the costs related to unaccommodated demand in Europe according to the Challenges of Growth report scenarios and hence the costs of not creating the required capacity.
2. Identifying how environmental / pressure can have an impact on the use of airport capacity.
3. Documenting studies on the environmental costs of air transport in order to understand what are the existing methodologies, and what would be their respective added value.

The main outcomes for the economic section

The work of the Taskforce encompassed more than just producing figures for the economic impact of EUROCONTROL's 2035 projections. Beyond this, the Taskforce discussed the nature of economic impact studies performed today. The learnings from this discussion informed the presentation of the results.

As there is no 'silver bullet' number, and the economic impact of aviation can be considered from a number of different perspectives, and informed by different assumptions, several different figures are provided, quantifying different elements of the adverse economic impact of Europe being unable to accommodate demand for air services in 2035.

In addition, where figures are presented, there is a clear explanation as to what these figures represent, with an outline as to the methodology used to derive the figures. The methodologies used do not seek to quantify the environmental cost of aviation. However, the economic projections supplied in the report are applied to the Eurocontrol scenarios which reflect the impact of environmental restrictions on airport capacity.

Summary of Potential Negative Economic Impacts of EUROCONTROL Challenges of Growth Forecast within the EU[1]

	InterVISTAS Approach[2]	Oxford Economics/IATA Approaches[3]
Lost Potential Direct Impact	€11.8bn / 173,000 jobs	€19.3bn / 306,000 jobs
Lost Potential Indirect & Induced Impact	€16.4bn / 261,000 jobs	€33bn / 513,000 jobs
Subtotal of Economic Footprint	**€28.2bn / 434,000 jobs**	**€52.3bn / 818,000 jobs**
Foregone catalytic impacts and economy-wide	€44.1bn	€86.3bn

[1] Not all figures should be added together to derive a 'total impact' as they are derived via incompatible methodologies. Rather they should be considered holistically.
[2] In 2013 prices
[3] In 2012 prices

productivity		
Lost Potential Tourism Impact	N/A	€24bn / 485,000 jobs
Negative Economic Welfare Impact	N/A	€5.4bn – €13.6 bn

To put these figures in perspective, the GDP of the EU economy in 2013 was €13.519 trillion, or €13,519 billion, while the GDP of Croatia was €43.6 billion and the GDP of Germany was €2,809.5 trillion. It should also be noted that the results are in constant 2012 and 2013 terms, and have not therefore been increased to allow for 2035 price levels. The EU economy in 2035 is forecast by Oxford Economics to be €20.176 trillion, or 20,176 billion, in constant 2012 terms.

<u>The main outcomes for the environmental section</u>

To draw a complete picture of the debate on airport capacity, it is essential to integrate the environmental dimension in the discussions. Indeed, environment is a critical factor to secure aviation growth. The objective of the Task Force was to add some context to the environmental impacts of aviation. It did not attempt to quantify these impacts, as this would not fall under the scope of the Observatory.

The Task Force based its work on as concrete and robust information as possible. However, it identified shortages that could be addressed through future European Commission's initiatives:

- There is no assessment of the impact of environmental restrictions on the use of airport capacity within the European Union and compared with other world regions.
- A methodological assessment of existing studies linking environment and health should be conducted and further research carried out.

Section I – Economic Impact

How to Consider the Economic Impact of Aviation

As the work of the Taskforce progressed, it became clear that there exists a wider debate, as to the methodological approach to calculating the economic impact of the aviation sector. Some commentary considers that individual methodological approaches were more or less valid than other approaches, with a particular focus on what economic effects should or should not be included.

These methodological issues were discussed at length within the Taskforce. A number of points emerged from the discussions and were agreed upon by the group.

Choice of Approaches

- There are a range of approaches towards the consideration of the economic impact of aviation. Where these approaches are employed in a professional and rigorous way, and where the results presented in a balanced and transparent manner, these approaches have merit;
- When considering the economic impact of aviation, the choice of the most appropriate approach will be driven by a number of different concerns. These include:
  - The purpose of the work
  - The data available (volume and quality)
  - The scope of the work (is a specific project being examined, or an individual airport or some specific section of the industry?)
  - The feasibility of employing that methodology to the project in question (often impacted by the scope of the project and data availability)
  - The audience the work is intended to be presented to;
- No single approach can be considered in isolation. There is no "silver bullet" approach which will completely and indisputably quantify the total economic impact of an airport or a volume of aviation activity upon society.

The Right Approach for the Right Local Circumstance

- Instead economic impact assessments should be considered holistically. Where there are different approaches which can reasonably be used, these should be employed, taking into account the specificities of the situation. The results should then be used to complement, rather than to contradict each other, and to lead towards a better understanding overall of the economic impact, taking into account the specificities of the situation. Results should be viewed side-by-side but not automatically added to each other, to create a "total", in instances where these results are derived from incompatible methodologies.
- In this respect, ranges of estimates or different scenarios may also strengthen understanding, for example as used in EUROCONTROL's "*Challenges of Growth"* study.

- A mature and objective approach towards the assessment of the economic impacts of aviation is required of both the producers and the consumers of reports.

Maturity of Approach

Producers and users of these reports may have different interests, and may therefore be pre-inclined to take specific positions on the economic impact of aviation. This can create tensions, with claims of over or under-stating of specific results. To ensure that economic impact work contributes value to discussions, it is important that:

- Producers of reports should be transparent as to the methodological approach taken, the data sources employed and the main assumptions made.
- Users of the reports should have realistic expectations as to what methodological approaches can reasonably be used as well as what results any one methodological approach can deliver.
- Both parties need to accept that while there is a need for accessible overall figures on the economic impact of an airport, or of a volume of aviation activity, these headline figures should not be divorced from the methodological approach which produced them. Those who wish to use economic impact figures need to familiarise themselves with the methodological approach employed, and understand what economic impacts are both contained within and excluded from those figures. Users need to have an understanding of the limitation of each of the methodologies.

Assessing the Economic Impact of the European Airport Capacity Crunch

These approaches can capture some of the same impacts or have overlapping components. Furthermore, the metrics used to present the impacts may not always be the same. For these reasons, the result from each of these methods should not be assumed to always be additive. The approaches presented below are not exhaustive, as other recent and similar studies exist[4] – however these were not commissioned or carried out in the context of this work.

The below section is divided into the following parts:

1. Methodology for assessing the economic footprint (the direct, the indirect & the induced impact):
    a. according to the Inter*VISTAS* approach and subsequent results;
    b. according to the Oxford Economics approach and subsequent results;
2. Methodology for assessing impact of connectivity on productivity (including catalytic impacts) and subsequent results;
3. Methodology for assessing impact based on economic welfare and subsequent results;

[4] E.g. DG MOVE's commissioned study on employment and working conditions in air transport (author: Steer Davies Gleave). See 2012 edition under: http://ec.europa.eu/transport/modes/air/studies/doc/internal_market/employment_project_final_report_for_publication.pdf . An update is foreseen, covering the period up until 2013, to be published in the summer 2015

4. Projecting the relationships between passenger traffic & air connectivity and aviation's economic impact to EUROCONTROL's 2035 passenger forecasts.

The methodologies in Section 1 parts 1a and 1b are entitled "Inter*VISTAS* approach" and "Oxford Economics approach"[5] to reflect the fact that both methodologies employ a similar framework. In both cases, Input-Output tables are used to quantify direct, indirect and induced impacts. However there are different individual approaches, involving different assumptions and scopes. This allows the calculation of a range of figures for the direct, indirect and induced impacts.

Section 2 only covers one approach towards the assessment of economic welfare.

Section 3 encompasses two approaches towards the calculation of the impact of connectivity on productivity, and this again allows the creation of results which are in the form of a range. However, closer similarities in these approaches mean that these can be outlined within only one section. The differences between the two approaches are outlined within the Section.

Section 4 specifically explains how the methodologies in Sections 1 to 3 were applied to EUROCONTROL's forecasts for 2035.

In line with the conclusions reached by the Taskforce, it should be stated that the below approaches capture different elements of economic impacts, and that not all elements are captured. For example, it was not possible to explicitly quantify on a pan-European level the adverse impacts associated with aircraft noise[6]. Experts in the field addressed the Taskforce on this topic, and it became apparent that there is currently no pan-European methodology to quantify these environmental impacts. This reflects some of the considerations outlined above, as to the choice of relevant methodologies.

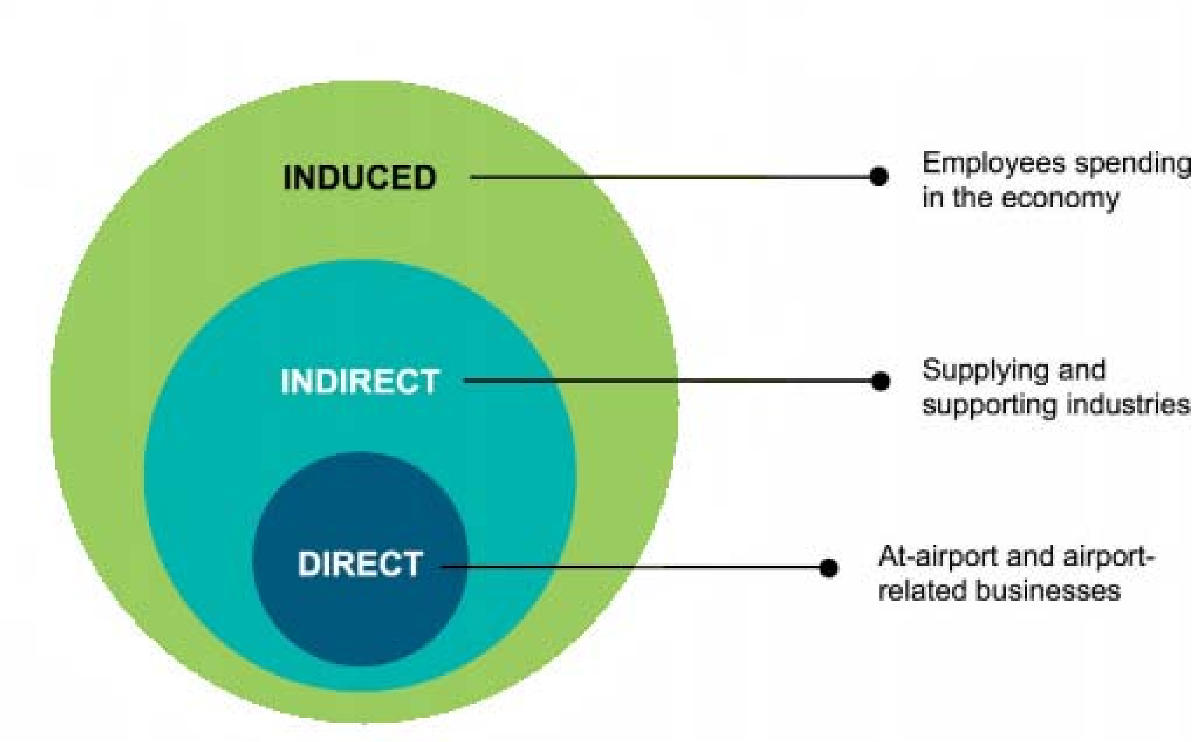
The direct economic impact of airports and associated aviation activity relates to the employment and GDP associated with the operation and management of activities at the airports including firms on-site at the airport and airport-related businesses located elsewhere near the airport.

