

Institution: Manchester Metropolitan University		
Unit of Assessment: B7 Earth Systems and Environmental Sciences		
Title of case study: Making airports more sustainable: lowering carbon emissions and tackling noise		
Period when the underpinning research was undertaken: 2000 - 2019		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Ken Hume	Principal Lecturer	1984 - 2012
David Raper	Lecturer to Professor	1992 - present
Paul Hooper	Lecturer to Professor	1994 - present
Delia Dimitriou	Senior Research Fellow	1999 - present
Callum Thomas	Professor	2000 - 2019
Christopher Paling	Research Associate, Lecturer, Senior Lecturer	2012 - present
Rachel Dunk	Lecturer to Principal Lecturer	2013 - present
Period when the claimed impact occurred: 1 August 2013 – 31 December 2020		
Is this case study continued from a case study submitted in 2014? No		
<p>1. Summary of the impact</p> <p>Research at Manchester Metropolitan University has provided airport operators worldwide with evidence-based methods to address two barriers to sustainability: aircraft noise and airport carbon emissions. Research on the use of new, alternative noise metrics and community engagement informs noise management practice at UK airports, including Stansted and Heathrow, Europe's most noise-affected airport. Heathrow uses our advocated supplementary noise metrics in noise reports communicated to over 1,000,000 nearby residents; these metrics also underpin proposed noise mitigation strategies for 22,000,000 people, potentially affected by flight paths following Heathrow's future runway expansion. Research on airport carbon emissions directed the design of the global Airport Council International (ACI) Airport Carbon Accreditation (ACA) programme, which today boasts 312 airports accounting for nearly half of global air passengers. Our research directly underpins the ACA Level 3 requirement that airport operators engage to reduce emissions outside their control or ownership (Scope 3 emissions). Today, 121 airports worldwide have this status, meaning that they work with stakeholders to reduce emissions across their value chain, including those from aircraft and surface access.</p>		
<p>2. Underpinning research</p> <p>Over the past 25 years, airports have faced two important barriers to their sustainability, namely, aircraft noise and carbon emissions. Research at Manchester Metropolitan has investigated the nature and complexity of these concerns, using findings to shape evidence-based industry best practice and sustainability schemes.</p> <p>Alternative noise metrics: improving airport-community relations and dialogue</p> <p>Despite significant reductions in aircraft noise achieved through technological advances over many decades, noise continues to be a major concern to local communities around airports. Ken Hume led our research on operational noise around airports, beginning with studies on objective and self-reported sleep disturbance. He quickly recognised that annoyance and sleep disturbance were inter-related and thus the research expanded into social surveys exploring self-reported disturbance and noise complaints, where the significance of non-acoustic factors in the human response to aircraft noise emerged [1]. These exacerbating non-acoustic factors helped to explain the acute resistance to airport expansion at many airport locations, which we highlighted in a research report for EUROCONTROL on airport environmental capacity. Our survey-based analysis found that the majority of airports were experiencing environmental constraints that demanded proactive management, particularly around aircraft noise [2].</p> <p>The excellence and influence of aviation-environment research at Manchester Metropolitan was recognised in 2006 with a competitive HEIF award of GBP5,000,000 for Project OMEGA. Led by Manchester Metropolitan, OMEGA involved collaboration with other UK universities, industry, regulators and policy-makers to support the sustainable development of UK aviation.</p> <p>One project, supported by OMEGA, entitled 'Indices to Enhance Understanding and Management of Community Responses to Aircraft Noise' was the first systematic evaluation of airport noise metrics. The Manchester Metropolitan researchers found that residents preferred</p>		

metrics that disaggregated key elements of aircraft noise, namely, timing, frequency of events and individual sound levels. The project and supplementary work, sponsored by Heathrow Airport, showed that local residents were interested in site-specific information that is easy to interpret in relation to their own personal exposure [3].

Over the following decade, our community-centric research methods revealed the complex relationship between noise exposure and the human response. For example, using coding methodologies to analyse in-depth interviews regarding stakeholder engagement during airport master planning, the researchers revealed that stakeholder participation was largely tokenistic. Consultation often used closed questions, and stakeholders rarely received feedback [4].

