WATER AGENT V003

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WATER AGENT V003

Environmental education of pupils in the field of water management

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WATER AGENT

V003

Handbook for educators
Water Agent V 003: Environmental education of pupils in the field of water management

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Water in the City – IMRO (Ildikó Galambos, Bence Cseke, Renáta Berta et al.)
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Contents

6 **Introduction to the Handbook**
Jan Macháč, Marek Hekrle, Michaela Jeřábková

9 **Educational Analysis**
Michaela Jeřábková et al.

12 **Water in Households**
IREAS — Jan Macháč, Michaela Jeřábková, Alena Vacková et al.

51 **Water in the Landscape**
GWP CEE — Jana Pangrácová, Jana Menkynová, Andrea Vranovská et al.

91 **Water in the City**
IMRO — Ildikó Galambos, Bence Cseke, Renáta Berta et al.

111 **Water and Cooperation — Two Games**
IREAS — Martin Brzobohatý, Michaela Jeřábková, Jan Macháč et al.

124 **Glossary**

126 **References**

Introduction to the Handbook

Water is the most necessary condition for the existence of life on Earth. It influences the possibilities of human settlements and agricultural land use and it predetermines the environment not only for people but also for animals and plants. We often do not realize that water is an irreplaceable part of our lives and our daily activities. It is very important for our daily consumption, cooking, showering, dish-washing and toilet flushing. Water is the most important material; its quantity determines the quality of our lives. In a broader perspective, water is a very strategic resource which has had a significant impact on development of human dwelling and whole society in history. In this perspective, there is an assumption that the role of water as a strategic resource will be increasing. Only areas with enough water or with appropriate water management will prosper.

Why is it necessary to solve these problems? How can we do it?

Due to climate change, there is a need for people's better behaviour towards water. Water quality and availability is now under severe pressure due to climate events such as temperature growth with long-term periods of drought, torrential rainfall and floods, warmer winters and lack of snow, etc.

These consequences of climate change influence water regime in the environment and water management. The consequences are not only local anymore. They do not influence only the most sensitive regions, in fact they affect the vast majority of Central European countries and their inhabitants. Their consequences are interconnected with all human activities. Increasing demand for water can lead to conflicts of interest between subscribers and also between subscribers and protection of water and the environment.

i) Water in the landscape

Inappropriate water management and extreme rainfall cause soil erosion in the landscape and transport of sediments, nutrients and other substances (e.g., pesticides) to water bodies. The lack of capacity of the landscape to retain more water has major impacts. Fast water outflow is often caused by unsuitable management on agricultural land and by watercourse shape. Long periods of drought decrease crop yields and cause higher demand for irrigation. Drought has a negative effect on lack of forage for livestock and higher operating costs of veterinary aid and ventilation. These negative impacts can be reflected in higher prices of food products.

Decreased water flow rates and higher water temperature in watercourses increase the probability of algae and blue-green algae in water reservoirs and increase pollution concentration. In addition to reducing aesthetic and recreational value, there is a danger to human health. Well-known effects are, for example, decreasing numbers of insects and insectivorous animals such as birds.

We can see the most visible impacts caused by extreme climate change and drought in forests. Trees, and especially spruce monocultures, disappear due to lack of moisture and weakening of defences. In addition, drought makes it difficult to replace planting in places where new seedlings are planted.

The last but not least problem is water pollution, both in its classic forms (insufficient wastewater treatment in municipalities/industry) and modern forms, which include transfer of plastics by rivers to the sea.

ii) Water in the city

In cities, water management changes relate to great dangers for water management infrastructure. Drinking water resources are under pressure of abstraction, which is incompatible with rising water scarcity and low groundwater levels. Higher operational requirements are also made on the drainage and sewage treatment processes and affect the entire industry.

The high share of paved areas with poor infiltration does not contribute to better water management in cities. Cities are confronted with parched parks and public greenery, which means higher operating costs and decreasing aesthetic and tourism value. There are also well-known cases of damaged structural integrity of buildings due to wall and floor cracks caused by shrinking ground under the building.

iii) Water consumption in households

Changes in water availability and increasing daily consumption in hot seasons are also increasingly noticeable in households, where water is necessary for consumption and everyday use. Municipalities are forced to supply citizens or their own water sources with drinking water from tanks. Citizens feel a lack of water directly due to the prohibition of watering plants, washing cars or filling swimming pools from municipal water supply systems. Restrictions or prohibitions on water abstraction are becoming more frequent.

Often these impacts are referred to as the end of water welfare and flushing toilets with drinking water is called barbarism. Most households are unaware that rain water or so-called grey water can be used for flushing toilets or watering plants. Grey water is produced by all households; it is drained from bathrooms and kitchens and makes up the vast majority of our drinking water consumption.

Role of the individual

Thrifty water management in the light of these societal impacts becomes important not only for water managers and farmers, but also for common inhabitants. Unfortunately, people's awareness of these topics is still very low. Implementation of necessary adaptation actions is therefore not supported by inhabitants very much. Addressing bad water management is a prerequisite for maintaining everyone's well-being, including that of next generations. Awareness of nature-based solutions and technical measures and their benefits for water retention in the landscape plays a key role.

However, with the increasing negative effects, we can also expect positive change in the problem perception by society and the effort to manage water. Reducing negative water-related impacts and effects such as drought or floods requires an active attitude not only at the national and international levels, but also at the local and individual levels.

Project Water Agent V 003

In the context of the above, environmental education and inclusion of water management topics in education are important.

That is why the project Water Agent V 003 was created. The aim is to introduce water resource-related topics to the youngest generation and through them also act on families. The goal is to prepare the youngest generation for addressing water problems that Visegrad countries already partly face. The impacts may continue to grow in the context of climate change. Emphasis is placed on providing teachers with a useful tool for interactive teaching about the role of water at different levels with focus on raising awareness in the field of water management. Support materials cover three main topics: water in households, water in the landscape and water in the city. Two additional games focusing on cooperation conclude this handbook.

Besides the interactive methods used in the handbook, the teacher may also appreciate its flexibility. It is possible to work with the handbook in several ways. First of all, you can integrate it into the common subject lessons (for example, Science) as all the modules have a highly logical structure as a base on which they can be used in the lesson straight away. Each module includes at least three whole lessons and also additional activities which can be done with pupils for further development of the topic. **The great advantage is that every single activity in the handbook can be also used on its own. It means you can choose only some shorter activities to start or enliven the lesson and then continue with your own programme. It is not necessary to work with the whole module if your time table is not suitable for it.**

A second option is to use the modules for larger educational units and therefore strengthen the cross-curricular relations. **This can be done by merging more lessons together or even by means of school-wide project days such as a "Water Day**". Different grades or classes could then work on different modules and present the knowledge gained to each other later. Likewise, the modules provide a very good programme for school trips and stays, as nature is the best educational tool.

