AIR POLLUTION AND CLIMATE CHANGE

Sources of greenhouse gas (GHG)emissions, for example combustion (i.e. burning) of fuels for energy to power transport, heating, lighting, manufacturing and industry contribute to climate change, are also sources of air pollution.

Air pollution is a complex mix of particles and gases of both natural and man-made origin. Sources include emissions from transport, energy generation, manufacturing, construction, domestic heating and burning and agriculture. (Figure 1). A major source of both GHG and air pollution is the burning of fossil fuels.

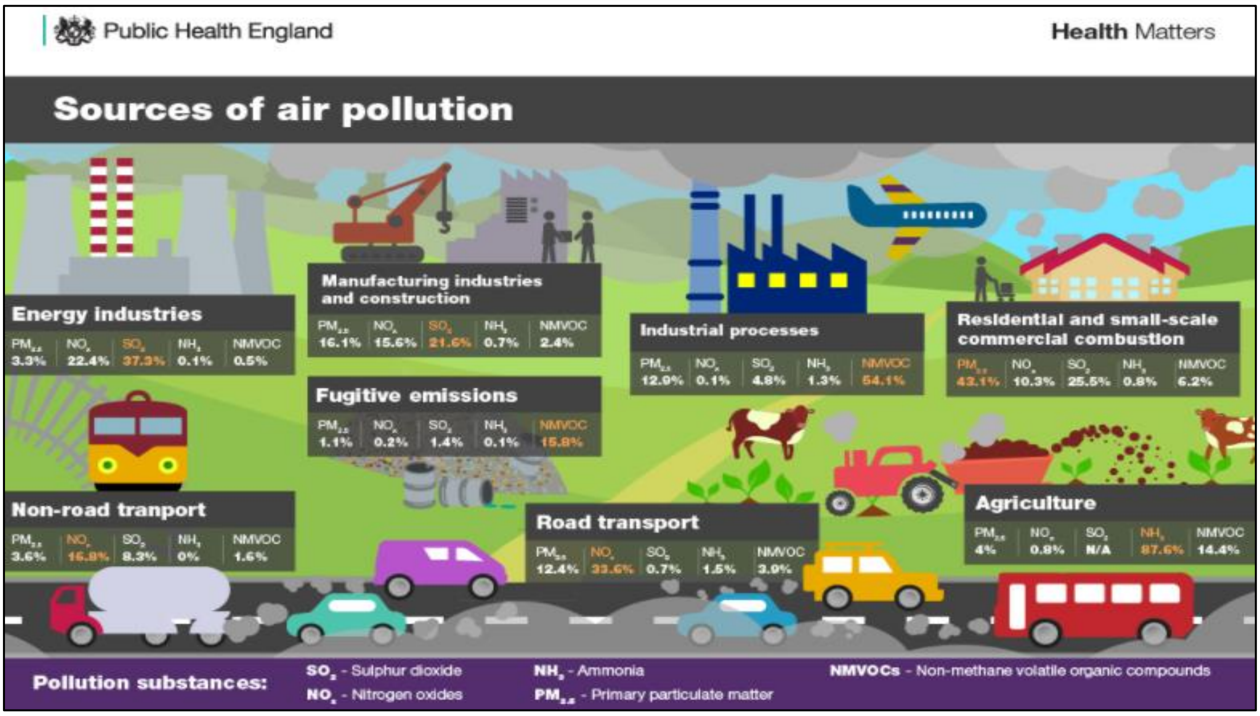

Figure 1 – Sources of air pollution[1]

Air Pollution and Health - In the UK, air pollution is the largest environmental risk to public health. Short-term exposure (over hours or days) can lead to a range of health impacts including coughing, wheezing, exacerbation of asthma, increases in respiratory and cardiovascular hospital admissions and mortality. Over long timescales (years or lifetimes) exposure can lead to reduced life expectancy, due to cardiovascular diseases, respiratory diseases, and lung cancer. It is estimated that long term exposure to man-made air pollution in the UK has an annual effect equivalent to 28,000 to 36,000 deaths[1]. More recent research has associated air pollution with affecting the brain causing dementia and cognitive decline; diabetes and affecting early life leading to various birth outcomes, for example, low birth weight and developmental problems.

