PLANET CHANGE

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Air Pollution:
Looking at our own lives' impact

Teachers' manual

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Planet change is the short name of an EU Erasmus+ project aimed at VET teachers and their students. With small activities, the idea is to create awareness about sustainability and acquire 21st century skills. All this is done in a technical context, mostly from space technology.

www.planetchange.eu

Contents:

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1. General information

Duration: A set of days of autonomous work (depending on teachers' choice); 105 min of class time

Target group: 14-16 years old

European qualifications framework level: 2

Teacher preparation: Before starting the activity, teachers should have read the list of pollutant actions (and alternatives) and the exercise sheet and be prepared to support students in its completion. The first step, before starting the actual implementation of the activity, should be to raise awareness among students that gas emissions are a form of pollution, and that they come from various sources, many of them human-made.

The activity doesn't focus on calculating the exact polluting impact of a certain action, as it would be very difficult to find standardised values or measure each one of the tasks; rather, it intends to raise awareness of the multiple sources of the problem, to capacitate students to also reflect about diverse solutions and lifestyle changes.

Teachers should also be aware that the activity can be adapted to be implemented both with younger as well with older students. In this template, both versions can be found, and the one more suitable for younger students is marked with **Adaptation*.

Topic

Themes: air pollution

Keywords: *air pollution; human-made pollution; individual action; sustainability*

Activity

Goals
This activity intends to raise awareness among students about the role each one of them plays in air pollution, by making them reflect on the impact of their daily actions. They will register all the steps that constitute their everyday routines and try to search for the pollution potential of each one of them. This activity, as it is a simple one, should be used as a starting point and as an introductory challenge to introduce the topic of pollution and environment protection in the classroom.

Summary
In this activity, students will not calculate their specific pollutant emissions, but rather learn how to identify them by looking at their daily routines and reflect about them by categorising their sources. By looking at the most frequent origins of pollution in their daily lives, it will be easier to take action and understand which actions need to be taken

in specific areas. Also, they will be able to compare their emissions with the ones from a family member from another generation, which will spark a conversation about how families can collaborate on these issues. This activity aims at placing students at the centre of the problem and making them reflect, not only on their role in it but also on possible solutions.

2. Introduction

Air pollution refers to the release of pollutants into the air—pollutants which are detrimental to human health and the planet as a whole. The sources of this pollution are various, but the highest negative impact is propelled by energy use and production (Air Pollution: Everything You Need to Know), by activities such as burning fossil fuels and others that emit chemical and pollutant gases into the air. Most of these gases are greenhouse gases, which trap heat in the atmosphere, and contribute to the worrying rising of Earth's temperature.

Carbon dioxide (CO2) is the primary greenhouse gas emitted through human activities, which alter the carbon cycle– both by adding more CO2 to the atmosphere and by influencing the ability of natural sinks, like forests and soils, to remove and store CO2 from the atmosphere. The main human activity that emits CO2 is the combustion of fossil fuels (coal, natural gas, and oil) for energy and transportation. Stoves and incinerators, especially ones that are coal or wood-fired, and farmers burning their crop waste produce carbon monoxide, carbon dioxide, as well as particulates. Other human-made sources include aerosol sprays and gases leaking from refrigeration systems, as well as fumes from paint, varnish, and other solvents. Additional pollutants, like ozone and acids, are made in the atmosphere when human-made gases combine chemically (Source: Center for Science Education).

When talking about all these reasons, they can normally be categorised into four main groups, according to their source: (1) gasoline-burning vehicles and engines, (2) electricity from fossil fuels like coal, (3) activities that launch particles in the air like fires, (4) products that release chemicals into the air (like hygiene and cleaning products). However, we should also consider a large category - consumption -, which is estimated to be responsible for more than 60% of global GHG emissions (Environmental Impact Assessment of Household Consumption), and, consequently, for air pollution. Here, we can consider, especially, the consumer good people buy and use (food, electronics, textile), the transportation of that same goods, and the waste disposal (as landfills, where much of our waste ends up, produce methane, a potent greenhouse gas, and burning waste, such as in incinerators, can release harmful pollutants into the air, including dioxins and heavy metals).

