Department for Transport

Met Office

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Transport hazard summary series

Air quality and air pollution

High levels of air pollution can impact transport systems and adversely affect the health of transport workers and passengers. These conditions can also increase operational risk by reducing visibility or degrading equipment. Future air pollution levels will be most affected by changes in the emissions of pollution, but climate change will also play a role. The overall impacts are difficult to predict due to the complex interactions between pollutants. To address this challenge, the transport system must be equipped with resilience measures to withstand current and future hazards.

The Department for Transport, Met Office and partners have created this series of **transport hazard summaries** to explain natural hazards and other hazards that are not the result of malicious acts, their impacts, and how they may change in the future.

This summary will introduce what is meant by air quality and air pollution and how these can impact transport, with further information to help decision makers manage and adapt to these risks.

Around 30,000 deaths are estimated to be attributable to long-term exposure to air pollution in the UK each year.*

* Royal College of Physicians, 'A Breath of Fresh Air: Responding to the Health Challenges of Modern Air Pollution', 2025, available at: **https://www.rcp.ac.uk/media/hvbeolvx/21072025-update-rcp-full-report-a-breath-of-fresh-air.pdf**

What do we mean by air quality and air pollution?

Air quality is the term used to describe how clean or polluted the air we breathe is. A pollution episode is a period of poor air quality that can occur at any time of year, typically triggered by weather conditions that allow one or more pollutants to accumulate.*

Air pollution is a mixture of harmful airborne gases and particles that can damage human health. Air pollution can be 'primary', meaning it is emitted directly from a source, or 'secondary', meaning it is created when primary pollutants react in the atmosphere with each other, or with other naturally occurring substances.

Causes of air pollution†

Air pollutants come from many sources, including combustion engines and industrial processes, with traffic emissions one of the major sources in the UK.‡

Nitrogen oxides (NO_x) are primarily emitted from the burning of fuels, with road transport being the main source of emissions.‡

Sulphur dioxide (SO_2) is emitted from burning fuels which contain sulphur, with the main source being power stations and refineries.‡

Ground-level ozone (O_3) is formed when sunlight triggers chemical reactions between various air pollutants, resulting in an increase of ozone at ground-level.‡,§

Fine particles ($PM_{2.5}$) are very small particles that can be emitted from vehicles, fires and industry, or formed from other particles in the atmosphere.‡

Coarse particles (PM_{10}) are larger dust particles that can be emitted from construction, roads, agriculture and natural sources, such as dust blown from the Sahara desert in North Africa.‡

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* Department for Environment, Food and Rural Affairs, 'What defines a pollution episode and when was the first official episode?', available at: **https://uk-air.defra.gov.uk/air-pollution/faq?question=7**

† Department for Environment, Food and Rural Affairs, 'What are the causes of air pollution?', available at: **https://uk-air.defra.gov.uk/assets/documents/What_are_the_causes_of_Air_Pollution.pdf**

‡ Department for Environment, Food and Rural Affairs, 'Causes of air pollution', available at: **https://uk-air.defra.gov.uk/air-pollution/causes**

§ European Climate and Health Observatory, 'Ground-level ozone', available at: **https://climate-adapt.eea.europa.eu/en/observatory/evidence/health-effects/ground-level-ozone**

Air quality and air pollution in the UK

When is air pollution most severe?
Pollution episodes can occur at any time of the year, most often during dry, calm weather with little or no wind. In summer, hot and sunny conditions can cause a build-up of ground-level ozone. In winter, cold, calm conditions can trap pollutants near the ground.

Where does air pollution occur?
Primary pollutants are highest near their sources, meaning air pollution is typically higher in industrial and urban areas and along busy transport routes. Pollutants can also enter buildings and transport hubs and can accumulate in enclosed or partially enclosed spaces, such as underground or covered stations.* The London Underground has much higher levels of fine particles than other parts of the London transport network.† Secondary pollutants affect both urban and rural areas. For example, there can be more ground-level ozone in suburban and rural areas located downwind of city centres.

Air pollution occurs across all UK regions and can be both widespread and highly localised, depending on the source and weather conditions.

Wildfire smoke from the UK or abroad can dramatically increase particle levels over parts of the UK.

Pollution from continental Europe can be transported by wind into the UK, with the south-east particularly exposed.

Saharan dust storms can bring high levels of dust particles to the UK when the wind is coming from the south.

How long do air pollution episodes last?
Typical episodes last around 3 to 4 days, but more severe episodes can last up to a month. Pollution only improves once winds pick up, dispersing the pollutants, or when rain arrives, washing the pollutants out of the air.

