

University of Southampton response to the Environmental Audit Committee call for evidence – Air Pollution in England

Context of Submission

The University of Southampton is a research-intensive Russell Group University with research strengths and an interdisciplinary approach to better understanding air pollution. In 2024 we established [Clean Air South](#) – a partnership with Wessex Health Partners to connect academics, local government, health professionals, and local businesses to build a collective understanding of the local air quality challenges and build foundations for collaborative research. In 2026 we will be launching the [Centre for Green Maritime Innovation](#) as a national facility driving technology to cut maritime emissions.

Our researchers are working on understanding:

- The composition of air pollution and how this relates to effects on health using a range of techniques, including studies at the cellular level and use of hospital admissions data
- How far pollution sources spread and who is most exposed
- Spatial distribution of air pollution, using experimental fluid dynamics
- Human behavioural psychology and interventions to reduce air pollution exposure and disease symptoms
- Methods of public engagement awareness raising regarding air pollution
- Cleaner, more efficient maritime operations, including decarbonisation

The following responses have been provided by:

Dr Nat Easton, Research Fellow in Air Pollution, N.H.C.Easton@soton.ac.uk

Prof Matt Loxham, Professor of Respiratory Biology and Toxicology, M.Loxham@soton.ac.uk

Prof Ian Williams, Professor of Applied Environmental Science, I.D.Williams@soton.ac.uk

Prof Dominic Hudson, Shell Professor of Ship Safety and Efficiency, dominic@soton.ac.uk

Dr Thomas Daniels, Consultant Respiratory Physician, Thomas.Daniels@uhs.nhs.uk

Dr James Parkin, Research Fellow, J.Parkin@soton.ac.uk

Prof Christina Vanderwel, Professor of Experimental Fluid Dynamics,
C.M.Vanderwel@soton.ac.uk

Dr Ben Ainsworth, Associate Professor of Psychology, ben.ainsworth@soton.ac.uk

1. What are the main causes and sources of air pollution?

Over time, sources of air pollution change – in recent years the UK has made very positive reductions in road vehicle exhaust emissions of both particulate matter (PM) and gases (including NO₂). However, alongside this we have seen a resurgence in emissions from domestic solid fuel burning (including wood), and an increase in road traffic volume and average vehicle weight.

In terms of overall national contributions, the main sources of outdoor air pollution of concern are domestic solid fuel burning (<https://doi.org/10.1016/j.envint.2025.109537>), non-exhaust road vehicle emissions (i.e. tyres, brakes, roadwear, and resuspension of road dust), and ammonia emissions, which have the ability to form new particles (known as secondary PM) by reacting with other pollutants. These are well-documented within published reports by Defra and its advisory expert group AQEG.

(<https://www.gov.uk/government/statistics/emissions-of-air-pollutants>;
<https://uk-air.defra.gov.uk/research/aqeg/>).

The indoor environment represents a key air pollution challenge, with limited monitoring, targets or legislation. Indoor emission sources are highly variable, and heavily influenced by individual behaviours.

Importantly, *local* pollution sources can also be highly variable. For compliance we measure air pollution using mass concentrations – i.e. the weight of a pollutant in a defined volume of air. For some pollutants like NO₂, ozone, and SO₂, the pollutant is identical irrespective of where you are, and so, mass concentrations in different locations can be directly compared.

For PM, the composition and size of PM is dependent on the sources involved in its generation. Typically, combustion generates more smaller particles, richer in reactive metals and soot (known as black carbon). Smaller particles (i.e. PM_{2.5}) are considered more harmful as they can reach deeper into the lungs, and are more reactive owing to their size and composition.

As such, identical PM_{2.5} masses can have very different chemical and health-impacting properties depending on source, which contrasts with current regulations, which regard all PM₁₀ and all PM_{2.5} as equally harmful.

Recommendation: Combine current and evolving mass-based targets with source-specific monitoring and controls. We also recommend expansion of monitoring for emerging pollution measures of relevance to health – especially particle number concentration monitoring for ultrafine PM.

2. What evidence exists of the extent of air pollution directly or indirectly impacting the health of individuals or communities in England?