Therefore, for the purposes of this activity, five sources of air pollution will be considered:

- gasoline-burning vehicles and engines
- electricity from fossil fuels like coal
- activities that launch particles in the air like fires
- products that release chemicals into the air (like hygiene and cleaning products)
- consumption and daily habits (food, electronics, textile, transportation processes and waste disposal)

3. Description of the activity (standard version)

The core of the activity is to comprehend the importance of space observation to track the existing air pollution, understand the multiple sources of air pollution, reflect on the impact of daily actions in the emissions, and self-reflect and analyse our routines and how they can be improved.

In terms of structure, this activity is divided into three parts:

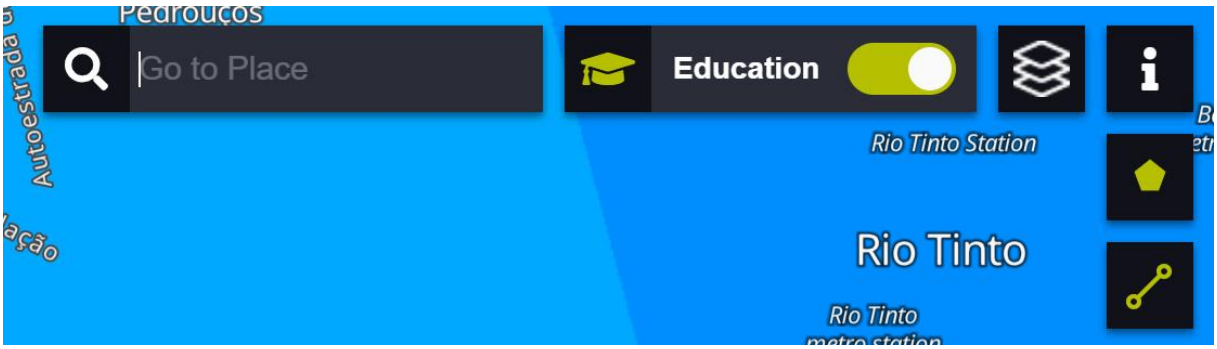
1. Satellites' eyes help from space
2. Where is the pollution coming from?
3. Reflection and future steps

The implementation that follows is the standard one. The alternative can be found further on this document.

Part 1: Satellites' eyes help from space (30 min)

Using the EO Browser

Satellites can be really helpful in monitoring the air quality all over the world and keep a record of its evolution over the years. The students should go to the EO Browser and register in order to use the app. First things first, we are going to select "Education" at the top of the page.



Up to the left, you can find the Theme selected. This is set to "Default" when the application starts. We can access to other themes by clicking and selecting in the theme list. Select "Atmosphere and Air Pollution". The application will display only the relevant features for this theme - in this case, we are able to check the emissions of different pollutant gases, and we can focus on just one or get an overview of all of them. We can also see that we are able to access only Sentinel 5P in data sources since this is the satellite for monitoring the atmosphere and air pollution.

Students can choose the area that they want to investigate - it can be a place in their own country or in another that they are curious about. They can search for it in the search bar, in the top-right area of the screen.

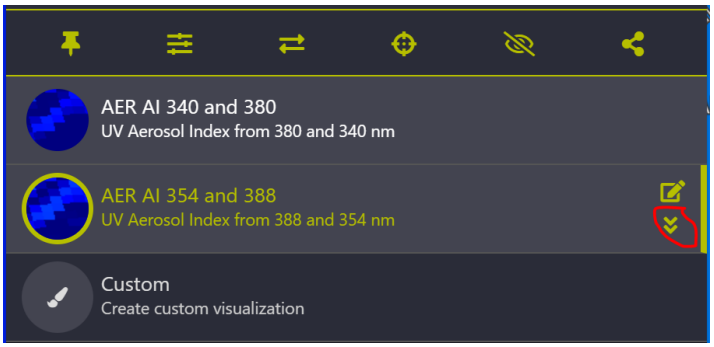
Analysing the polluting emissions all around us