The indirect economic impact of airports and associated aviation activity relates to the employment and GDP generated by up-stream industries that supply and support the activities at the airport. For example, these could include: wholesalers providing food for inflight catering, oil refining activities for jet fuel, companies providing accounting and legal services to airlines, travel agents booking flights, etc.

The induced economic impact of airports and associated aviation activity captures the economic activity generated downstream by the employees of firms directly or indirectly connected to the airport spending their income in the national economy. For example, an airline employee might spend his/her income on groceries, restaurants, child care, dental services, home renovations and other items which, in turn, generate employment in a wide range of sectors of the general economy.

[5] The InterVISTAS work was prepared for ACI EUROPE. The Oxford Economics approach was prepared for ATAG.
[6] However the EUROCONTROL forecasts reflect reductions in airport capacity associated with environmental-based operating restrictions.

1: Methodology for assessing the economic footprint



1a: Methodology for assessing the economic footprint (Inter*VISTAS* approach)

The direct, indirect and induced economic impacts described above can be estimated with reference to Input/Output tables. Each Input/Output table is a representation of the flows of economic activity within a national economy. The model captures what each business or sector must purchase from every other sector in order to produce a euro's worth of goods or services and is therefore based on real economic data. Using such a model, flows of economic activity associated with any change in spending may be traced either forwards (spending generating income which induces further spending) or backwards (visitor purchases of meals leads restaurants to purchase additional inputs - groceries, utilities, etc.). By tracing these linkages between sectors, Input/Output tables can estimate indirect and induced economic impacts. These indirect and induced impacts are represented by economic multipliers, normally expressed as a ratio to direct impacts. Using the Input/Output tables, multipliers can be produced for employment and GDP contribution, normally expressed in terms of a unit of direct impact – in this case per direct job.

Figure 1: A highly simplified Input-Output Accounting Framework[7]

	Industries (Purchases)	**Final Demand**	**Total Output**
Industries (Sales)	Z	Y	X
Value-added (primary inputs)	V		
Total output	X		

Direct jobs on site at European airports (which includes direct jobs generated by all relevant actors within the airport campus, such as airlines, ground handlers, retail activites, etc.) can be derived from employment surveys, annual reports, and existing economic impact studies.

The figures presented in Table1 & 2 are primarily based upon an employment survey sent directly to European airports, and augmented with data on direct employment from pre-existing studies. These cover 125 airports representing circa 71% of annual commercial passenger traffic in Europe.

This employment survey was also used to derive a relationship between the number of passengers at an airport and the number of direct jobs associated with that airport, depending upon the airport's size. This was used to infer the number of direct jobs at airports for which employment data was not available.

Table 1 summarizes the direct, indirect and induced economic impact of EU28 airports as reported in the Inter*VISTAS* study concerning the "*Economic Impact of European Airports"* released in January 2015[8].

Table 1: Economic activity in 2013 supported by the aviation sector, EU 28

Economic activity in 2013 supported by the aviation sector, EU 28			
	Employment	**GDP (€ Billion)**	**% of EU28 GDP**
Direct	1,276,200	83.7	0.6%
Indirect & Induced	1,982,400	119.8	0.9%
Total	*3,258,600*	*203.4*	*1.6%*[9]

[7] For more information on how to interpret this highly simplified rendering of an Input-Output table, see Appendix F of '*Economic Impact of European Airports*', Inter*VISTAS*, January 2015
[8] '*Economic Impact of European Airports*', Inter*VISTAS*, January 2015 – available on the ACI EUROPE website: https://www.aci-europe.org/component/downloads/downloads/4159.html
[9] Does not exactly sum due to rounding

Table 2 summarizes findings based upon the methodology and data used within the Inter*VISTAS* study. The findings quantify the lost potential direct, indirect and induced economic activity associated with unaccommodated passengers in EU 28 countries, according to EUROCONTROL projections under the "Regulated Growth" scenario.

Table 2: Projected lost potential 2035 direct, indirect & induced economic activity associated with EUROCONTROL projections of unaccommodated passengers under the "Regulated Growth" scenario

EUROCONTROL Scenario C: Regulated Growth - EU 28 Economic Impact		
	Employment	**GDP (€ Billion)**
Direct	173,000	11.8
Indirect & Induced	261,000	16.4
Total	*434,000*	*28.2*

1b: Methodology for assessing the economic footprint (Oxford Economics approach)

An "economic footprint" analysis of the industry is measured by looking at the contribution to GDP and jobs generated by the sector and its supply chain. The resources deployed by the aviation sector are measured by its Gross Value Added (GVA). GVA is calculated either as the output created by the sector less the cost of purchased inputs (net output measure), or by the sum of profits and wages (before tax) generated from the sector's economic activity.

From this direct contribution, the sector's economic footprint is calculated by adding to it the output (and jobs) supported through indirect and the induced contributions. The indirect contribution measures the resources deployed by the aviation sector through using domestically produced goods and services produced by other firms – i.e. the resources used through its supply chain. The GVA generated through the indirect and direct channels supports jobs both in the aviation sector and in its supply chain. The workers whose employment depends on this activity in turn spend their wages on goods and services. The induced contribution is the value of the domestic goods and services purchased by this workforce. Taken together, these three channels give the aviation sector's economic footprint in terms of GVA and jobs. This assessment can also be expanded to include other associated activities such as tourism.

This approach does not take into account the benefits created for the passengers and shippers (users) and the wider economy through enabling trade, investment as well as access to new markets, development of business clusters, specialization and other spill over impacts that support and enhance productivity of the economy.

When using this approach for impact assessments it needs to be taken into account that some of the jobs and GVA may not be additional, that the indirect and induced (and where used catalytic) effects all double-count some jobs/GVA generated by sectors other than air transport. In order to avoid double-counting of jobs/GVA an economy wide model can be used to identify the net impacts of policy choices. To assess the net impacts on GDP and jobs different types of general equilibrium models can be used to assess the net policy impacts[10].

Oxford Economics analysed the economic and social benefits of aviation at a national level in over 50 countries and used the results of that assessment to build a comprehensive global picture of air transport's many benefits. Working with partners across the industry, the Air Transport Action Group (ATAG) has expanded the analysis. The ATAG 2014 Benefits Beyond Borders report includes an assessment of the economic footprint of the air transport industry in the European Union in 2012.[11] The Oxford Economics and ATAG economic footprint estimates were then used by IATA[12] to assess the projected economic activity support by aviation in the EU 28 in 2035 based on the EUROCONTROL passenger growth scenarios for regulated and unconstrained growth.

Table 3 summarizes findings from the ATAG 2014 report Benefit Beyond Borders on the direct, indirect and induced economic activity supported by aviation in EU 28 countries. These findings were developed based on extensive research and industry surveys. Data from national input-output tables was used for quantitative economic assessment of the interdependencies between different branches of the economy.

Table 3: Economic activity in 2012 supported by the aviation sector, EU 28

	Jobs, thousands	GDP, EUR bn
Direct	2,031	121
Indirect & Induced	3,499	213
Total	5,530	334

Source: ATAG, Aviation Benefits Beyond Borders 2014

Table 4 provides a summary of the IATA assessment of the projected economic activity supported by aviation in the EU 28 in 2035 based on the EUROCONTROL passenger growth scenarios for regulated and unconstrained growth scenarios. It also presents the difference between the two scenarios.[13] Compared to the "unconstrained growth" scenario, in the "regulated growth" scenario aviation will support 818,000 fewer jobs and have a contribution to GDP that is lower by €52 billion.

Table 4: Projected 2035 economic activity supported by aviation sector in EU 28, regulated growth and unconstrained growth scenarios

	2035 (Unconstrained)		2035 (Regulated growth)		Difference	
	Jobs, '000	GDP, EUR bn	Jobs, '000	GDP, EUR bn	Jobs, '000	GDP, EUR bn
Direct	2,727	170	2,421	151	306	19
Indirect & Induced	4,977	318	4,465	285	513	33
Total	7,704	488	6,886	435	818	52

Source: ATAG, EUROCONTROL, IATA

10 Within the scope of work of the task force it was not feasible to construct general equilibrium models for the EU 28 economies 20 years into the future, and so the exercise was not performed in this case.

11 *"Aviation Benefits Beyond Borders"*, ATAG, April, 2014– available on the ATAG website: http://aviationbenefits.org/media/26786/ATAG__AviationBenefits2014_FULL_LowRes.pdf

12 *"Foregone Economic Benefits from Airport Capacity Constraints in EU 28 in 2035"*, IATA, February 2015 - available on the IATA website: http://www.iata.org/publications/economic-briefings/Foregone-Econ-Benefits-EU28.pdf

13 This analysis incorporates an annual industry wide productivity improvement of 1.75% per year.

The wider catalytic impacts are not included in the above analysis. However, the above framework can be applied to assess the impacts on the tourism industry using national statistics on tourism flows. Tourism plays an important role in contributing to economic activity. Globally aviation plays a central role in supporting tourism with over 52% of international tourists now traveling by air. Table 5 summarizes the EU 28 tourism economic activity supported by aviation in 2012, these figures are in addition to the aviation sector supported economic activity described in tables 3 and 4.

Table 5: Tourism economic activity supported by aviation in 2012, EU 28

	Jobs, thousands	GDP, EUR bn
Tourism	3,749	178

Source: ATAG, Aviation Benefits Beyond Borders 2014

Table 6 provides a summary of projected tourism economic activity supported by aviation in the EU 28 in 2035 based on the EUROCONTROL passenger growth scenarios for regulated and unconstrained growth. It also presents the difference between the two scenarios.[14] Compared to the "unconstrained growth" scenario, in the "regulated growth" scenario there will be 485,000 fewer jobs supported in the tourism sector and contribution from tourism to GDP will be €24 billion EUR lower.

Table 6: Projected 2035 tourism economic activity support by aviation sector in EU 28, regulated growth and unconstrained growth scenarios

	2035 (Unconstrained)		2035 (Regulated growth)		Difference	
	Jobs, '000	GDP, EUR bn	Jobs, '000	GDP, EUR bn	Jobs, '000	GDP, EUR bn
Tourism	4,856	235	4,371	211	485	24

Source: ATAG, EUROCONTROL, IATA

As you will see, the "economic footprint" results in Section 1a and Section 1b differ. This is due to different approaches taken. These can be summarised as:

- The Inter*VISTAS* approach does not consider the tourism impact. The Oxford Economics approach does;
- The Inter*VISTAS* approach does not consider aircraft manufacturing and off-airport air navigation service provision or other off-airport related activity in the supply chain, while the Oxford Economics approach does;
- There were separate data collection exercises to inform the jobs associated with the direct impacts, performed in different years.

These similar but different approaches allow a range of figures to be presented, allowing a more balanced understanding of the potential "economic footprint" impact of the forecast capacity crunch.

[14] This analysis incorporates an annual industry wide productivity improvement of 1.75% per year.

Table 7 – Range of lost potential GDP associated with economic footprint of unaccommodated passengers in 2035

	Inter*VISTAS*	Oxford Economics/IATA
Direct	€11.8bn	€19.3bn
Indirect & Induced	€16.4bn	€33.0bn
Total	€28.2bn	€52.3bn

Table 8– Range of lost potential jobs associated with economic footprint of unaccommodated passengers in 2035 (in thousands)

	Inter*VISTAS*	Oxford Economics/IATA
Direct	173	306
Indirect & Induced	261	513
Total	434	818

Note: Figures don't exactly sum due to rounding

2: Methodology for assessing impact based on economic welfare

Economic welfare assessments are informed by cost-benefit analysis methods. When scoped and performed correctly cost benefit analysis can offer a powerful method for identifying the policy option that is best suited to deliver societal benefits. It can serve two important objectives. First, it can be used to identify whether a policy offers a sound investment that on net creates benefits. Second, it can offer a common metric with which to compare policy options.

