



## „What pollutes the air” - lesson plan

Duration	1 hour
Age	15-19
Type of classes	Didactic and educational activities
Goals	<ul style="list-style-type: none"> <li>● To familiarize students with the problem of air pollution and the prevalence of its occurrence, also in rural areas,</li> <li>● To acquaint students with the causes of poor air quality and the harmfulness of burning coal and wood,</li> <li>● To familiarize students with the key definitions from the scope of atmospheric pollutants (particulate matter, benzo (a) pyrene, emission concentration)</li> <li>● To make students understanding the effects of air pollution - health, social, image,</li> <li>● To create a sense of real influence on the state of air in the region,</li> <li>● To shape the attitudes of social responsibility for corrective action to improve air quality (organization of happenings, educational campaigns, etc.).</li> <li>● To raise awareness of students of the need to check the air quality and familiarization with possible ways of how to do this,</li> <li>● To develop the ability to compare the air quality and acceptable levels of persistence test the proper behavior of concentrations of pollutants in the air.</li> </ul>
Methods	Show, talk, film screening, brainstorming, didactic games
Forms of work	Individual, collective
Needed materials	<ul style="list-style-type: none"> <li>● Cards with written themes to work on,</li> <li>● Projector, laptop, film "Spin the Smog!",</li> <li>● Two cubic cubes - on the walls of the first written nouns (air, garbage, smog, smoke, health, man), and on the walls of the second verbs (pollute, burn, damage, protect, destroy),</li> <li>● "T-shirts" cut from paper,</li> <li>● Newspapers with articles about air pollution,</li> <li>● Several pieces of scissors, markers, glues,</li> <li>● Printed tables with air quality standards and calendars</li> </ul>

Attention: During the lesson, it is worth using the dedicated presentation available to download from the "Clean Air" website.



The presentation consists of slides related to topics discussed during the lesson. The teacher after completing each exercise can use a slide (or slides) summarizing the given issue, to remind the most important information and to systematize the knowledge of students.

## 1. Introduction - acquiring knowledge related to air pollution and its causes

The teacher divides the students into four groups (or the students choose the groups themselves). Each group gets a different topic to work on while watching the movie. Themes are (slide 2):

- a) What substances pollute the air? - **air pollutants**
- b) **Basic definitions** in the field of air pollution: smog, particulate matter, benzo(a)pyrene, emission, concentration.
- c) The **main causes of air pollution**.
- d) **Air quality** in the city and in the countryside.

## 2. Film screening

The teacher shows the film

## 3. Presentation of the obtained information

Each of the groups presents information on the subject they worked on in the order as above. The teacher asks additional questions for each group. Sample questions:

- a) What substances pollute the air? What kinds of pollution do we have the biggest problem with? Why we have problem with PM and benzo(a)pyrene?
- b) What is the difference between the terms 'emission' and 'concentration'? In which units do we give the concentration value? How small is PM10 and PM2.5?
- c) What is the largest source of particulate matter emissions and benzo (a) pyrene? What is the largest source of nitrogen dioxide emissions?
- d) What kinds of pollutants mentioned earlier we have the biggest problem in rural areas with? Is the air always better in rural areas than in the city? Where do you think this belief come from?

After the presentation of each group, the teacher displays knowledge summary slides (3-12).

### **GROUP 1 - AIR POLLUTANTS**

There are various substances which pollute our air, for example:



**particulate matter** - a mixture of various small particles suspended in the air. PM10 are particles with a diameter of 10 micrometers and less, while PM2.5 - particles with a diameter of 2.5 micrometers or less. It can carry various dangerous substances (ex. benzo(a)pyrene).

**PAHs** - polycyclic aromatic hydrocarbons, for example benzo(a)pyrene - a carcinogenic and mutagenic chemical compound

**sulfur dioxide** - is produced as a by-product of the burning of fossil fuels contaminated with sulfur compounds. Inhaling sulfur dioxide is associated with increased respiratory symptoms and disease, difficulty in breathing, and premature death

**nitrogen oxides** - for the general public, the most prominent sources of NO<sub>2</sub> are internal combustion engines burning fossil fuels. Outdoors, NO<sub>2</sub> is a result of traffic from motor vehicles. For the public, chronic exposure to NO<sub>2</sub> can cause respiratory effects including airway inflammation in healthy people and increased respiratory symptoms in people with asthma.

**ozone** - its formation is caused by NO<sub>2</sub>. Exposure to ozone is linked to premature death, asthma, bronchitis, heart attack, and other cardiopulmonary problems.

**heavy metals** - e.g. mercury, lead, cadmium, chromium, nickel, copper, zinc. Their toxic effects are related to with the ability to accumulate in the body, including bones, kidneys, and the brain.

## GROUP 2 - BASIC DEFINITIONS

**Smog** - this term was created from the combination of two English words: smoke and fog. Smog is, in simple words, an unnatural and dangerous phenomenon, during which there is a combination of significant air pollution and adverse weather conditions, conducive to the accumulation of pollutants.