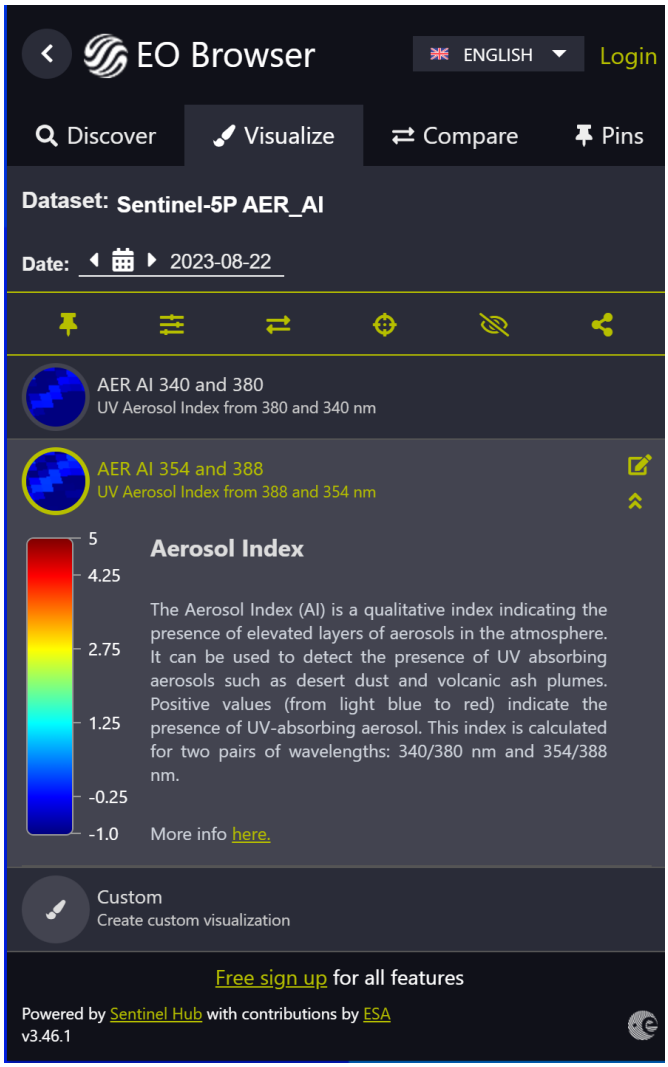
Step 1: Analyse the situation in the area chosen. To make things more interesting, you can perform the following actions:

- Let's play with the time. Select the "Time range" to define the time interval for searching images. Click in the two dates (small calendars). In this case, we select from 2022-06-01 to 2022-09-30. Click over the button "Search" (green button, see picture above). The Search window changes into a new window showing the results. We proceed to choose one image. Select the image taken on a specific date within the time range selected, according to your preference, as the example below shows. Now, you should pin your image! This option will save it so we can use it afterwards. Click over the pin button to save it. In the main menu, the window will change to display the Pins section. Now can see the image added to your list (see below).

Step 2: Now go back and select an image from another day. Do the same as you did before and pin it. Then, go to the "Compare" tab and analyse the two images side-by-side. Select the section Compare. The program will display the two images, one on the top of the other. You can uncover to see the one below by using the "Spit position" bar. You can gradually uncover and cover to compare the images, as you can see below:

Step 3: Play with the different emissions! You can try to see the difference between emissions of different gases, to see which one is more predominant. By clicking on the small arrow you can see on the picture, you are able to access the legend and understand the colour code.





Step 4: Discuss the findings with your colleagues, trying to understand the following questions:

- How polluted is the area selected? How has the situation changed over the time frame you selected?
- Which are the main emissions occurring in that area?
- Do you have any idea of what could be the reasons behind them?

