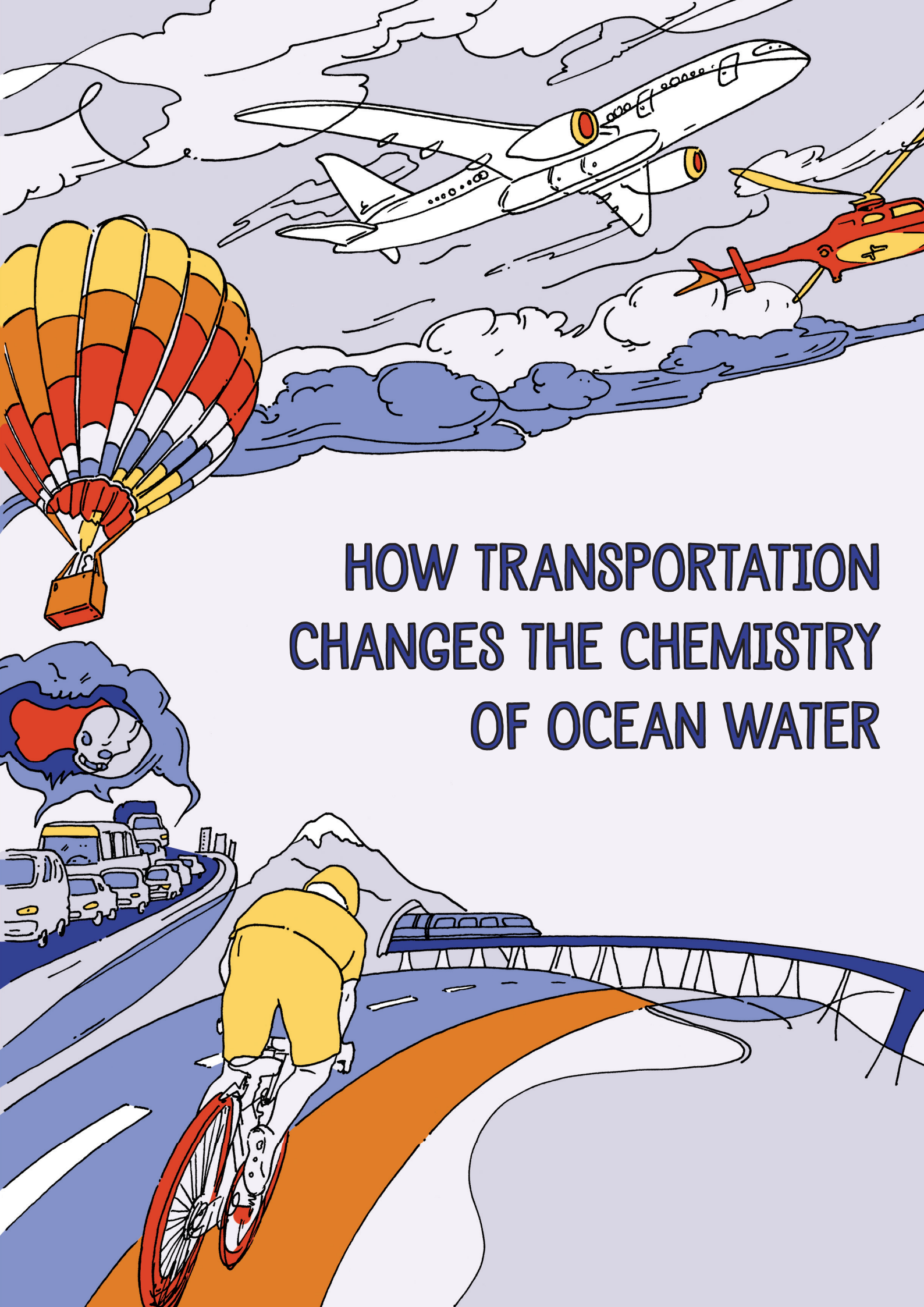


HOW TRANSPORTATION CHANGES THE CHEMISTRY OF OCEAN WATER

INTRODUCTION

This indicator book was created as part of the Teaching Green project and should support teachers of students aged 10 – 16 years who are implementing education about climate change.