In summary, this body of research has highlighted general dissatisfaction, and even mistrust, among members of the public with communication based on conventional (mandatory) noise metrics. Findings reveal the importance of developing a 'common language' in which aircraft noise issues can be made comprehensible to local communities and, thus, underpin meaningful engagement over how better to manage, and mitigate against, noise and non-acoustic factors.

Airport carbon emissions reporting and management

Early attempts by airport operators to capture their full contribution to climate change – considering all emissions from the entire airport system – were poorly defined or considered in emissions reduction plans. Manchester Metropolitan has worked closely with airport operators to develop insights and methods for more effective reporting and carbon management planning.

Research on carbon emissions reporting began in the early-2000s. Initially focused on airlines, Hooper discovered a lack of consistency in emissions reporting that prevented stakeholders from making informed assessments or comparisons of company environmental performance [5]. It became clear this applied as much to airports as aircraft operators.

Recognising the need for comprehensive reporting of environmental impacts. Hooper and Thomas made the first attempt to apply an emerging 'eco footprint' tool to airports, using Manchester Airport as a case study. This study provided the basis of later research conducted on behalf of spin-out airport carbon management consultancy, Airport Footprints Ltd, for the European Investment Bank. The study defined an 'airport system' for emissions reporting, and involved comprehensive quantification of carbon emissions arising from surface access, aircraft, utilities, supply chain and waste (so-called 'Scope 3' emissions). The study revealed that by focusing only on emissions within their control or ownership (Scopes 1 and 2 emissions, and not Scope 3), airport operators were likely to report just 5%-10% of emissions [6].

Since 2010, research on airport system emissions has continued largely through commercial contracts with airports to inform carbon reporting and management, but ten years on, Paling and Dunk have re-examined Scope 3 emissions reporting, with support from ACI. They conclude that airport operators still do not report all emissions arising from their activities, with poor alignment with widely-used global reporting standards. By not reporting these significant emissions, understanding the full contribution of airports to climate change is incomplete, as are carbon management plans. This work has informed the new Level 4/4+ of ACI's ACA (see Section 4). Publication of this research has been delayed by COVID-19 but will shortly be submitted to the Journal of Cleaner Production.

3. References to the research

1. Hume K, Gregg M, Thomas C, Terranova D. (2003). Complaints caused by aircraft operations: an assessment of annoyance by noise level and time of the day. *J. Air Transp. Manag.* 9(3):153-160. DOI: 10.1016/S0969-6997(02)00079-0.
2. Upham P, Raper D, Thomas C, McLellan M, Lever M, Lieuwen A. (2004). Environmental Capacity and European Air Transport: Stakeholder opinion and implications for modelling. *J. Air Transp. Manag.* 10(3):199-205. DOI: 10.1016/j.jairtraman.2003.10.016.
3. Hooper PD, Flindell I. (2013). Exchanging aircraft noise information with local communities around airports: 'the devil is in the detail!'. *INTERNOISE 2013, Proceedings Vol. 2 (SS13)*, pp1047-1054. Innsbruck, 16-18 September 2013. *Invited paper*: <https://www.ingentaconnect.com/content/ince/incep/2013/00000247/00000002/art00098>.
4. Rawson R, Hooper PD. (2012). The importance of stakeholder engagement to sustainable airport master planning in the UK. *Environmental Development* 2(1):36-47. DOI: 10.1016/j.envdev.2012.03.013.