Part 2. Where is the pollution coming from? (45 min + autonomous work)

As students may now have realised from the features in the EO Browser, our cities must deal with different types of emissions (aerosols, methane, carbon monoxide, Nitrogen dioxide, ozone, sulphur dioxide, etc.), which come from different sources.

Step 1: Ask students to search about those emissions, and to understand and make a list of what are their main sources. Then, ask them to organise those sources into five categories: (1) gasoline-burning vehicles and engines, (2) electricity from fossil fuels like coal, (3) activities that launch particles in the air like fires, (4) products that release chemicals into the air (like hygiene and cleaning products) and (5) consumption and daily habits (buying and using of consumer goods, including their transportation, and waste disposal).

Step 2: Now that students are aware of the sources of pollution (keep them visible, so they don't forget the categories), ask them to choose one of the colours of the post-its to represent each one of the categories. For example: **yellow** for pollution from vehicles and engines; **pink** for pollution arising from energy and electricity; **green** for pollution from particles circulating in the air; **blue** for pollution caused by chemicals and orange for consumption and **daily** habits.

Step 3: Ask students to check the exercise sheet and read about Maria's daily life and pollution emissions. This should serve as an example, so they understand what they need to do in the activity. They should take Maria's routine example and adapt it to their own.

Step 4: Now it's their time to do some homework. Ask them to fill, during a time set by you (we suggest a minimum of three days, so they can implement some habits) **Table 2, available in the Exercise Sheet, with their own daily habits and activities.** In parallel, they should also ask an older family member (could be grandparents, parents, aunts - but it's important that they are of another generation) to help them fill in **Table 4**. For that (both tables), they will select actions listed in the List of Polluting Actions (if there's not one exactly as they wanted, they should take the most similar one). They should attribute points to their actions, depending on the instructions of the list: **+3, +2 or +1 polluting points** depending on the level of severity, and **-3, -2 and -1, depending on the level of "compensation" or benefit for the environment**.

Part 3: Reflection and next steps (30 min)

Step 1: When students are back to class, ask them to categorise their own and their relatives' emissions using the post-its. Each polluting action corresponds to a post-it, and the colour of it should correspond to the specific source. All exercise sheets should be transferred into post-its and exposed somewhere where all students can see them.

Extra: the names of the students can be written on the board, and they can add the sum of all points they got. A ranking can be made of the most and least polluting students, to challenge them a bit.

Note: In the digital version, they won't need to do this part, as they will have an automatic visual representation of the impact of their daily lives on air pollution and also what sources are the most frequent in their habits. However, after watching the animation, they should discuss as mentioned in the following point.

Step 2: Comparing the board, ask them some questions:

- How were your results? How is the balance between polluting and sustainable actions in your life?
- What's the main source of pollution in our life? And in your family's life? What are the differences and similarities?
- Does this correspond to what you've seen in the EO browser? If you have to imagine the gas that you emit more during your daily life, what would it be?
- Which aspects are worse or better in your own routine, when comparing it with the one from your family member?
- What can you change?

Based on the list provided, they can compromise to implement some alternatives mentioned, or discuss others. At the end of the week, for example, the class can be reunited and asked about any changes they have made.

3. Description of the activity (adapted version)

**Adaptation: younger students might need extra support from teachers in Part 1. If needed, the professor can perform the actions on the EO Browser and involve students by asking them to observe and comment what they see. The last step, which concerns analysing different emissions, can also be omitted – students can just stop after the comparison between the two years selected.*

Part 1: Satellites' eyes help from space (30 min)