How is air quality monitored and forecast?
In the UK, the Met Office and Department for Environment, Food and Rural Affairs provide a Daily Air Quality Index forecast.‡

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* Chief Medical Officers, Annual Report: Air Pollution (December 2022), available at: **https://assets.publishing.service.gov.uk/media/639aeb81e90e0721889bbf2f/chief-medical-officers-annual-report-air-pollution-dec-2022.pdf**

† Smith, J.D. and others, 'PM2.5 on the London Underground', Environment International, available at: **https://www.sciencedirect.com/science/article/pii/S0160412019313649**

‡ Department for Environment, Food and Rural Affairs, 'UK AIR: Air pollution forecast', available at: **https://uk-air.defra.gov.uk/**

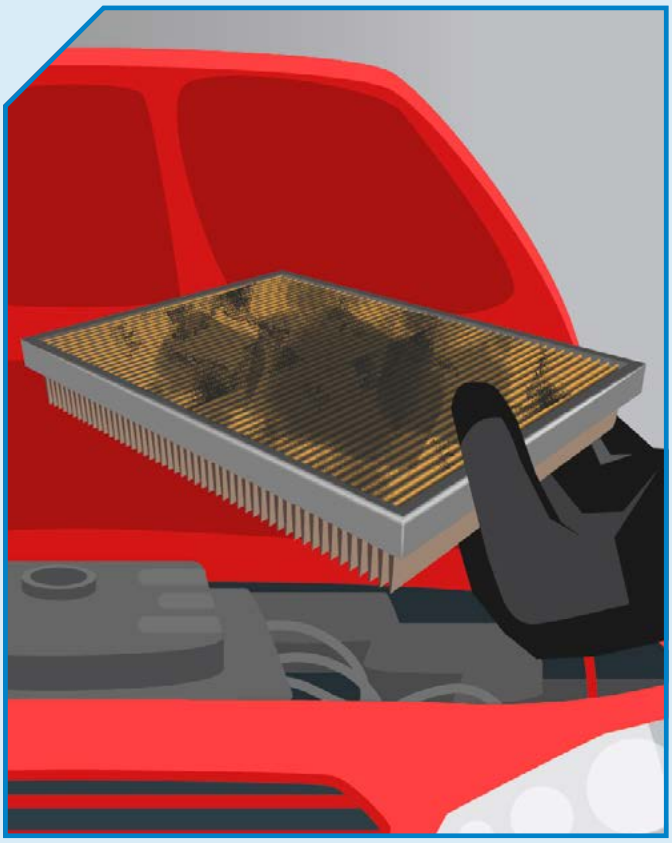
Direct transport impacts due to air pollution

Human health and safety

- Air pollution is one of the biggest environmental threats to human health. Both short-term exposure to high pollutant levels and long-term exposure to low levels have harmful health effects.*
- Staff, passengers and road users who spend long periods near pollution sources, such as busy roads or transport hubs, may be at greater risk than the general public.*
- Vulnerable individuals, such as older people, children, and those with respiratory conditions, may suffer more.

