



Teachers' Pack

<http://carefor.kentair.org.uk>

What is the aim of the Care for KentAir website?

The aim of the Care for KentAir website is to provide a resource that can be used by teachers in Kent to help facilitate learning about the importance of good air quality and learn more about climate change. The site is primarily targeting the 11-13 age group about air pollution through use of the Care for KentAir website although other age groups may benefit from the resource.

What is the aim of these notes?

To provide late year primary school and early year secondary school teachers with supplementary information on the subjects and materials on the Care for Kentair webpages. The teacher's notes are not meant to provide complete lesson planning as this will be bespoke to each classroom and age group. These notes provide information on the site, lesson ideas to promote learning around the subjects or air quality and climate change, plus a simple test to assess understanding.

These notes also refer to other resources and provide a Links section that teachers may find useful.

The Care for Kentair website also links to the KentAir website that provides air quality information and reporting, as well as having a quiz and other information that may be useful in the teaching environment.

Air quality

The website should provide a resource that can be used to plan lessons about air quality and how poor air quality can impact on our lives. Often the air we breathe is taken for granted, however poor air quality can impact on the health of people especially the young, old and those with specific health conditions. By using the website, students should be able to:

- Find out about the main pollutants affecting air quality
- Understand different techniques used to measure concentrations of pollutants in the air
- What concentrations are like in the local area in Kent
- The impacts of poor air quality
- How weather affects air quality
- How to make a difference to the local air quality

Climate change

The website should also facilitate learning about the basics of climate change:

- What the causes of climate change are
- What the sources of 'Greenhouse' gases are
- What the impacts of climate change are
- How to make a difference to climate change

Background understanding for the teacher

What is air quality?

The term “air quality” essentially means the state of the air around us. Good air quality refers to clean, clear, unpolluted air. Poor air quality is a result of a number of factors, including emissions from various sources, both natural and anthropogenic. Clean air is required to maintain the delicate balance of life on earth— not just for humans, but wildlife, vegetation, water and soil. Poor air quality is generally considered to be present when pollutants reach high enough concentrations to endanger human health and/or the environment.

The UK government use a daily air quality index (DAQI) (<http://uk-air.defra.gov.uk/air-pollution/daqi>) which provides users with information about levels of air quality and provides recommended actions and health advice. The index is numbered 1-10 and divided into four bands, low (1) to very high (10), to provide detail about air pollution levels in a simple way, similar to the sun index or pollen index. Although details of the air quality index are not provided directly on the Care for KentAir website, there are links from that site to the KentAir site which does provide information on the DAQI

More information about the Daily Air Quality Index is available from the UK-AIR website (<http://uk-air.defra.gov.uk/air-pollution/daqi?view=more-info>).

What is air pollution?

Air pollution is considered to have occurred when there is introduction of a substance into the air that has harmful or poisonous effects to humans, animals or that could cause damage to plants and materials. The substances that cause air pollution are called pollutants. Air pollutants mainly occur as a result of gaseous, fume or particulate discharges from anthropogenic (human activities). Sources vary but can include industry, transport or power generation. There are also natural sources such as wind-blown dust, volcanic eruptions or smoke from forest fires. There are many types of pollution, however the Care for KentAir website concentrates on nitrogen dioxide (NO₂), sulphur dioxide (SO₂), ozone (O₃), particulates (PM₁₀ and PM_{2.5}) and carbon monoxide (CO).

Primary and Secondary Pollutants

Primary pollutants are those pollutants that are emitted into the atmosphere directly polluting the air. Primary pollutants include sulphur dioxide from mineral based solid fuel combustion such as coal and carbon monoxide from car exhausts. Further pollution can arise if primary pollutants in the atmosphere undergo chemical reactions. The resulting compounds are called secondary pollutants, an example of such a pollutant is ground-level ozone. Ground-level ozone forms when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight.

Historical explanation of air quality and pollution

Prior to urbanisation and industrial emissions, nature's own systems kept the air quality reasonably consistent. Wind allowed gases to be dispersed, rain washed dust and other easily dissolved substances from the air to the ground and plants absorbed carbon dioxide and replaced it with oxygen through photosynthesis.