Using the EO Browser

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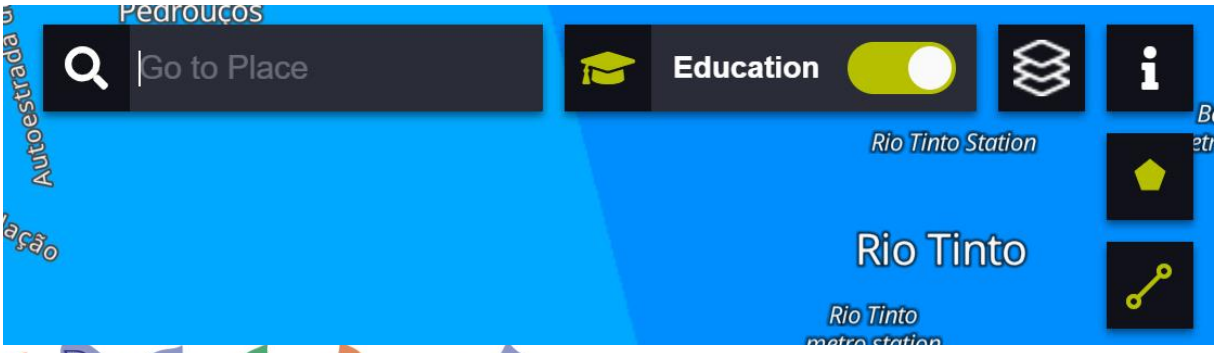

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Students can choose the area that they want to investigate - it can be a place in their own country or in another that they are curious about. They can search for it in the search bar, in the top-right area of the screen.

Analysing the polluting emissions all around us

Step 1: Analyse the situation in the area chosen. To make things more interesting, you can perform the following actions:

- Let’s play with the time. Select the “Time range” to define the time interval for searching images. Click in the two dates (small calendars). In this case, we select from 2022-06-01 to 2022-09-30. Click over the button “Search” (green button, see picture above). The Search window changes into a new window showing the results. We proceed to choose one image. Select the image taken on a specific date within the time range selected, according to your preference, as the example below shows. Now, you should pin your image! This option will save it so we can use it afterwards. Click over the pin button to save it. In the main menu, the window will change to display the Pins section. Now can see the image added to your list (see below).

Step 2: Now go back and select an image from another day. Do the same as you did before and pin it. Then, go to the “Compare” tab and analyse the two images side-by-side. Select the section Compare. The program will display the two images, one on the top of the other. You can uncover to see the one below by using the “Spit position” bar. You can gradually uncover and cover to compare the images, as you can see below:

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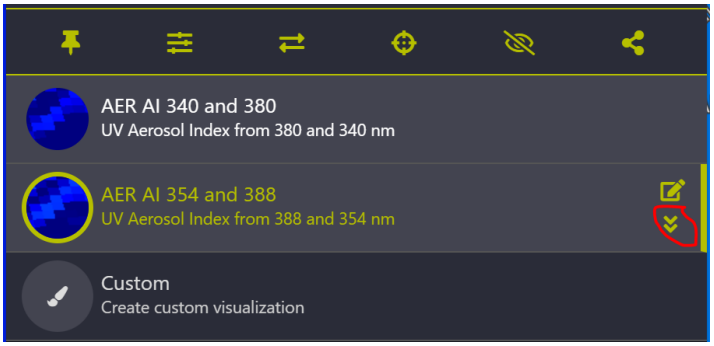
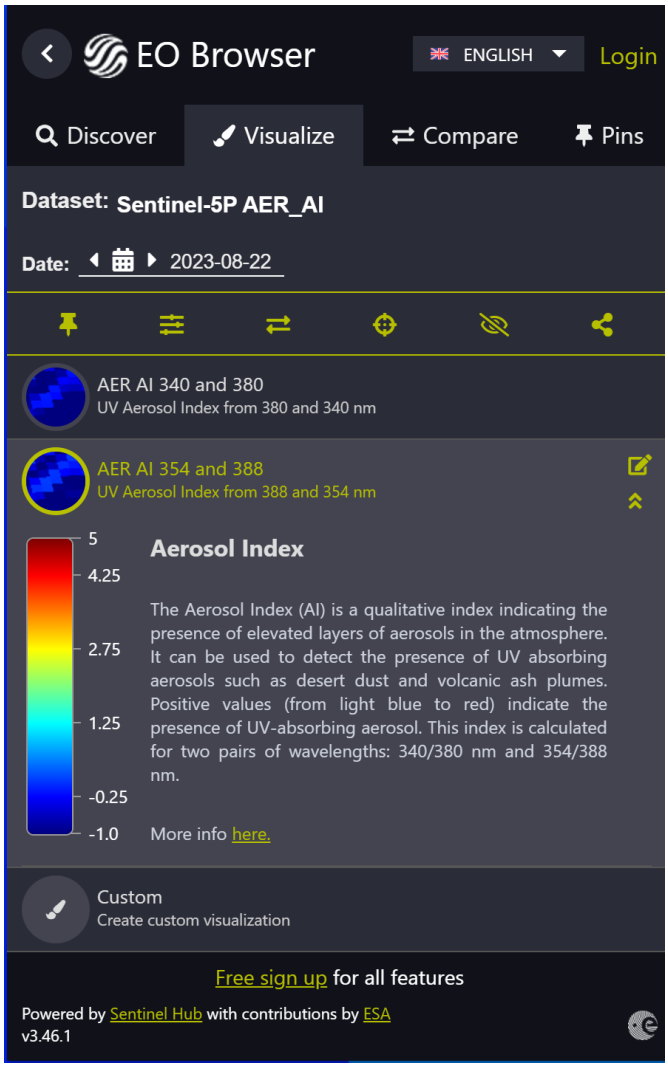