5. Hooper PD, Greenall A. (2005). Exploring the potential for environmental performance benchmarking in the airline sector. *Benchmarking* 12(2):151-165. DOI: 10.1108/14635770510593095.
6. RDC Aviation and Airport Footprints Limited. (2009). *Induced GHG Footprint: Methodology for the Assessment of Airport-related Projects: Part I. Report for European Investment Bank.*

Grants and funding

The work outlined above has been supported by external funding totalling nearly GBP7,500,000 since 2000; representing over GBP6,000,000 from competitive awards (EU, EPSRC, DTI/Innovate and HEIF) and over GBP1,000,000 from industry. Examples include:

- Sustainability Indicators for Airport Inter-modal transport Hubs. 1999-2002. EPSRC (Ref: GR/M60200/01). Total award: GBP99,092. PI: Raper
- Opportunities for Meeting the Environmental challenge of Growth in Aviation (OMEGA). 2007-2009. Competitive Department for Trade and Industry funding delivered through HEIF. Total award: GBP5,000,000. PI: Raper.
- Investigation of alternative aircraft noise communication metrics. 2010-11. BAA Heathrow. Total value: GBP48,000. PI: Hooper
- Aviation Noise Impact Management through novel Approaches (ANIMA). 2017-21. European Commission, Horizon 2020 (Grant ID: 769627). Total award: EUR7,479,618 (10-2017). Award to Manchester Metropolitan: EUR877,546 (10-2017). Project leads: Dimitriu, Hooper
- The implications of climate change for air transport. 2008-11. Eurocontrol. Total value: GBP166,000. PI: Thomas

Additional indicators of research quality

- Repeat research funding from industry, including: International Air Transport Association (IATA), Dublin Airport Authority, Airports Mauritius Limited, UK Airports Commission (via Jacobs Engineering Group), Airports International Group (AIG), Manchester Airports Group, and Airports Council International (ACI) to inform carbon management practices.
- Invited membership to advisory boards: ACI Airport Carbon Accreditation Advisory Board (Thomas, 2010-18; Paling 2018-present); Chair of the Advisory Board to UK Sustainable Aviation (Paling, 2019-present); XNoise – EU Coordination Actions (Dimitriu, 2000-15); Advisor to UK Airports Commission (Thomas, 2014-5); Advisor to the International Transport Forum of the OECD (Thomas, 2016-7); Expert Advisor to UK Independent Commission on Civil Aviation Noise (Hooper 2020-present).
- Manchester Metropolitan (Raper) was also a founding member of the ECATS Network of Excellence and subsequent ECATS International Association, which brings together leading national research institutions and universities in the field of sustainable aviation.

4. Details of the impact

The research findings have been transferred through two key routes. First, a substantial volume of research has been conducted with – and funded by – airport industry partners, especially Heathrow and Manchester Airports Group. Second, through appointments to advisory panels and committees at national and international levels (see Section 3), the researchers have had unprecedented opportunities to share findings and drive the adoption of evidence-based practice relating to aircraft noise, community engagement and carbon management.

Improving airport-community dialogue and collaboration around aircraft noise

The research on noise, metrics and community engagement was developed, in part, through applied research conducted at Heathrow Airport (e.g. reference [3]). Heathrow is Europe's most noise-affected airport and one of the UK's three airports regulated for noise and night flights. As such, it plays a *de facto* role in developing, disseminating and guiding evidence-based best practice around noise management.

Commenting on the OMEGA-funded research, Heathrow's Head of Noise Strategy (formerly Head of Noise across BAA UK airports) says: *"I recognised that this research directly addressed problems we were encountering in our attempts to communicate complex noise matters to local communities as part of our efforts to engage them in dialogue on noise management"* [A].

Drawing on this project, and recommendations from supplementary commissioned research (see Sections 2-3), Heathrow changed its methods for both noise reporting and how it conducts meaningful dialogue with local communities [A]. Today it goes "beyond compliance" in its noise reporting, for example, providing data on aircraft heights and numbers of flights. xPlane and the WebTrak system, for example, are tools that enable local residents to visualise and access data

on flights, flight paths and noise levels [B]. Heathrow's Community Noise Reports for the 21 most noise-affected communities (over 1,000,000 affected residents) also go beyond minimum reporting requirements, for example, extending to 51db L_{eq} (rather than conventional 57db) with disaggregated noise metrics focusing on the loudness, number and timing of individual events and operational data, such as radar flight track charts and event histograms [A,B]. The Chair of the Heathrow Association for the Control of Aircraft Noise (HACAN) lobby group states that the 51db L_{eq} contour *"is a much more accurate reflection of the reality on the ground and goes beyond that required by regulation in terms of noise reporting"* [C]. Heathrow's Airspace and Noise Performance Annual Report 2018 also includes supplementary noise metrics, and highlights the airport's commitment to community engagement in its 'Noise Action Plan' stating that: *"Our noise management framework has a structure similar to the ICAO Balanced Approach with a fifth pillar on community engagement"* [B].