The educational process is divided into 4 steps. The first step is the creation of a group of students who will implement the project activities. In the introductory part, students fill out also an questionnaire about their attitudes link to the indicator mentioned below. The second step is theoretical preparation. You can use online learning models or your own resources. The third step consists of practical monitoring of the indicator (at least twice). The result of the monitoring is a presentation prepared by the students containing findings from the practical part. In the final fourth part, students fill out the attitudes questionnaire again and the changes in their character qualities are evaluated.

CLIMATE CHANGE IMPACT

The chemistry of ocean water is changing, mostly by absorption of carbon dioxide from the atmosphere. Transport was responsible for about a quarter of the EU's total CO_2 emissions in 2019, of which 71.7% came from road transportation, according to a report from the European Environment Agency. The EU aims to achieve a 90% reduction in greenhouse gas emissions from transport by 2050, compared with 1990.

INDICATOR: Monitoring modes of transport and alternatives to reduce CO_2.

Project activities support development of 6 essential character qualities:

- **mindfulness**
- **curiosity**
- **courage**
- **leadership**
- **resilience**
- **ethics**

You can find these icons next to the exercises.

Mindfulness
wisdom, self-awareness, observation, insight
"The awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experiences moment by moment."

Curiosity
open-mindedness, exploration, passion, initiative, enthusiasm
"The essential desire for information, the drive to resolve uncertainty."

Courage
bravery, determination, confidence, risk taking
"The ability to act despite fear or uncertainty, in risky situations or when we are feeling vulnerable."

Leadership
responsibility, accountability, dependability, reliability, selflessness
"The relational and ethical process of people attempting to accomplish positive change."

Resilience
perseverance, grit, tenacity, resourcefulness, self-discipline
"The ability or set of qualities that allow one to overcome obstacles."

Ethics
benevolence, humaneness, integrity, respect, justice, fairness
"The moral principles that govern a person's behavior or the conducting of an activity."

Before you start, let students fill out the questionnaire about their attitudes!

THEORETICAL PART

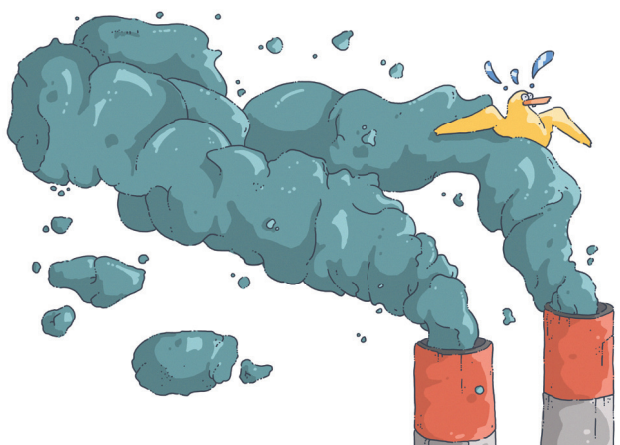
Introduction to students

Carbon dioxide (CO_2) is a colorless, non-flammable atmospheric gas. Naturally it is produced by humans, animals, and plants in the process of respiration. The problem arises when it is **artificially produced in excess**, especially when fossil fuels such as coal, oil, and natural gas are burned. Transport vehicles are a significant contributor to burning fossil fuels such as aircraft, cars, trucks, ships, and buses. Approximately 40% of the carbon dioxide added to the atmosphere by **fossil fuel burning** since the dawn of the industrial era has been taken up by the ocean. The other two main carbon sinks are **soil** and **forests.** When CO_2 is absorbed by seawater, a series of chemical reactions occur causing the seawater to become more acidic (acidity increases by 30% since industrial revolution). Decreasing pH levels cause extinction of certain species which will affect the entire food chain.

Open discussion about increases in CO_2 with your classroom to find out what they know about the topic already.

? Questions for students

- **What causes increased CO_2 in the atmosphere?**
- **What are the main sources of CO_2 production emissions?**
- **What are the consequences of the climate change?**
- **Have you ever wondered what impact you have on the environment?**



RESOURCES FOR FURTHER STUDING:

- MODULE 1
- MODULE X

PRACTICAL PART

Aim of activity

Students will calculate the amount of CO_2 emissions they produce in relation to traveling to and from school. Students become aware of their contribution to CO_2 emissions and reflect on ways to reduce their impact.

