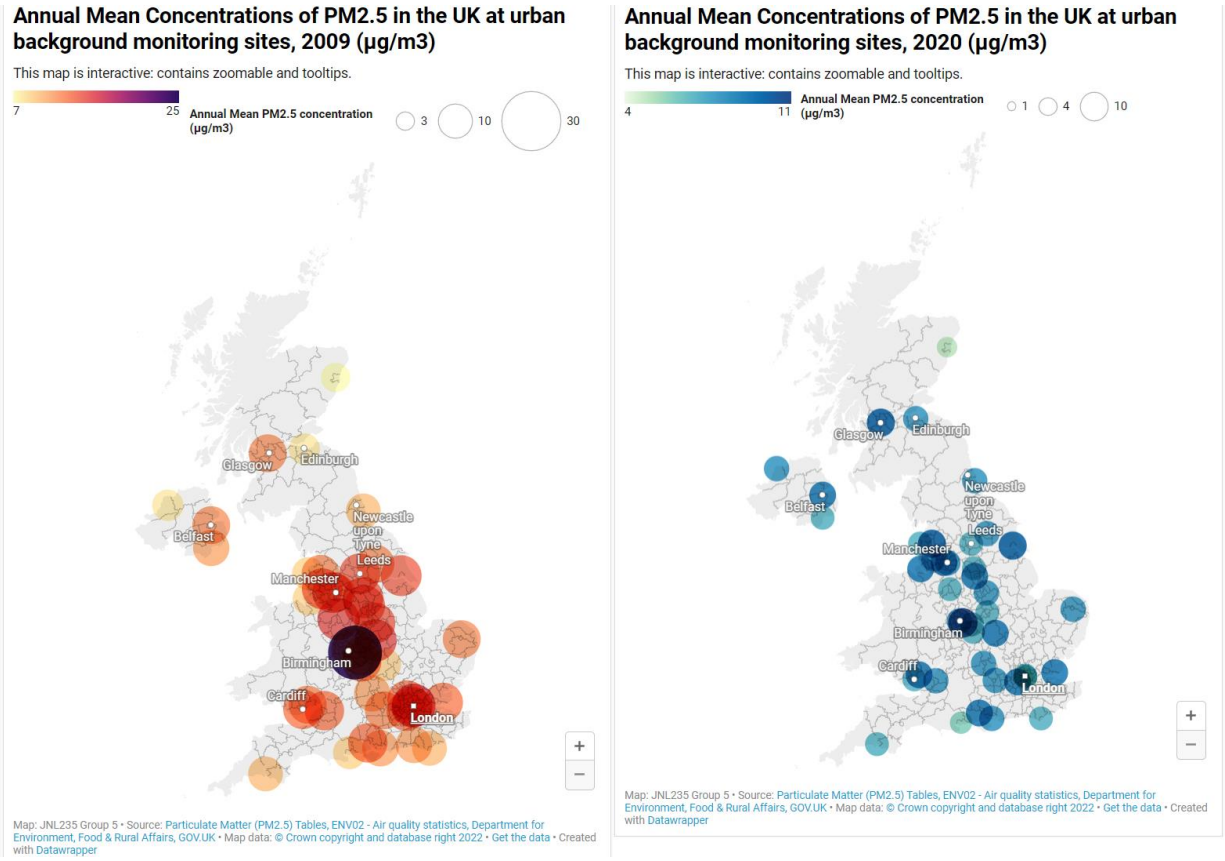

Two maps of the air pollutant PM2.5 in 2009 and 2020. Air pollution remains an important part of environmental protection in the UK.
https://datawrapper.dwcdn.net/zem7Z/2/
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With Climate Change and Net 0 targets dominating the news, there is another environmental issue largely going unnoticed. The air we breathe is unsafe. Across the country, data shows we are not meeting air quality standards with data from the government's Department for Environment, food and rural affairs (DEFRA), stating around 38 million people across the UK live with air pollution levels that do not meet world health organisation's standards. This has major implications for the environment, climate change and importantly, is killing people.The annual mortality of human-made air pollution in the UK is roughly equivalent to between 28,000 and 36,000 deaths every year and by 2025 it will have cost the NHS £1.6 billion, according to the Office of National Statistics. But just why should we care? What areas are most affected? What are these pollutants and how might they affect your health?