All the modules are structured to include as much information for teachers as possible. It means that every reader should be able to manage the lesson with the help of the information and procedures provided in the handbook. There is a clear table at the beginning of each module containing the basic structure of the lesson and individual activities, including the required educational tools, an estimated time duration for the activity and also for its preparation. Under the table you can read more specific information for the actual implementation of the activity in the lesson. Of course, all the necessary worksheets that you can use while working with pupils are prepared in the handbook. You can either print them for the pupils or you can just show them on the screen.

All the teaching materials were developed in cooperation of three partners from three Visegrad countries. Each partner covered one of the areas according to their primary focus and contributed their ideas to other modules. All the partners then tested the individual modules jointly.

The IREAS (Czech Republic), the main author of the handbook concept, developed the module on water consumption in households and created the board game "*Cooperation matters"*. The GWP CEE (Slovakia) manages and coordinates a number of projects related to drought and floods; therefore, their topic of water in the landscape was developed with a high level of expertise. The IMRO (Hungary) focused on water in cities based on its experience in the environmental field.

The inspiration for the joint project was the Slovenian Water Agent project; the content of the education was adapted to the conditions of Central Europe, especially the Visegrad countries. The project was solved between June 2018 and July 2019.

We wish you to enjoy good work with the handbook and we hope it will bring you a lot of inspiring moments with your pupils. If you have any feedback or suggestions concerning the handbook, we will be pleased if you share it with us by email to jerabkova@ireas.cz.

The project, and thus also this handbook, was supported financially by the International Visegrad Fund. We are thankful for the support.

Educational analysis

Where to use the handbook activities?

We consider it very important to put the handbook and its activities in the educational context of each country – Czechia, Hungary and Slovakia. Thus, you can be sure that activities you will decide to use in your class are really suitable for your national curriculum and meet its goals.

Below, you can find short information about the educational system of each country and practical tips on where and when it is possible to integrate the suggested modules and educational activities of the handbook. Of course, the final inclusion of modules and activities in the instruction is the matter of your own professional decision.

Czechia

There is an educational area called "Human and his World" in the national Framework Educational Programme. This area can be realized through different subjects, especially Science (Přírodověda, Vlastivěda). The main topics that are connected with this handbook are defined in the framework as follows:

- Water and air – occurrence, forms and qualities, water cycle, composition, meaning and importance for life
- Nature-friendly behaviour and nature protection – human responsibility, environmental protection, plant and animal protection, waste disposal, natural disasters and ecological disasters

It is up to each school to implement these topics in its own School Educational Programme and curriculum. Mostly, pupils gain really basic knowledge in the 1st to 3rd school years. Then they continue with the topic of water and nature protection during the 4th and 5th years. There is enough space to include the suggested activities because they fit into the curriculum very well. The suggested activities may overlap a little with the topic of water; however, it is up to the teacher where they would like to put the emphasis.

There are also other options to use these activities. The Czech Framework Educational Programme works with the concept of crosscutting themes. There is a whole theme called Environmental Education, which should appear across the whole educational process. In this theme, water is also an important topic. The goal is to teach about water, the importance of water for life and other human activities, purity protection and hygiene, drinking water at home and in different countries, how is it solved, natural resource management, ecological problems, effects of globalization, climate change, etc. The crosscutting theme Environmental Education can be implemented through different forms. The teacher can address the goals while teaching conventional subjects (Science, Civic Education, Geography, etc.) or they can organize external lectures, excursions, etc. Some schools also organize project days for environmental topics, for example a "Water Day". If there is enough space in the curriculum, schools can also implement a special subject.

Therefore, the suggested modules and activities can be used in various ways. It is up to the teachers which way they will choose – implementation in a specific subject or organization of a project day. Activities can be used as a whole or it is possible to choose only some of them to enliven a lesson, start the topic, summarize the topic, etc.

Pupils should know basic facts about the world around us, about water, air, etc. It depends on the pupils' age – some of them should also know basic facts about the water cycle. The modules will build on the basic knowledge from subjects, but also from pupils' implicit knowledge of the world around them. The handbook will develop pupils' experience of water at home, at school or in their environment.

It is also a very good basis for the development of ethics, discussion skills, critical thinking, etc. You can work with these topics in every subject thanks to the crosscutting themes (Personal and Social Education or Democratic Citizen Education).

Hungary

The stage of basic education in Hungary, which begins in the first grade and runs until the end of the eighth grade, is divided into two parts: lower (4 grades) and upper (4 grades). The curriculum and requirements of each school year are based on each other.

The content unit of school education and interoperability between schools is provided by the National Core Curriculum, which defines the literacy content to be acquired and establishes mandatory provisions for the organization of education, in particular to limit the weekly and daily load of pupils. It includes the aims of education and training, the subject system, contents of each subject, the requirements for one or two grades of subjects, and the tasks of developing the interdisciplinary areas of knowledge and ability and defining the requirements as well as the recommended timeframe.

Themes of the handbook appear in countless areas of education in Hungary. Water can be found not only within the Sciences, but also in Literature and other human subjects. The topic of water pollution and water purification itself appears in the History lesson as well as in the Sciences. In the lower section there are different types of water in the context of Environmental Knowledge (salt water, the concept of fresh water, the amount of fresh water on Earth compared to salt water, water conservation, protection of the freshwater stock, recognition of its importance). The top-class Natural Science subject includes topics such as features, appearance, significance and role of water in nature. Children hear about water pollution, the individual and socio-economic impacts of water resources, the recognition of problems and ways of solving them. The foundation of the habit of saving water starts already in the lower classes. The concept, state of the water and its occurrence in nature also appear in the upper part of the Physics subject. In all the mentioned topics, you can use activities from the handbook to support your instruction.

The issue of pollution and water purification has a more central role in upper classes (sources of water pollution, signs of water contamination, causes of floods and inland waters, water savings, water treatment and its challenges). Pupils get to know the different types of water in more detail and their characteristics and significance in the life and economic life of man. The benefits and importance of rivers and lakes are also evident during education. The causes, consequences, possibilities of prevention of water pollution, water protection and water purification processes are not only mentioned at the level of mentioning, but it is possible to deepen this knowledge through several lessons in the subject of Natural Sciences and later in the fields of Biology or Chemistry.

Awareness of personal responsibility for maintaining water purity is deepened in the upper age group. Encouraging pupils to take active action to protect nature at individual and community level is also important (Oktatáskutató és Fejlesztő Intézet, 2016).

In the 5th–6th class in the course of Natural Sciences, pupils can hear about the connection between environment – organization – lifestyle – health condition and the development of the hygienic culture, while in the upper grades, children hear about the role of personal hygiene in the course of Biology. Eating habits, hand washing and the role of bacteria and viruses are also mentioned. The relevant parts of this handbook could be suitable to go through these topics in the class.

Slovakia

Within the Slovak educational system, elementary schools (5th and 6th grade pupils are the target group of the handbook) are part of regional education. The main role of the regional education is covered by education according to education programmes, in the 5th to 9th grade by lower secondary education (ISCED 2).