EUROCONTROL have been able to quantify the impact of airport congestion on network performance in terms of delays. EUROCONTROL expects a growing delay challenge and estimate total delays to increase from 8.75 minutes per flight in 2012 to 14.2 minutes in 2035. One of the main causes of airport-related delay is the air traffic flow of capacity management (ATFCM) regulations at airports responding to capacity shortfalls, which is expected to increase from 1.12 min/flight in 2012 to 5.6 min/flight in 2035. The implication for air transport users is that the increasing shortfall in performance will imply an increase in time lost due to delays from 84 million hours in 2012 to 231 million lost hours in 2035. When quantified in terms of the value of time lost the increase is expected to go from €4 billion in 2012 to €13.6 billion in 2035. The monetary values for the value of time are based on figures in Eurocontrol's standard CBA inputs.[15] If considering only ATFCM delays, time lost increase from 11 million in 2012 to 91 million hours lost in 2035 with the value of time lost expected to grow from about €0.5 billion in 2012 to €5.4 billion in 2035.

This is only an assessment of delay impacts, which means it's only a partial assessment of the impact from lower network resilience and reliability. A more comprehensive assessment of the impacts would need to also take into account other factors to measure network reliability and resilience.

[15] Projection for 2035 incorporates a 1% per year increase in the value of time. If no increase in value of time is incorporated the associated value from the time lost by passengers in 2035 would equal about €11 billion, of which ATFCM delays would be €4.3 billion.

3: Methodology for assessing impact of connectivity on productivity (including catalytic impacts)

Greater connections to the global air transport network can boost the productivity and growth of economies by providing better access to markets, enhancing links within and between businesses and providing greater access to resources and to international capital markets.

There are a range of air connectivity indices in existence. Although these use different methodological approaches, the underlying objective remains the same – to quantify how well connected by air a country, region or airport is, taking into account some measure of the quality of the connectivity, and allowing comparison with the equivalent air connectivity of other countries, regions or airports.

IATA developed an air connectivity measure in 2007 and is the basis of this analysis[16]. Within this index aviation connectivity is a measure which reflects the range and economic importance of destinations, the frequency of service and the number of onward connections available through each country's aviation network Other parties have also developed air connectivity measures, such as York Aviation or the SEO Economics Airport Connectivity Index, which forms the basis for the ACI EUROPE "*Airport Industry Connectivity Report*".

Research undertaken based on the IATA measure show that there is a strong positive link between higher connectivity to the global network – as a proportion of GDP – and labour productivity. I.e. the better air connectivity a country has, the more productive are its residents. And the more productive the residents are, the more they each produce, and the correspondingly wealthier they are. This increased productivity is derived via the reduced transport costs (in terms of both time and money) which air access allows. This facilitates a more efficient allocation of resources within the economy, and access to greater economies of scale associated with larger markets, and can manifest itself via increased international trade and capital flows, such as foreign direct investment.

This was examined empirically by gathering data on European countries' GDP per capita and air connectivity over a number of years, as well as data on other variables which can impact GDP per capita, such as spend on education and research & development. Statistical analysis of this data allowed for the calculation of the aggregate relationship air connectivity and GDP per capita.

This analysis showed that there was a statistically significant relationship between a country's air connectivity and its GDP per capita. **A 10% increase in national air connectivity was associated with a 0.5% increase in GDP per capita[17]**. This relationship can then be used to assess the proportion of a country's economy (as measured in terms of GDP) which was associated with historical growth in that country's air connectivity, and used to produce the below figures. Other studies offer

[16] *"Aviation Economic Benefits"*, IATA, July 2007 - available on the IATA website: http://www.iata.org/whatwedo/Documents/economics/aviation_economic_benefits.pdf
[17] "*Economic Impact of European Airports*", Inter*VISTAS*, January 2015

findings within the same range concluding that a 10% increase in connectivity will raise the level of productivity in the economy by between 1%[18] and 0.07%.[19] It should be noted that these are aggregate figures, and so different types of connectivity (e.g. short haul versus long haul, low cost carrier versus legacy carrier, etc.) may have different economic impacts. The below figures are therefore based upon a medium estimate within the range.

Discussion often centres on the causational direction of these effects – does connectivity growth lead to GDP growth or visa versa? Testing of this in the Inter*VISTAS* study found that there was a two-way relationship. Both connectivity and GDP reinforce each other. This makes intuitive sense. In this respect the relationship can be thought of as a "virtuous cycle" – neither GDP nor connectivity alone is driving the relationship, but both are equally necessary.

The below table summarizes the estimated range of possible impacts from the lower connectivity using the projections of expected connectivity and the statistical relationships between connectivity and productivity. The low end figure projects forward the current EU 28 economy. The high end scenario uses Oxford Economics forecasts of EU 28 GDP in 2035 combined with the statistical relationship between lower connectivity and productivity. Therefore the range of estimates allows for choice as to whether wider increases in productivity and growth in the economy between now and 2035 are taken into consideration or not.

Table 9: Projected impact of lower connectivity on economy-wide productivity in 2035

	Low End	High End
Foregone catalytic impacts and economy-wide productivity benefits associated with unaccommodated passengers under EUROCONTROL's 'Regulated Growth' scenario	€44.1 billion[20]	€86.2 billion

Source: IATA, Inter*VISTAS.* As with economic footprint figures, IATA figures refer to 2012 euros and InterVISTAS to 2013 euros

4: Projecting the relationships between passenger traffic & air connectivity and aviation's economic impact to EUROCONTROL's 2035 passenger forecasts

The EUROCONTROL "*Challenges of Growth"* study provides passenger forecasts on the absolute number of passengers which will not be accommodated in 2035. To estimate the economic consequences of these forecasts, it is necessary to project forward how the relationship between passenger traffic, air connectivity and aviation's economic

[18] "*Econometric Analysis to Develop Evidence on the Links Between Aviation and the Economy",* by PWC for the UK Airports Commission, December 2013

[19] "*The Economic Catalytic Effects of Air Transport in Europe*", by Oxford Economic Forecasting (2005) on behalf of the EUROCONTROL Experimental Centre and "*The Economic Contribution of the Aviation Industry in the UK*", by Oxford Economic Forecasting (2006). These studies also allow for connectivity to increase the long-run level of GDP through increasing investment. "*Measuring the Economic Rate of Return on Investment in Aviation*" by InterVISTAS Consulting Inc. (2006).

[20] This equates to 669,400 jobs

impact will evolve. Given that EUROCONTROL provides passenger forecasts, the direct, indirect and induced economic impact figures can be readily derived, subject to some conservative assumptions:

- Due to economies of scale, there is a weaker relationship between the number of passengers and the number of direct jobs at airports with more than 10 million passengers per annum (i.e. the same number of passengers will generate a lower number of direct jobs than at a smaller airport). As future capacity constraints are anticipated at these larger airports, this lower ratio is used. In addition it is assumed that this ratio is reduced by a further 33%, to account for additional productivity which is expected by 2035 within the aviation sector as a whole (i.e. less direct jobs are required to serve the same number of passengers, due to induced efficiencies, new technologies, etc.).
- These conservative estimates significantly reduce the estimation of the economic impact of the capacity crunch in 2035. For example, according to the InterVISTAS report, on average today across the industry, one million passengers is associated with circa 950 direct jobs, while for the purposes of the EUROCONTROL projections, the same number of passengers is associated with only circa 570 jobs. However this is necessary to ensure a credible and realistic forecast.
- To derive the future catalytic economic impacts, the EUROCONTROL forecasts must be considered in terms of air connectivity, and not passenger numbers. There is a relationship between a country's passenger numbers and its degree of air connectivity, while passenger numbers tend to increase at a higher rate than air connectivity values (as well as new routes and frequencies, growth in passengers also tends to occur on existing routes and frequencies, which may not have as high of an impact on a country's air connectivity). To control for this, it was assumed that a country's air connectivity only increased at 75% of the increase in passenger numbers, as forecast by EUROCONTROL.
- This allowed a value to be derived for the estimated air connectivity of affected countries in 2035 – and an estimation of the lost connectivity associated with the absence of adequate airport capacity. This was then combined with the current relationship between air connectivity and GDP per capita growth.

Conclusion

The Taskforce considered the economic cost of EUROCONTROL's forecasts for unaccommodated demand in 2035, due to insufficient airport capacity in Europe. As well as producing a range of figures to attempt to quantify this impact, the group also discussed the nature of economic impact assessments more generally. This allowed the group to form some conclusions as to the use of impact methodologies:

- In some instances economic impact work is performed or commissioned by parties with specific interests – these can be from industry, resident associations or special interest groups. This does not undermine the validity of the work, but it can create situations where all parties – both producers as well as users of reports - may have incentives to depart from a purely objective approach. Even if a fully objective approach is taken, the differing perspectives can create mutual distrust amongst parties. Transparency is the key response to deal with this reality;

- Consequently, producers of reports should be transparent as to the methodological approach taken, the data sources employed and the main assumptions made;
- No less importantly, users of the reports should have realistic expectations as to what methodological approaches can reasonably be used as well as what results any one methodological approach can deliver;
- All parties need to accept that while there is a need for accessible overall figures on the economic impact of an airport, or to a volume of aviation activity, these headline figures should not be divorced from the methodological approach which produced them. Those who wish to use economic impact figures need to familiarise themselves with the methodological approach employed, and understand what economic impacts are both contained within and excluded from those figures.

It was agreed within the group that there is a high economic cost by 2035 to the EU 28 from not addressing airport constraints. This assessment compares EUROCONTROL's "regulated growth" (most likely) scenario to the "unconstrained growth" scenario and finds that in 2035:

- Constraints lead to unaccommodated passenger departures whereby about 1 in 10 passengers wishing to travel by air are unable to do so.
- One estimate[21] of the associated reduction in the apportioned economic footprint of air transport sector is that:
  - Aviation will support 818,000 fewer jobs, in addition there will be 485,000 fewer jobs supported in the tourism sector
  - Aviation's contribution to GDP will be lower by €52 billion, in addition contribution from tourism will be €24 billion lower.
- An alternative estimate by InterVISTAS of EUROCONTROL's 'Regulated Growth' scenario projects a loss of 434,000 potential direct, indirect and induced jobs, which is associated with a loss of €28.2 billion in GDP per annum.
- Foregone catalytic impacts and annual economy-wide productivity losses are estimated to be €44.1 bn to €86.3 bn in 2035."
- Economic welfare dips: Longer delays lead to lost passenger time worth €13.6 billion per year, of which over €5.4 billion is associated with AFTCM delays.

Summary of Potential Negative Economic Impacts of EUROCONTROL Challenges of Growth Forecast within the EU[22]

	InterVISTAS Approach[23]	Oxford Economics/IATA Approaches[24]
Lost Potential Direct	€11.8bn / 173,000 jobs	€19.3bn / 306,000 jobs

[21] *"Foregone Economic Benefits from Airport Capacity Constraints in EU 28 in 2035"*, IATA, February 2015 - available on the IATA website: http://www.iata.org/publications/economic-briefings/Foregone-Econ-Benefits-EU28.pdf

[22] Not all figures should be added together to derive a 'total impact' as they are derived via incompatible methodologies. Rather they should be considered holistically.