Through increasing urbanisation and industrialisation, humans started to release more pollution into the atmosphere than the Earth's environmental processes could cope with. The adverse effects of poor air quality were highlighted in London in 1952 when, in just a few days, an estimated over 4000 people died from effects of air pollution during the smogs. This subsequently led to legislation to start to control air pollution. It is the air pollution that led to London getting the nickname of "The smoke".

More about pollutants

The following section provides information on a number of pollutants and some specific information relating to their health effects. Further resources are available in the Links section.

Nitrogen dioxide (NO₂)

Nitrogen dioxide is a red/brown coloured gas with a sharp, unpleasant smell. NO₂ is made up of one nitrogen atom. It is a secondary pollutant and is created when nitric oxide (NO) – formed in the combustion process – reacts with oxygen in the atmosphere. It is generally formed when fuels are burned at high temperature, such as in a vehicle engine.

The major sources of NO₂ in the UK are through the burning of fossil fuels (coal, oil, gas, petrol and diesel) for domestic heating, power generation and road transport. In Kent and Medway, transport emissions are thought to be the largest contributor to NO₂ air concentrations which are highest near busy and congested roads.

NO₂ can be formed naturally in the atmosphere by lightning and can also be produced by plants; although naturally formed NO₂ only represents a fraction of the total NO₂ found in the atmosphere.

Nitrogen dioxide has an important role in the formation of other pollutants – including ozone, which can be produced from chemical reactions involving NO₂, in warm, sunny conditions.

Nitrogen dioxide (NO₂) and health

Nitrogen dioxide is an irritant to the respiratory system (airways and lungs). Where there are increased levels of nitrogen dioxide in air we breathe, the result can be an increased likelihood of respiratory problems. It is also believed that breathing air with increased levels of NO₂ can reduce resistance to infections of the respiratory system, and therefore may make people more vulnerable to catching infections such as coughs, colds, flu etc.

People who are young and healthy are unlikely to experience serious effects from short-term exposure to moderate concentrations of nitrogen dioxide and other pollutants. However, increased levels of nitrogen dioxide can have more serious impacts on people with existing heart or lung problems, because it can cause a worsening of their symptoms.

Sulphur Dioxide (SO₂)

Sulphur dioxide is a colourless gas and has a pungent, irritating smell. SO₂ is made up of one sulphur atom and two oxygen atoms. It reacts with other chemicals to form harmful compounds such as sulphuric acid (H₂SO₄) that can cause acid rain.

SO₂ can be formed naturally and emitted by volcanoes or from geothermal hot springs – not many of these are found in Kent! However, emissions from volcanoes such as those that erupted in Iceland in 2010, can travel thousands of miles – it is not just local emissions that affect your environment.

The major sources of SO₂ in the UK have decreased significantly over the last few decades. The largest current sources of SO₂ in the UK are from the processing and burning of materials containing sulphur such as the generation of electricity from coal and oil at power stations and from combustion processes such as solid fuel burning and particularly in industry. Shipping emissions may also be a potential source of SO₂ in busy coastal areas.

The Kingsnorth Power Station in Kent which began operating in the 1970's closed in 2013 as it could not meet stricter emissions requirements for SO₂. Newer coal and oil fired power stations can have systems to remove large proportions of SO₂ that are produced.

Sulphur dioxide (SO₂) and health

Sulphur dioxide can have adverse effects when it is inhaled. It irritates the nose, throat, and eyes and can cause the airways to become inflamed, which can then cause coughing, wheezing, shortness of breath and can even result in a tight feeling in the chest. Asthma sufferers are believed to be more sensitive to sulphur dioxide. The effects can be felt after just a short time; this is why the UK has an air quality standard based on the 15 minute average SO₂ concentration.

Particulates (PM₁₀ and PM_{2.5})

Particulates are very fine particles found in the atmosphere and be made of a wide range of different materials from many different sources.