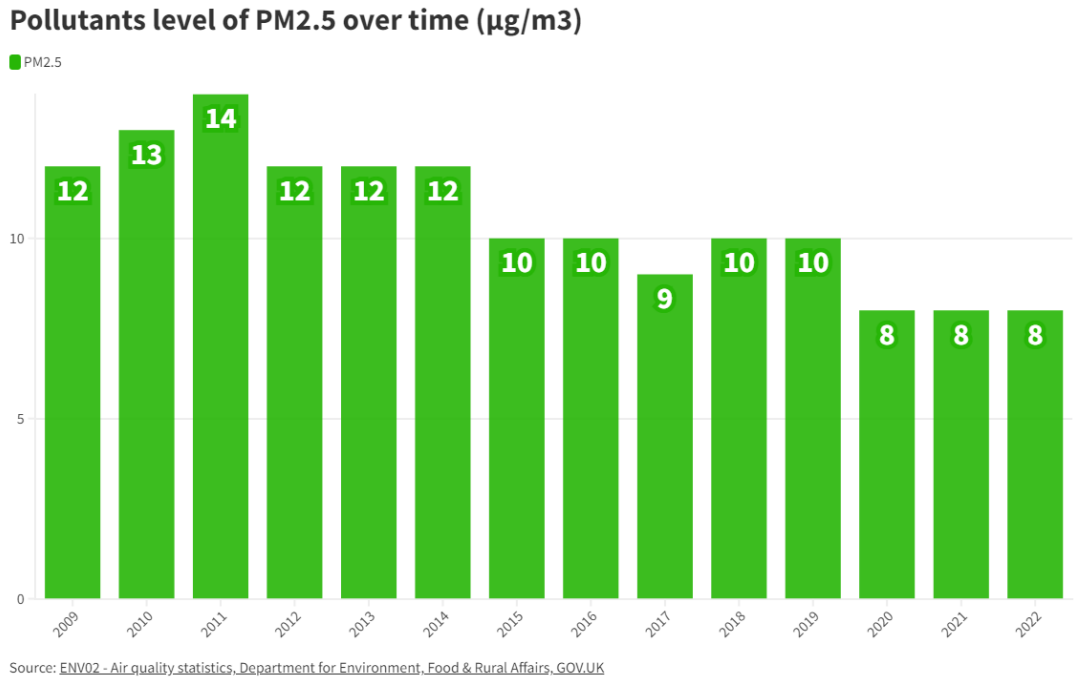
Yes, people are dying and yes this issue is costing the NHS ridiculous sums of money, but, more importantly, what do all these big words actually mean, and what *is* air pollution?

There are four main types of air pollutant affecting the UK, Nitrogen Dioxide (NO_2), Ozone (O_3), Particulate Matter 2.5 (PM2.5) and Particulate Matter 10 (PM10), each with different characteristics and each harming our body in a different way and measured in $\mu g/m^3$ (the amount of micrograms of a pollutant inside one cubic metre of air).

Professor Stephen Holgate is a Professor of Immunopharmacology at the University of Southampton and is a Clean Air champion who works to battle the scourge of air pollution

He said: “All the particles do differ, NO_2 and O_3 are gases, whereas the Particulate Matter is made from solid particles, not pure chemical substances.”

“That makes it like a trojan horse, carrying all kinds of particles into the body and blasting through into the bloodstream.”



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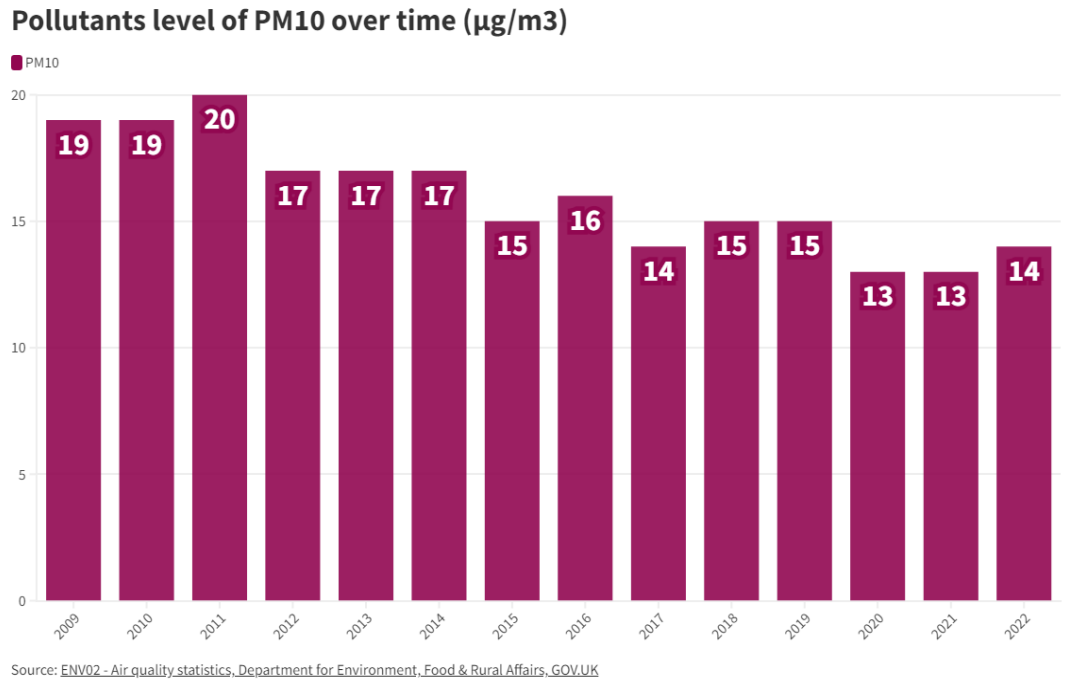