[23] In 2013 prices

[24] In 2012 prices

Impact		
Lost Potential Indirect & Induced Impact	€16.4bn / 261,000 jobs	€33bn / 513,000 jobs
Subtotal of Economic Footprint	**€28.2bn / 434,000 jobs**	**€52.3bn / 818,000 jobs**
Foregone catalytic impacts and economy-wide productivity	€44.1bn	€86.3bn
Lost Potential Tourism Impact	N/A	€24bn / 485,000 jobs
Negative Economic Welfare Impact	N/A	€5.4bn – €13.6 bn

To put these figures in perspective, the GDP of the EU economy in 2013 was €13.519 trillion, or €13,519 billion, while the GDP of Croatia was €43.6 billion and the GDP of Germany was €2,809.5 trillion. It should also be noted that the results are in constant 2012 and 2013 terms, and have not therefore been increased to allow for 2035 price levels. The EU economy in 2035 is forecast by Oxford Economics to be €20.176 trillion, or 20,176 billion, in constant 2012 terms.

Section II – Factoring the environmental dimension of aviation activities within the context of the airport capacity crunch

When assessing the economic impacts of not meeting expected demand by 2035, the Task Force based its work on the 2013 Challenges of Growth study carried out by Eurocontrol. In this study, Eurocontrol looked into 4 scenarios for aviation growth in 2035. Each scenario sets various regulatory and economic conditions that are expected to have an impact on the growth of the aviation sector. It is commonly accepted that the most likely scenario is scenario C of "Regulated Growth".

Under this scenario, economic growth is moderated, regulations applying to the aviation sector take into account its environmental impacts, while allowing the sector to deliver social and economic benefits. This scenario takes into account the effects of environmental regulations on the use of airport capacity, and as such appears as the most adapted to the work of the Task Force.

The aim of this report is not to study the adverse effects of air transports and of airport related activities but recognise the environmental component in the discussions on airport capacity.

The Task Force acknowledges that managing the environmental impacts of aviation is one of the key to secure the long-term "permission to operate and grow". Indeed, *Challenges of Growth* confirms the role of local communities as affecting positively or adversely the ability of air transport to develop in Europe in the next decades

The Task Force then decided to build further on this analysis and to contribute through identifying:

- The various environmental impacts of aircraft and airport operations;
- The regulatory measures taken to tackle/limit adverse environmental impacts and the mitigation measures that could be enforced to reduce the impacts on the population and thus to allow for maximising the use of available capacity;
- Existing studies linking the environmental impacts of aviation with their economic impacts, including the impact on noise and pollutants on health.

1: The environmental impacts of air transport and airport activities - A typology of impacts

In order to better scope this section, the Task Force listed the environmental impacts of aviation activities at airports. They are similar to the ones identified in the European Commission's 2014 *Handbook on External Costs of transport,* even if this document focused primarily on ground transport.

The Task Force classified the impacts in three categories:

- The impacts which are directly generated by air transport and airport related activities
    - Noise impacts

- Air quality impacts
- Climate change impacts

- The group also identified impacts that are, in a systemic vision of air transport and airport related activities, at least partially related to these activities
  - Ground access to airports and road congestion, which imply pollution and noise
  - Various land use restrictions due to safety risk or noise zones, which could result in a scarcity of land or impact the localisation of activities and imply urban sprawl, mobility and pollution issues
- At last, there are non-aviation specific impacts:
  - Impacts on landscape, biodiversity, heritage, soil and water quality
  - Impacts on the urban activities localisation (especially economic functions) around airports.

2: Possible mitigation measures affecting airport capacity in some EU airports

In order to illustrate the nature of the measures that could be adopted in order to mitigate the environmental impacts of airport and aircraft operations, a survey was undertaken by the Task Force. It focused on those airports that do have a growth agenda and/or are operating at full capacity either throughout the day or during certain hours during the day and/or have recently implemented or are projected to implement infrastructure expansion plans. These airports are:

Frankfurt Airport (Germany)	Schiphol Airport (The Netherlands)
Paris-Orly Airport (France)	London Heathrow Airport (The UK)
Paris-Charles de Gaulle Airport (France)	Barcelona Airport (Spain)
Warsaw Airport (Poland)	Stockholm Arlanda Airport (Sweden)
Helsinki Airport (Finland)	Munich Airport (Germany)

In order to stay within the scope of its mandate, the Task Force decided to look into those mitigations measures that have an impact on the ability of the airport operator to maximise the use of its infrastructure. These measures are:

- Restrictions on the number of movements on the platform
- Restrictions on the runway usage
- Operational procedures affecting the use of the airport capacity
- Noise quotas and noise enveloppes.

In addition, a range of mitigation measures were identified that can contribute to performing aircraft and airport operations within a tight regulatory framework. These measures are:

- Ground vehicles policies
- Restrictions on aircraft based on their noise certification
- Noise insulation programmes.

This survey is a snapshot of concrete case studies and does not constitute an exhaustive European-wide analysis of environmental measures and mitigation actions performed at airports. Its scope and objectives are been specifically tailored to the mandate of the Task Force.

While the detailed outcome of the survey can be found in Annex I, a few conclusions can be drawn:

- The survey shows that many airports are subject to environmental regulations seeking to address or minimize the environmental impacts of their activities.
- Most of the surveyed airports operate traffic volumes that are near their movement caps. For example London Heathrow is at 98% of the cap, Orly at 92% and Schiphol at 83%. As such, movement caps could be considered as critical limiting factors on airport capacity that compound the existing runway capacity crunch. This is illustrated by the fact that existing physical capacity in congested airports will frequently not be fully utilised because of movement caps.
- Many of the airports also operate a noise quota system. Unlike the movement caps, the noise quota system distinguishes between the certificated noise levels of aircraft and therefore is environmentally effective and operationally efficient. Indeed, it enables airlines to adapt the aircraft used, depending on their noise certificates.
- Many airports run mandated (by regional or national authorities) insulation schemes which are financed through levies or charges to airlines (based on the aircraft noise certificates), making the sector contribute to its external costs.

The Task Force agreed that the survey of the airports was an interesting exercise, and recommends that a study be carried-out on a wider and more representative scale in order to better assess the scope of environmental/operational restrictions and their impact on airport capacity utilisation within the European Union (including a comparison with other World regions) as well as their evolution over time. Equally important for future policy recommendations would be to assess the economic impact of these restrictions on airport capacity, taking into account the fact that airports' business model can evolve over time.

3: The economics of the environmental impacts of aviation

Having identied the impacts of airports and air transport activities, and listed some of the mitigation measures and their links to capacity, the Task Force sought to collect information on existing methodologies to quantify environmental impacts.

It appears that there are two steps for the economic evaluation of the impact. The first step would be to quantify the exposure and the second step would be the monetisation of the impact. The Task Force had no expertise in any of these areas and invited external speakers to present the latest research on each, Dr. Bernard Berry and Dr. Diana Sanchez.

3a. Where do we stand?

Given the scope of the mandate of the Task Force, i.e. assessing the costs of non-accommodated demand at European airports, a related work stream was identified. While there are methodologies to assess the economic benefits of aviation, the Task Force raised the question of the existence of such methodologies to assess the negative impacts of aviation, especially the health impacts of exposure to aircraft noise and emissions.

To this end and in order to benefit from the most robust possible information, the Task Force invited two independent experts, Dr. Bernard Berry and Dr. Diana Sanchez, co-authors of the paper "The economic and social value of aircraft noise effect: A critical review of the state of the art"[i] (biographies available in Annex III).

Their presentation included a range of elements of strong interest to the Task Force.

There are two key elements in any assessment of the effects of noise. The first is a measurement of the extent of exposure to noise, for example the size of the population that is affected by noise at a certain level. The second is a judgement as to the extent to which that exposure is having an adverse effect. This element of "dose-response relationship" deserves a sound and robust assessment.

As Berry and Flindell point out in their 2009 review[ii], a thorough understanding of the origin of the dose-response relationships involved, the statistical uncertainties inherent in such relationships, and the assumptions underlying their practical use are vital in considering the issue of defining "adverse" effects and thresholds[iii].

The figure below provides a summary of the health effects associated using standardised World Health Organisation (WHO) evidence categories and some brief comments on the limitations of this evidence.

Summary of amenity/quality of life and health effects associated with aircraft noise[iv]Health effect	Strength of evidence[a]	Comments & limitations
Annoyance	Sufficient	Complex interaction with other health effects and non-acoustic factors
Cardiovascular[v]	Sufficient	Importance of; confounding factors, e.g air pollution modifying factors , e.g. length of residence
Sleep - awakenings	Sufficient	A certain number of spontaneous awakenings is normal
Sleep – self reported	Sufficient	Subject to bias

disturbance		
Mental health, psychiatric disorders	Lacking, Inadequate	Some evidence of symptoms, but not of severe clinical disorders
Sleep - long term effects	Lacking, Inadequate	Complex mechanisms underlying long-term effects, many factors
Hearing impairment	None at noise levels < 75 dBA	

[a]Source of definitions of strength of evidence –WHO International Agency for Research on Cancer (IARC) http://www.iarc.fr/

Sufficient: a relationship has been observed between noise exposure and a specific health effect, chance, bias and confounding factors can be ruled out with reasonable confidence.
Limited: an association has been observed between noise exposure and a specific health effect, chance, bias and confounding factors cannot be ruled out with reasonable confidence.
Inadequate: the available studies are of insufficient quality, lack the consistency or statistical power to permit a conclusion regarding the presence of absence of a causal relationship.
Lacking: several adequate studies are mutually consistent in not showing a positive association between exposure and health effect.

- While noise and pollutants have an impact on people's health, a clear limitation is the lack of information on the robustness of exposure-response relationships or curves. There are different degrees of confidence in the curves for different health outcomes even across those health effects where the evidence is classified as sufficient.
- Amongst the reasons for various degrees of confidence is that any observational study is prone to bias. It needs to make appropriate adjustment for confounding factors - risk factors that may influence the observed associations if differently distributed between exposed and unexposed (or greater and lesser exposed) individuals. Because of this, it is preferable to base decisions on a large number of studies of good quality – i.e. where bias is minimized and important confounders taken into account.
- The scientific evidence for exposure-response relationships that would provide the basis to derive a threshold is inconclusive or lacking for many health outcomes as very few studies have examined a full range of noise exposures. This is important since the use of different thresholds in quantitative risk calculations can make significant differences to the overall results.

Two other conclusions from Berry and Findell appeared of specific interest to the Task Force:

- *While there is a benefit in monetising the impact of aircraft noise, this can only be considered as an element amongst others for decision-making by public authorities or private airport operators. It should be used to enhance the understanding of trends rather than quantifying a health effect in absolute terms.*
- *To date, there is no commonly accepted methodology to monetize the health effects of aircraft noise exposure. It is a complex issue. Consideration of uncertainties and limitations is a key part of this work.*

Keeping these conclusions in mind, further work has been carried out to list and introduce some of the numerous studies available in the area of monetization of environmental impacts.

3b. Learning from available studies

A detailed review of available studies on the monetisation has been made. A full review of these methodologies is available in Annex IV of this report.

There are many methodologies to assess the negative impacts of air transport, but few are comprehensive and take all impacts into account and even fewer propose a monetization of the impacts.