Orientation or Engagement

After finishing the theoretical part, lead a discussion about what forms of transportation are available in your area (public transportation, carpooling, biking...). The result of the discussion should be that students are curious about the CO_2 emissions they produce by transportation.

Use these questions to guide the discussion towards mindfulness and resilience.

? Questions for students

- **How do you feel when you pass a car with visible smoke coming out of its exhaust?**
- **How does breathing feel next to a very busy street?**
- **How do you feel when you know what your chosen form of transit does to the environment and to the life in oceans?**
- **Do you feel like your surroundings are doing enough to lower their carbon emissions?**

Conceptualization

Let students suggest (in the form of brainstorming and group work) possible best practices for the investigation of how much artifical CO_2 emissions are caused by their transportation. Provide students with a table of means of transport and CO_2 production it produces per passenger on average.

Each student needs to record the route to/from school and the means of transport used for a specific period of time (minimum 1 week). If someone changes transportation methods during the journey to/from school, it is necessary to make a note of the point at which this happens. The ***first step*** is, using mapping platforms or GPS devices, to find out the length of the route for each means of transport used on the route to/from school on a specific day. The ***second step*** is, based on the length of the route and the means of transport used, to calculate the number of emissions produced on that day. At the end of the monitoring period. They should come out with methods of data collection (mobile tracking or google maps for calculating the length in km and the type of transport used; google form, excel file or paper notebook for data collection and analysis).

Table: ***Means of transport and artifical CO_2 production it produces per passenger on average.***

FOOT OR BICYCLE	0 G/KM
TRAM OR TROLLEY BUS	42 G/KM
ELECTRIC CAR	43 G/KM
MINIBUS	55 G/KM
DIESEL TRAIN	60 G/KM
ELECTRIC TRAIN / METRO	65 G/KM
BUS	69 G/KM
MOPED	73 G/KM
HYBRID CAR	84 G/KM
MOTORCYCLE	94 G/KM
SMALL CAR	110 G/KM
FERRY	115 G/KM
MEDIUM CAR	133 G/KM
TAXI	170 G/KM
BIG CAR	183 G/KM

These are average emissions based on the study of the UK Department of Environment (Defra). However, the real emissions may vary. For example, the amount of CO_2 emitted by a car using petrol will depend on many things:

- engine size and car weight (bigger engines and cars emit more CO_2),
- the kind of fuel used and the fuel efficiency,
- age of the car (older cars emit more CO_2 than new ones of the same category),
- number of passengers (more passengers means lower emissions per person),
- car maintenance (engine, and tire pressure),
- how the car is driven (speed, idling, starting and stopping, acceleration, braking).

To calculate more accurate results would be very complicated and it would take a lot of work for students to collect the data. We chose to make it relatively simple so that students could spend more time learning about their local transport systems and working with others to find sustainable solutions.

Investigation

Now you are ready for monitoring and calculating the daily production of CO_2 from transportation. Remind students that they should use their usual means of transport during the monitoring period and not try to be better. The goal is to track their normal habits, not modified behavior.

Check that all students have the necessary tools. If a student does not go to school on a specific day, he/she can use his/her average daily CO_2 production calculated for the entire monitoring period as the data for that day. However, if some student does not participate in more than half of the monitoring period, his/her data must be excluded from the analysis. Enjoy monitoring and try to motivate each other to record data on a daily basis.