The education content for particular levels of education is set by education standards within the state education programmes (StEP). StEP are issued by the Ministry of Education, Science, Research and Sport or the Ministry of Health. StEP also set compulsory school subjects that are incorporated into particular areas of education. StEP (for higher education levels than kindergartens) include a framework educational plan which contains areas of education as well as a list of compulsory and optional subjects. The second level of the programme system is represented by school education programmes (ScEP) within each school. Besides the regular subjects, cross-section topics are established to intersect all areas of education.

The topics “Water in the landscape”, “Water in households” and “Water in the city” are also included in the cross-section topic Environmental education. This first topic is covered in all education areas, such as Nature and landscape conservation – water resources (human activities linked with water management), Elements of the environment – water (importance of water, water cycle, water quality protection, water hazards, fresh water in Slovakia and abroad, wastewater treatment), Natural resource usage and conservation, Human activities and environmental problems as well as Human connection with the environment.

The topics “Water in households” and “Water in the city” are discussed during the cross-section topic Environmental education in some educational areas, such as Nature and landscape conservation (water around us and its importance – human activities linked with water management; water and hygiene – human activities linked with water management and urbanization), Elements of the environment – water (importance of water, water quality protection, water hazards and wastewater treatment), Natural resource usage and conservation (water around us and importance of natural resources for humans), Human activities and environmental problems (wastewater treatment, agriculture and the environment) as well as Human connection with the environment (water consumption and its consequences). The topic “Water in the city” is also covered in another education area of the cross-section topic Protection of life and health, such as Emergency response – civil protection – water and hygiene (Hygienic cleansing and protection of food and water).

The framework educational plan also enables schools to use optional subjects (3 lessons within the 5th grade, 4 lessons within the 6th grade) for creating tailored school education programmes (ScEP). In this way they can be used to create a particular subject as well as to extend existing subjects with more topics or experiments, e.g., in the field of water management.

Intersections with the topic “Water” for fifth- to sixth-graders in the state education programmes are seen in the following subjects: Biology, Ethics Education, Physics, Geography and Civil Science.

The subjects Ethics Education and Civil Science develop mostly pupils’ communication skills, taking over responsibility for their own opinions, attitudes, consequences of their acts, and critical thinking. Both contribute to creation and development of pupils’ social and civil awareness and lead them to civil involvement, which is crucial in solving environmental problems. This handbook has a lot of activities that support and develop these skills.

Water in households

The main objective of module:

To increase pupils' awareness of water consumption and possibilities of water savings in the household. Pupils would be aware of the importance of water and of saving it as a rare resource. The first step is to be aware of the amount of water that we usually consume. Water consumption and savings are very important for all the Visegrad countries, because these countries have faced a problem of water resources in times of drought. The objective will be achieved using a set of activities.

Theoretical introduction to water consumption:

The amount of water consumed is changing over time. In the past, people mostly carried water from the source (rivers or wells). This type of transport limits water consumption to the necessary level. The consumption in households was mostly connected with drinking, cooking or cattle breeding. Laundry was usually washed right by the river. Over time, hygiene has become more and more important to avoid diseases such as plague. Water was brought to public fountains in the vicinity of households; later, water was transported directly to houses in pipes. Water consumption increased rapidly due the washing of clothes at home.

The highest water consumption was in the communist period. The increase in water consumption is connected with development of water supply systems in municipalities. The high water consumption was given by the price setting, which was determined by the planned economy. The costs for water did not reflect the real costs of running the waterworks. This situation resulted in a great waste of water. Partly this situation was also determined by the non-existence of water consumption measurement in individual flats in apartment buildings. The expenditures on water were divided by the number of flats or people living in the house. In this situation, there was no motivation to save water. Table 1 shows the development of water consumption based on SUEZ Water CZ (2018). After the end of the communist period (after 1990), the water consumption in households began to decrease as a result of price increases. At present, almost all flats have water consumption measurement. Table 1 shows the development of water consumption in the Czech Republic. The situation in all the Visegrad countries is similar.

Table 1: Development of household water consumption

Year	Consumption (in litres of water per person per day)
1760	20
1850	80
1945	100
1965	300
1990	170
2000	137
2010	120
2017	89

Source: Based on SUEZ Water CZ (2018), Czech Statistical Office (2018)

Since water is currently flowing out of the pipes by itself without the need to exert any effort to transport it, the awareness of water consumption is low also among adults. (The situation is almost the same in energy consumption.) If adults have any information about water consumption, it is connected with expenditures on water, the amount of water.

The current water conditions are changing in Central Europe due to climate change. The change in precipitation distribution in the year influences the water sources. Many villages face the problem of lack of water in the dry summer period. Upstream countries (which is mostly the case of all the Visegrad countries, especially of the Czech Republic and Slovakia) are also affected by the location and the dependence on rainfall.

In the case of drought periods, it is important to know which activity demands more or less water. This awareness helps to save water in necessary cases. Water in households is mostly used for activities listed in Table 2.

Table 2: Amount of water consumed for household activities per capita per day (average consumption in the Czech Republic)

Activity	Amount of water
Toilet	23 litres
Personal hygiene	31 litres
Cleaning, doing laundry	13 litres
Cooking (including dishwashing)	8 litres
Drinking	4 litres
Washing hands	5 litres
Watering plants and others	5 litres
Total average consumption (person per day)	**89 litres**

Source: Severočeské vodovody a kanalizace, a.s. (2018)

The above data are based on average consumption, but there are big differences among consumers in their behaviour. The next table provides information about the amount of water for one instance of an activity (such as one flushing of a toilet, etc.).

Table 3: Amount of water consumed per instance of activity

Activity	Amount of water per instance
flushing a toilet	3–10 litres
taking a bath	50–150 litres
taking a shower	30–80 litres
washing hands	2–3 litres
washing clothes in a washing machine	30–90 litres
washing dishes in a dishwasher	7–30 litres
washing a car	100–200 litres

Source: Combination of sources, e.g.: Výzkumný Technologický Institut (2018) and SUEZ Water CZ (2018) and own measurements

All these activities are very often connected with excessive water consumption. There are a lot of ways to reduce consumption. Some of them are about changing behaviour (taking a shower instead of taking a bath, brushing teeth with/without water off or washing hands with/without consuming water by using soap, etc.). Sometimes saving water is connected with technical solutions such as toilets with two buttons which distinguish how much water is needed for flushing. Another example can be taps with water flow aerators or ECO programmes while using dishwashers or washing machines. A slightly different way of water saving is the use of rain water or grey water (e.g., bath water for toilet flushing).

There is very little awareness of the quality of water in the Visegrad countries. Very often, the quality is very high, so it is not necessary to buy water for drinking in plastic bottles. In this case, it is not about wasting water directly, but about wasting energy and other resources for production of bottles.

Although it may seem, based on the above, that the lower the consumption the better, there are limits in reducing water consumption in connection with hygiene. Based on WHO (2013), the short-term minimum consumption (for survival) is between 7.5 and 20 litres per capita per day. This amount is used for drinking and cooking. The medium-term minimum consumption includes maintenance. Based on WHO (2013), this involves especially personal washing, washing clothes, cleaning home, growing food, sanitation and waste disposal and of course drinking and cooking. In this case, we speak mostly about 60 or 70 litres per capita per day. In the long-term consumption, other activities need to be taken into account such as recreation. The hygiene minimum declared by the World Health Organization is 100 litres per capita per day.