It should be highlighted that unlike the economic studies available to assess the benefits of aviation, no assessment has been made on the methodological limitations of the studies listed in this Annex.

Composition of the Task Force

Chair: Airport Regions Conference (ARC) & Airport Council International-Europe (ACI-Europe)

Secretariat: European Commission, Dg MOVE

ACI - Airport Council International (Europe)
AEA – Association of European Airlines
ARC – Airport Regions Conference
BMVI – German Federal Ministry of Transport and Digital Infrastructure
BMVIT - Austrian Ministry for Transport, Innovation and technology
DGAC - Direction Générale de l'Aviation Civile - France
DFT – Department for Transport - UK
EC - European Commission
ENAC - Ente Nazionale Aviazione Civile - Italian Civil Aviation Authority
ERAA - European Regions Airline Association
IATA – International Air Transport Association
UECNA – Union Européenne contre les Nuisances des Avions
ULC - Urząd Lotnictwa Cywilnego - Polish Civil Aviation Authority

Annex I – Survey Results
European Observatory for Airport Capacity – Task Force 1

Comments on Environmental restrictions at selected EU airports

Restrictions on movements

Restrictions on the number of movements (whether night movements, total movements, or both) are implemented in almost all of the airports surveyed.

In **Schiphol**, there is a 510,000 total flight limit in place (actual traffic around 425,000) of which 32,000 can take place at night (actual traffic 30,800 – night meaning 23.00-07.00). The night cap will be tightened to 29,000 in three years.

In **Stockholm Arlanda**, the environmental permit of the airport mandates a cap at approximately 372,000 movements per year without distinction between day, evening or night. Current traffic is at approximately 219,500.

In **Paris CDG**, there is a limitation of slots for night-time movements at 22,500/year. Unused slots are lost, which, since the start date of the system, has brought slots down to less than 20,000/year.

In **Frankfurt Airport**, a night-flight ban is imposed between 11.00-05.00 and a cap of 133 movements in the shoulder period 22.00-23.00/17.00-18.00.

In **Orly Airport**, a total night ban is in force. There is a limitation of total slots to 250,000 / year. Current traffic stands at 229,600 movements.

At **London Heathrow**, a cap on total movements per annum is in force at 480,000 movements, with actual traffic at approximately 472,000. A separate quota applies to night flights (11.30-06.00) and is currently set at 5,800 movements.

At **Munich Airport**, a cap on night movements is in place between 22:00-06:00 at 28 flights per night.

At **Warsaw Airport**, a cap of 600 operations per day (560 day time 06.00-22.00 and 40 for night time 22.00-06.00). The level of cap is determined by noise impact range level.

Restrictions on runway usage

Restrictions on runway usage are in force in the majority of survey airports implement. These can vary from noise-preferential runway systems to the closure of a runway at night.

In **Schiphol**, there is noise-preferential runway use based on 2+1 runway use. Due to noise abatement considerations, the use of a non-preferential runway for take-off and for landing is not permitted unless specifically requested for safety reasons.

In **Barcelona Airport,** restrictions are in place on 2 out of 3 runways at night (one ban on take offs from either end, one ban on landings from one).

In **Frankfurt**, the new fourth runway (25R/7L) is closed during night hours 23-5.

In **Helsinki Airport** there are restrictions on two runways between 22:00-7:00. Runway 15 forbidden for take-offs and runway and 33 forbidden for landings.

In **London Heathrow,** no flights take off northern runway eastwards (day & night). Runway alternation during the day to offer noise respite to local communities.

Paris Orly operates a noise-preferential runway system.

<u>Operational procedures affecting capacity</u>

Extensive operational procedures are in place in the surveyed airports. They include bans on reverse thrust, low noise climb and approach procedures, among others.

In **Schiphol**, Continuous Descent Approaches are used during night and evening and specific routes. Runway use and Route monitoring. There is a P-RNAV requirement.

In **Barcelona Airport,** specific noise abatement SID and climb procedures. Forbidden use of reverse thrust (in two runways), specific procedures for low noise approach. During night hours, arrivals procedures in continuous descent (CDA) are used for noise abatement reasons.

In **Frankfurt Airport,** reverse thrust allowed only for safety reasons, which can result in longer runway use times and hence capacity limitations.

In **London Heathrow t**here are longstanding departure routes which are set by the Government under powers to limit or mitigate noise. There are also rules set by the Government on height limits and noise limits on departure.

<u>Noise quota/envelope</u>

Noise quota systems are used in **Schiphol, London Heathrow, Munich, Orly** and **Warsaw.**

In **Schiphol,** a noise quota system is in place based on total volume of noise Lden 65 Lnight 55

In **London Heathrow,** a noise quota system is in place that is based on aircraft noise profiles.

In **Munich,** the system is based on a legal definition of annual noise volume based on the calculated energy equivalent continuous sound level L(eq), which must not be higher than 50dB in avg night of calendar year at intersections of flight routes with the boundary of the combined day/night protective area.

In **Warsaw**, a Quota Count system that uses QC points depending on aircraft acoustic parameters is in place.

Aircraft restrictions

Most airports surveyed have measures in place to restrict marginally compliant aircraft:

In **Schiphol**, Ch 3 -5EPNdB new operations not allowed, for aircraft engines with bypass ratio (ratio of uncombusted vs combusted air) less or equal to 3, take off and landing not allowed in evening and night periods.

In **Barcelona**, a scheme is in place to reduce marginally compliant aircraft (Ch3 – 5)

In **Paris CDG**, night time ban of Ch3 – 10 aircraft, while during the day there is a ban of marginally compliant Ch 3 – 5 aircraft.

In **Orly** a ban on Chapter 2 aircraft was reported.

In **Frankfurt Airport**, fully compliant Chapter 3 can only operate during 06.00-22.00, whereas marginally compliant only during weekdays between 08.00 - 20.00, as part of the airport's planning approval for expansion.

In **Helsinki**, there is a night ban on jets with ICAO take off noise higher than 89 EPNdB and exclusively cargo (under processing by authorities)

In **London Heathrow**, a voluntary agreement not to schedule marginally compliant aircraft or cargo operations at night (23:30 – 6) is in place. Otherwise rely on differential landing charges.

In **Munich**, there is a ban on chapter 2 aircraft, and only “Munich list” aircraft (creating less than 75 db (A) around MUC) are allowed to operate at night.

In **Warsaw**, it is reported that only aircraft compliant with Annex 16, Vol 1, part 2, Chapters 3, 4, 5, and 10 can operate at night (22:00-6:00).

Insulation programmes

Almost all of the airports surveyed have insulation programmes in place for neighbouring communities. Many of these programmes are mandated by regional or national authorities and are financed through levies or charges to airlines. Most of them determine eligibility and scope of insulation programmes based on average and night noise intensity areas.

Schiphol has insulation programme financed through levy that has spent 575 million euro since 1990.
Policies by State (construction of railways), Regional Transport Plans and Schiphol (for its workers) all directed to public transport and cycling. Recent trend:electrical transport.

Barcelona has an Insulation scheme paid by AENA that has spent approx. 3 million euros on 50 properties inside the Leq(day)>65 and Leq(night)>55

Paris CDG following national rules insulates homes inside the Lden > 55 area, which are 96,000 in total. 31000 of those remain to be insulated.

Paris Orly following national rules insulates homes inside the Lden > 55 area, which are 52,000 in total. 16000 of those remain to be insulated.

In **Frankfurt Airport**, authorities have mandated an insulation programme for homes in 50dB(A) at nighttime (with maximum at least 53dB indoors) and 60dB(A) during the day. This includes 86,000 households (night) and 12500 for day. The programme is financed by noise insulation charges to airlines.

In **Munich Airport**, there are extensive noise abatement measures so that the individual sound events are in principle not higher than 55 dB (A) inside rooms with the windows closed; ca. 21.000 soundproof windows and around 20.000 ventilating fans have been installed; since 1992 investment of 62 Mio € on noise abatement measures.

Warsaw has insulation program which applies to the buildings located in the Restricted Use Area. Investments related to the acoustic insulation are financed by the airport noise emission fund.

Ground vehicles policies

Some of the airports surveyed reported that they have policies in place on the ground vehicles that can be used on their aprons.

In **Schiphol**, there is electrical transport on airport premises, electrical buses. Taxi-permits for 100 TESLA's. Aiport Carbon Accreditation.

In **Barcelona Airport**, 20% emissions reduction from ground vehicles at El Prat is aimed for by 2020, in line with regional policy

In **Frankfurt Airport**, there is no ground vehicles policy in place. The airport operator operates vehicles with strict emission standards.

In **London Heathrow** there are restrictions on ground vehicles and also Clean Vehicles Partnership programme promoting clean vehicles that involves 22 companies and 3000 vehicles.

In **Warsaw Airport** depending on vehicle date, vehicles may have to meet certain EURO standards.

Annex II – Detailed Biographies

Berry Environmental Limited

SYNOPSIS – RECENT and current WORK - PUBLICATIONS

Name	**Bernard Berry**
Present Appointment	Director – Berry Environmental Limited
Date of Birth	14 January 1947
Nationality	British
Education	BSc, [Electronic Engineering] Manchester University MSc [Human Factors in Engineering], ISVR, University of Southampton
Professional Qualifications etc.	Honorary Fellow of the Institute of Acoustics www.ioa.org.uk President of Institute of Acoustics from 1996 to 1998, IoA Vice President for International Relations 2001-2007. Vice President [Europe and Africa] for 2005-2009, of the International Institute of Noise Control Engineering I-INCE www.i-ince.org

Awards

- **Institute of Acoustics Award for Distinguished Service.** October 2009 – "*for his outstanding contribution to the life of the Institute*".
- **Distinguished International Member of the Institute of Noise Control Engineering of the USA**. 2010. This distinguished, honorary status is conferred upon individuals who have personally made extraordinarily significant contributions to the theory and/or practice of noise control engineering.
- **UK Noise Abatement Society, Lifetime Achievement Award** 2011

Synopsis

Bernard was born in Manchester, and educated at St Bede's College, and Manchester University [BSc Electrical and Electronic Engineering]. Postgraduate studies and an MSc [Human Factors in Engineering] followed at the Institute of Sound and Vibration Research ISVR, University of Southampton.

He then won a NATO Science Fellowship and spent a year as a guest worker at the National Research Council of Canada in Ottawa, with Dr George Thiessen investigating the effects of impulse noise on sleep, using EEG techniques.

In 1970 he joined the National Physical Laboratory – the UK national standards laboratory, to work with the late Professor Douglas Robinson, and dedicated 30 years there to an extensive portfolio of activities in research, standardisation, consultancy and policy advice in the field of environmental noise and its effects on people. This ranged for example, from compiling the first ever "Leq Guide" for the Government's Noise Advisory Council in the 70s, through directing a long-term consultancy project with the Royal Air Force during the 80s and early 90s, to more recent joint EC-funded team projects on the effects of noise on health. He has been a consultant and expert adviser to industry, UK Government, Defra, MoD, CAA, other national Governments, the Greater London Authority, the World Health Organisation WHO, the European Commission, and has collaborated in research projects with a large number of organisations.

On July 1st 2001 he left NPL to form a new company - ***Berry Environmental Ltd – BEL***.

Projects have included the EC project on Road traffic and Aircraft Noise and Children's Health, [RANCH - see http://www.wolfson.qmul.ac.uk/RANCH_Project/], and consultancy to the World Health Organisation's European Centre for Environment and Health in Rome on 2 other EC projects; - Health Effects and Risks of Road Transport Systems - HEARTS, www.euro.who.int/hearts and - Integrated Software for Health, Transport Efficiency and Artistic Heritage Recovery - ISHTAR.