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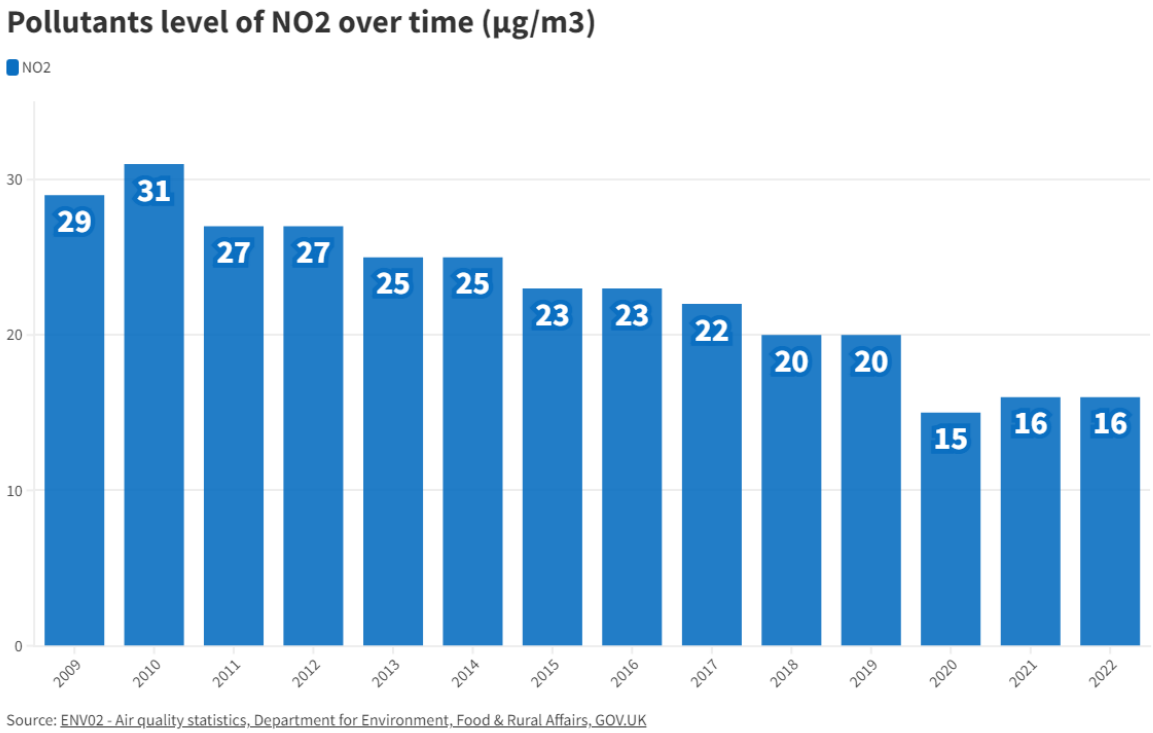
After a massive rise in the early 2010's, our levels of PM2.5 and PM10 have begun to level out in the last few years, with PM2.5 levels especially steadying at 8 µg/m^3, but this flattening out is still concerning, just why isn't it going down?

PM2.5 and PM10 are made up of small bits of plastic floating around in our air, so small they're impossible to see by the naked eye, but, once they get into your system, can cause major disruption. Caused mainly by the burning of plastic at waste disposal plants, the chunks of plastic can start off large, and over time slowly break down to microscopic levels. PM10, is made up of much larger particles that can irritate your eyes and nose, think of dust from riverbeds or when you pat a seat particularly hard on a public bus. The major issue though, is the much smaller PM2.5. Being so much smaller than PM10, PM2.5 can keep travelling, down deeper and deeper into your body, until, eventually, it reaches deep into your lungs, or, in extreme cases, even into your bloodstream and arteries. This can cause major blockages and, to people already suffering with weak lungs or asthma, can be fatal, especially to babies who can have extremely low birth weights if their mother was exposed to extreme levels of PM2.5 and PM10 during pregnancy. The foreign particles getting into your body also accelerates the build up of fatty acids, which can cause heart attacks and even strokes as well as damaging the cells that keep your body running smoothly.

Professor Holgate said: "It's vulnerable groups we're worried about, who may have underlying conditions, and when paired with air pollution and these particles in their system, it can become seriously bad."



