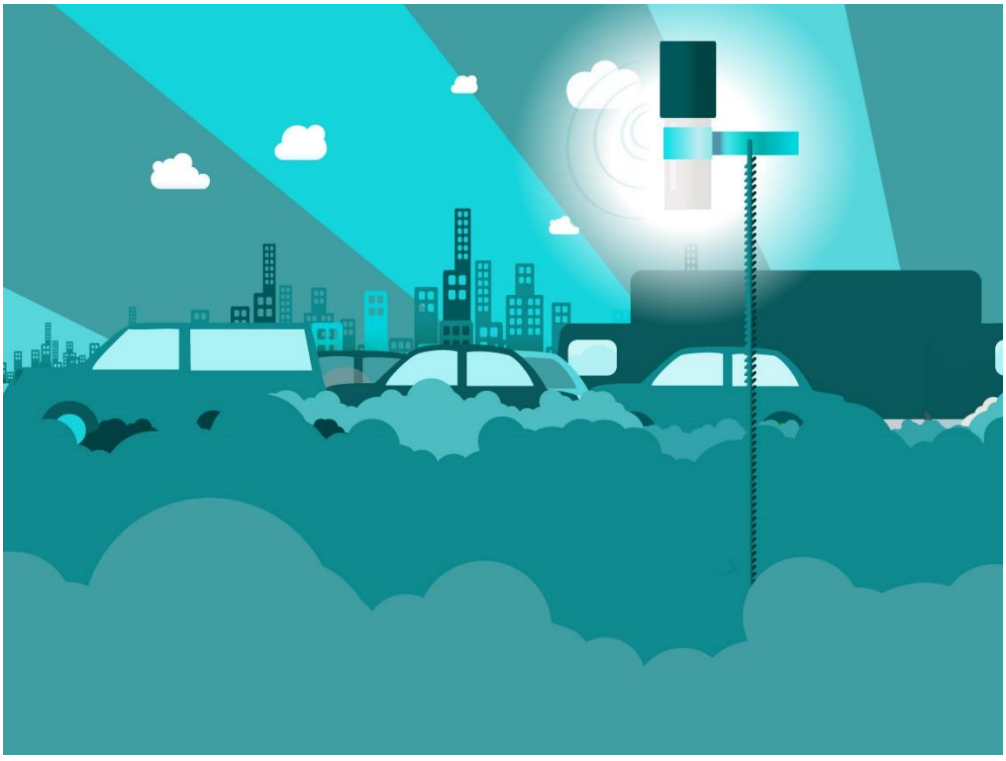
Some Facts about Air Pollution



From "Learning about air quality".

Teacher resource

Contents

In this resource, you will find up-to-date information on air pollution. It complements the main teacher resource "Catch them if you can" (NO_2 measurements and learning activities). Feel free to convey some of the key points in your own way to account for your students' age, sensitivity, health profile, etc.

1. Why air pollution matters

It is key to raise awareness about air pollution as it negatively impacts human health, the environment and is strongly linked to climate change.

When we think about air pollution, images may instantly spring to mind, such as billowing smoke from car exhaust and chimney stacks. Although it is now **mostly invisible to us**, it **still has a significant impact on our health**.

Many studies have contributed to the understanding of the impact of air pollution on health. Starting in 1974, the Six Cities study involved over 8,000 people in six locations in the US for sixteen years. A correlation between mortality rates and air pollution was found; in the most polluted town the mortality rate was nearly 30% higher than in the least polluted town.

The evidence that **air pollution impacts human health and shortens lives** is unequivocal and has been confirmed by many subsequent studies. In Ireland, over 1,510 premature deaths each year are attributable to air pollution. This is 10 times more than road deaths! The National Health Service says that almost 30% of preventable deaths in England are due to diseases specifically attributed to air pollution.

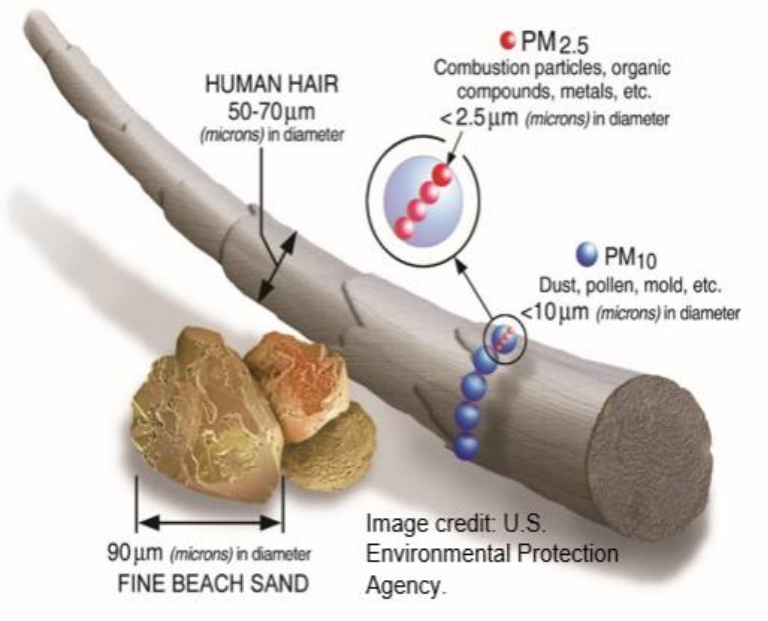
2. What air pollution is

Humans create air pollution through a range of activities that involve the **combustion of fossil fuels**[1] (including ground transport, air travel, shipping, heating, power generation and manufacturing), **agriculture** or **construction/demolition**.