When scientists talk about particulates they generally categorise them into two main groups, depending on the size of the particles. PM₁₀ is the term given to a group of particles of up to 10 microns in size. PM_{2.5} refers to the group of smaller particulates up to 2.5 microns in size. To give a sense of size, a human hair is 50-70 microns in diameter so five to seven times as big as a single PM₁₀ particle and over twenty times bigger than a PM_{2.5} particle. Microns are very small indeed – 1 micron is equivalent to one thousandth of a millimetre!

PM_{2.5} is made up of finer particles than PM₁₀, including organic compounds and some metals. These fine particles are emitted by all types of vehicles and some industrial processes. Other sources include natural sources such as forest/wild fires – geology suggests that 55 million years ago, at Scalers Hill near Cobham in Kent, a series of regular

and severe wild fires occurred! Fires still occur in Kent, although they are usually started accidentally or deliberately.

The particles that make up PM_{10} includes $PM_{2.5}$ particles, but is also made up of coarser particles including dust, pollen and mould. These small sized particles can be produced from human activity through road transport, diesel trains, shipping, industry and solid fuel burning or naturally occurring such as sand and sea salt.

The smaller particles are lighter therefore they stay in the atmosphere longer and travel further. PM_{10} particles can stay in the air for minutes or hours while $PM_{2.5}$ particles can stay in the air for days or weeks.

Maybe you've noticed particulates resulting from sea salt or sand if you live near the coast in Kent? Having said that, even sand from the Sahara Desert can affect the UK, as can particulate from human activity on the continent.

Particulates (PM_{10} and $PM_{2.5}$) and health

When air is inhaled, along with the air, any particles in the air are also inhaled. The particles can travel through the airways and the lungs. Larger (coarser) particles may be trapped by nose hairs, or the mucus which coats the sides of airways. These larger particles that can be caught in airways can cause coughing as it causes the body to produce more mucus and a cough is needed to help clear the airways. PM_{10} particles however, can get into the airways in the chest, and $PM_{2.5}$ particles can travel right into your lungs. Inhaled particulate matter can irritate and inflame the airways and lungs which can worsen the condition of people who already have a heart or lung disease. In addition to this, the particles can carry surface-absorbed carcinogenic compounds (i.e. directly involved in causing cancer) into the lungs.

Ozone (O₃)

Ozone is a very pale blue, almost colourless gas made up of three oxygen atoms joined together. It has a distinct smell at high concentrations.

Ozone is a naturally occurring gas in the upper layers of the atmosphere, between 10 and 30 miles above the earth's surface, which protects the earth from the sun's harmful ultraviolet rays. You'll probably have heard it referred to as the ozone layer.

However, at ground level, ozone is a harmful secondary air pollutant. Ozone is created by chemical reactions between emissions from industrial facilities, vehicle exhausts and chemical solvents in sunlight. Nitrogen oxides (NO₂ and NO) and volatile organic compounds (VOCs) react in the presence of sunlight to produce ozone. Ozone and the primary pollutants that lead to its production can also be transported long distances e.g. from continental Europe.

In the UK, ozone is the most common cause of air quality problems in rural areas such as some parts of Kent. The highest levels of ozone pollution occur in the summer on hot, sunny, windless days.

Ground level ozone is harmful to health, it can have a noticeable effect on health, triggering asthma, causing breathing problems, reducing lung function and potentially causing lung diseases. At sufficiently high concentrations, ozone is also harmful to plants and trees. Ozone can also corrode building materials, statues and monuments, and natural rock features in the landscape.

Ozone (O₃) and health

At sufficiently high concentrations, ozone can also be harmful to plants and trees. It is a powerful oxidising agent which means it readily transfers oxygen and is highly reactive. These properties make ground level ozone dangerous to living things. Ozone has the same kind of effect on human health as NO₂ and SO₂ – it is an irritant. In contact with living tissues, such as our eyes, airways and lungs, ozone irritates the cells, causing inflammation. Asthma or other respiratory symptoms can be exasperated by ozone. It can damage, also age or bleach some man-made materials such as fabrics.

Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless and tasteless gas that is slightly less dense than air. It is made up of 1 carbon and 1 oxygen atom.