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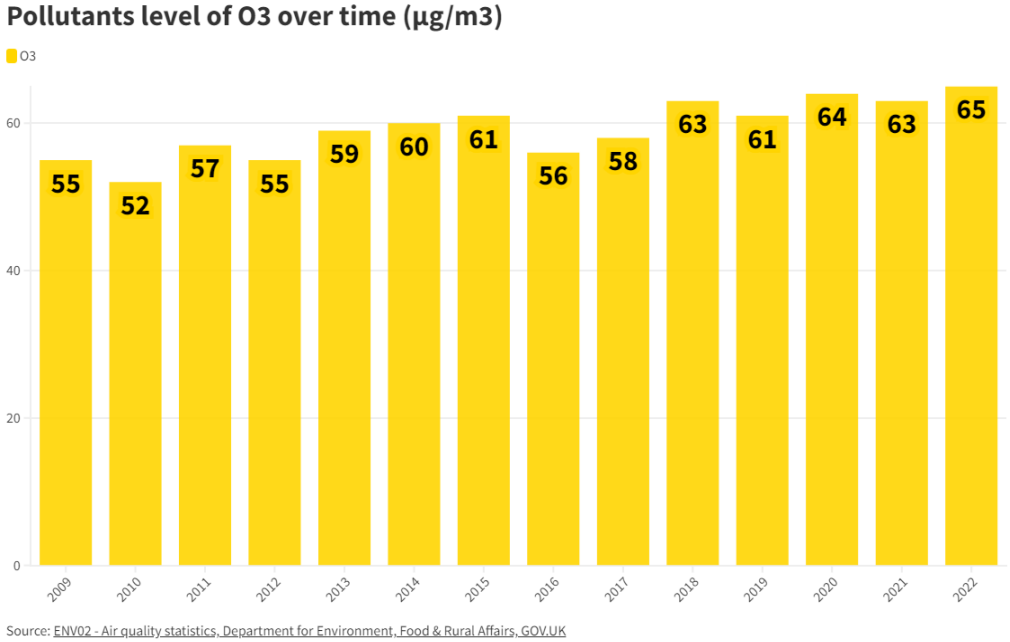
NO_2 is just as bad. It comes mainly from the burning of fossil fuels, large construction projects, vehicles such as cars and, even small seemingly innocent things such as mowing your lawn

can pump the dangerous gas into the air. The gas is colourless and odourless, making it, once again, impossible to spot. NO_2 will often cause damage to a person's respiratory system, attacking their lungs, nose, and throat, among other organs in your body. Additionally,in extreme cases, it can cause chronic lung disease. However, unlike PM2.5 and PM10, its effects on the environment are just as bad, harming vegetation and limiting crop growth.
Due to Covid, we have seen a major drop in NO_2 production over the past few years, dropping by 5 $\mu g/m^3$ between 2019 and 2020. With us now opening everything back up after the pandemic though, NO_2 emissions could be on the rise.



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Unlike the other air pollutants, which are all going down, O_3 is increasing each and every year with a 15% increase since 2009. This is actually a good thing…when it's high up in the atmosphere.

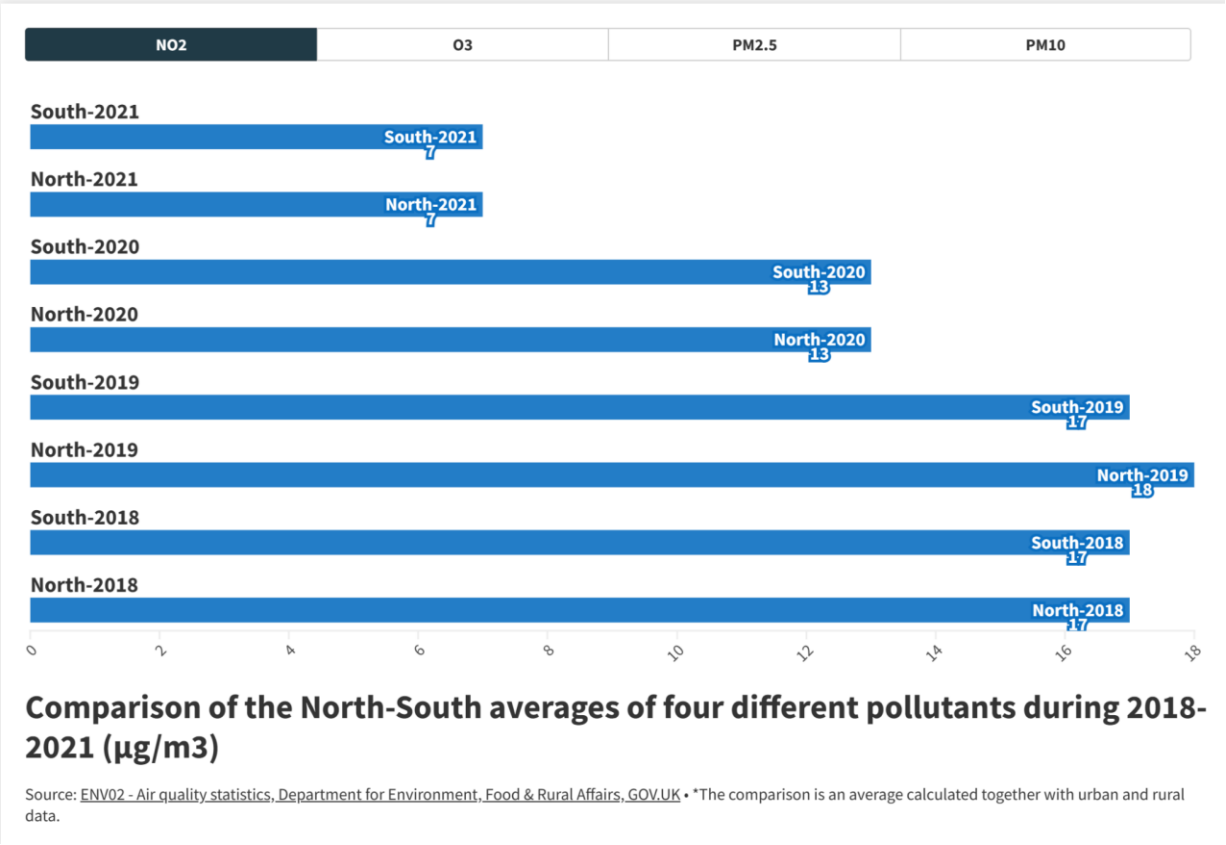
That's where O_3 helps filter out damaging ultraviolet radiation from the sun. Yet, lower down in the atmosphere, that's when the issues arrive. O_3 can harm our body, attacking our lungs. This has coined the phrase "good up high, bad nearby" in discussions about O_3. O_3 is created through the chemical reaction of oxygen with other pollutants, most notably the previously mentioned NO_2. This means that, when it may at first seem as if Air Pollution is lowering in other areas, a lot of the time, it can just be turning into O_3, causing even more damage to the environment.