Water consumption in households influences the family budget. For example, reducing water consumption by about 20 litres per member per day leads to a saving of more than CZK 700 in one year in the Czech Republic. A family with two children save (based on water prices) about CZK 3 thousand. You can find the level of savings in Hungary and Slovakia in activity 4 in Block 3. Many of the above ways to reduce the consumption have a very short payback time. With the money saved, the family can buy, e.g., 60 hamburgers, 4 cinema tickets for the entire family (2 adults, 2 children), 8 visits to the bowling alley, 5 sets of headphones, 4–5 family trips to the zoo (2 adults, 2 children).

Key subthemes:

(i) Water around us and its importance; (ii) Water consumption; (iii) Water savings and their meaning

Block 1:
Water around us and its importance

Educational objective of block 1:

Pupils realize different forms of water. They are aware of places where they can find them.

Development of values and attitudes:

Pupils realize the importance of water for them, for others and for nature.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	Searching for pupils' experience with water (preconcepts) – the goal is to find out the state of knowledge. Do pupils know where they can find water? Do they know it has different forms and functions?	Dialogue	Blackboard – writing ideas	Children can speak about their own experience and the world around them. They can share it with the group.	5–10 min	
2	Drawing – specific picture about water, building of knowledge	Drawing, creating a product	Paper, pencils, etc.	Activity is on the side of the pupils, they can draw as they fancy.	15–20 min	Papers and pencils for pupils (they may have their own)
3	Quiz – systematization and structuring of knowledge (water around us, water functions, why it is important,…)	Didactic game	Paper and blackboard	Game is always motivating for children. They want to find the right and original words. Activity is on their side.	10–15 min	5 min – preparing pieces of paper for children
4	Summary – anchoring of knowledge	Monologue plus visual elements	Could be some sum-mary on paper or a picture	Tell pupils they will remember it better if they revise. If they get a picture it could also be motivating.	5 min	

Activity 1

This activity is important to start with. It serves as a tool to find out the state of knowledge in the classroom. It means you will find out what children already know about water. You can later build on their knowledge in the following activities.

One possible way to do it is a dialogue. You ask questions and write down the children's answers on a blackboard or a flipchart.

Possible questions:

- Where can you find water at home?
- Where can you find water at school?
- Where can you find water in the city?
- Where can you find water in the landscape?
- Tell us some positive experience connected with water.
- Tell us some negative experience connected with water.
- Do you know where water comes from?
- Do you know what happens with water after rain?
- Why do we need water?
- Who else needs water?
- … (add your own questions)

You can adjust the questions according to the thematic plan of your subject. Some questions should seem too easy or too difficult. It is up to each teacher to manage a dialogue. The important goal is to find out what children already know, what you can use to build further knowledge, what should be repeated and what is completely new for them. Then you can start other activities with this useful overview. You can also use it when making groups (i.e., put in every group someone with a broader overview together with someone with a narrow one, etc.).

Activity 2

When working with younger pupils, you can strengthen their motivation for the topic of water with drawing pictures. This activity is optional. You can process it before or after Activity 1, you can skip it or you can decide to start with the drawing and skip Activity 1 if you think that dialogue is too difficult for younger children. You can also cooperate with your colleague and ask them to do this activity in an Art lesson.

If you choose only drawing, do not forget to sum up the children's drawings together. What did they draw and why? Where else can they see water? Why is water important, etc. You can also help children to sum up if they do not come up with their own ideas.

The topic for drawing can be:

- water in the household,
- water in the landscape,
- water in the city,
- positive experience with water,
- animals and water,
- etc.

Activity 3

This game should help pupils summarize the importance of water in the city and landscape and of water consumption. It is possible to use this game as an introduction to each module (water in the household, water in the city and water in the landscape) or as a recapitulation of other modules.

First, pupils need to make 4 to 6 groups with approximately 5 members per group. Each group prepares 12 pieces of paper large enough to be visible on the blackboard (these can also be prepared beforehand or the groups can write this on paper and then copy it to the blackboard).

There are three stages in this game. The first stage focuses on the topic of *water in the city*, the second stage focuses on *water in the landscape* and the last one focuses on *water consumption*.

The first stage begins with the teacher announcing the first topic – *water in the city*. The pupils' task is to come up with 4 words that are closely related to this subject. Each group writes these 4 words they came up with on their 4 pieces of paper. After everyone has finished, each group places their words in a column on the blackboard.[1] Once each group has a column of words on the blackboard, the teacher discusses the words together with the pupils. Then, the teacher goes through the pupils' ideas and awards points to groups as follows:

- If the word fits the topic and if the groups have the same word or values, the teacher awards one point to these groups.
- If the word fits the topic and it is original (it means that it was used by only one group), this group gets two points.
- If the word does not fit the topic, the group gets zero points for it.

In Table 1, there are examples of some relevant words. The group with the most points wins.

1 Alternatively, they can just write them on the blackboard.

Table 1: Example of words

Water in the city	Sewerage	Water treatment plant
	River	Lake
	Gutter	Park
	Pond	Fountain
Water in the landscape	River	Swamp
	Water reservoir	Peat-bog
	Sea, ocean	Lake, pond
	Stream	Forest
Water consumption	Water conduit (water pipes)	Swimming pool
	Hygiene	Boiler
	Washing the dishes	Well
	Watering plants	Cooking

Advice on preparation:

The appropriate size of pieces of paper is 4 pieces of paper per A4.

You can attach the pieces of paper on the blackboard using magnets or tape.

Suggestions for supplementary questions:

- What is the importance of water? Why is it important for people/animals? Why is it important at home, at school, in the city or in the landscape, etc.?
- Where does water consumption reflect?

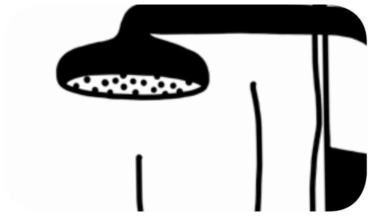
Activity 4

This activity varies depending on the lesson time left. It can be a very short summary of the knowledge and information that were mentioned in the lesson or it can be a longer activity that will help pupils to remember the information better.

Pupils should be able to:

- name where they can find water around them,
- explain why water is important (for people, animals, etc.), and
- understand that water is rare.

Block 2:
Water consumption



Educational objective of block 2:

Pupils are aware of the average consumption and its consequences. They can imagine the amount of consumption from concrete examples.