- The Committee on the Medical Effects of Air Pollutants (COMEAP) calculated that 10 µg/m³ increase in PM_{2.5} and NO₂ concentrations increases the risk of death by 8% and 2.3%, respectively (<https://www.gov.uk/government/publications/particulate-air-pollution-quantifying-effects-on-mortality>).
- Subsequent research using these figures calculated that there were between 26,000 and 38,000 premature deaths in England in 2018 associated with PM_{2.5} and NO₂ (<https://www.gov.uk/government/publications/chemical-hazards-and-poisons-report-issue-28>).
- A recent Royal College of Physicians Report adapted published data to determine that in the UK, PM_{2.5} concentrations exceeding the WHO guideline level were associated with 4,410 heart attacks, 9,750 new cases of asthma in children, 3,010 cases of lung cancer, 5,940 cases of stroke, around 39,900 cases of dementia, 18,500 cases of diabetes, and 315,000 days of school absence

(<https://www.rcp.ac.uk/policy-and-campaigns/policy-documents/a-breath-of-fresh-air-responding-to-the-health-challenges-of-modern-air-pollution>; <https://doi.org/10.1016/j.envint.2025.109283>; <https://doi.org/10.1016/j.envint.2024.109164>).

These values are based on “average” PM_{2.5}, neglecting source-specific PM characteristics. Specific sources may contribute substantially to the PM_{2.5} exposure of certain population groups. In Southampton, we have investigated the potential source-specific harm of several key sources.

Shipping Emissions

We have undertaken a series of studies of maritime emissions in Southampton. We first collected and characterised different sizes of real-world airborne PM adjacent to different sources across the Port of Southampton. We saw distinct differences by location, size fraction, and season, in both the composition and, importantly, effects on laboratory models of the lining of the lungs. **This research highlighted clear increased risk of harm of one port source versus other sources, including road traffic. This research is currently in peer review, but we can provide an advance briefing for the Committee on request.**

We also quantified how much different sources were contributing to airborne PM using a long-term PM dataset from the port. For fine PM the greatest contributors were mixed road vehicle exhaust-wood burning combustion signature (55%) and shipping fuel combustion (15%). Preliminary data from follow-on work attempting to experimentally determine the spread of shipping emissions suggests that a zone of at least 3 km downwind of the port is exposed to elevated concentrations of shipping emissions.

<https://eprints.soton.ac.uk/496547/>; <https://doi.org/10.5194/egusphere-egu25-7152>

Non-Exhaust Vehicle Emissions

We compared PM generated by different types of brake pads with particles from diesel exhaust emissions, to understand how harmful they may be to lung health by using laboratory models of human lung lining. **Our findings demonstrated that the toxicity of vehicle-derived PM_{2.5} emissions depends strongly upon the source. Copper-enriched brake-wear particles were notably more potent than those with lower copper content, and notably more potent than diesel particles** (<https://doi.org/10.1186/s12989-024-00617-2>).

Of relevance to this work, the states of Washington and California have restricted copper content in brake pads, to protect aquatic life from the effects of brake dust in surface water runoff.

Underground Railways

PM found in underground railways, may be present at mass concentrations 10 or more times greater than above ground. Underground PM is highly metallic (<https://doi.org/10.1021/es304481m>), however, in the spite of its increased concentration, and our understanding that metals in PM may be an important source of impacts on health, we found little evidence to suggest adverse effects on the population, although the evidence base is somewhat small (<https://doi.org/10.1186/s12989-019-0296-2>).

3. What are the wider environmental impacts of air pollution, and what are their cascading effects?

Air pollutants drive ecosystem acidification, nitrogen deposition, reduced crop yields, biodiversity loss and altered soil and freshwater chemistry. Ammonia and nitrogen oxides are key drivers of eutrophication and biodiversity change in sensitive habitats. Geographically, agricultural ammonia concentrates impact in rural and downwind semi-natural habitats, while urban corridors concentrate NO₂ and traffic-derived PM; current policy and monitoring remain biased toward urban compliance metrics and under-represent rural ecological exposure.

Whilst it is rational to reduce emissions reaching the greatest number of people (i.e. densely-populated urban areas), pollution does not stop at the boundaries between urban and rural areas. Agricultural emissions, including those from northern continental Europe, are substantial contributors to UK air pollution levels (especially in the South and East of England). Domestic wood burning represents a major source of air pollutants that is present in both urban and rural areas – recent work led by researchers at UCL in collaboration with Southampton found that rural homes were more likely to have domestic wood burning, but the greatest concentrations of wood-burning homes are found in densely populated urban areas (<https://doi.org/10.1016/j.envint.2025.109537>).

Ecotoxicological experiments funded by an EU Horizon2020 grant to a consortium including Southampton-based academics revealed that water-based discharges from ship exhaust gas cleaning systems pose substantial risks to key species in marine food webs. Even at extreme dilution levels, such discharges impaired fertility and development of these species (<https://doi.org/10.35614/isbn.9789523361898>). Models highlighted that significant amounts of these effects were due to currently unregulated components of the discharge fluid. The same study predicted substantial increases in discharge volumes in the future, with potential contamination risks extending up to 10-30 km from major shipping lanes, with high risks for near-shore and archipelagic ecosystems due to the proximity of shipping lanes (of which the English Channel is the world's busiest) to sensitive coastal environments. These findings emphasize the need for stricter regulatory measures to mitigate long-term ecological impacts.