All four of these pollutants damage the environment. Professor Holgate said: "These pollutants altogether cause about 30% of the climate problems."

"It's [CO_2] low hanging fruit to help solve all these Net 0 targets."

Over time, there has been a steady decrease in the amount of these damaging air pollutants in our atmosphere, but it's nowhere near enough and is still far from meeting our targets,with some areas of the UK faring far worse than others.

According to the data there are slight discrepancies in the amount of NO_2, in areas of the north compared to the south. As well as a consistent and noticeable difference in the amount of particulate matter in northern areas, with the south proceeding to have a higher average of particulate matter pollution since 2018.



Comparison of the North-South averages of four different pollutants during 2018-2021 (µg/m3)

Source: ENV02 - Air quality statistics, Department for Environment, Food & Rural Affairs, GOV.UK • *The comparison is an average calculated together with urban and rural data.

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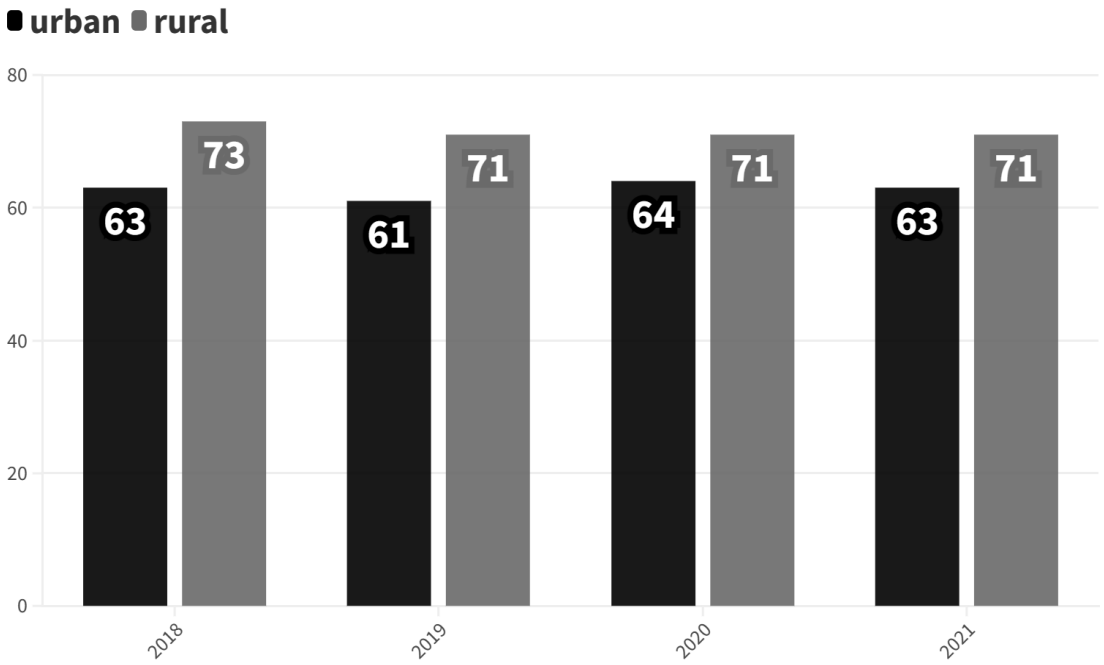
Despite the North's long history of being an industrial powerhouse, just why are these areas in the south more polluted or susceptible to particulate pollution?