Heathrow's Head of Noise Strategy summarises thus: *"I am not aware of any other airport that publishes as wide a range of community noise reports including such supplementary information. LHR has led the way in publishing and utilising a wider range of metrics to enhance transparency and is often cited by other airports and community groups as best practice"* [A].

Heathrow's sector-leading practice is recognised by HACAN, which has several thousand members and is the 'go to' group for Heathrow community dialogue [C]. HACAN's Chair describes a *"huge shift in Heathrow's engagement and communication with its local communities. It has listened to many of the residents' key concerns and indeed has encouraged them to shape future policies... There is no doubt, in my view, that MMU research has influenced Heathrow. In its attitude towards, and work with, local communities Heathrow is a changed organisation from the one I started dealing with 20 years ago"* [C]. Concrete examples of strong collaborative working around noise management include two joint Heathrow-HACAN submissions to recent DfT policy consultations, one on the need for an independent noise oversight body (the Independent Commission for Civil Aviation Noise (ICCAN) was established in 2019; Hooper is an expert advisor), and the second relating to airspace change [A,C]

Both Heathrow and HACAN confirm that the Manchester Metropolitan research informed the Heathrow Working Group on Respite from Aircraft Noise (Hooper participated, Thomas is on the steering group) [A,C]. Findings allowed the airport to develop a rigorous approach to offer systematic noise relief to over 22,000,000 people living within the proposed expanded airport's noise envelope. The airport is unique in its commitment to provide respite to communities when future airspace changes are implemented, irrespective of any final decision on Runway 3 [A,C].

Other airports are beginning to follow Heathrow's lead. Work by Hooper in 2014 directly informed Stansted Airport's response to airspace modernisation currently underway, the outcome of which will impact on approximately 250,000 residents within 20km of the airport. Specifically, the airport changed how it reports noise exposure, extending L_{eq} noise contours to below conventional thresholds and including "number-above 70dB" (N70) supplementary metric in their publications [D]. These changes were made prior to the ICCAN review of aviation noise metrics, which cites a key output from the ANIMA project (see Section 3) co-authored by Hooper, that recommends airports now publish both L_{eq} and N-type indicators as standard [D].

Finally, the significance of Heathrow's leadership in noise management is evident from its collaboration with ACI Europe's Noise Task Force in 2015-2017 to define a noise research roadmap that draws directly on Manchester Metropolitan's work. It emphasises the importance of building effective community relationships to underpin efforts to address non-acoustic factors and enhance the value of airport interventions to mitigate noise and improve quality of life [A].

Creation of the Airport Carbon Accreditation scheme drives emissions reductions

Through the Airport Carbon Accreditation (ACA) pilot work with Manchester Airport and Thomas' appointment to the ACA Advisory Board, evidence from the airport system carbon footprinting research (references [6]) directly shaped ACA's accounting principles and methods, specifically the inclusion of Scope 3 emissions within the scheme. Consequently, all airports accredited at Levels 3/3+ and 4/4+ calculate and report Scope 3 emissions [E,F].

ACA is the only independent and widely-recognised global carbon management standard for airports and is commended by the United Nations Framework Convention on Climate Change (UNFCCC) [E]. As of July 2020, there were 312 ACA-accredited airports worldwide, representing more than 3,700,000,000 air passengers (nearly half of the global total), which indicates the significant reach of the scheme. Collectively, these airports reduced emissions

within their control or ownership by 322,297tCO₂ in 2019 compared to 2018 (4.9% annual reduction). Cumulative CO₂ reductions since July 2013 are 1,419,387tCO₂ (equivalent to planting and growing 23,000,000 tree seedlings for ten years) [G]. Notably, 121 airports have been accredited to Level 3/3+ (required to engage with stakeholders around Scope 3 emissions) [E]. Since the launch of Level 4/4+ in November 2020 (see Section 2), three airports have been accredited; their required Stakeholder Partnership Plans outline absolute reductions in Scope 3 emissions [E,F].