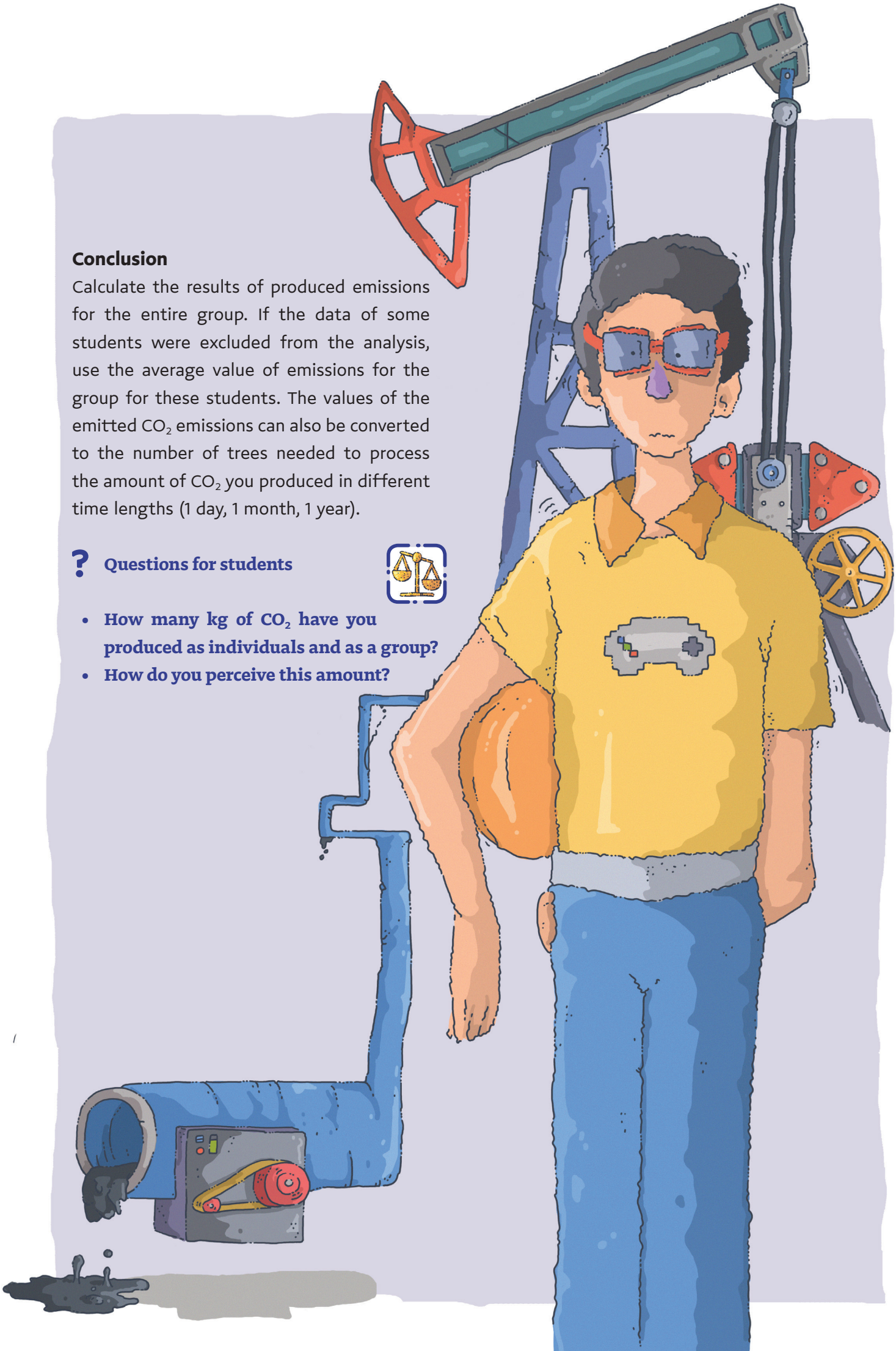
Allow students to use the methods they chose during the leadership section. Make sure they all use the same methods so that the data collected can be compared between them.

Conclusion

Calculate the results of produced emissions for the entire group. If the data of some students were excluded from the analysis, use the average value of emissions for the group for these students. The values of the emitted CO_2 emissions can also be converted to the number of trees needed to process the amount of CO_2 you produced in different time lengths (1 day, 1 month, 1 year).

? Questions for students

- **How many kg of CO_2 have you produced as individuals and as a group?**
- **How do you perceive this amount?**



ACTIVE PART

Discuss together how you could **reduce** your CO_2 emissions when traveling to/from school as a group. Write down your suggestions. Think about whether your solutions are feasible. Set a target by what percentage you will reduce your CO_2 production from transport to/from school as a group. It can be 10%, 50% or another value. The decision is yours. In order for the goal to be met, some students will have to change their transportation habits rapidly, others will only adjust them slightly, and there may be students who will not have to do anything because they walk to school. Cooperation between students may be necessary.

Encourge the students to fulfill the goal in the second monitoring period. After the second monitoring evaluate, whether you succeeded in meeting the goal.