Step 4: Discuss the findings with your colleagues, trying to understand the following questions:

- How polluted is the area selected? How has the situation changed over the time frame you selected?
- Which are the main emissions occurring in that area? **Adaptation: younger students can skip the source of emissions if needed.*
- Do you have any idea of what could be the reasons behind them?

Part 2. Where is the pollution coming from? (45 min + autonomous work)

Step 1: As students may now have realised from the features in the EO Browser, our cities must deal with different types of emissions (aerosols, methane, carbon monoxide, Nitrogen dioxide, ozone, sulphur dioxide, etc.), which come from different sources.

Step 2: Youngers students can skip the categorisation into "source of pollution", that was included in the standard version. In their case, ask them to consult and have by them the list of pollutant actions and alternatives that was prepared (List of Polluting Actions).

Step 3: Ask students to check the exercise sheet and read about Maria's daily life and pollution emissions. This should serve as an example, so they understand what they need to do in the activity. They should take Maria's routine example and adapt it to their own.

Step 4: Now it's their time to do some homework. Ask them to fill, during a time set by you (we suggest a minimum of three days, so they can implement some habits) **Table 3, available in the Exercise Sheet, with their own daily habits and activities.** In parallel, they should also ask an older family member (could be grandparents, parents, aunts - but it's important that they are of another generation) to help them fill in **Table 4**.

Step 4: For that (both tables), they will select actions listed in the List of Polluting Actions (if there's not one exactly as they wanted, they should take the most similar one). They should attribute points to their actions, depending on the instructions of the list: **+3, +2 or +1 polluting points** depending on the level of severity, and **-3, -2 and -1, depending on the level of "compensation" or benefit for the environment**.

Part 3. Reflection and next steps (30 min)

Step 1: When students are back to class, ask them to present their tables and their relatives' and to write them in post-its so everyone can see. **Adaptation: in this version, students can just categorise the actions between "pollutant" and "sustainable alternative", choosing one post-it colours for each one of those categories. They will then see if they are on the path to a more sustainable life or not.*

Extra: the names of the students can be written on the board, and they can add the sum of all points they got. A ranking can be made of the most and least polluting students, to challenge them a bit.

Note: In the digital version, they won't need to do this part, as they will have an automatic visual representation of the impact of their daily lives on air pollution and also what sources are the most frequent in their habits. However, after watching the animation, they should discuss mentioned in the following step:

Step 2: Comparing the results, ask them some questions:

- How was your result? Did you have a lot of polluting points? Were you surprise watching the animation?
- Can you identify the main source of pollution in your life? (is it related to food, transportation…?) And in your family's life? What are the differences and similarities?
- Which aspects are worse or better in your own routine, when comparing it with the one from your family member?
- What can you change?