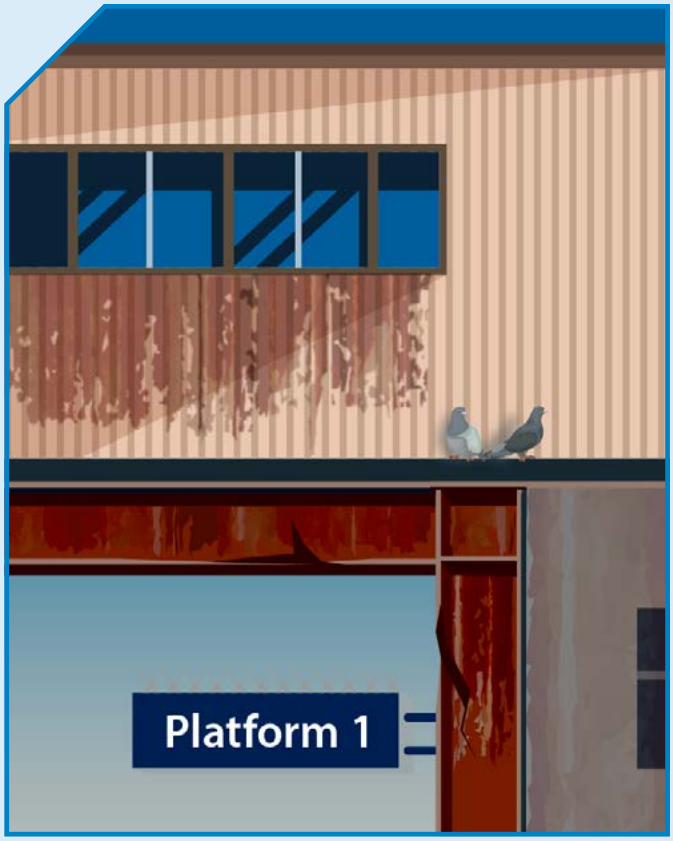
Vehicle and service operations

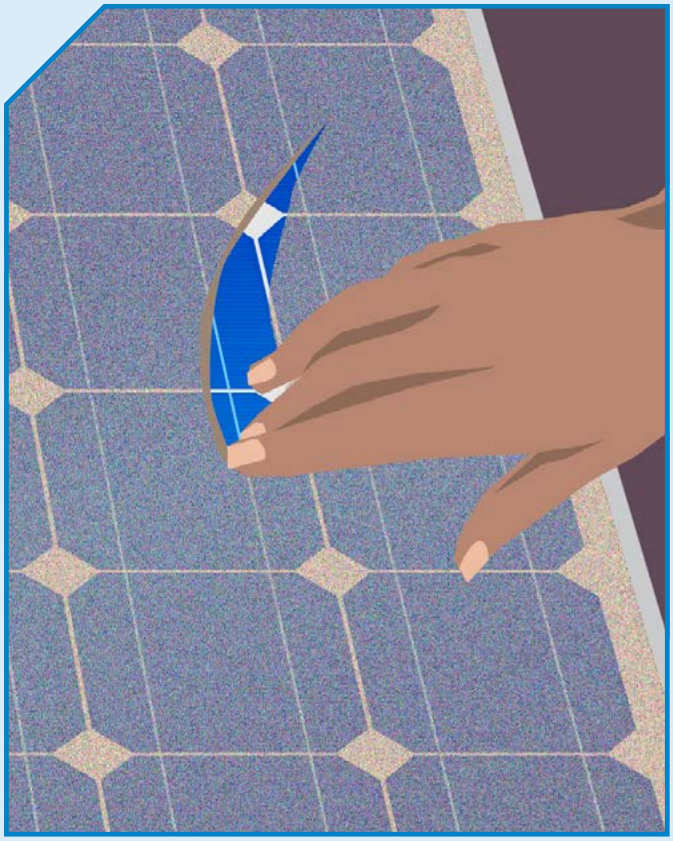
- Severe air pollution can reduce visibility, disrupt operations and increase safety risks.
- Fine and coarse particles can clog parts of engines, leading to increased maintenance.
- Ozone exposure can speed up the rate of wear and tear on vehicle components such as rubber seals.†



* Chief Medical Officer's Annual Report 2022: air pollution, available at: **https://www.gov.uk/government/publications/chief-medical-officers-annual-report-2022-air-pollution**

† TRL Published Project Report PPR904 'Tyre Ageing: Its effect on material properties and structural integrity', 2019, available at: **https://www.trl.co.uk/publications/tyre-ageing**





Infrastructure

- A build up of particles on signage, tunnels, and terminals increases maintenance and cleaning costs.
- Over longer periods, some pollutants can accelerate the corrosion of metal structures and components, as well as increasing the rate of erosion of transport assets and facilities made of concrete or stone. This reduces their lifespan and increases the need for repair or replacement.*

Interdependencies: high levels of air pollution can reduce solar energy output, affecting energy supply reliability for any transport assets that use solar power as an energy source.

* Kumar, P., Imam, B., 'Footprints of air pollution and changing environment on the sustainability of built infrastructure', 2013, Science of the Total Environment, available at: **http://dx.doi.org/10.1016/j.scitotenv.2012.11.056**

How are air quality and air pollution in the UK changing due to climate change?

Future air pollution levels will be most affected by changes in the emissions of pollution, but climate change will also play a role. The overall effect of climate change on air quality is difficult to predict and uncertainty remains high due to the complex interactions between pollutants. Future changes are broadly categorised as follows.

Changes to the weather

In summer, more frequent and intense heatwaves are likely to increase summer air pollution episodes. This is due to the dry conditions with little or no wind, combined with long periods of sunshine (which is needed for the chemical reaction to create ground-level ozone).

In winter, wetter conditions overall could mean that air quality becomes better, as rainfall removes pollutants from the atmosphere and dry, calm conditions become less likely.*

Changes to how pollution is moved around in the atmosphere

Changes to large-scale weather patterns over the UK, which affect wind direction, could change how much pollution arrives from outside the UK.

Changes to the production and destruction of pollutants

Wildfires are projected to increase in a warmer climate. The wildfire season is expected to lengthen, and fires are expected to become more frequent.* This will mean more air pollution episodes from smoke, with higher particle levels and reduced visibility. See the ‘wildfire’ transport hazard summary for more details.

Globally, the changing climate is also likely to affect the chemical processes that create and destroy pollutants, altering their amounts and how long they persist. However, the UK’s transition to lower-emission technologies in many sectors should help reduce pollutants.