? Questions for students in your evaluation session.

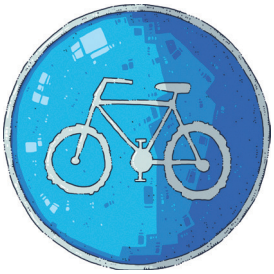
- **How much less CO_2 did you produce during the second monitoring in comparison to the emissions before?**
- **How did the environment react to your changing habits?**
- **Were you met with understanding?**
- **Was it easy to control your behavior and use more eco-friendly transportation methods?**
- **Are you proud that you took part in this project?**

Let the students prepare a presentation about their journey within the project.

THEY MAY FOCUS ON:

- **How does our daily transit impact the environment and ocean life?**
- **How our carbon emissions impact us?**
- **How can we reduce transportation emissions at the regional/national/international levels?**
- **What is our personal story?**
- **How to persuade others to reduce their CO_2 production from transportation?**

Present the findings to other students of your school. If it is possible, make the presentation public and invite local authorities. Suggest what should be changed in your local area that would help lower the CO_2 production from transportation. Are there other solutions that could be applied? For example some good practice from other cities or countries?



SLOGAN (MAIN MESSAGE)

RESOURCES

European strategy for Low Emission Mobility

Range of life-cycle CO_2 emissions for different vehicle and fuel types. Available at: <https://www.eea.europa.eu/signals/signals-2017/infographics/range-of-life-cycle-co2/view>.

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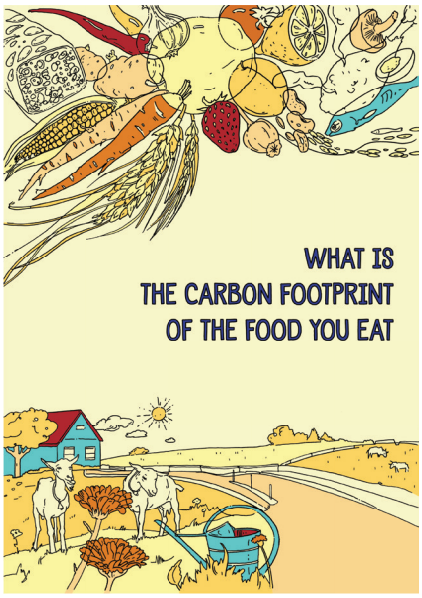
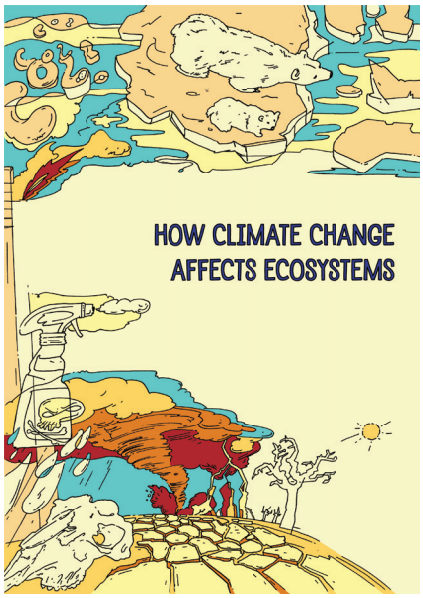
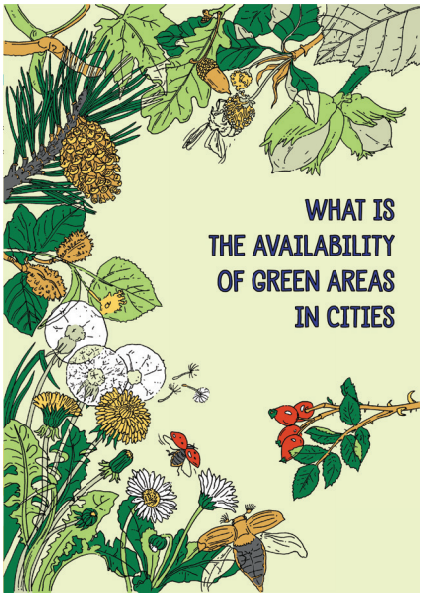
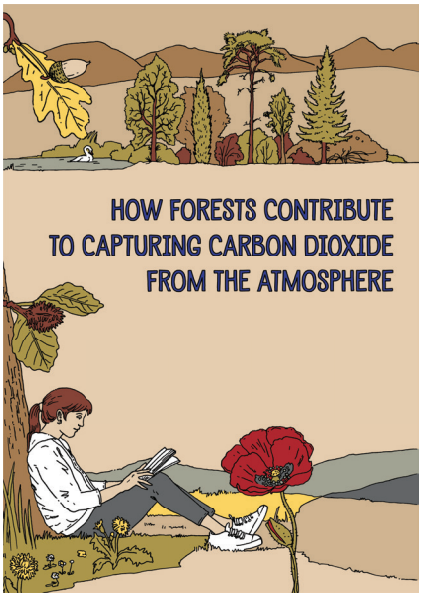
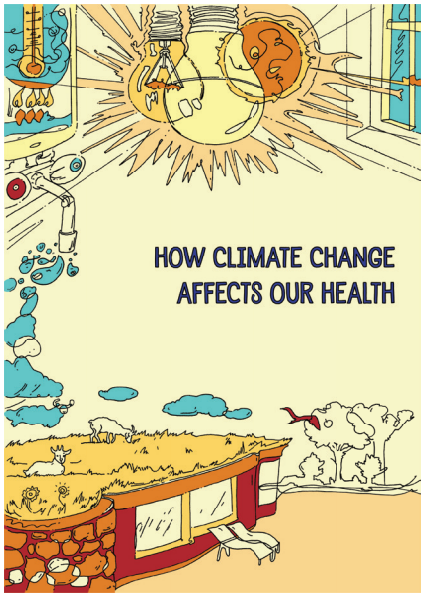
OTHER INDICATOR´S BOOKS YOU MAY LIKE CAN BE FOUND ON: TEACHINGGREEN.EU