Relationship between air pollution and climate change - Air pollution and climate change impact each other through complex interactions in the atmosphere. Air pollution also has a short-term regional climate effect – pollutants like black carbon, ozone and its precursors contribute to warming and are thus recognized as short-lived climate pollutants. Generally, greenhouse gases such as carbon dioxide, methane, nitrous oxide and ozone, trap heat in the atmosphere leading to a warming of the climate. However, particles in the air (particulate matter, or aerosols) show more complex behaviour. Black carbon aerosols can absorb incoming solar radiation and so have a positive radiative forcing (i.e. earth receives more incoming energy from sunlight than it radiates to space). Other aerosol components, such as sulphate, reflect solar radiation and have a negative radiative forcing effect (they lead to cooling). Aerosols also affect cloud formation and clouds obviously impact the radiation balance[2].

Impacts of Climate Change on Air pollution

In the UK the most recent decade (2011–2020) has been on average 0.5°C warmer than the 1981–2010 average and 1.1°C warmer than 1961–1990[3]. Even under the ambitious global scenarios for cutting greenhouse gas emissions, it is likely to experience around an additional 0.5°C increase in annual average temperature by 2050. This is projected to lead to hotter, drier summers, with more heatwaves and droughts and milder wetter winters, with more flooding and severe storms[4]. The Climate Change Committee (CCC) has predicted this change in weather is likely to lead to increased frequency and intensity of wildfires[5]. Smoke from large-scale wildfires can contain a mixture of gases and fine particles decreasing the local air quality and leading to short-term health impacts including irritation of the eyes, nose, throat and lungs, and may cause coughing, wheezing, breathlessness and chest pain. As well as exacerbation of pre-existing conditions such as asthma and chronic obstructive pulmonary disease (COPD).

Increased temperature and sunlight can also impact air quality by increasing the concentrations of ground level ozone, through photochemical reactions involving the precursor pollutants nitrogen oxides (NO_x) and volatile organic compounds (VOCs) (Figure 2). Ozone is a gas and occurs both in the earth's upper atmosphere and at ground level. In the upper atmosphere, ozone occurs naturally where it forms a protective layer that shields us from the sun's harmful ultraviolet rays. However, at ground level ozone is harmful to human health and there is evidence of short-term exposure to O_3 and impacts on respiratory and cardiovascular health.

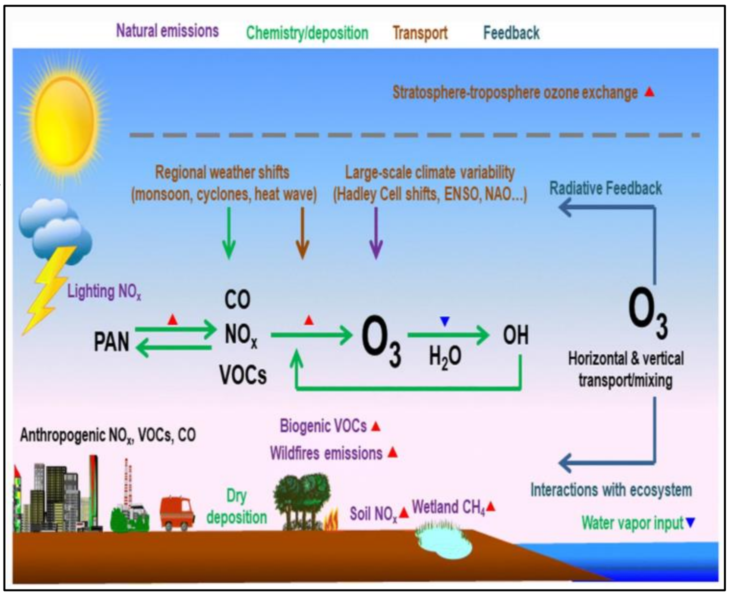

Figure 2 – Pathways of interaction between meteorology /climate changes and tropospheric ozone[6]

Other impacts of climate change like flooding, can have indirect effects on air quality as well. For example, mould introduced to the home from flood water can decrease the quality of the indoor air. Inhaling mould can cause adverse health effects, including allergic reactions. Indoor air quality could also be further decreased during the clean up after a flood, by introducing other substances into the indoor environment. These include carbon monoxide from generators used for pumping water and cleaning products themselves release VOCs into the air. Other chemicals which could already be in the home such as lead or asbestos could also be dislodged and liberated, which may also affect your health.