* Royal Society, ‘Effects of net-zero policies and climate change on air quality’, 2021, available at: **https://royalsociety.org/-/media/policy/projects/air-quality/air-quality-and-climate-change-report.pdf**

Case studies

March to April 2014: $PM_{2.5}$ and PM_{10} pollution from outside the UK*

From 26 March to 8 April 2014, high levels of fine particles ($PM_{2.5}$) and coarse particles (PM_{10}) were recorded across most of the UK.*

Pollution during this event was produced locally in the UK and also transported by wind into the country from sources such as agricultural emissions in Europe and dust from the Sahara. These factors led to high particulate levels across the UK, with air pollution reaching the Daily Air Quality Index maximum of 10. This prompted health warnings for at-risk individuals to avoid strenuous activity, and for the general population to reduce physical exertion, particularly outdoors.† Dust build-up on surfaces increased the need for cleaning and maintenance of vehicles and infrastructure.

July 2022: heatwave, ground-level ozone‡

The heatwave of July 2022 led to high levels of ground-level ozone, especially in rural areas in the south-east of the UK. In some locations along the southeast coast, ozone levels were nearly double the World Health Organisation's recommended limits.

Wildfire smoke: July 2022‡ and July 2025§

The July 2022 heatwave resulted in many wildfires, smoke from which led to the closure of several major roads causing significant congestion and widespread travel delays. A case study on the 2022 wildfires can be found in the 'wildfires' transport hazard summary.

In July 2025, the A30 – a main road in Devon – was temporarily closed, as thick smoke from a nearby wildfire drifted across the road and would have posed a danger to drive through.

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* Vieno, M., Heal, M.R., Twigg, M.M. and others, 'The UK particulate matter air pollution episode of March–April 2014: more than Saharan dust', Environmental Research Letters, volume 11, article 044004, 2016, available at: **https://iopscience.iop.org/article/10.1088/1748-9326/11/4/044004**

† Department for Environment, Food and Rural Affairs, 'Air Pollution in the UK 2014', available at: **https://uk-air.defra.gov.uk/assets/documents/annualreport/air_pollution_uk_2014_issue_1.pdf**

‡ National Centre for Atmospheric Science, 'How UK's record heatwave affected air pollution', 2022, available at: **https://ncas.ac.uk/how-uks-record-heatwave-affected-air-pollution/**

§ BBC News, 'Main road temporarily closes due to wildfire smoke', 2025, available at: **https://www.bbc.co.uk/news/articles/c5yp7znz0pko**

Hazards associated with air quality and air pollution

Cold weather

Cold, calm weather can trap pollutants close to the ground, exacerbating winter pollution episodes.

Drought

Droughts create dry, dusty conditions, increasing airborne particles and pollution episodes.

Extreme heat

Hot, sunny weather during heatwaves significantly increases the build-up of ground-level ozone.

Wildfire

Wildfire smoke significantly increases particulate pollution and can lead to reduced visibility.

Volcanic eruptions

Volcanic eruptions from elsewhere in the world can release ash and gases that impact the UK, although this is infrequent.

Further information on these hazards can be found in our series of Transport hazard summaries: **www.gov.uk/government/collections/transport-hazard-summaries**

Risk mitigation and adaptation

Various risk mitigation measures are already in place across the UK to reduce air pollution and protect passengers and transport workers. Some examples include:

- improving ventilation and filtration in transport hubs and vehicles to protect users and staff from high pollution levels and implementing measures to reduce idling of vehicles
- using real-time air quality monitoring forecasts to manage exposure during pollution episodes
- replacing polluting vehicles with low- and zero-exhaust emission models, such as hydrogen-powered or electric vehicles, to reduce pollution at the point of use
- supporting technologies that reduce pollution at source, such as cleaner industrial processes in the transport supply chain

Questions for decision makers

- Do you understand which areas of your transport infrastructure are likely to be most exposed to poor air quality, and what this could mean for passengers and staff?
- Are you able to monitor air pollution levels and do you know when these may be dangerous to passengers and staff?
- Do you currently use any air quality forecast information in your business planning? If not, how could you incorporate it?
- How could you adapt your transport fleet and enclosed environment to reduce exposure to air pollution?

Further reading

Air Information Resource – UK Air

Air Pollution in the UK – Defra

Air Quality Mitigation Measures – RSSB

Air quality statistics – GOV.UK

Chief Medical Officer's Annual Report 2022: Air Pollution – GOV.UK

Environmental Improvement Plan annual progress report: April 2024 to March 2025 – GOV.UK

National Air Pollution Control Programme – GOV.UK

National Risk Register 2025 –Defra

Onboard passenger air quality improvement - RSSB

Climate information and risk assessment

See 'The changing climate' and 'Transport hazards, risks and resilience' transport hazard summaries for more information on identifying and planning for risks to transport and where to find climate data, including more detail on projected changes on a regional level.