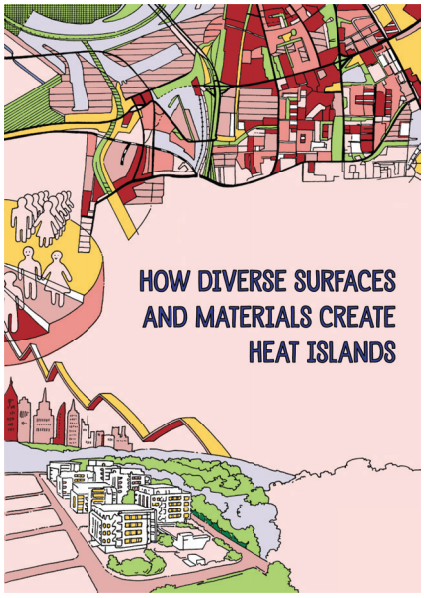


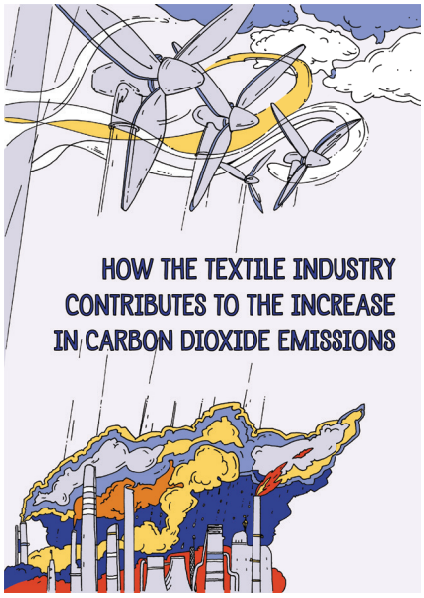


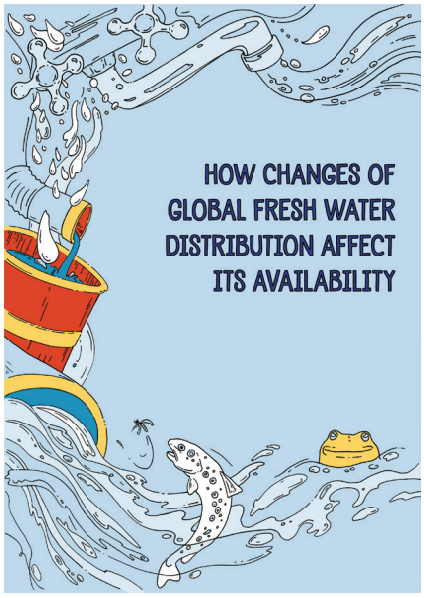