BEL was awarded a Defra research contract in November 2003, for a "Review and analysis of published research into the adverse effects of industrial noise, in support of the revision of planning guidance." A follow-up contract to develop a searchable database of relevant publications was awarded in December 2004.

BEL provided written Evidence, and Bernard acted as an Expert Witness in an Environment Court hearing in Christchurch, New Zealand, in March 2004, concerning a proposed change in the regulations governing land-use planning at Christchurch International Airport.

BEL completed a contract with the TNO Prevention and Health Organisation in the Netherlands to assist Dr Henk Miedema in an EC Study Contract on "Dose-response relationships for Sleep disturbance", as the basis for an Annex of the new Directive on Assessment and Management of Environmental Noise.

Bernard was a member of the international Committee of Experts of the Netherlands Health Council which produced the 1997 report "Assessing noise exposure for public health purposes." He also assisted the WHO Task Group in the development of the Year 2000 edition of the WHO "Guidelines on Community Noise".

He was an Expert Adviser to the WHO European Centre for Environment and Health, [ECEH] in Rome in the development of the Children's Environment and Health Action Plan for Europe CEHAPE.

He is an Expert Adviser to the World Health Organisation [WHO] European Centre for Environment and Health [ECEH] in Bonn, and a member of the WHO Working Group on Aircraft Noise and Health [commenced October 2007]. http://www.euro.who.int/Noise

He assisted in the development of the 2011 WHO Report *"Burden of disease from Environmental Noise - Quantification of healthy life years lost in Europe"*
http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf

He has published over 130 papers in academic journals and conference Proceedings, reports and book chapters, and given more than 120 presentations at conferences.
These include a Plenary Distinguished Lecture at the 1997 Internoise conference in Budapest, and the Inaugural "Dr Gerry McCullagh Memorial Lecture" in November 2006 at the University of Ulster.

More recent publications are listed in this CV – with hyperlinks where available.
See details of earlier publications and presentations on the NPL Acoustics website.
http://publications.npl.co.uk/npl_web/search.htm Search on B F Berry

He is Chairman of the main British Standards Institution [BSI] Technical Committee on Acoustics, and Chairman of the BSI Technical Committee "Residential and Industrial Noise".

He was an expert member of the Department of Health Ad Hoc Advisory Group on the Health Effects of Noise – and contributed to the July 2009 publication "Environmental Noise and Health in the UK ".
http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1279888026747

He has been a Visiting Lecturer at the Bahcesehir University in Istanbul.

He was made a Fellow of the UK Institute of Acoustics in 1994, and was President of the Institute from 1996-1998. He was also the Institute's Vice-President for International Relations from 2001 to 2007.

He was awarded Honorary Fellowship of the Institute in September 2007, in recognition of outstanding service to the Institute over many years.

In October 2009 he was presented with the Institute's **Award for Distinguished Service** – "*for his outstanding contribution to the life of the Institute*".

In April 2010 he was elected a **Distinguished International Member of the Institute of Noise Control Engineering of the United States of America**. This distinguished, honorary status is conferred upon individuals who have personally made extraordinarily significant contributions to the theory and/or practice of noise control engineering.

In November 2011, in a ceremony at the House of Commons, he was presented with the **Lifetime Achievement Award** by the UK Noise Abatement Society.

He has been on the International Advisory Committee of a number of major Conferences, including Internoise 2005 in Rio, Internoise 2006 in Honolulu, Internoise 2007 in Istanbul, Internoise 2010 in Lisbon and Internoise 2011 in Osaka.

He is also:
- Vice President for Europe and Africa, of the International Institute of Noise Control Engineering I-INCE, 2006-2009.
- European Editor of the I-INCE journal Noise News International.
- A member of the Editorial Board of the international journal Noise and Health. www.ucl.ac.uk/noiseandhealth
- A member of Team 9 "Policy and Economics" of the World Health Organisation [WHO] International Commission on the Biological Effects of Noise. http://www.icben.org/
- Member of the I-INCE Technical Study Group TSG 7, on "Implementation of a Global Noise Policy"
- Consultant to I-INCE TSG 6, "Community Noise: Environmental noise impact assessment and mitigation"
- UK expert member of ISO TC43 SC1 WG45, which is responsible for ISO 1996 "Acoustics - Description and measurement of environmental noise".
- A member of the Scientific Advisory Committee of the Institute of Sound and Vibration Research, ISVR, University of Southampton.
- a participant in the European Network on Noise and Health Research ENNAH – co-ordinated by Imperial College. September 2009-2011. www.ennah.eu

Diana Sanchez
Head of Knowledge Leadership
Anderson Acoustics Ltd.

Diana Sanchez is the Head of Knowledge Leadership at Anderson Acoustics, a noise management consultancy in the UK.

She has more than 8 years of experience in developing innovative sustainability strategies and initiatives for different organisations in Europe and Latin America, including the United Nations Human Settlement Programme. Diana has collaborated in the development of worldwide recognised sustainability standards such as the ISO 26000 and the GRI Sustainability Guidelines for the Financial Services Sector.

In the last years, her work has focused on research on the impacts of airports operations in sustainable development and quality of life. These include the economic valuation of the effects of aircraft noise on human health and importance of non-acoustic factors in the design of noise management strategies. Also, she has supported Heathrow's noise strategy and sustainability agendas in addition to providing technical responses to the Airport Commission's consultations in the UK regarding quantification and monetisation of aircraft noise effects.

She has published various papers on these matters and presented at international conferences.

Diana received her Bachelor of Science degree in Economics and holds a Master of Sustainable Business Administration, as well as a Master degree in Philosophy. She is an Associate Member of the Institute of Acoustics in the UK.

Annex III – Detailed Bibliography

E J Richards. 1976. *Putting a value on noise-The development of an index which is fair to both airport operators and the public*. Journal of Sound and Vibration, Volume 49, Issue 1, p. 53-73. http://adsabs.harvard.edu/abs/1976JSV....49...53R
B F Berry. 2008. Effect of Noise on Physical Health risk in London. Report on Phase 1 – Review of the Topic. BEL Technical Report 2008-1. http://www.lcacc.org/noise/glanoisereport1008ph1.pdf
B F Berry. 2008. Effect of Noise on Physical Health risk in London. Report on Phase 2 – Estimates of the numbers of people at risk. BEL Technical Report 2008-2. http://www.lcacc.org/noise/glanoisereport1008ph2.pdf
B F Berry and I H Flindell. 2010. Using health effects of noise in economic valuation policies Proceedings of Internoise 2010. Lisbon. June 2010.
A. Huss, A. Spoerri, M. Egger, and M. Röösli. 2010. "*Aircraft noise, air pollution, and mortality from myocardial infarction*". Epidemiology 21(6), 829-836, (2010).
M. Sorensen.2011. Exposure to road traffic and railway noise and associations with blood pressure and self reported hypertension: a cohort study. Environmental Health 2011, 10:92.
S Fidell, V Mestre, P Schomer, B F Berry. 2011. A first-principles model for estimating the prevalence of annoyance with aircraft noise exposure. J. Acoust. Soc. America. 130(2). August 2011. http://asadl.org/jasa/resource/1/jasman/v130/i2/p791_s1?isAuthorized=no
D Schreckenburg et al. 2011. Study on Noise Related Annoyance, Cognition and Health -the NORAH study. Proceedings of ICBEN 2011.
W Babisch et al. 2012. Exposure modifiers of the relationships of transportation noise with high blood pressure and noise annoyance. J. Acoust. Soc. Am. 132 (6), December 2012. 3788-3808.
H E Laszlo, B F Berry, P Abbott and A L Hansell. 2012. Environmental noise and cardiovascular disease – observations on a well known exposure-response relationship. Proceedings of Internoise 2012. New York. August 2012.
E. van Kempen and W Babisch. 2012. The quantitative relationship between road traffic noise and hypertension: a meta-analysis. J Hypertens 30:1075-86.
A. Evrard. 2012. *Health effects of aircraft noise near three French airports: results from a pilot epidemiological study of the DEBATS study*. Proceedings of Internoise 2012. http://debats-avions.ifsttar.fr/
Clark, C., Crombie, R., Head, J., van Kamp, I., van Kempen, E., & Stansfeld, S.A. (2012). *Does traffic-related air pollution explain associations of aircraft and road traffic noise*
W. Babisch. 2013. *Exposure-response curves of the association between transportation noise and cardiovascular diseases - an overview*. In: Serbian Medical Society, Section of Hygiene (ed) Proceedings of The First International Congress on

Hygiene and Preventive Medicine, "Preventive medicine as a pillar or public health", Belgrade, 22-24 May 2013. Serbian Medical Society, Belgrade, on CD (ISBN 987-86-6061-034-0), p 331-339
Clark, C., Head, J., Stansfeld, S.A. (2013). Longitudinal effects of aircraft noise exposure on children's health and cognition: a six year follow-up of the UK RANCH cohort. Journal of Environmental Psychology, 35, 1-9.
Burden of disease from environmental noise, OMS 2011.
Öhrström E., Research on noise since 1988: present state, Noise and man, Nice, I. ed. M. Vallet, vol.3, pp.331-338, 1993.
Muzet A. et Ehrhart J., "Amplitude des modifications cardiovasculaires provoquées par le bruit au cours du sommeil", Cœur et médecine interne, n°17 pp.49-56, 1978.
Carter N.L., Cardiovascular response to environmental noise during sleep, 7th International Congress on Noise as a Public Health Problem, Sydney, Australie, vol.2, pp.439-444, 1998.
Carter N.L., "Transportation noise, sleep, and possible after-effects", Environm. Internat., n°22 pp.105-116, 1996.
Naitoh P., Muzet A. et Lienhard J.P., Effects of noise and elevated temperature on sleep cycle. Sleep Research, 2nd International Congress of Sleep Research, Edimburgh, vol.4, pp.174, 1975.
Thiessen G.J., "Effect of traffic noise on the cyclical nature of sleep", J Acoust Soc Am, n°84 pp.1741-1743, 1988.
Fruhstorfer B, Pritsch MG " Effects of daytime noise load on the sleep-wake cycle and endocrine patterns in man ", 1988.
Kryter KD "Aircraft noise and social factors in psychiatric hospital admission rates", 1990.
Kawada T, Naganuma S, Kiryu Y, Suzuki S " The effect of noise on sleep: changes in hypnograms of subjects exposed to repeated truck-passing sound ", 1992.
Schmeck K, Poustka F " Psychological and psychiatric tests with children and adolescents in a low-altitude flight region ", 1993.
Stansfeld SA " Noise sensitivity and psychiatric disorder: epidemiological and psychological studies ", 1992.
Cohen JM, Mosnier A, Abramowitch JM, Goldberg P « Etude épidémiologique des troubles anxio-dépressifs autour des aéroports », Paris INRETS 1999.
Maschke C, Arndt D, Ising H, Laude G, Thierfelder W, Contzen S " The effect of night time airplane noise on excretion of stress hormones in residents living near airports ", 1995.
Babisch W « Stress hormones in the research of cardiovascular effects of noise » Noise Health 2003.
Avis du CNB sur le Grenelle de l'Environnement, assemblée plénière du 10 octobre 2007.
Etude Insomnia : Impact des Nuisances Sonores (Maladies et Insomnie) à proximité des Aéroports, mai 2004. Docteur Eric LAINEY Médecin spécialiste du Sommeil, Hôpital Européen George Pompidou, Docteur Simone NEROME Médecin Hospitalier, Docteur Jean-Pierre ENJALBERT Médecin spécialisé en Environnement et santé publique, CSNA, Docteur Stéphane BOUEE Médecin Epidémiologiste, CEMKA-EVAL, Céline DESCHASEAUX-VOINET Chargée d'Etude, CEMKA-EVAL
Effets des nuisances aériennes sur la scolarité et la santé des enfants CSNA-C.R.E.T.E.I.L. - août 2007. CSNA, Collectif Santé et Nuisances Aériennes BP6, 95390