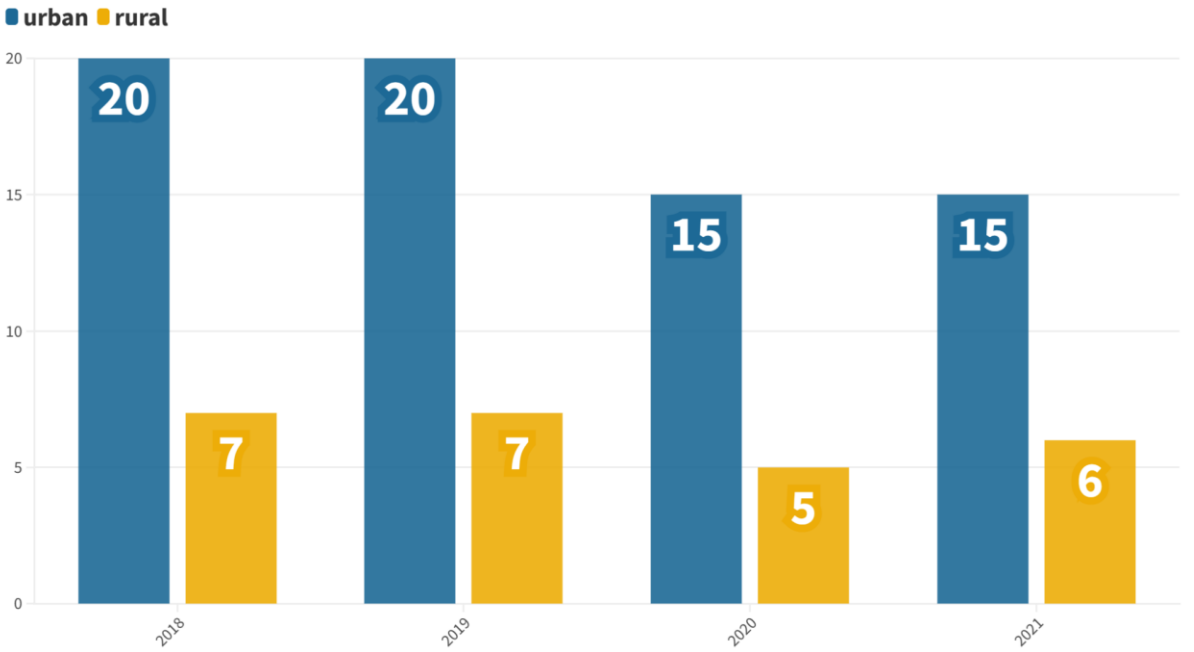
This data also reveals how urban and rural areas have been affected differently by certain air pollutants.

Comparison of annual mean O3 concentrations in urban and rural areas (µg/m3)



Source: Ozone (O3) Tables, ENV02 - Air quality statistics, Department for Environment, Food & Rural Affairs, GOV.UK • *The data is calculated on average

Comparison of annual mean NO2 concentrations in urban and rural areas (µg/m3)



Source: ENV02 - Air quality statistics, Department for Environment, Food & Rural Affairs, GOV.UK • *The data is calculated on average

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But what are the causes of such divides?

NO_2 is found in much higher concentrations in urban areas, due to the way it's produced. NO_2 is churned out by vehicles and appliances in our homes. With so many homes in these highly condensed urban areas, a much larger amount of the gas is pumped into our air. Whereas the lack of industry, vehicles and appliances in rural areas generates a lot less gas.

However, this doesn't make our rural areas totally clean. These areas on average produce more O_3 pollution but the difference between urban areas is nowhere as stark as the statistics for NO_2. This is because there is less nitrogen oxides in the outdoor air to interfere with the chemical reactions that make O_3 .

The average mean concentration of O_3 in rural areas reached a height of 73 $\mu g/m^3$ in 2018 and 71 $\mu g/m^3$ in the years since. In comparison in urban areas it only managed to reach a height of 64 $\mu g/m^3$ in 2020. But these results could be affected by the covid pandemic as less nitrous oxides were produced to inhibit O_3 production.

Essentially, the less pollutants in an area creates a much better environment for O_3 leading to dirty air in our countryside. So, as a reward for less manmade pollution, nature grants you with high concentrations of another pollutant. You really can't win.

One of the main sources of PM2.5 and NO_2 in urban areas is older diesel vehicles and transport as they produce 13% of the total of PM2.5 annually. 27% of UK primary PM2.5 emissions came from burning wood and coal in domestic open fires and solid fuel stoves and a further 13% came from solvent use and industrial processes. Industrial combustion also showed to produce 26% of the total.