Based on the list provided, they can compromise to implement some alternatives mentioned, or discuss others. At the end of the week, for example, the class can be reunited and asked about any changes they have made.

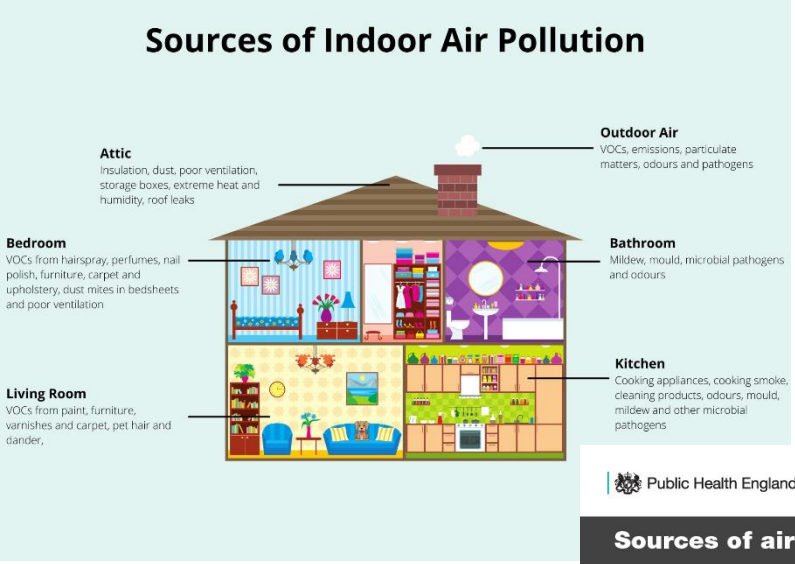
4. Annex I: Materials

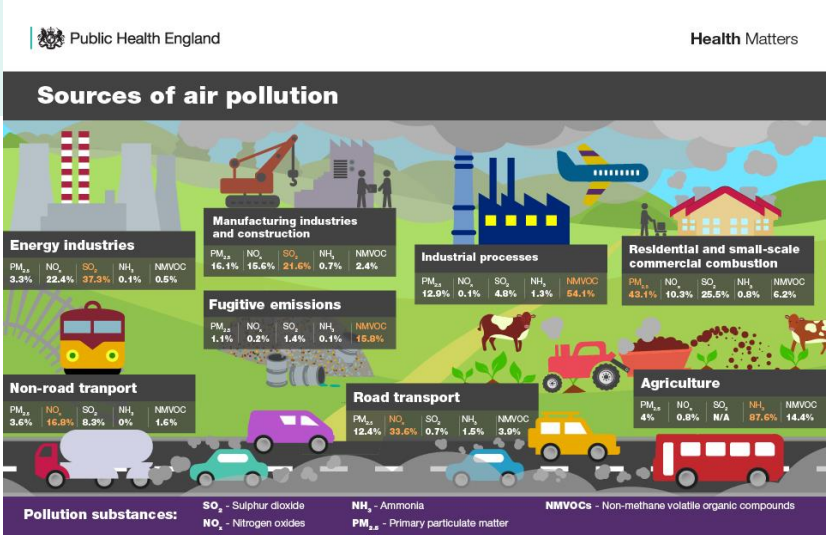
- List of pollutant actions
- Exercise sheet
- a whiteboard/cardboard;
- Post-its with different colours (5 different colours)
- Internet access to search for additional information
- EO Browser

5. Annex II: Background information and tutorials

Further information / background:

In order for students to remember daily actions that can be pollutants, they can also take a look at the next images for some ideas:





Some suggestions on how to reduce daily air pollution can be found here: https://www3.epa.gov/region1/airquality/reducepollution.html and here https://www.aqi.in/blog/10-best-ways-to-reduce-air-pollution/.

Tutorials:

- EO Browser Tutorial