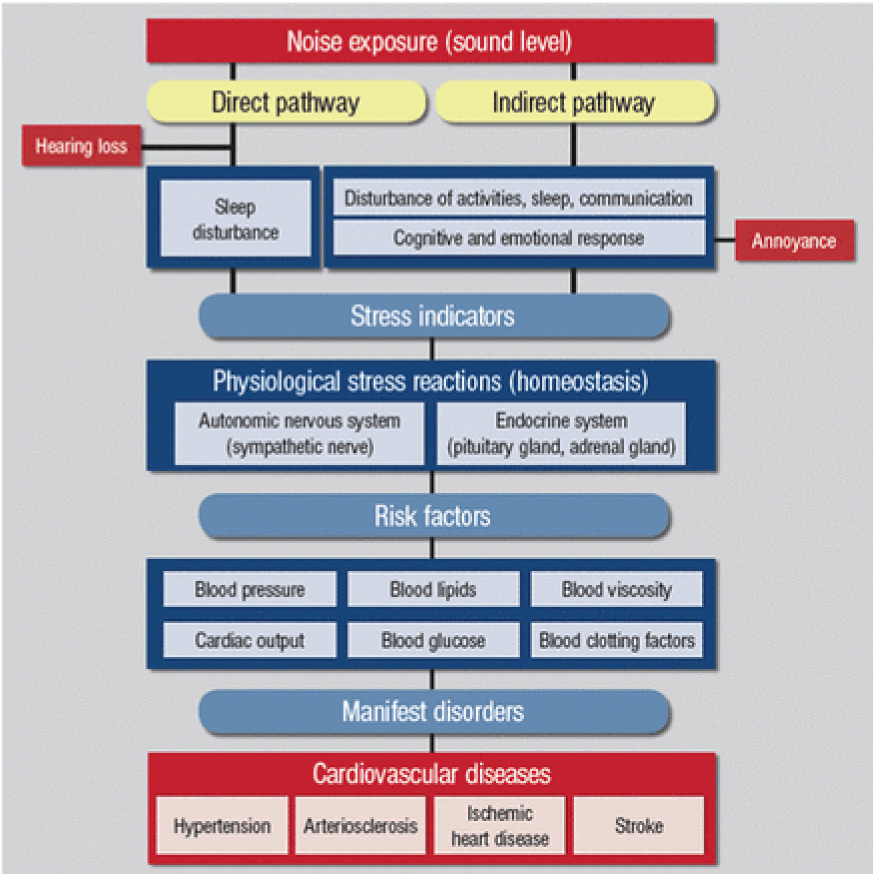
SAINT-PRIX
Open Rome Dr Cohen voir site www.idf.fr
USA Survey AIRPORT NOISE & Cardiovascular Disease 2013: *BMJ* 2013;347:f5561
Aircraft noise and cardiovascular disease near Heathrow airport in London: small area study. Anna L Hansell *assistant director* 1 *honorary consultant* 2, Marta Blangiardo *non-clinical lecturer in biostatistics*1, Lea Fortunato *research associate*1, Sarah Floud *PhD student*1, Kees de Hoogh *senior research officer*1, Daniela Fecht *research associate*1, Rebecca E Ghosh *research associate*1, Helga E Laszlo *acoustician* 1, Clare Pearson *research assistant* 1, Linda Beale *honorary research fellow,* Sean Beevers *senior lecturer in air quality modelling* 3, John Gulliver *lecturer in environmental science*1, Nicky Best *professor in statistics and epidemiology*1, Sylvia Richardson *visiting professor in biostatistics* 1 *director* 4, Paul Elliott *director* 1
1UK Small Area Health Statistics Unit, MRC-PHE Centre for Environment and Health, Dept Epidemiology and Biostatistics, School of Public Health, Imperial College London, W2 1PG, UK; 2Imperial College Healthcare NHS Trust, London, UK; 3Environmental Research Group, MRC-PHE Centre for Environment and Health, King's College London, UK; 4MRC Biostatistics Unit, Cambridge, UK
Residential exposure to aircraft noise and hospital admissions for cardiovascular diseases: multi-airport retrospective study. Andrew W Correia *quantitative analyst* 1, Junenette L Peters *assistant professor* 2, Jonathan I Levy *professor*2, Steven Melly *geographic information systems specialist*3, Francesca Dominici *professor, associate dean of information technology* 4
1NMR Group, Somerville, MA, USA ; 2Department of Environmental Health, Boston University School of Public Health, Boston, MA, USA; 3Department of Environmental Health, Harvard School of Public Health, Boston; 4Department of Biostatistics, Harvard School of Public Health, Boston, MA 02115-6018, USA
Noise pollution: economic analysis, Department for Environment, Food& Rural Affairs UK 9 April 2013
Noise & Health – Valuing the Human Health Impacts of Environmental Noise Exposure, A response by the Interdepartmental Group on Cost and Benefits Noise Subject Group, July 2010
An Economic Valuation of Noise Pollution – developing a tool for policy appraisal, August 2008, Department for Environment , Food and Rural Affairs UK
Good practice guide on noise exposure and potential health effects, European Environment Agency, 2010
Babisch W, Beule B, Schust M, Kersten N, Ising H: Traffic noise and risk of myocardial infarction (NaRoMI). Epidemiology 2005; 16: 33–40.
Eriksson C, Rosenlund M, Pershagen G, Hilding A, Ostenson C-G, Bluhm G: Aircraft noise and incidence of hypertension. Epidemiology 2007; 18: 716–72.
Gangwisch JE, et al.: Short Sleep Duration as a Risk Factor for Hypertension; Hypertension 2006: 47.
Graff C, Bockmühl F, Tietze V: (Lärmbelastung und arterielle (essentielle) Hypertoniekrankheit beim Menschen. In: Nitschkoff, S; Kriwizkaja, G.: Lärmbelastung, akustischer Reiz und neurovegetative Störungen. 1968.
Greiser: Risikofaktor nächtlicher Fluglärm. Abschlussbericht über eine Fall-Kontroll- Studie zu kardiovaskulären und psychischen Erkrankungen im Umfeld des Flughafens Köln-Bonn. Schriftenreihe Umwelt & Gesundheit 01/2010, Umweltbundesamt 2010.

Greiser E, Janhsen K, Greiser C: Beeinträchtigung durch Fluglärm: Arzneimittelverbrauch als Indikator für gesundheitliche Beeinträchtigungen. Förderkennzeichen 205 51 100, Umweltbundesamt 2006.
Huss A, Spoerri A, Egger M, Röösli M: Aircraft Noise, Air Pollution, and Mortality From Myocardial Infarction. Epidemiology 2010; 21(6): 829–83.
Jarup L, Babisch W, Houthuijs D, Pershagen G, Katsouyanni K, Cadum E, Dudley M-L, Savigny P, Seiffert I, Swart W, Breugelmans O, Bluhm G, Selander J, Haralabidis A, Dimakopoulou K, Sourtzi P, Velonakis M, Vigna-Taglianti F: Hypertension and Exposure to Noise near Airports – the HYENA study. Environmental Health Perspectives 2008, Vol. 116, Nr. 3: 329–33.
Kaltenbach M, Maschke C, Klinke R: Gesundheitliche Auswirkungen von Fluglärm. Dtsch Arztebl 105(31–32), 548–56.
LuftVG (2007): Luftverkehrsgesetz. BGBl. I S.698 (zuletzt geändert durch Artikel 1 des Gesetzes vom 24. August 2009, BGBl. I S. 2942).
Öhrström E, Barregård L: Undersökning av hälsoeffekter av buller fran vägtrafik, tag och flyg i Lerums kommun (Untersuchung von Gesundheitsbeeinträchtigungen hervorgerufen durch Straßenverkehrs-, Zugund Fluglärm in der Gemeinde Lerum). Technical Report, Västra Götalandsregionens Miljömedicinska Centrum & Sahlgrenska akademin. Gothenburg, Sweden 2005
Sørensen Mette, Martin Hvidberg2, Zorana J. Andersen, Rikke B. Nordsborg,Kenneth G. Lillelund , Jørgen Jakobsen, Anne Tjønneland, Kim Overvad, Ole Raaschou-Nielsen : Road traffic noise and stroke: a prospective cohort study. European Heart / Journal Advance Access published January 25, 2011
Stansfeld SA, Berglund B, Clark C, Lopez-Barrio I, Fischer P, Ohrström E, Haines MM, Head J, Hygge S, van Kamp I, Berry BF: Aircraft and road traffic noise and childrens cognition and health: a cross-national study. Lancet 2005; VOL: 365 (9475); p. 1942–9.
Umweltbundesamt 2010: Umweltbundesamt (2009): Night Noise Guidelines als offizielles WHO-Dokument veröffentlicht. Telegramm: Umwelt & Gesundheit, Ausgabe 06/2009.
WHO (1999): Guidelines for Community Noise (edited by Berglund B, Lindvall T, Schwela DH). World Health Organization, Genf
WHO: Night Noise Guidlines for Europe. World Health Organisation Regional office for Europa, Kopenhagen 2009. Aircraft noise and cardiovascular disease near Heathrow airport in London: small area study BMJ 2013;347:f5432

Annex IV – Detailed review of the monetization of adverse impact (Provided by UECNA)

In 2006, the Heatco project : "Developing Harmonised European Approaches for Transport Costing and Project Assessment"[vi] analysed and proposed a set of guidelines for project assessment and transport costing at the EU level and one of the areas covered was "Costs from health impacts and costs of other nuisances due to pollutants and noise". The aim of the study was the various means of transportation and not specifically air transport but its recommendation can be applied to air transport.

(i) Economic analysis of noise pollution



Babisch W,The noise/stress concept, risk assessment and research needs, Noise Health 2002

Heatco Project([vii])

In respect of noise pollution, the Heatco project had proposed the following procedure to calculate the impact of a new infrastructure or of the extension of an existing infrastructure:

"Step 1: quantification of the number of persons exposed to certain noise levels (should be available from noise calculations) for the Do-Minimum case and the DoSomething case.

Step 2: preparation of the cost factor table by increasing the cost factor according to the assumed country-specific GDP per capita growth for each year of the analysis.

Step 3: calculation of impacts (multiply percentage of highly annoyed persons by number of persons exposed) and costs (multiply cost per person by number of persons exposed) for both cases.
Step 4: subtraction of total costs for the Do-Something case from Do-Minimum case
Step 5: reporting of costs and impacts (change in number of people highly annoyed).”