There are various dangerous substances in our smog.

**Particulate matter** - a mixture of various small particles suspended in the air. It is not a homogeneous group of substances: it can be dust particles, ash, sand, pollen, as well as soot, worn tires or brake pads of vehicles. Importantly, very often such particles include (or settle on their surface) various dangerous substances, for example heavy metals or polycyclic aromatic hydrocarbons (PAHs), which can then be inhaled together with suspended dust and thus get into the body.

PM10 dust is particles with a diameter of 10 micrometers and less, while PM2.5 - particles with a diameter of 2.5 micrometers or less.

**benzo(a)pyrene** - a carcinogenic and mutagenic chemical compound that is a representative of polycyclic aromatic hydrocarbons (PAHs). The main source of this substance in the air is the combustion of solid fuels at low temperatures, that is carbon and wood in domestic heating installations. Benzo(a)pyrene is also found in cigarette smoke.

Benzo(a)pyrene shows low acute toxicity and high chronic toxicity, which is related to its cumulative capacity in the body.

Check how many cigarettes you would have to smoke to inhale the dose you breathe!  
<https://www.omnicalculator.com/ecology/smog-benzoapiren>

**emission of pollutants** - determines the amount of pollutants introduced directly into the air.

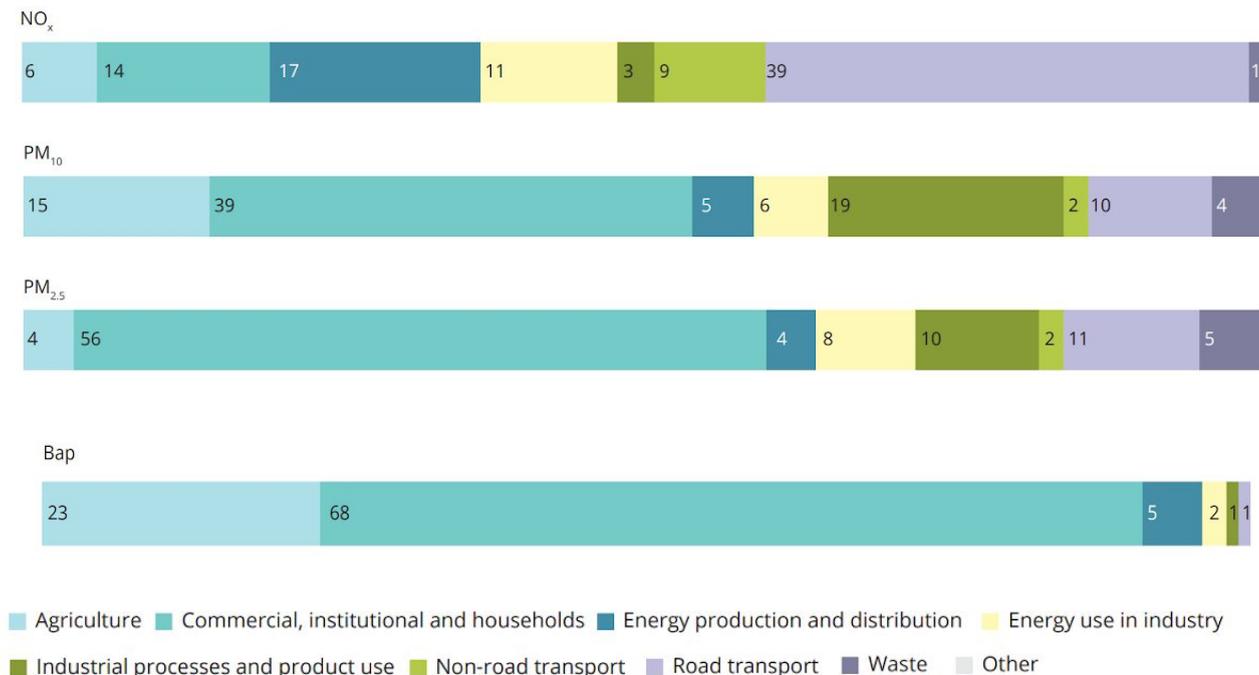
**pollutant imission (concentration of pollutants)** - determines the amount of dust or gas pollution in a unit



of atmospheric air volume.

The concentration of pollutants depends on the size of the emissions as well as on the conditions of spreading, including topography of the area and meteorological factors.

### GROUP 3 - MAIN SOURCES OF AIR POLLUTION



### GROUP 4 - AIR QUALITY IN RURAL AND URBAN AREAS

There is still a strong belief in clean and healthy air in the villages and small towns. In fact, there are no large factories and huge traffic, which could indicate a simultaneous lack of harmful emissions to the air.

However, it should be remembered that the main source of particulate matter and benzo(a)pyrene in the European air is not industry and energy, but the so-called low-stack emission, i.e. that coming from our domestic chimneys. This means that in rural areas the air might be worse than in big cities, because there are more numerous clusters of houses heated with often outdated, high-emission heating devices for solid fuels. Sometimes people burn there even waste.