Development of values and attitudes:

Pupils appreciate the value of water. They understand that water is a limited resource and everyone needs it. Pupils are aware of their consumption and of the fact that they can influence it with their own behaviour.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	Preconcepts – guessing of activities in pupils' (and their families') lives that require water	Dialogue, guessing	Pictures of activities, magnets or tape	Using pupils' experience, guessing	5–10 min	5 min – preparing the pictures of activities (Attachment 1) and magnets
2	Water consumption – pupils get a limited number of "water drops" (representing the average water consumption) and try to divide it between the specific activities that require water (Activity 1). The goal is to develop the ability to estimate consumption and to show them that it is more/less than they think and why.	Cooperative work in groups	Worksheet with activities that require water, worksheet with water drops	Cooperation, trying to find the answer close to the statistics	7–10 min	10 min – printing the worksheets (Attachment 2) and drops (Attachment 3), bringing scissors (if children do not have their own)
3	Clues – Groups of pupils get various clues that should help them make the guesses more accurate. E.g., they found out from the picture that taking a bath consumes a specific number of litres/ drops. Then they adjust all the other guesses according to that. The goal is to let them work with different types of information, plus show them that their guesses may differ from reality.	Different – text, video, story, pictures, etc.	Different clues prepared – video, advertisement, article – they contain some information about the consumption of an activity	Different sources where they can find the right information and adjust their guesses	15–20 min	5 min – printing the clues (Attachment 4). Then, you can prepare the video during the pupils' work in Activity 2.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
4	Real consumption according to statistics. The goal is to compare the pupils' guesses and adjust them according to statistics. Then it is important to speak with pupils about it. What were their guesses? Are they surprised?	Dialogue	List of activities with right answers	Discovering the real statistics, comparing of their guesses + discussion (How did they make the guess? What helped them make it real? What caused them to think it is more/less?	7–10 min	3 min – printing List of activities with the right answers
5	Strengthening the picture of consumption. Thinking together with children about comparisons of consumption. How many school drinks is a bath, etc. The goal of this activity is to produce a concrete idea about consumption, not only abstract.	Dialogue	Blackboard – writing down the comparisons	Thinking about things close to their life and experience.	3–5 min	

Activity 1

With the teacher's help, pupils guess their families' activities (household activities) that require water. When they guess an activity, the teacher attaches a picture of the guessed activity on the blackboard (pictures to print and cut in Attachment 1). Some smaller activities are aggregated into one group. For example, brushing teeth and showering would both be placed under personal hygiene.

Household activities that require water:

- toilet,
- personal hygiene,
- cleaning, doing laundry,
- cooking (including dishwashing),
- drinking,
- washing hands,
- watering plants, and others.

Advice on preparation:

You can attach the pictures on the board using magnets or tape. Alternatively, you do not have to print the pictures. You can just use a projector to show them.

Activity 2

Pupils make 4 to 6 groups with approximately 5 members per group. During this activity, pupils work together to estimate the amount of water needed for each household activity requiring water.

The average household consumes around 90 litres of water daily. Each group is to divide 90 litres between all the household activities requiring water as realistically as possible.

Each group is given a worksheet with pictures of the activities (Attachment 2) and a sheet with pictures of water drops, each representing 1 L of water (Attachment 3). Groups are to place water drops next to pictures of activities according to the amount of water they think that specific activity requires.

Example

Pupils in group A decided to place 5 water drops next to the picture of hygiene, because they agreed that they need 5 L of water for hygiene daily.

Advice on preparation:

Pupils do not have to cut the water drops separately. For example, if they wish to place 7 water drops next to *personal hygiene*, they can cut 7 water drops in a row.

Note for the teacher:

This activity may be extended with the activity described in part 3. Part 3 may be skipped if there is not enough time. This activity is then finalized in activity 4.

Please be careful about team work and cooperative work. If pupils work in groups, it is necessary to ensure that each member of the group is working on the task. You can divide roles in groups (guesser, cutter, writer, speaker, etc.) or you can make it a rule that each member is responsible for at least one guess, etc. If you have time, you can also evaluate the cooperation in the groups together with the pupils after the end of the activity.

Activity 3

After first guesses marked on the worksheet (i.e., every group has marked all household activities that require water with drops meaning water consumption), each group can receive several clues that should help them improve their estimations – make them more accurate, i.e., adjust the number of drops according to information from the given clues. Each group gets five clues from different sources and of a different type (Clues in Attachment 4):

- a video,
- an advertisement,
- a mathematical example,
- a description of a product from an e-shop, and
- an article.

This will make them work with different sources of information, which is also a very important skill for future. Also, each group will be able to improve their estimate of water consumption thanks to the given clues.

Activity 4

After each group has finished, the teacher sums up the pupils' guesses. It is appropriate to accompany this conclusion with questions such as "Which activity requires the most water according to your estimate?", "Why do you think that?", etc.

The teacher writes an average of the pupils' guesses (in litres of water) next to the picture of the activity on the board (for example, on the left of the picture). After each picture (each activity) is discussed, the teacher informs pupils about the right answers according to average. It means the teacher writes/says the right amount of litres/drops for each activity (for example, on the right of the picture). The entire diagram can be finished by writing the actual number of litres of water needed for each activity in pupil's worksheet (Attachment 3, for example, on the right of the pictures of water drops).

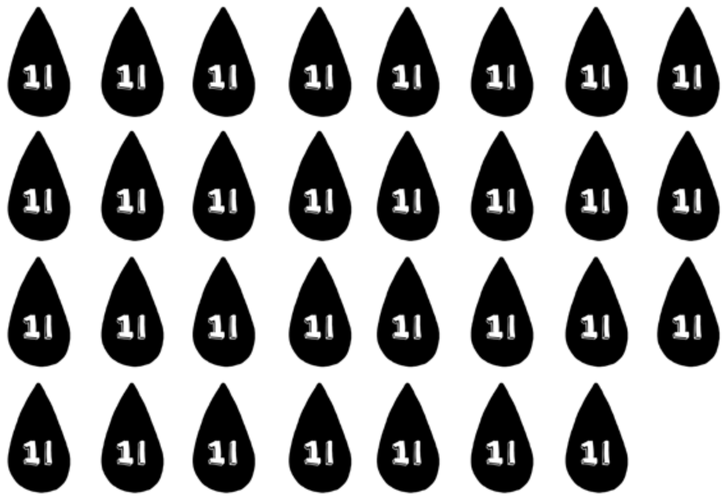
Solution: The amount of water required by each activity:

The summary is 89 L, for the game it will be 90 L. You can find the answers below**. Please take into account that this may be surprising to children. It is good to explain that these are average numbers. Someone uses more, someone uses less. Watering plants and other activities could be a subject of discussion.** You can again explain that even if they do not have a garden, this is the average amount that people use for gardening and other stuff that is not named in the previous activities.

The answers:

- Toilet 23 L
- Personal hygiene 31 L
- Cleaning, doing laundry 13 L
- Cooking (including dishwashing) 8 L
- Drinking 4 L
- Washing hands 5 L
- Watering plants and others 5 L

Example of a finished diagram:



25 L

Average of pupils' tips

31 L

Answer according to statistics

Suggestions for supplementary questions:

- Did you make many changes based on the clues?
- Where did you make the biggest changes?
- What was the biggest surprise for you?
- Why did you guess more/less? (in a specific activity)
- Why do you think this activity requires that much water?