CO is produced by the incomplete burning (i.e. there is not enough oxygen for each carbon atom to combine with two oxygen atoms) of carbon-based fuels, including petrol, diesel, gas, oil, wood and coal - this could have been a particular problem historically in Kent when wood or charcoal fires were used to dry hops in Oast Houses. In recent years though, CO is mostly produced by road transport, in particular petrol – vehicles.

If you have a solid or gas boiler or fire or other non-electrical heating you may have a CO sensor/alarm to warn of CO emissions if the appliance is not operating correctly. CO emissions can kill within minutes if inhaled. The early symptoms can be nausea/feeling sick and a feeling of disorientation. Carbon-based fuels are generally safe to use, it is only when the fuel does not burn completely so that CO is produced instead of CO₂ which is formed when combustion is complete (i.e. in the presence of plenty of oxygen).

CO can affect the transport of oxygen in the blood and reduce the supply of oxygen to the heart, particularly in people suffering from heart disease.

Carbon monoxide (CO) and health

Outdoors, carbon monoxide never reaches lethal concentrations. However, near very busy city roads, concentrations of carbon monoxide can become high enough to affect the health of people who have heart disease. At high concentrations it is dangerous because it combines with the haemoglobin in blood - when this happens haemoglobin is unable to absorb the oxygen we breathe so is unable to transport it around the body. Dangerous concentrations of CO can build up indoors, for example if there is a faulty boiler or heating appliance resulting in incomplete combustion.

What is Climate Change?

Climate change is a large-scale, long-term shift in the planet's weather patterns or average temperatures. The Earth's temperature depends on the energy balance between energy entering and leaving the planet's system. If there is more energy absorbed than released, the Earth warms. Many factors, both natural and anthropogenic, can cause changes in Earth's energy balance these can include variations in the amount of energy reaching Earth from the sun, the reflectivity of the earth and changes in the greenhouse effect (affects the amount of heat retained by the Earth's atmosphere).

After analysing a number of indirect measures of climate such as ice cores, tree rings, glacier lengths, pollen remains, and ocean sediments, and by studying changes in Earth's orbit around the sun, Scientists believe that the Earth's climate has been relatively stable at about 14 °C since the last ice age which was about 11,000 years ago. In recent years however, the average temperature has been observed to be increasing. According to an ongoing temperature analysis conducted by NASA scientists, the average global temperature on Earth has increased by about 0.8° Celsius between 1880 and 2014, with two-thirds of the increase occurring since 1975 with the rate of increase being about 0.15-0.20°C per decade.

Climate change can affect various aspects of climate including changes in:

- Precipitation
- Sea levels
- Glaciers and ice sheets

Precipitation

There have been many examples of changes in rainfall, for example the Met office have reported that the UK's summer rainfall is decreasing on average, while winter rainfall is reported to be increasing. There is also evidence that heavy rainfall events have become more intensive in other areas of the world.

Sea level rises

It has been reported by the UK Met Office, sea levels have risen by about 10 cm around the UK since 1900 and the increase has been greater globally at about 19 cm on average.

Retreating glaciers and shrinking ice sheets

There is an increased rate of shrinkage of glaciers all over the world including those in the Alps, Rockies, Andes, Himalayas, and Alaska. Ice sheets such as those in Greenland and Antarctic are both shrinking at an accelerating rate.

Climate change is likely to bring about changes that can affect our water supplies, agriculture, power and transportation systems, the natural environment, and even our own health and safety and therefore it is something that needs to be taken seriously.

The learning tools available on the Care for KentAir website

Although there is a lot of information on the Care for KentAir website, there are three main interactive areas on the website, these are the interactive Pollutants page, the Emissions Calculator and the My Local Area section.

About Air Quality and Climate Change. Pollutants - what you need to know

Care for KentAir

About air quality & climate change

Pollutants - what you need to know

Sources of air pollution

Health impacts of air pollution

Measuring air pollution

How can I make a difference to air quality?

Why is weather important to air quality?

About Climate Change

How can I make a difference to Climate Change?

Pollutants - what you need to know

Choose from the list of pollutants related to air pollution below, the image will update to illustrate the causes of each.