Recommendation: Integrate emissions reduction with habitat protection and targeted monitoring to prevent cascading ecological harms.

4. Are the current national targets and performance for air pollution, adequate, ambitious and wide-ranging enough?

In 2024 all locations except one were already in compliance with the 2040 statutory 10 µg/m³ fine PM target (<https://www.gov.uk/government/publications/air-pollution-in-the-uk-2024/air-pollution-in-the-uk-2024-compliance-assessment-summary>). Additionally the UK is out of step with the EU on NO₂ limits, whereby the annual EU limit is 20 µg/m³ ([Directive \(EU\) 2024/2881](#)), whilst the annual UK limit remains 40 µg/m³. Importantly, these are not concentrations without health impacts.

We can look to the ambition of international counterparts whereby several European cities and countries combine ambitious legal limits, rapid transport electrification, promotion of active travel, strict domestic burning bans, and shipping fuel controls to approach WHO 2021 guidelines which set the global health benchmark (PM_{2.5}, 5 µg/m³).

Recommendation: UK should adopt WHO-aligned interim targets and consider alignment with EU on NO₂. We also recommend pro-actively investigating pathways to introduce targets for emerging pollutions of concern such as ultrafine PM and ammonia.

5. Do local authorities in England have the resources and powers to enforce existing legislation and regulation to improve local air quality?

Local authorities have statutory duties under Local Air Quality Management but vary widely in capacity, funding and technical expertise. Many lack resources for comprehensive monitoring, source apportionment and enforcement. Transboundary pollution also represents a challenge – local authorities are responsible for meeting air pollution compliance, even if the pollution source originates from a neighbouring local authority.

Best practice examples (targeted low-emission zones, integrated transport, school streets and housing planning, community engagement) exist but are unevenly scaled. The term “clean air zone” means different things in different places, with some vehicles exempt in one location, but subject to charges in others. Consistent messaging would help make enforcement far more straightforward. Two particular enforcement challenges on existing legislation for local authorities are that of smoke-control areas and idling vehicles.

There are strong examples of regional collaboration, including Clean Air South, which brings together local authorities across the Central South with academics, health professionals and local businesses. Furthermore, within the Clean Air Programme (a £42.5 million UKRI investment into UK air quality research and innovation, centred at the University of Southampton) we produced a [guide on how to develop and support collaboration between universities and local authorities](#) to jointly tackle air pollution.

National funding and clearer delegated powers are required to enable consistent enforcement and rapid local action. The focus on compliance introduces challenges, which can hinder public engagement when the current data suggest we have met compliance, despite there being no known safe lower limit of PM_{2.5}. **Compliance does not represent a safe level of exposure.**

Recommendation: Work with local authorities to understand and identify what works, and what barriers exist. Removal of Defra grants have prevented local air quality initiatives, and we encourage investigation of restoration of these. However, it should be noted that previously less well-resourced local authorities were hampered in their ability to dedicate time and resource to submitting bids and this should be considered.

6. Is data capture and analysis sufficient to provide a detailed and accurate assessment of air quality within England?

The UK operates extensive monitoring networks and in recent years there has been a substantial increase in the number of locations with PM_{2.5} monitoring, which is welcomed.

We wish to highlight remaining monitoring gaps for key health-relevant metrics and source-specific assessments.

- PM_{2.5} coverage remains absent across large areas of the North West, Lincolnshire, East Midlands, Kent, Cornwall, Wales and Scotland. (<https://uk-air.defra.gov.uk/interactive-map?network=aurun>).
- For the very smallest particles, known as ultrafine PM (PM_{0.1}), it is considered that particle number concentration is a more appropriate metric than mass concentration. However the current UK monitoring network only has four active sites in the [Particle Concentrations and Numbers Network](#) despite mounting evidence that ultrafine PM may be especially harmful.
- The need for monitoring of ultrafine PM, alongside other pollutants of emerging concern for human health such as black carbon, ammonia, and PM oxidative potential, as set out by the EU [Directive \(EU\) 2024/2881](#).
- The National Ammonia Network is currently tailored around agricultural emissions. As the plan is to increase the use of ammonia as a shipping fuel, ports risk becoming new sources of ammonia emissions, but currently major ports are absent from the network.
- There is a lack of formal monitoring of indoor air quality, in spite of people spending the great majority of their time indoors.

7. How joined up is government in planning, policies and action towards national targets and fostering communication and data sharing between departments?