Additional activity:

Measuring consumption – pupils measure the consumption of different behaviours. They compare the consumption while washing a mug under running water and, on the other hand, while stopping the water wisely. (Time depends on the number of activities compared.)

Pupils alternately pass a device to measure the consumption of chosen activities.

Activity 5

The aim of this closing activity is to make a clear picture about consumption, a specific idea about it (i.e., not only a number such as 31 L but by comparing it to something that pupils can easily imagine, e.g., bottles of water, etc.).

Tip: You can note actual comparisons on the blackboard or flipchart to make them more specific.

Teachers can use questions to make pupils think about comparisons:

- Can you count how many bottles of water this consumption is (*choose specific activity – you can do it for all of them or only for some chosen*)?
- How many buckets would this be?
- Do you think that this consumption is high or low?
- Do you think we can reduce the consumption somehow? How?

You can also use the questions to motivate children for the next lesson. The next lesson will be about reducing consumption, so they can make some tips now and know more of them and about them later in the next class.

Block 3: Water savings and their importance

Educational objective of block 3:

Pupils understand that water consumption can be reduced. Pupils know the easy ways to make water savings. They understand what these savings mean (for nature, for money savings, etc.).

Development of values and attitudes:

Pupils realize that it is important to reduce water consumption and they know they should start with their own behaviour. Pupils find it important to share the idea of water savings further.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	Card game “More or less” – pupils play a game of cards that contain pictures of good and bad behaviour towards water (bath vs. shower, etc.). The goal of the game is to start thinking about different behaviour towards water and perceive different ways to save water.	Didactic game	Cards prepared for the game	The elements of the game motivate pupils	15–20 min	15 min – preparing and printing the cards for the game (Attachment 5; the last page of this attachment contains the reverse side of the cards, which is the same for all front side of cards). Once you do it, you will have them for other groups. Remember: The game will be played in more groups and each group needs a whole pack of cards.
2	Summing up of the game. What pupils have found out during the game (summary of the game, what different ways of savings pupils found in the card game) Comparing different behaviour towards water.	Dialogue	Blackboard + pictures of good and bad behaviour	Pupils can show their mindfulness	5 min	
3	Drought and the necessity to save water – how to do it? Pupils try to distribute a reduced amount of water among activities from block 2. The goal is to show them the reality of the need for water savings and to discover together that there are different ways of saving water.	Cooperative work in groups	Worksheet with activities that require water, worksheet with water drops	Pupils should solve a challenge, they cooperate, they can come up with their own ideas	10–15 min	3–5 min – Printing the worksheets (you can use printed activities from block 2 – Attachment 2 and 3, so you will print only worksheet with drops again – Attachment 3)
4	Water savings in concrete examples – in this activity we would like to make water savings more concrete for pupils. Pupils should be informed about what saved drops of water mean in money, or in some other things they need or can buy. The benefits for nature will also be discussed.	Verbally illustrative method, dialogue	Picture of things they can or cannot buy for the saved money	Showing pupils the results of their behaviour, what they can save, what they can do for the future	5–10 min	5 min – Printing the Attachment 6 for each pupil. Alternatively, you can just show it on the screen.
5	What can I do for the world and also for myself – write down 1 concrete thing that I will do to save water. Plus one thing that I found out about water that I will share with my family and friends.	Individual work	Paper, pencil	Show the pupils that they can do something for nature, motivation for action	5 min	

Activity 1

Pupils make 4 to 6 groups with approximately 5 members per group. During this part, pupils play a card game called *More or less* in each group (i.e., each group will need a whole pack of cards). You can find the cards in Attachment 5.

Goal of the game: The goal is to get rid of the cards by making pairs from the cards that you have and will have during the game. When you have a pair, you can get rid of the cards by putting the pair down on the table. But there is one card called the "Sad Drop", which has no pair. A player that holds the card called the "*Sad Drop*" in their hands at the end of the game, loses.

Pairs: Pairs of cards symbolize examples of good and bad behaviour towards water consumption. An example is brushing teeth with running water and brushing teeth with the water off. Each pair is marked by the same number in the corner of the card for clarity.

Playing: At the beginning of the game, mix the cards thoroughly and deal all of them among all the players in the group. Since the number of cards in this game is 33, some players will hold fewer cards than others. The difference between players' cards may be one – that is okay. It may happen that some players will have some pairs straight after the initial dealing. That is okay. They should put the pairs down on the table at the beginning of the game.

After each player has placed pairs from the initial dealing on the table, the first round may start. A player with the most cards[2] offers cards held in their hand to a partner sitting on the left, who picks (blindly) one of the first player's card and place it among their own cards. If this newly acquired card forms a pair with one of the cards they had in hand, they place this pair on the table in front of them. Now it's their turn to offer their cards to the player on their left, and so on. A player that has placed their last pair on the table and no longer holds any cards, wins. The game ends when everyone has placed their pairs on the table and one player is holding the last card – the *Sad Drop*. The player holding the *Sad Drop* loses. Some players may have finished the game earlier, because they placed all of their pairs on the table and no longer have any cards.

List of all pairs:

Number of pair	Good behaviour (marked as a)		Bad behaviour (marked as b)	
1	1 a	Short shower	1 b	Bath
2	2 a	Lever basin taps	2 b	Compression basin taps
3	3 a	Two press buttons on a toilet	3 b	One press button on a toilet
4	4 a	Full washing machine	4 b	Half-empty washing machine
5	5 a	Swimming in a public pool*	5 b	Swimming in a family pool*
6	6 a	Using rain water for watering plants	6 b	Watering plants with mains water
7	7 a	Brushing teeth with water off	7 b	Brushing teeth with running water
8	8 a	Soaping hands while washing hands with water off	8 b	Soaping hands while washing hands with running water
9	9 a	Using water from a well**	9 b	Using tap water**
10	10 a	Public bathroom using sensor taps	10 b	Accidently leaving the water running in a public bathroom

2 If there are more than one player with the same number of cards, the younger one begins or you can make any other rule for the first player.

Number of pair	Good behaviour (marked as a)		Bad behaviour (marked as b)	
11	11 a	Washing dishes in dishwasher on ECO programme	11 b	Washing dishes by hand
12	12 a	Taps with water flow aerators	12 b	Taps without water flow aerators
13	13 a	Shampooing hair with water off	13 b	Shampooing hair with running water
14	14 a	Cooking with the appropriate amount of water	14 b	Cooking with surplus water
15	15 a	Drinking tap water ***	15 b	Drinking water from plastic bottles***
16	16 a	Using water twice, for example using water from showering for watering plants	16 b	Draining water from the shower into the sewer

* Public swimming pools are open to all people, save the amount of water need for private pools for each individual person. Open-air pools are mostly supplied with water from streams so there is no wastage of drinking water. Family swimming pools very often use drinking tap water. **The private family swimming pool considered bad behaviour in terms of drinking water wastage.**

** In the case of gardening or other open-air activities such as family swimming pools (pair 5), it is not necessary to use drinking tap water. There are options such as wells or use of rain/grey water, which are more eco-friendly options.