WHO for the European Commission
In 2011 and 2012, WHO and the European Commission published together a study : *Burden of disease from environmental noise : Quantification of healthy life years lost in Europe*[viii]. The publication concludes that :
“*There is sufficient evidence from large-scale epidemiological studies linking the population's exposure to environmental noise with adverse health effects. Therefore, environmental* ***noise should be considered not only as a cause of nuisance but also a concern for public health and environmental health****.”*
In the 2012 *Methodological guidance for estimating the burden of disease from environmental noise*[ix] WHO and the European Commission confirm the necessity to base the valuation on the Disability Adjusted Life Years (DALY).
The estimate (for 2011) of the Disability Adjusted Life Years (DALY) lost from environmental noise in western Europe only were:

- 61,000 years for ischaemic heart disease,
- 45,000 years for cognitive impairment of children,
- 903,000 years for sleep disturbance,
- 22,000 years for tinnitus and
- 587,000 for annoyance.

UK - DEFRA
In 2014, the UK Department for Environment, Food & Rural Affairs (DEFRA) published *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet*[x]. Since 2008, DEFRA had organised a working group to develop a cost-benefit analysis of policies and health was already a priority[xi]. Monetisation of noise impacts was originally based on the “willingness to pay - willingness to receive” method which was applied for road noise. A specific analysis relating to aviation noise was made in 2013[xii].
In the November 2014 report, the main recommendations are:

- The impacts of noise on sleep disturbance should be monetised and reflected in appraisal where it is proportionate to do so. The methodology is based on both the expected number of people who report being sleep disturbed and the value of this impact.
- It recommends the use of Disability-Adjusted Life Years (DALYs) to reflect the value of impacts on public annoyance from environmental noise. This approach allows annoyance and other effects such as sleep disturbance to be valued through a consistent approach.
- Where a decision is expected to alter the level of environmental noise, the impacts on hypertension—and consequently on dementia and stroke—should be quantified and valued where proportionate to do so.

(ii) Economic analysis of air pollution

Cohort studies around Los-Angeles – ultrafine particulates pollution at Los-Angeles airport (LAX)[xiii] - and Denmark – evidence of the contribution of NOx on health condition (road traffic)[xiv] - have evidence the adverse impact of air pollution on the population.

The Aphekom[xv] project has also evidenced the direct impact of emissions on health. Premature deaths, coronary heart disease, asthma, are only a few examples of the adverse effect of pollution on the population[xvi], not mentioning the loss of quality of life and suffering of the people.

To our knowledge there is one report on the monetisation of the adverse effects of the emission of toxic pollutants in the air specific to air transport, in Switzerland. However, there are several studies on the economic cost of air pollution. Quantifying the contribution of air transport to the global pollution will enable to deduct the economic cost of the pollution attributable to air transport.

Heatco project

The Heatco project mentioned above recommended the following procedure to assess the cost of the impact or air pollution due to a new infrastructure of the extension of an existing infrastructure:

"Step 1: quantification of change in pollutant emissions (NOx, SO2, NMVOC, PM2.5/PM10) due to a project, measured in tonnes, using state-of-the-art national or European emission factors.

Step 2: classification of emissions according to height of emission sources (ground-level vs. high stack) and local environment (urban – outside built-up areas). Ground level emissions are released from internal combustion engines, high stack emissions are released during electricity production in power plants.

Step 3: preparation of the cost factor table by increasing the cost factor according to the assumed country-specific GDP per capita growth for each year of the analysis.

Step 4: calculation of impacts (multiplication of pollutant emissions by impact factor) and costs (multiplication of pollutant emissions by cost factor).

Step 5: reporting of impacts and costs."

Switzerland - Office fédéral du développement territorial

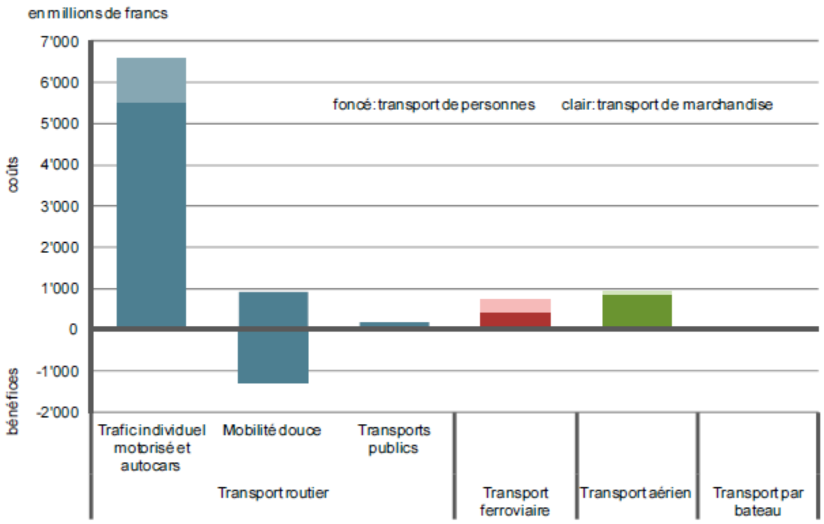
The Swiss study published in 2014 but analysing figures for the year 2010, was made by the Office fédéral du développement territorial (ARE)[xvii xviii] and aimed at calculating the exernal cost of the adverse environmental effects for the community not already paid for by the user of the transport. The calculation of the costs takes into account:

Type of cost	Calculation method
Health cost due to air pollution	Medical treatment, loss of productivity, replacement costs, shorter life expectancy and induced diseases
Damages to buildings due to air pollution	Renovation works, cleaning works
Loss of cultures due to pollution	Reduction of agricultural yield due to ozone pollution

Type of cost	Calculation method
Damages to forests due to air pollution	Reduction of forestry yield due to ozone pollution, acidification of the soils,
Biodiversity loss due to air pollution	Cost of the restoration of ecosystems
Noise	Loss of rental income, health costs (same as for emission)
Climate	Cost of preventive measures to reach international climate objectives on the long term
Nature and landscape	Replacement costs of naturel habitats, of ecosystems, etc.
Damages to the soil due to toxic substances	Costs of depolluting
Accidents	Medical treatments, productivity loss, replacement costs, administrative costs, police and judicial costs, etc.

The cost benefit analysis for 2010, by type of transport is presented in the following table: **SOURCE?**

Figure R–2: Vue d'ensemble des effets externes en 2010 selon l'approche « mode de transport »
Pour le transport routier/ferroviaire: principe de territorialité*, pour le transport aérien/bateau: principe de la moitié du trajet**



* Principe de territorialité : trafic à l'intérieur des frontières de la Suisse
** Principe de la moitié du trajet: trafic à l'intérieur des frontières de la Suisse ou la moitié de la distance en avion/ en bateau de la Suisse vers une destination étrangère et vice-versa (cf. chapitre 2.3.2)

Aphekom project
Aphekom, a pan European project[xix] adopts a different approach from other studies as the authors propose to assess the value of the gain from a better environment rather than the cost of the pollution.

The components of the assessment include[xx]:

- "Direct costs:
  - **Direct medical costs** cover medical resources consumed, like consultations (specialists, general and hospital practitioners), drugs, in-patient and out-patient hospitalizations, emergency room stays and cost of rehabilitation.
  - **Direct non-medical costs** cover nonmedical resources consumed in direct connection with the health outcome: i.e., cost of social support (like home help), transportation, major home modifications.
- Indirect costs:
  They cover different types of resources lost: Loss of productive work by patient (either due to time off work or a poorer access to employment due to poorer health), Loss of productive work by patient's family and friends (e.g. mother taking time off work), Loss of productive work due to patient's early retirement or premature death.
- Intangible costs:
  They apply not only to the patient but also to his/her friends and family: grief, fear, pain, unhappiness, loss of well-being and loss of quality of life."

---

[i] http://www.aef.org.uk/uploads/Berry-B.-Sanchez-D.-monetisation-of-noise-effects.pdf International Congress on Noise as a Public Health Problem, Nara Japan - 2014

[ii] B F Berry and I H Flindell, 2009, Estimating Exposure-Response Relationships between Noise Exposure and Human Health Impacts in the UK, BEL Technical Report 2009-2 Full Report

[iii] B F Berry and I H Flindell, 2009, Estimating Exposure-Response Relationships between Noise Exposure and Human Health Impacts in the UK, BEL Technical Report 2009-2 Full Report

[iv] Summary Table provided by Bernard Berry.

[v] Includes ischaemic heart disease (IHD), acute myocardial infarction (AMI) and hypertension

[vi] http://heatco.ier.uni-stuttgart.de/background.html

[vii] HEATCO, Developing Harmonised European Approaches for Transport Costing and Project Assessment, Deliverable 5 Proposal for Harmonised Guidelines , 2006, http://heatco.ier.uni-stuttgart.de/HEATCO_D5_summary.pdf

[viii] http://www.who.int/quantifying_ehimpacts/publications/e94888.pdf?ua=1

[ix] Tomas Hellmuth, Thomas Classen, Rokho Kim and Stylianos Kephalopoulos, 2012, *Methodological guidance for estimating the burden of disease from environmental noise*, http://www.euro.who.int/__data/assets/pdf_file/0008/179117/Methodological-guidance-for-estimating-the-burden-of-disease-from-environmental-noise-ver-2.pdf?ua=1

[x] Department for Environment, Food & Rural Affairs, *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet*, November 2014, a report by the Interdepartmental Group on Costs and Benefits Noise Subject Group, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/380852/environmental-noise-valuing-imapcts-PB14227.pdf

[xi] *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 August 2008 http://webarchive.nationalarchives.gov.uk/20130402151656/http://archive.defra.gov.uk/environment/quality/noise/igcb/documents/igcb-first-report.pdf

[xii] 2013, Airports commission, *Discussion paper 05 : Aviation noise*, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223764/airports-commission-noise.pdf

[xiii] 2011- Yifang Zhu, Elinor Fanning, Rong Chun Yu, Qunfang Zhang, John R. Froines, *Aircraft emissions and local air quality impacts from takeoff activities at a large International Airport,* http://www.sciencedirect.com/science/article/pii/S1352231011008995

[xiv] 2011 - Ole Raaschou-Nielsen, Zorana J Andersen, Martin Hvidberg, Steen S Jensen, Matthias Ketzel, Mette Sørensen, Johnni Hansen, Steffen Loft, Kim Overvad and Anne Tjønneland, *Air pollution from traffic*

and cancer incidence: a Danish cohort study, http://www.biomedcentral.com/content/pdf/1476-069X-10-67.pdf

[xv] http://www.aphekom.org/web/aphekom.org/home

[xvi] Mathilde Pascal, Sylvia Medina on behalf of the Aphekom network, 14/06/2012, *Main results of the Aphekom project - Closing the gap between science and action*, http://www.aphekom.org/c/document_library/get_file?uuid=54c0a465-229e-4017-ab67-1b20c3bfc2e2&groupId=10347

[xvii] 2014 - Christina Hürzeler ARE, Office fédéral du développement territorial (ARE), Coûts et bénéfices externes des transports en Suisse : Transports par la route et le rail, par avion et par bateau en 2010 et évolution depuis 2005, http://www.are.admin.ch/themen/verkehr/00252/00472/index.html?lang=fr

[xviii] 2014 - Ecoplan / Infras, *Externe Effekte des Verkehrs 2010 : Monetarisierung von Umwelt-, Unfall- und Gesundheitseffekten*, http://www.are.admin.ch/themen/verkehr/00252/00472/index.html?lang=fr

[xix] http://www.aphekom.org/web/aphekom.org/home

[xx] May 2011, Olivier Chanel, Assessment of the economic benefits of a reduction in urban air pollution