Air quality intersects climate, health, transport, housing, agriculture and maritime policy. A formal cross-government delivery board with statutory reporting and ringfenced funding would improve coherence and accountability. We wish to highlight particular cross-departmental challenges for maritime emissions.

Shipping Emissions

Shipping emissions are governed by international regulations established by the International Maritime Organization (IMO) and nationally are affected by decisions from DfT and its executive agency the Maritime and Coastguard Agency. **There is little action local government can take to mitigate these emissions**, despite being mandated to ensure local air pollution is within UK legal limits. This is a major issue for port cities in the UK, whereby there are competing interests in retaining the economic benefits of port operations, but a trade-off in terms of emissions the local population is exposed to.

Decisions are being made by DfT on maritime decarbonisation, and the transition away from Heavy Fuel Oil is welcomed. **However, there needs to be consideration that changing fuel will change the emissions, and the monitoring network needs to reflect this.** Liquefied natural gas (LNG) use as a fuel can reduce some pollutants, and can be (in some cases already is) implemented now. All scenarios in the maritime decarbonisation plan propose increasing the use of ammonia as a shipping fuel. Currently the national ammonia air pollution monitoring network is centred around agricultural emissions. In the future ports risk becoming sources of ammonia emissions if sufficient measures are not taken to prevent release of ammonia directly (ammonia slip).

Shoreside power has the potential to reduce emissions from berthed ships, but national grid power is insufficient, and expenses often prohibitive for operators. Equally, alternative fuels and electric power are only cleaner options if the fuel/power is produced in sustainable/efficient/cleaner processes.

For improving air quality, electrification for short-sea and harbour craft, with ammonia, methanol or hydrogen for longer distance shipping represent viable options. Non-combustion options exist for LNG, ammonia, and hydrogen in fuel cells representing mutual air quality and climate change benefits. **However, if not sufficiently mitigated for, “methane slip” from LNG use, and “ammonia slip” introduce a potential conflict and risks offsetting the CO₂ reduction gained in using these alternative fuels owing to their roles as greenhouse gases themselves.**

8. How well is the Government spreading awareness of the impacts of poor air quality and promoting action being taken to tackle the issue?

Public understanding is improving but remains patchy, as evidenced by the recent [RCP commissioned poll](#); national campaigns and local air quality dashboards may help, yet are frequently designed and developed without consulting communities about their priorities or engaging in co-design or co-development, leading to proposals that are not effectively implemented and subsequently have limited effect. This is currently being addressed by the Air Quality Information System review (https://uk-air.defra.gov.uk/library/reports?report_id=1168).

Communities need to be involved and consulted regarding proposed solutions, and provided with feasible and actionable information, local monitoring, and legal routes to redress. Empowerment measures may include funding of community monitoring networks, requirements for transparent, localised exposure maps, mandatory health impact assessments for major developments, and support for community-led interventions (e.g. school streets, domestic burning reduction schemes) to increase accountability and drive equitable local action.

<https://doi.org/10.31025/2611-4135/2022.17230>;
<https://doi.org/10.1016/j.jclepro.2023.139398>; <https://doi.org/10.1016/j.jclepro.2025.147261>;
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1180706/Air_Quality_Strategy_Web.pdf; <https://www.rcp.ac.uk/media/jzul5jgn/every-breath-we-take-the-lifelong-impact-of-air-pollution-full-report.pdf>.

Awareness amongst medical professionals

The evidence that air quality affects human health is overwhelming. There are very few health conditions where poor AQ likely has no role to play and indeed in many, such as ischaemic heart disease, stroke, COPD and dementia it has a major role. Most healthcare practitioners recognise that AQ impacts health, and yet there is evidence that it is infrequently discussed in consultations, and sparsely raised in medical curriculums. As of 2025, AQ receives one mention in 30 medical speciality training curriculums (overseen by Federation of Royal Colleges) covering 2000 pages of guidance. Our research (<https://doi.org/10.1016/j.fhj.2024.100130>) showed there is a **lack of understanding of how AQ affects individual patients and their conditions, and what actionable advice can be given.**

A common comment, was that *“there’s no point in discussing AQ as there is nothing that they can do to improve the quality of air they breathe”*. More work needs to be done to establish the optimum advice (most impactful, most actionable etc.) with refinement for delivering to different demographics (by age, gender, education, language, culture) and in different environmental settings (urban, suburban, rural, coastal). There then needs to be a concerted effort to inform and educate both clinicians and the public about what they can do to improve the quality of air that they breathe. **This should include revision of post-graduate and undergraduate curriculums for all doctors and allied health professionals, and a public health campaign.**

DOI: <https://doi.org/10.5258/SOTON/PP0171>