Pollutants include tiny particles and gases that are harmful to human health. In Ireland, the main pollutants of concern for human health are particulate matter (PM) and nitrogen dioxide (NO_2).

a. Particulate matter

Particulate matter (or particle pollution) are a mixture of solid particles and liquid droplets found in the air. Some particles such as sand, soot or smoke are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope[2].



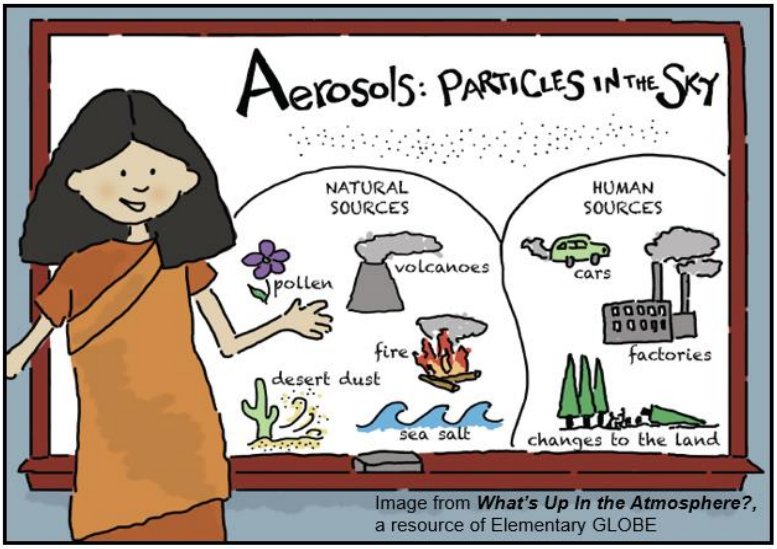
PM is extremely small. If put side-by-side like beads on a necklace, a chain of five PM_{10} is like the diameter of a human hair; and four $PM_{2.5}$ can fit across a PM_{10}.

Natural particles like sea salt or pollen form larger particles that our body can filter. In contrast, fine particulates (known as $PM_{2.5}$) are usually man-made and a major health worry as they can penetrate our lungs, pass into your bloodstream and get embedded in our organs and brain.

Particles in the air come in a variety of natural and man-made sources:

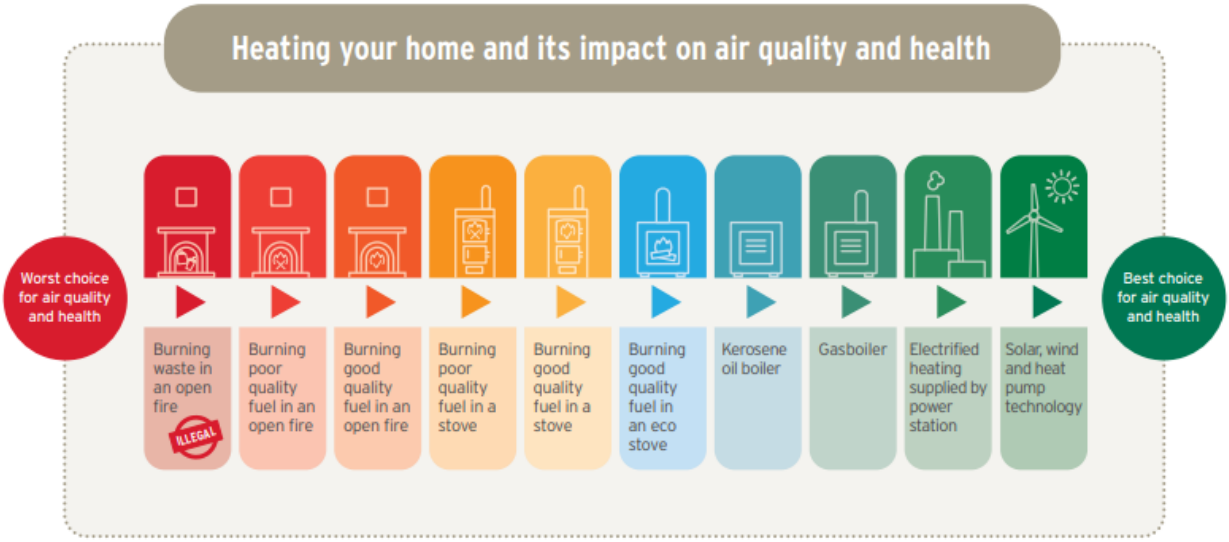
[1] Fuels such as peat, coal, crude oil or natural gas formed in the geological past from the remains of living organisms.