*** In many countries such as the Czech Republic, Slovakia or Hungary we can use tap water for drinking. The tap water quality is very high, almost the same as from bottles, so it is not necessary to buy bottled water for daily drinking purposes. Buying bottled water is connected with waste production (plastic bottles) and adverse effects of water transport. **This pair is not directly about water saving, but about broader environmental protection.**

Advice on preparation:

Cards are to be printed beforehand and they should be prepared for each group.

Additional activity:

Water agent – pupils go around their household or school while trying to find if there is water being wasted (e.g., finding a dripping tap, running toilet, etc.). Then they can also measure the consumption – e.g., how much water is wasted through a dripping tap during a 45-minute lesson, etc.

Short video about saving water: https://www.youtube.com/watch?v=B4ZR53n0D8I

Activity 2

After each group has finished the game, the teacher discusses with pupils what the pairs represent. Why some of them are good and some of them bad. Then, it is important to compare the consumption of water (in litres) of a household following the good examples of behaviour towards water consumption and a household following the bad examples of behaviour towards water consumption. This comparison may be made with the aid of the pictures from block 2. You can also write the saved amount on the blackboard.

The teacher can also discuss with the pupils what measures they apply at home, what they have seen at school or at a hotel/restaurant/shopping mall, etc.

Activity 3

In this part, you will come back to the activity in block 2 (water consumption), part 2, where the pupils' task was to distribute 90 L of water among household activities that require water.

You will explain to pupils that due to drought it is necessary to reduce water consumption down to 60 L.[3] In order to simulate this situation, pupils will make 4 to 6 groups with approximately 5 members per group and try to distribute 60 L litres among all the household activities (instead of 90 L). (Use Attachments 2 and 3 again to process this activity).

After each group has finished, the teacher discusses their results. It is appropriate to ask why they think they need only this little water for an activity, how they will achieve it, etc. Mostly, they will try to reduce the consumption by responsible behaviour from the cards. Maybe they will try to reduce something that has to be done. It is up to the teacher to show them what the minimum amount for each activity respecting well-being is.

Then, motivate them to think – what are some other ways to save water? Pupils will surely come up with something. If not, you can help them with questions:

- How can they do an activity without using water/using zero drinking water?
- How can they flush a toilet with zero drinking water?
- How can they shower and flush a toilet with the same amount of water?

Pupils will come up with some ideas. If they say a relevant way of saving water, the teacher places the according picture on the board or write it down.

At the end, it is appropriate to sum up that besides reducing consumption by responsible behaviour, there are other ways to save water (you will find out more about these activities in the module Water in the City):

- using rain water,
- using a nearby stream,
- using a spring (well),
- using water more than once (for example, using water from showering to flush, etc.).

At the end of this activity, discuss with children about the reason why save water and what it may mean, why it is important, etc. They should find the problem of drought to be real. You can also show them some news about drought.

3 To show the reality of drought, you can use real situations from your country or different countries. You can Google, for example, "drought South Africa" and use this article to begin the activity.

Activity 4

In this part, pupils either work individually or they make 4 to 6 groups with approximately 5 members per group – it is up to the teacher to decide. The pupils' task is to decide what they can or cannot buy if they save enough water (in this case, they would save 20 L per day per person for one year in a 4-member family) and therefore save some money.

Information for the teacher: Water consumption in households influences the family budget. For example, reducing water consumption by about 20 litres per member per day leads to a saving of more than CZK 700 in one year per person. A family with two children may save approximately CZK 2000–3000 per year, based on the water price.

You can easily calculate the money savings using this formula:

4 (number of family members) × 0.02 m^3 (=20l/per day/per person) × 365 day in year × PRICE of water (CZK/m^3) = 58.4 m^3 × PRICE of water (CZK/m^3).

Examples of current prices (2019) in capital cities:

- Bratislava: 3.01 EUR/m^3 → saving for 4 members in a household: EUR 88.03 per year;
- Budapest: 754.94 HUF/m^3 → saving of HUF 22,044.21 per year;
- Prague: 89.66 CZK/m^3 → saving of CZK 2618 per year.

Use the picture in Attachment 6. You can give it to each pupil, to each group or you can just show it on the screen using a projector.

Pupils discuss what things from the picture and list of things (and other things they come up with) they could/could not buy if they save 20 litres a day per person for one year in a 4-member family. This exercise should help pupils be more aware of the value of water.

When working in groups:

Each group decides and presents what things they think they can and cannot buy with the money saved by saving water. The groups can then discuss together and the teacher facilitates the discussion and explains whether a thing can be bought or not.

When working individually:

Each pupil receives a worksheet with a picture and list of things and decides on their own what things they think they can and cannot buy with the saved money. The pupils can then discuss together and the teacher facilitates the discussion and explains whether a thing can be bought or not.

After the discussion is finished, the teacher tells pupils how much water costs and what the "correct answers" are. You can find all the necessary information about prices and savings in the theoretical introduction or on the Internet.

Examples: [4]

What we can buy in one year if we save 20 L per day per person in a 4-member family:	What we cannot buy in one year if we save 20 L per day per person in a 4-member family:
• 60 hamburgers	• Summer vacation
• 4–6 cinema tickets for the entire family (2 adults, 2 children)	• House
• 8 visits to the bowling alley	• Car
• 1 pair of sports shoes (tennis shoes)	• Bicycle
• 3 board games	• Helicopter
• 4–5 family trips to the zoo (2 adults, 2 children)	• 3D printer
• 9 books	• New PlayStation or Xbox
• 4 children's tennis racket	• Family trip to Disneyland or Legoland
• 5 balls	
• 2 giant plush bears	
• 7 regular plush toys	
• 130 chocolate bars	
• Bicycle helmets for the entire family (2 adults, 2 children)	
• 2 concert or music festival tickets	
• 3 subscriptions to favourite magazines	
• 2 video games	

At the end, you can also discuss with the pupils the benefits of water saving and good water treatment for nature, for animals or the whole planet. You can discuss with them the generally responsible behaviour towards water and its importance. You can prepare them for two other modules – water in the city and water in the landscape. There you can find other types of challenges and responsible behaviour.