Inequalities

The scale of the health impacts from climate change will not be the same for everyone; some individuals, groups and communities are more at risk, due to several factors including exposure, sensitivity and their capacity to adapt[7]. Certain groups are also more vulnerable to the impacts of air pollution exposure because they live in a polluted area, are exposed to higher levels of air pollution in their day-to-day lives, or are more susceptible to health problems caused by air pollution. The most vulnerable can face all these disadvantages. For example, older people and people with pre-existing medical conditions can be especially sensitive to the direct impacts of climate change such as heat and also more susceptible to the health impacts from exposure to air pollution[1]. If these people are then living in low-income communities, they may also have limited adaptive capacity, i.e. to reduce their exposure to risks from climate and air quality.

Net Zero - In 2019, the UK Government and devolved administrations committed to the target of Net Zero emissions by 2050, as recommended by the CCC. The implementation of Net Zero will likely lead to a decrease in certain primary air pollutants[8]. For example, the shift from petrol and diesel vehicles to low emission vehicles could bring significant improvements in air quality and therefore health outcomes[9]. Even a small reduction in nitrogen dioxide (NO_2) annual average concentrations in England could help to avoid over 30,000 new cases of diseases caused or impacted by NO_2 over the next 18 years[1]. It should be noted though that tyre and brake wear will continue to emit PM and could even increase if vehicles become heavier or overall vehicle-miles driven were to increase[10]

Air Quality Considerations of Net Zero - Whilst achieving net zero is expected to bring about improvements in air quality in the UK, in the long term, there is potential for some unintended consequences which are important to consider[11].

The CCC identified that bioenergy coupled with carbon capture and storage (BECCS), where energy is recovered and carbon captured and contained in biomass, delivering negative carbon energy[12] could be a valuable tool in achieving net zero emissions. However, depending on the particular use and the proximity of emissions to areas of population there are potential negative impacts on air quality. For example, ammonia emissions from anaerobic digestion can cause biodiversity loss and negative impacts on human health. The use of biomass for domestic burning is also a significant contributor to the UK's PM2.5 levels[13].

Improving energy efficiency of buildings (e.g. through reducing draughts, and better insulation) could lead to the accumulation of indoor air pollutants, if suitable construction materials, ventilation and air management are not considered. This is particularly relevant for particulate matter (PM), VOCs and the by-products of indoor chemical reactions[8].

Secondary pollutants (PM and ozone) are formed by complex pathways, a change in atmospheric chemistry brought about by the transition to net zero could increase their formation. This rise in secondary pollutants was evident during the first national lockdown during the Covid-19 pandemic, where roadside NO_2 concentrations fell dramatically due to the fall in vehicle use, changing the atmospheric chemistry leading to a rise in local ground level O_3 concentrations[14].

Summary
The relationship between climate change and air pollution is complex. Without action the impacts of climate change will worsen the air quality in the UK, increasing the health burden from exposure to air pollution. Achieving net zero may lead to a reduction in primary air pollutants but there may be unintended consequences for other air pollutants. However, policymakers can achieve substantial gains by approaching the challenges of air pollution and climate change together. For example, ensuring actions included in Net Zero supporting the transport modal shift, to options such as walking, cycling and public transport are delivered to maximise the air quality and health benefits.

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Professional Development Questions

1. How could hotter, drier summers have a negative effect on air quality?

2. What are the potential unintended consequences for air quality of achieving net zero?

For answers, see separate document “Model Answers to CPD Questions” on the Sustainable Development Resources introductory page https://www.fph.org.uk/policy-campaigns/special-interest-groups/special-interest-groups-list/sustainable-development-special-interest-group/resources-on-sustainable-development-and-climate-change

FPH General CPD Questions

1. What did I learn from this activity or event?

2. How am I going to apply this learning in my work?

3. What am I going to do in future to further develop this learning and/or meet any gaps in my knowledge, skills or understanding?