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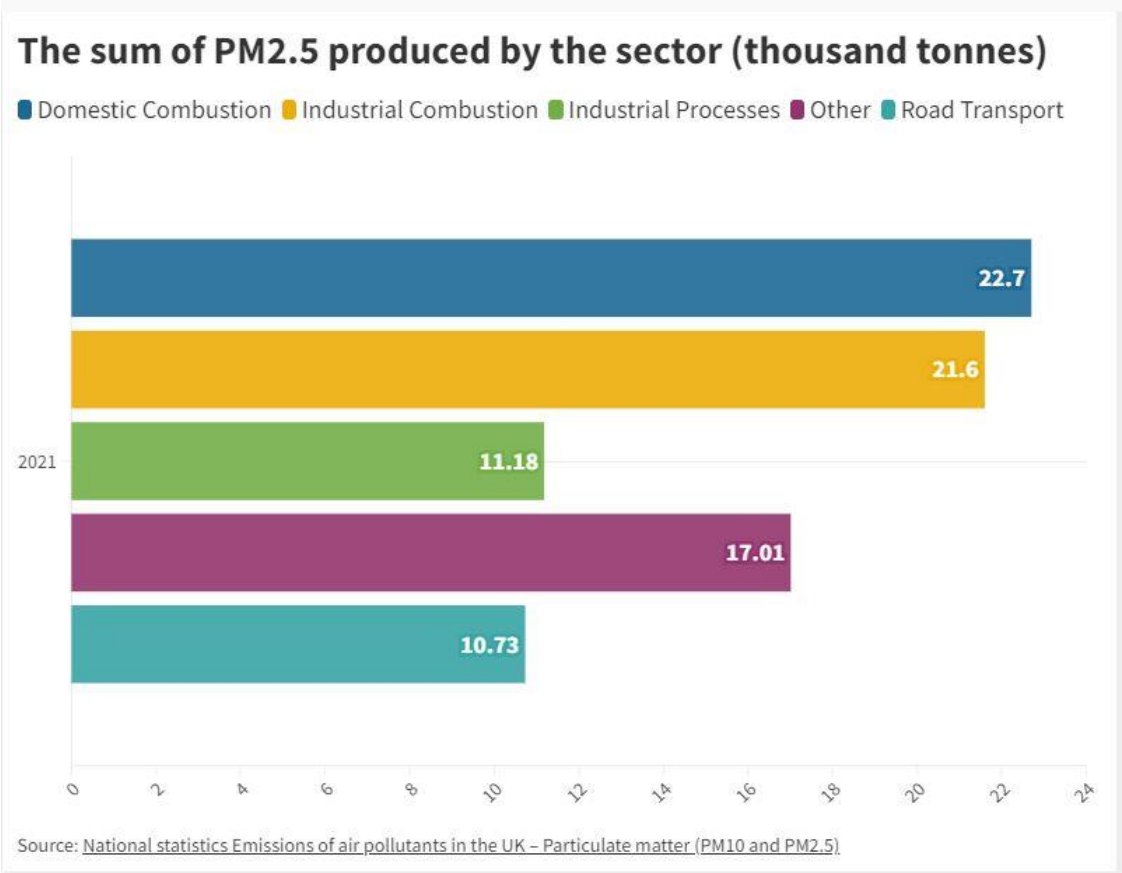


One of the ways the government is fighting air pollution in urban areas is with ‘clean air zones’. These major metropolitan zones charge vehicles that produce these pollutants. The aim is to ‘supposedly’ encourage people to use other forms of transport and for businesses and citizens to upgrade to more environmentally friendly and efficient vehicles. This is because road transport contributes to 13% of primary PM2.5 at 10.73 thousand tonnes.

Many claim the zones unfairly affect businesses, while others say they do not go far enough. One of the biggest concerns raised is that many vehicles such as taxis and other commercial vehicles will simply ‘put up with the charge’ and still drive through this area, ultimately continuing to pollute the area. Vehicles may also take longer routes to avoid the charge, producing more net pollution. There are also concerns raised by businesses about the disruption and fiscal damages it may cause.

But Professor Holgate says: “We need to try and remove our dependance on the car but on short journeys think about active travel…and try and encourage more exercise and walking to places.”

There has been a total 1% decrease in NO_2 since 2021 after a 5 % decrease the previous year but that was likely due to covid restrictions. In urban areas the average amount of NO2 since 2019 has dropped 25% but the same can not be said for rural areas.The average annual concentration of NO_2 in rural areas has only dropped by 1 $\mu g/m^3$ since 2018. It did drop by 2 $\mu g/m^3$ in 2020 but that has not been consistent since.

The biggest source of PM2.5 is domestic combustion. When we burn wood and coal in open fires and stoves, it accounts for 27% of the UK's emissions of particulate matter. This is the equivalent of 22.7 thousand tonnes annualy.