[2] A microscope with high magnification and resolution, employing electron beams in place of light and using electron lenses



Particle pollution in Ireland

The burning of solid fuels such as peat, briquettes, wood or coal in open fires and domestic stoves[3] contributes the most to particulate pollution in Ireland. Different ways of heating a home are listed below starting on the left from the most harmful one in terms of air pollution to the cleanest on the right:



Credit: EPA. http://www.epa.ie/media/Home_Heating_Infographic_v2.pdf

[3] In Ireland, the natural gas grids developed later than in the rest of Europe. The lack of widespread natural gas leaves the winter air of Ireland's towns and cities dominated by particle air pollution from home heating with coal, peat and wood.

Most particles from traffic form in the atmosphere as a result of chemical reactions: **nitrogen oxides emitted by the exhaust of diesel vehicles go on to form one of the major components of our particle exposure from traffic**. Otherwise, particles from traffic are produced by tyres, breaks and, in the case of diesel vehicles, are also directly emitted by exhausts.

Ammonia emitted by farming activities reacts in the atmosphere with other chemicals to also produce particulate matter.

World Health Organization's guidelines for PM:

$PM_{2.5}$:

- 10 $\mu g^4/m^3$ annual mean
- 25 $\mu g/m^3$ 24-hour mean

PM_{10}:

- 20 $\mu g/m^3$ annual mean
- 50 $\mu g/m^3$ 24-hour mean

b. Nitrogen dioxide

Nitrogen dioxide (NO_2) is a reddish-brown poisonous and nasty-smelling gas.

Nitrogen oxides (NO) are produced in hot combustion in the engine of diesel vehicles. When NO is released by the exhaust and meets fresh air, it combines with oxygen molecules to form nitrogen dioxide (NO_2).

The main source of NO_2 are diesel powered vehicles (cars, buses, lorries and trains). It was discovered recently that some new diesel vehicles produce more NO_2. The increase in exhaust pipe NO_2 is due to technologies to reduce the emission of other pollutants from the exhaust, including particles.

By contrast, NO is filtered by the exhaust of modern petrol cars, which emit much lower levels of NO_2. Electric cars produce none directly.

World Health Organization's guidelines for NO_2:

- 40 µg/m3 annual mean
- 200 µg/m3 1-hour mean

FAQ: my family owns a diesel car – shall I feel bad about it?

[4] Pronounce "microgram". A microgram is 10^{-6} of a gram (or 0.000001g).

The purchase of diesel cars was encouraged by governments in Europe through subsidies. As a result, around 50% of the cars on European roads are diesels [information from Ireland]. Europe is an exception among the major car markets that also include the US and Japan, as Europe accounts for around 70% of all the world's diesel vehicles. For example, in the US diesel cars account for less than 5% of the fleet.

Subsidies had different motives including that it was believed diesel cars would emit less carbon dioxide than petrol cars, a greenhouse gas that contributes to climate change. Studies now show that in real-world use petrol and diesel cars emit about the same carbon dioxide. So, in hindsight subsidizing diesel was a bad idea as it contributes significantly to air pollution without benefiting the environment.

3. People most affected by air pollution

Everyone is affected by air pollution; however, some people are more at risk than others. This includes people with:

- **asthma**: exposure to air pollution might worsen the symptoms or trigger asthma attacks.
- **a lung disease**, such as chronic bronchitis (also called chronic obstructive pulmonary disease or COPD) or cystic fibrosis: exposure to air pollution might worsen the symptoms
- **a cardiovascular (heart) disease**: exposure to air pollution might induce symptoms such as palpitations, chest pain or shortness of breath.

People can also be more susceptible to some types of air pollution in certain life stages:

- **Unborn babies (pregnant women):** exposure to high levels of air pollution over longer time periods (i.e. weeks to months) may be linked to adverse pregnancy outcomes such as reduced birth weight or preterm birth.
- **Children** are likely to be more vulnerable to exposure to air pollution compared to adults for the following reasons:
  - Their lungs are still growing and developing
  - Their immune and metabolic systems are still developing
  - They suffer from frequent respiratory infections
  - They are more active outdoors than adults and therefore breathe in higher doses of outdoor pollutant
- **Older adults**: older people are more likely to be affected by air pollution, perhaps due to generally weaker immune systems, or undiagnosed respiratory or cardiovascular health conditions. Air pollution can aggravate heart disease and stroke, lung diseases such as

chronic bronchitis (also called chronic obstructive pulmonary disease or COPD) and asthma.

4. Air quality in Ireland

Below are some key points from the EPA's report "Air Quality in Ireland 2017" that can be downloaded here.

When comparing air monitoring data (collected in 2017 from 29 stations in Ireland) to the World Health Organization (WHO) guideline values:

- the PM_{10} 24hr guideline was exceeded at 11 monitoring sites.
- the $PM_{2.5}$ 24hr guideline was exceeded at 9 monitoring sites and the annual guideline at 1 monitoring site.
- the NO_2 1hr guideline was exceeded at 1 monitoring site.

The 2017 data show that burning of solid fuel is the biggest threat to good air quality in Ireland, followed by emissions from vehicle exhausts.