NO₂ SO₂ **PM_{10/2.5}** O₃ CO

Particulates (PM₁₀ and PM_{2.5})

PM₁₀ PM_{2.5}

This page enables the user to click on the individual pollutants at the bottom of the image to highlight the potential sources of the individual pollutants. Doing this also displays additional information relating to the pollutants below the image. Students will be able to prepare notes on the pollutants, their chemical structures and what the potential sources of the pollutants are.

Emissions calculator



Emissions calculator

Use the emissions calculator below to explore how emissions you generate when you travel in cars, buses, or even motorcycles!

Once you've entered the details into the form, graphs will be generated to show you how it all compares.

Transport Type: Distance to your school (miles): Passengers:



Your calculated emissions for a Petrol Car

Explore each result and graph to understand the emissions further. [Read how we calculate this, and the assumptions made](#)

NO_x
264 g

Annual vehicle emissions of oxides of nitrogen (NO_x) per person

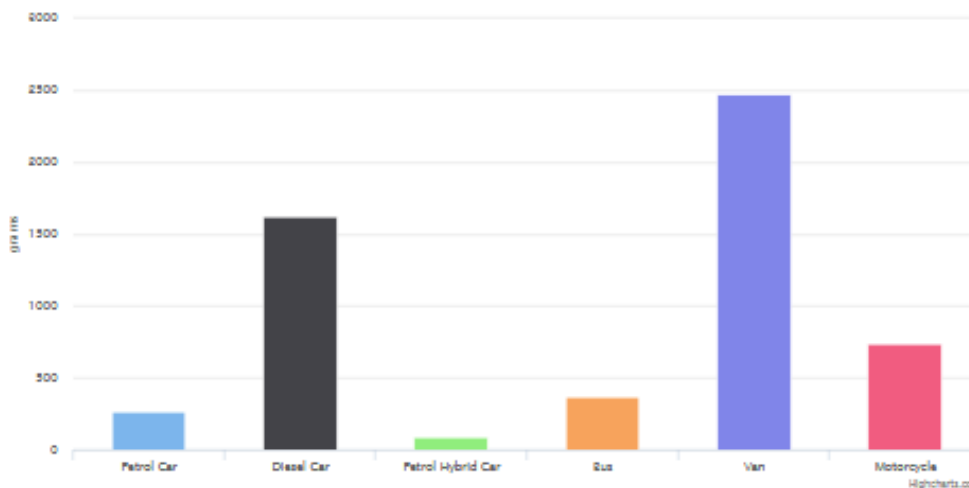
PM₁₀
88 g

Annual vehicle emissions of particulate matter, per person

CO₂
432 kg

Annual vehicle emissions of carbon dioxide (CO₂) per person

Annual vehicle emissions of oxides of nitrogen (NO_x) per person (grams)



This page enables the user to enter their chosen vehicle, mileage and passenger numbers and the tool will then estimate emissions per person by the vehicles. Students could use this to compare emissions from various scenarios (e.g. car journeys against bus journeys)

What's air quality like in my local area?



What's air quality like in my local area?

Enter the location of your home or school below and find out the nearest air quality monitoring site near you.

Top tips for searching

- Make sure the location you enter is in Kent!
- Adding a postcode will help you get a more accurate location
- Ensure you have Javascript enabled in your web browser

For more comprehensive information about air pollution levels and how they affect the whole of Kent, take a look at the [KentAir website](#).



KentAir
Reporting Air Quality
in Kent and Medway

Want to know more?
There's lots more detail
about air quality at [KentAir](#)

© 2015 Ricardo Energy & Environment
[Cookies and Privacy Policy](#)



This web page enables the user to enter a location in Kent then the local Air Quality monitoring sites are displayed on the map. The user is then able to click through to the site information and data from that site which is available on the KentAir website. Students could download data from the KentAir website and then plot this in a graphics package. It may be possible to identify either periods of high ozone which happen in summer or increases in concentrations of NO₂ and particulates during the daily commuting times at roadside sites.

Lesson activity Ideas

A plan of potential lesson activities has been produced and this is available from the Downloads page (<http://carefor.kentair.org.uk/downloads/>) along with a simple test.