Manchester Metropolitan's research continues to underpin ACI leadership in airport carbon management. In 2019, ACI adopted a Resolution that first called on its member airports to commit to net zero carbon emissions (Scope 1 and Scope 2) by 2050. It also called on the whole aviation sector to chart a pathway towards net zero. ACI's Director General confirms the contribution of Manchester Metropolitan's research to this policy position: Thomas drafted two Board papers that underpinned the Resolution; Paling is now guiding airport operators to embed stakeholder engagement (e.g. with aircraft operators) into their net zero roadmaps [E].

Advancing skills and capacity for carbon management in less developed regions

Based on the underpinning research, ACI Global Training awarded its training contract for environmental and carbon management to Manchester Metropolitan in 2010 and has since renewed it every three years. The training focuses on regions where environmental management is least developed. It covers carbon management best practice and highlights the benefits of including Scope 3 emissions for environmental risk reduction. Since August 2013, 13 in-house courses reached 227 staff from 44 global airport operators, with excellent feedback [H].

In 2008, Thomas and Hooper established Airport Footprints Ltd (AFL) with former PhD student, Marcus Sutcliffe, as the world's only dedicated airport carbon management consultancy. AFL supports nine world airports (including Dublin, Abu Dhabi, Queen Alia, Antalya, Adelaide and Tallin) to introduce effective carbon management, including engaging with Scope 3 emissions. AFL has supported 334,000tCO₂e reductions (Scopes 1+2) since 2013, including 125,396tCO₂e reduction in Scope 3 emissions for airports in the Asia-Pacific region. [I]

Queen Alia International Airport (Jordan) is one example of the significant impact of this training and AFL consultancy. A representative of the airport received training in 2012 and then approached AFL to develop a carbon management programme. The airport was hence the first in the Middle East to attain Level 3+ Accreditation in 2018 and has since achieved carbon savings of over 106,000tCO₂e. ACI acknowledged the airport's excellence in carbon management in the ACA Annual Report 2017/18 – the only non-European airport to receive such an accolade. Since 2015 the airport has achieved energy cost savings of USD3,000,000 (10-2020) whilst growing infrastructure by 40%. This success effectively sets the benchmark in the region for carbon management; AFL is supporting Level 4+ Accreditation [I].

5. Sources to corroborate the impact

- A. Statement from Head of Noise, Heathrow Airport Ltd, *provides evidence on how the airport uses alternative noise metrics and its methods for engaging with residents.*
- B. Heathrow Airport webpage *describes the xPlane and WebTrak tools for mapping plane movements, flightpaths and noise.* Heathrow's Airspace and Noise Performance Annual Report 2018 (latest available) and East Molesey Community Noise Report 2018 *embed supplementary metrics and mention the airport's commitment to community engagement.*
- C. Statement from Chair of HACAN *describes improvements in Heathrow's noise communication and community engagement including joint submissions to consultations.*
- D. Group CSR and Future Airspace Director, Manchester Airports Group, *describes use of alternative noise metrics on airspace modernisation flightpath and respite decisions.*
- E. Director General, ACI Europe *describes the influence of the underpinning research on the design of ACA Level 3/3+ and Level 4/4+ and updates to scope 3 definitions.*
- F. Airport Carbon Accreditation Application Manual (Issue 12) *shows the requirements for Scope 3 emissions reporting and a Stakeholder Partnership Plan at Level 4/4+.*
- G. Counting the CO₂ Reduction (Airport Carbon Accreditation webpage) *provides details of direct carbon reductions, 2013-2020.*
- H. Senior Manager, Global Training, ACI World *provides evidence on the global reach of Manchester Metropolitan carbon management and footprinting training.*
- I. Managing Director, Airport Footprints Ltd *outlines significant impacts for airport clients.*