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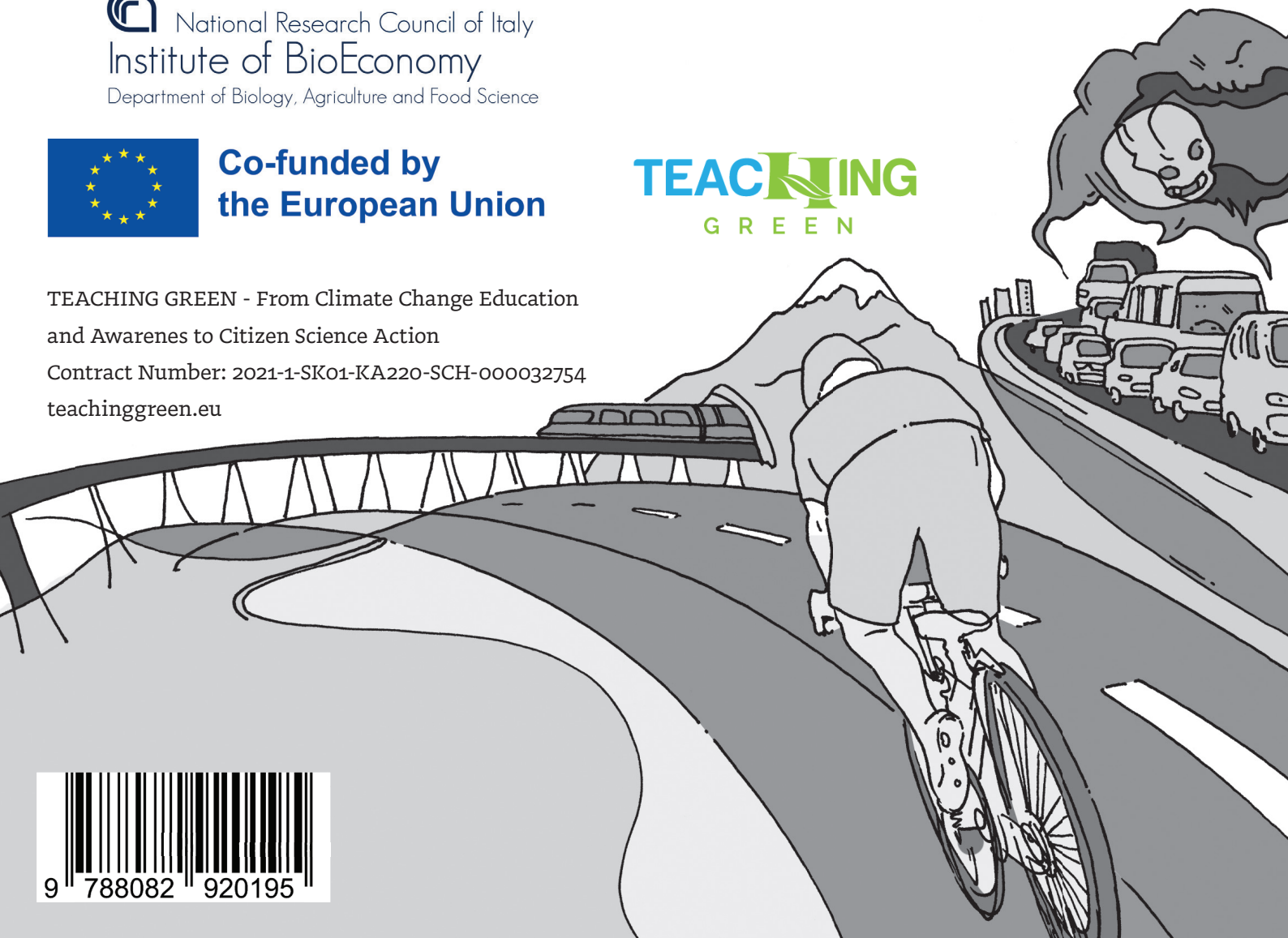

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