Links to further resource information from third party websites

Teaching resources – the following websites have information that may be useful in aiding lesson plans or providing activities for pupils to either take part in or that can be used in classroom demonstrations:

<https://en.vmm.be/publications/joaquin-air-pollution-lesson-package>

This lesson package has been designed for students aged 9 – 12 and is built around four separate interactive lessons. It was originally developed to aid learning in Belgium.

<http://www.opalexplornature.org/schools>

The Open Air Laboratories (OPAL) network is a UK-wide citizen science initiative that allows you to get hands-on with nature, whatever your age, background or level of ability.

<https://www.tes.com/teaching-resource/unit-9g-environmental-chemistry-pollution-1-6076077#> and <https://www.tes.com/teaching-resource/unit-9g-environmental-chemistry-pollution-2-6076080>

Resources from TES

<http://www.grida.no/climate/vital/intro.htm>

The United Nations Environment Programme has produced a number of videos online or other electronic media that provide information about climate change from a variety of perspectives. An introduction to climate change can be found here.

http://www.grida.no/files/publications/vital_ozone_graphics_2/ozonell_updt.pdf

Pupils may confuse ground level ozone contributing to reduced air quality and the ozone layer which protects the earth from harmful radiation. It may be helpful to provide them with a simplified explanation of how the ozone layer works and informing them of the health effects of ozone. Useful information relating to the ozone layer that may be suitable for teachers.

[https://www.london.gov.uk/sites/default/files/CA4S%20Toolkit\[1\].pdf](https://www.london.gov.uk/sites/default/files/CA4S%20Toolkit[1].pdf)

The London Sustainability Exchange have prepared a toolkit that provides tools to identify areas of poor air quality around a school, promotes pupil understanding of the causes and impacts of air pollution and gives ideas for engaging staff, pupils and parents/carers in improving air quality.

<http://www.cleanerairforlondon.org.uk/projects-campaigns/cleaner-air-for-schools/educational-air-quality-activities>

Clean Air for London provide an excellent resource that includes teacher-led activities which can help young people learn about the sources and effects of air pollution. This resource also contains videos that might form a useful visual addition to a lesson.

http://www.foe.co.uk/learning/educators/resource_index.html

Friends of the Earth educational resources relating to the environment and climate change.

Higher level learning – the following sites may have information that is beyond the target age range but may still be useful for some students or teachers:

<http://www.kentair.org.uk/>

KentAir website which is a network that is funded by the district and borough councils within the county, with an additional contribution from Kent County Council. The aims of the network are to promote the improvement of air quality within the region.

<http://carefor.kentair.org.uk>

<http://uk-air.defra.gov.uk/>

Defra's air quality information resource

<http://www.who.int/mediacentre/factsheets/fs313/en/#>

Factsheet relating to ambient (outdoor) air quality and health from the World Health Organisation (WHO)

<http://naei.defra.gov.uk/>

The National Atmospheric Emissions Inventory provides an overview of the main pollutants.

<http://www.knowyourairforhealth.eu/spip.php?rubrique43>

An educational resource prepared by the Health and Environment Alliance (HEAL) that provides information on pollutant, health and air quality.

Other links that may be of interest are available at

<http://www.kentair.org.uk/related-links>

There are many resources available to teachers to aid learning relating to air quality and climate change some have been selected and are shown below with a brief description of their content. It should be noted that the content of third party websites is not controlled by KMAQMP or Ricardo Energy & Environment therefore content should be reviewed and links checked prior to using the links in a classroom environment.

This teachers' pack, related resources and website was created and hosted by Ricardo Energy & Environment and was funded by contributions from Kent County Council Public Health and Medway Council Environmental Protection.

Ricardo Energy & Environment is a leading global sustainability consultancy and has expertise in air quality and climate change. Our consultants have experience of providing monitoring solutions in urban areas including mobile units that can be used around schools and also have expertise in citizen science programs involving pupils getting hands-on measurement experience which aim to allow the collection and analysis of air pollution data as a school project (for example <http://cleartheair.scottishairquality.co.uk/citizen-science>). To find out more about Ricardo-Energy & Environment go to ee.ricardo.com.