Deliver Change

Key Stage 4 AQA BIOLOGY 4401
GCSE

Lesson 2: "Outdoor air pollution, pollution indicators and environmental change"
Divided into two Parts:
Length of Part 1 can take 15 minutes
Length of Part 2 can take 1 hour

For Exams June 2014 onwards
Lesson Topics:
B1.4.1 Environmental Change
B3.4 Humans and their environment
http://filestore.aqa.org.uk/subjects/AQA-BIOL-W-SP-14.PDF *page 21 and 53*

CURRICULUM

3.3 Unit 1: Biology 1
B1.4.2 Environmental change
Part C: Living organisms can be used as indicators of pollution: Lichens can be used as air pollution indicators, particularly of the concentration of sulphur dioxide in the atmosphere.
Part D. Additional guidance: Candidates should understand the use of equipment to measure oxygen levels, temperature and rainfall.

CURRICULUM

Unit 3: Biology 3
3.4 Humans and their environment
Analyse and interpret scientific data concerning environmental issues.
Candidates will be given data to work from.

LESSON PLAN

Part 1: In the first half of the class students will be reminded of what air pollution is, with an emphasis on outdoor air pollution. Students will learn about the ways air pollution is a growing concern. The information provided can be of use to teachers as well as students, and may be useful for student exam and project revision.

Students will be taught about the different ways of identifying pollution, from using sensor equipment to natural organisms. In this class there is a key focus on using lichen and how it is used to detect and determine the types of pollutants present in the atmosphere. The class will be shown images of three types of lichen that are present in the UK.

Part 2: In the next half of the class students will be introduced to AirSensa data (providing real-time recordings of common and local air pollutants and interpret trends and patterns in outdoor pollution levels in their local area and across London. Students are asked to complete two tasks that help students understand the air quality in their environment. One is based around the data and the other on natural lichen growth.
For schools that do not have an AirSensa, Deliver Change can supply a prepared data set to be used in class. For schools that have their own AirSensa, accessing data is described in Part 2.

LEARNING OBJECTIVES

- Explain the difference between primary and secondary pollutants.
- List several of the pollutants that increasingly afflict human environments and state the major sources of these pollutants.
- Understand how climate and environmental change, with a focus on air pollution, can be identified and measured using natural and living indicators, such as lichen.
- Students will engage with AirSensa data records to interpret trends in pollutant levels.
- Students will use AirSensa data to describe specific and general patterns of air quality across London.

LESSON REQUIREMENTS:

- Part 1 class handout
- Task 1 and Task 2 handout
- AirSensa data
- Paper and pens
- Web access/ access to outdoor pollution and weather information
- Outdoor clothing

Part 1

What is Outdoor Air Pollution?

Air pollution occurs when the air contains gases, dust, fumes or odour in harmful amounts. That is, amounts which could be harmful to the health or comfort of humans and animals or which could cause damage to plants and materials.

The substances that cause air pollution are called pollutants. Pollutants that are pumped into our atmosphere and directly pollute the air are called *primary pollutants*. Examples of primary pollutant include carbon monoxide from car exhausts and sulphur dioxide from the combustion of coal.

Secondary pollutants are formed when primary pollutants react in the air. Examples include:
- Ozone, formed when hydrocarbons (HC) and nitrogen oxides (NO_x) combine in the presence of sunlight to form O_3
- NO_2, which is formed as nitrogen oxides (NO_x) combine with oxygen (O_2) in the air;
- Acid rain, which is formed when sulphur dioxide (SO_2) or nitrogen oxides (NO_x) react with water.

Pollution is a growing concern.

In the days before large cities and industry, nature's own systems kept the air fairly clean. Wind mixed and dispersed the gases; rain washed the dust and other easily dissolved substances to the ground; and plants absorbed carbon dioxide and replaced it with oxygen. The systems of waste creation and waste consumption were relatively in balance through the processes of the natural world.

With increasing urbanisation and industrialisation, humans started to release more wastes into the atmosphere than nature could cope with.

Since then, more particles have been added to the air by industrial, commercial and domestic sources. The effects of air pollution were graphically illustrated in London in 1952 when, in just a few days, an estimated 4000 people died from effects of fine particle pollution.

It is when these concentrated gases exceed safe limits that we have a pollution problem. Nature can no longer manage air pollution and we need to take action against the increasing deterioration of our atmosphere.

Identifying Pollution

We often cannot see pollutants in the air we breathe because they may be colourless, tasteless and/or odourless. But this does not mean we are unable to detect them. We may use indicators of pollution to identify the presence of pollutants. Humans have created machines that can detect the type and abundance of various air pollutants, using large containers or small devices.

But not all indicators of pollution need to be man-made. Natural indicators of pollution are organisms in the natural environment whose presence, population and health can reveal a great deal about the functioning state of an ecosystem. We will now consider a plant-indicator: Lichen.

Lichens are plants that grow in exposed places such as rocks or tree bark. They need to be very good at absorbing water and nutrients to grow there, and rainwater contains just enough nutrients to keep them alive. Lichens are particularly responsive to environmental changes, in particular, changes in air quality. Air pollutants dissolved in rainwater, especially sulphur dioxide, can damage lichens, and prevent them from growing. Being able to detect the amount of stress that lichens are going through in an environment may indicate the amount of air pollution in the region. This is what makes lichens a natural indicator of air pollution.

It is important to note that different types of lichen flourish in different compositions of air. Different types of lichen can be used to determine the types of pollutants that are present in the atmosphere.

For example:

- Bushy lichens need really clean air
- Leafy lichens can survive a small amount of air pollution
- Crusty lichens can survive in more polluted air.

In places where no lichens are growing, it's often a sign that the air is heavily polluted with sulphur dioxide.

Types of lichen

Bushy lichen	Crusty lichen	Leafy Lichen

Part 2

Accessing the AirSensa data

If a school has its own AirSensa, the individual data can be accessed by adding in the school specific log-in code, that is shared with the head teacher or head of faculty. If you (the teacher) have not yet received access to the log-in code and data please contact the individual who is responsible for the AirSensa and it's data.

Once you have typed in the log-in code you will see a dashboard page which contains graphs of key air pollutants, with their level of pollution against a time gradient. Teachers can alter the time average by adding in the time-frame of pollutant measurements in the task bar at the top of the page. The data can also be downloadable as an Excel CVC file, allowing students to draw their own graph, if applicable.

If the school does not have its own individual AirSensa, Deliver Change will be able to supply a prepared data set for students to work with. In this case, please contact info@deliverchange.org to receive this information.

Task 1

Engage with the AirSensa data to prepare answers about:

- How air quality changes on a day to day and weekly basis around the school.
- How air quality changes across the London area.
- Where the pollution hotspots are within the capital.
- What times of day record spikes in levels of pollution.

Research:
- Develop ICT research skills by investigating factors that might affect sensor recordings, with a look to accurate air quality measurements. Such factors could include wind, location, temperature and other weather conditions.

- Explain how weather patterns can cause pollution to migrate, and name an example of where this has happened.

- Suggest how atmospheric chemical imbalances (creating harmful pollutants in the air) cause environmental damage. Pupils may wish to explore concepts such as acid rain.

Task 2

Practical Investigation:
Explore locations near your home or school building. See whether you can find any lichen near your chosen property, and if so, see if you can identify what type of lichens they are. If you cannot find any, consider reasons why this may be and discuss how else you might evidence the presence of lichen-inhibiting pollution.

As part of your investigation, describe and explain the variance of lichen presence and type in relation to the proximity of roads and green spaces.
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