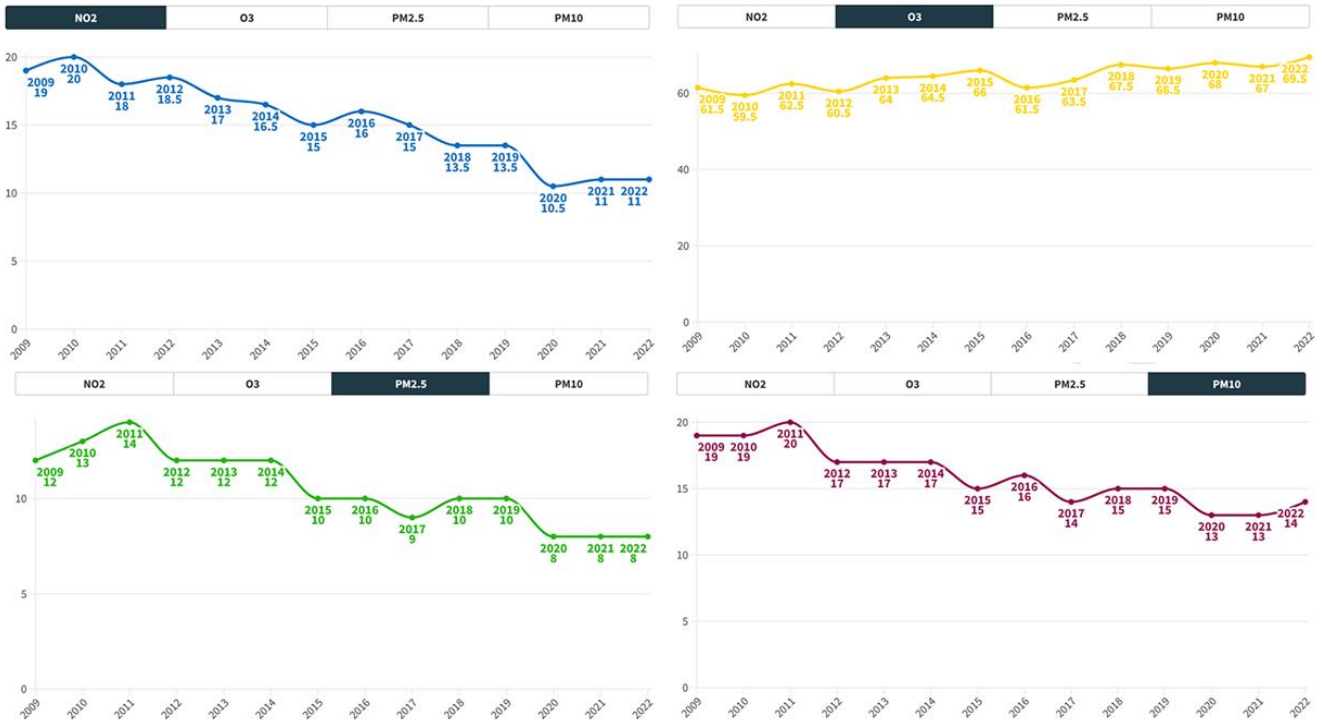
In 2019, the government planned to introduce legislation regarding the sale of the most polluting fuels to improve awareness of the environmental and health impacts of burning' They also planned to phase out the sale of older more polluting appliances.However, how this has been measured is unsure and whether this has had success is debatable.

The UK government is also taking steps to tackle the air pollution issue by investing £10 million into improving their data and analytical tools. Hopefully this will provide a more accurate forecast of air quality in the future. With better data, theoretically, the government will be more equipped to take action and make policies to reduce air pollution.

But the air outside isn't the only concern. Professor Holgate said: "Don't forget, we spend 85% of our day in our houses."

"We really need to limit the amount of chemicals being produced in our own homes as well as outside."

Indoor materials such as cleaning and decorating products also produce chemicals that contribute to air pollution. All these poisonous chemicals float around the air when we're sitting in our homes watching tv and doing dishes, and we don't even realise.



Trends of average emissions of four pollutants from 2009 to 2022 (µg/m3)

Source: ENV02 - Air quality statistics, Department for Environment, Food & Rural Affairs, GOV.UK • *The comparison is an average calculated together with urban and rural data.

Trends of average emissions of four pollutants from 2009 to 2022 (µg/m3) | Flourish

In the long term, nitrogen dioxide, PM2.5 and PM10 as a whole have shown a significant downward trend from 2009 to 2022. Ozone maintained a steady trend of slightly rising around 70 µg/m^3 during the 14 years. Therefore, the government's measures to improve the air quality have been implemented and have achieved encouraging results.

But, is it enough? Compared to the UK government's strategy, outlined in 2019, particulate matter has met the 2020 concentration limit of 20 µg/m^3 but for nitrogen oxides, the target of a 55% reduction by 2020 is still far off. The government has responded with an air quality plan, which provides further restrictions. The trends in data show we are going in the right direction, but, with over 30,000 people dying last year due to the dirty air they're breathing, we need to take more action sooner rather than later