In addition, the level of air pollution in rural areas is underestimated, as air quality monitoring stations are usually located in large cities.

In conclusion:

In large cities, the problem is transport emissions (mainly responsible for high concentrations of nitrogen oxides) and industry, and in small towns, in rural areas, the society is struggling with low emission, ie emissions from household furnaces for solid fuels, responsible for high concentrations of particulate matter and carcinogenic benzo(a)pyrene.

It is a myth that air quality in rural areas is always better than in the city. Very often it happens that in smaller towns and villages concentrations of pollutants significantly exceed acceptable levels, especially in terms of PM and B(a)P.



## 4. Creative part - anti-smog campaign project

**After presenting all the presentations, the teacher goes to the creative part of the lesson (slide 13), choosing the exercises from the following suggestions at his own discretion (and the remaining lesson time).**

The teacher introduces students to the topic of anti-smog campaigns, explaining how important it is to raise people's awareness of how big the problem of air pollution is, also in rural areas.

The teacher asks students to play the role of anti-smog activists for a while and help them carry out an effective campaign on the health risks of breathing contaminated air, banning burning waste and poor fuel quality, and the need to exchange old boilers for ecological heat sources.

### Proposal 1: Setting up an anti-smog password from randomly drawn words (short exercise, approx. 8 minutes)

The teacher recommends that each of the previous groups should be divided into two smaller ones (about 3-4 people). The teacher gives the students a special prepared dice. Dice has three nouns and three verbs written on walls, which are related to the concern for air quality and pollution of it. Then each group throws dice prepared by the teacher twice. The words randomly drawn by each group should also be written on the board.

The teacher gives students about 5 minutes to come up with a password for an anti-smog campaign consisting of any number of words, but containing necessarily both drawn words. The teacher presents an example. He asks students for the greatest possible creativity, reminding them that the slogan is designed to attract the attention of the recipient.

Then each group presents the prepared password, and the teacher writes them on the board.

The teacher stresses the importance of raising public awareness of the effects of air pollution and the need to improve it.

ATTENTION: The task can be hampered by choosing more words that should be used in one entry.

ATTENTION: Instead of cubes, you can simply write words on small cards. However, the cube version seems to be more interesting.

### Proposal 2: Analysis of articles and creating an anti-smog t-shirt design (long exercise, about 20 minutes)

The teacher distributes to each participant one article cut out from the newspaper on air pollution and asks everyone to read its contents. S/he also asks each participant to choose the most important information from it, to summarize its content, and then present the rest of the group - this type of exercise develops an important ability to express themselves in front of audience.

After a few minutes of preparation, each participant presents to the group what he learned from the given article.

After presenting the content of all the articles, the lecturer distributes more newspapers - this time all



newspapers, no matter what on, and also t-shirts cut out from paper. S/he asks participants to prepare a design of their own anti-smog t-shirt with a strong, catchy slogan. The brought newspapers have to be used: the students can cut out whole words, letters, pictures and stick them on paper shirts. There are also colored markers available.

Then everyone presents their anti-smog t-shirt and password, which he made on it. The teacher encourages the group to put the prepared work on the school newspaper.

ATTENTION: The exercise can also be performed by instructing students to use the slogans from the previous exercise.

## 5. How much pollution can be in the air?

- a) The teacher explains that there are certain thresholds acceptable for substances in the air (permissible concentrations of pollutants in the air). They shouldn't be exceeded!
- b) The teacher distributes the tables and calendar of air quality measurements printed on the pages.
- c) Next, the teacher shows on presentation (slide 14) the levels acceptable for individual compounds and asks students to complete the missing data on their pages.

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Table for the teacher:

Substance	Averaging period	Permissible / target level
PM10	24 hours	50 µg/m <sup>3</sup>
	A year	40 µg/m <sup>3</sup>
PM2.5	A year	25 µg/m <sup>3</sup>
Benzo(a)pyrene	A year	1 ng/m <sup>3</sup>
NO <sub>2</sub>	1 hour	200 µg/m <sup>3</sup>
	A year	40 µg/m <sup>3</sup>
SO <sub>2</sub>	1 hour	350 µg/m <sup>3</sup>
	24 hours	125 µg/m <sup>3</sup>

Tabele for students

Substance	Averaging period	Permissible / target level
PM10	24 hours	
	A year	
PM2.5	A year	
Benzo(a)pyrene	A year	
NO <sub>2</sub>	1 hour	
	A year	
SO <sub>2</sub>	1 hour	
	24 hours	

- d) After completing the table with the admissible levels, the teacher students the students where exactly they can check the air quality and instructs them to record the daily concentrations of PM10 at the nearest station over the next week (slide 15).



- e) During the next lesson, students analyze the results, calculate the percentage of the norm and check if the admissible levels have been exceeded. Together with the teacher, they draw conclusions about air quality in their area.

Date	PM10 mean daily concentration	Percent of the norm

The teacher completes the lesson by showing slide 16.