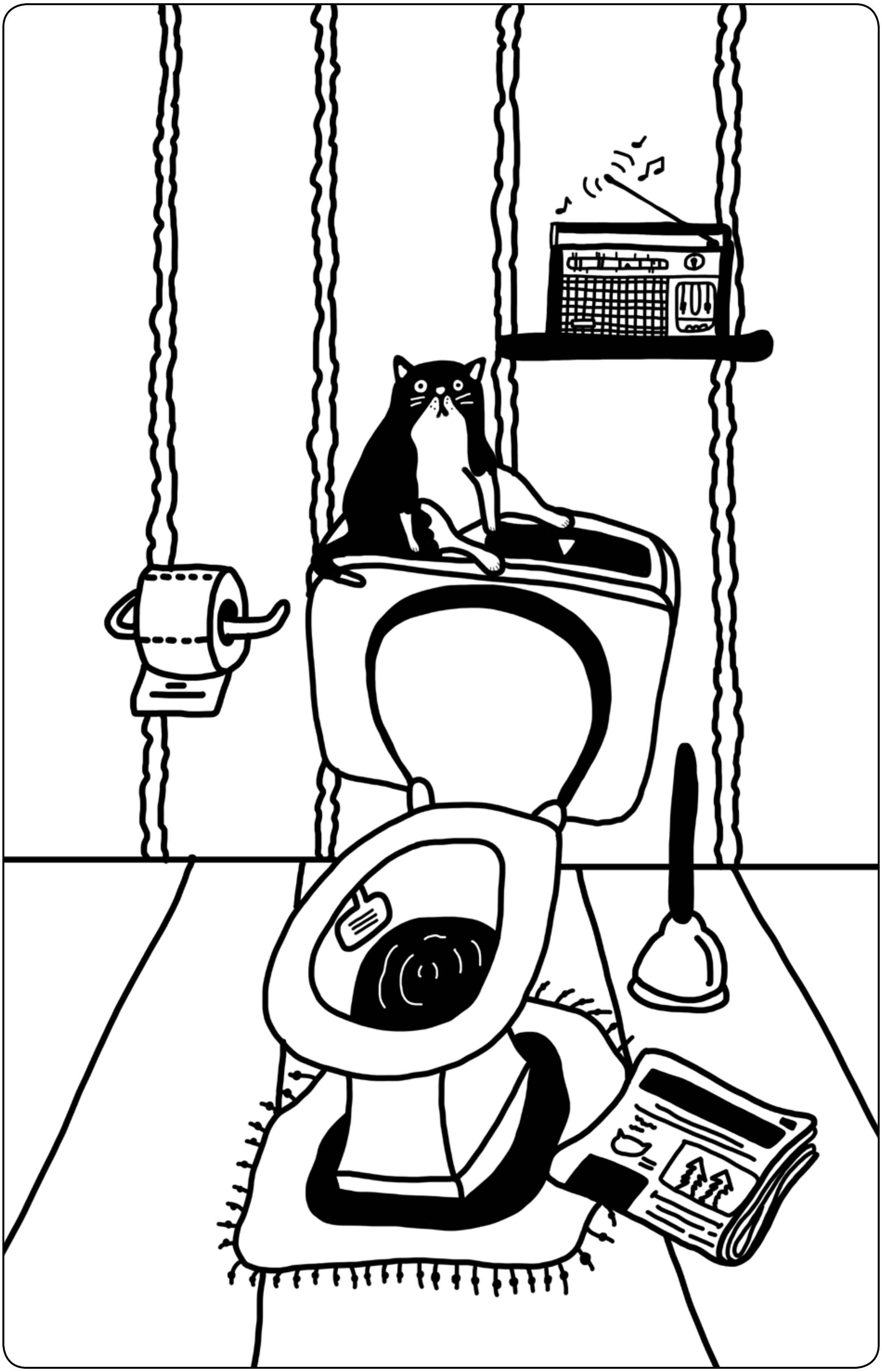
Activity 5

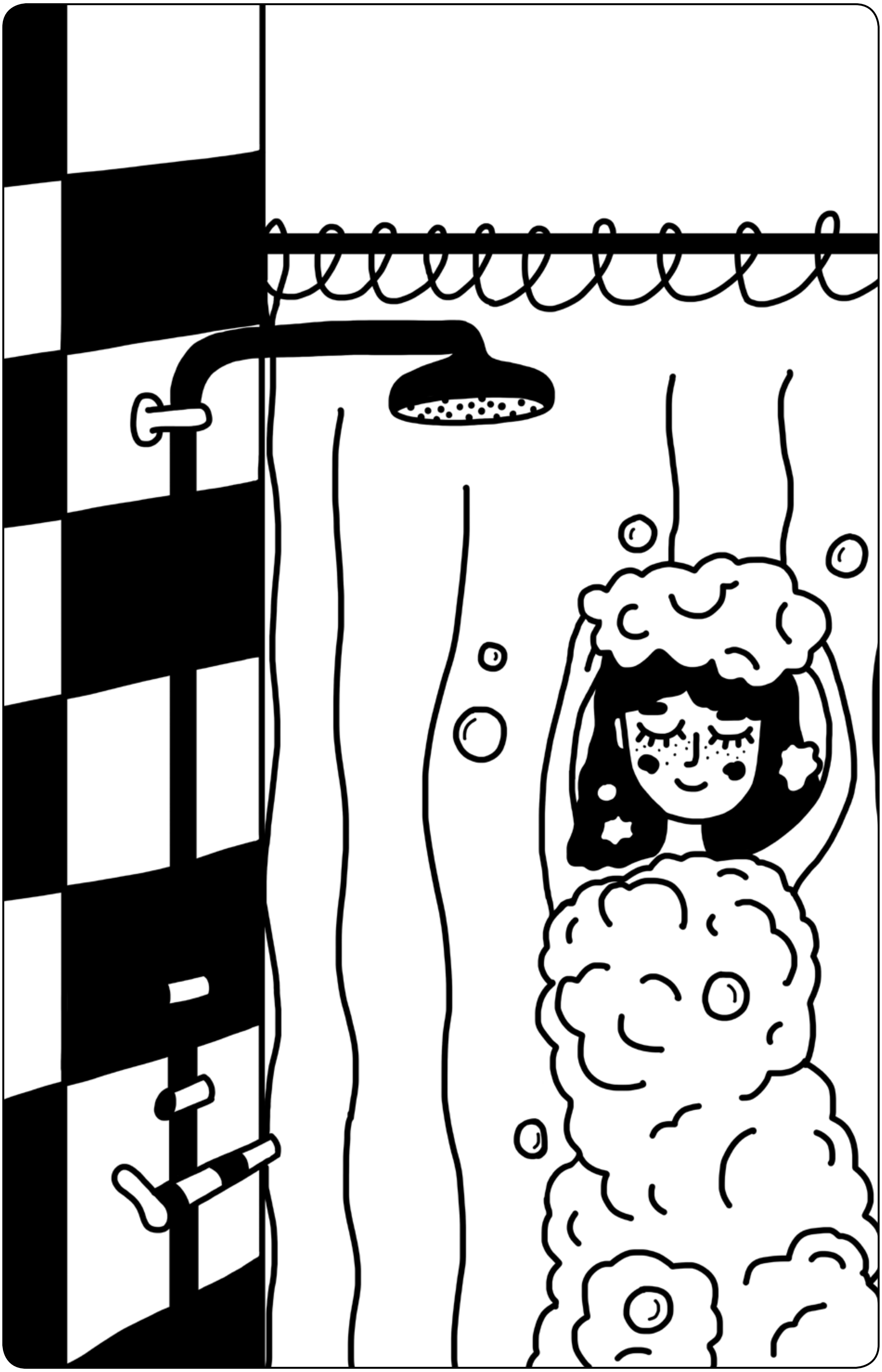
Call for action. Show pupils that they affect the world around them, and motivate them to do one concrete action to help nature.

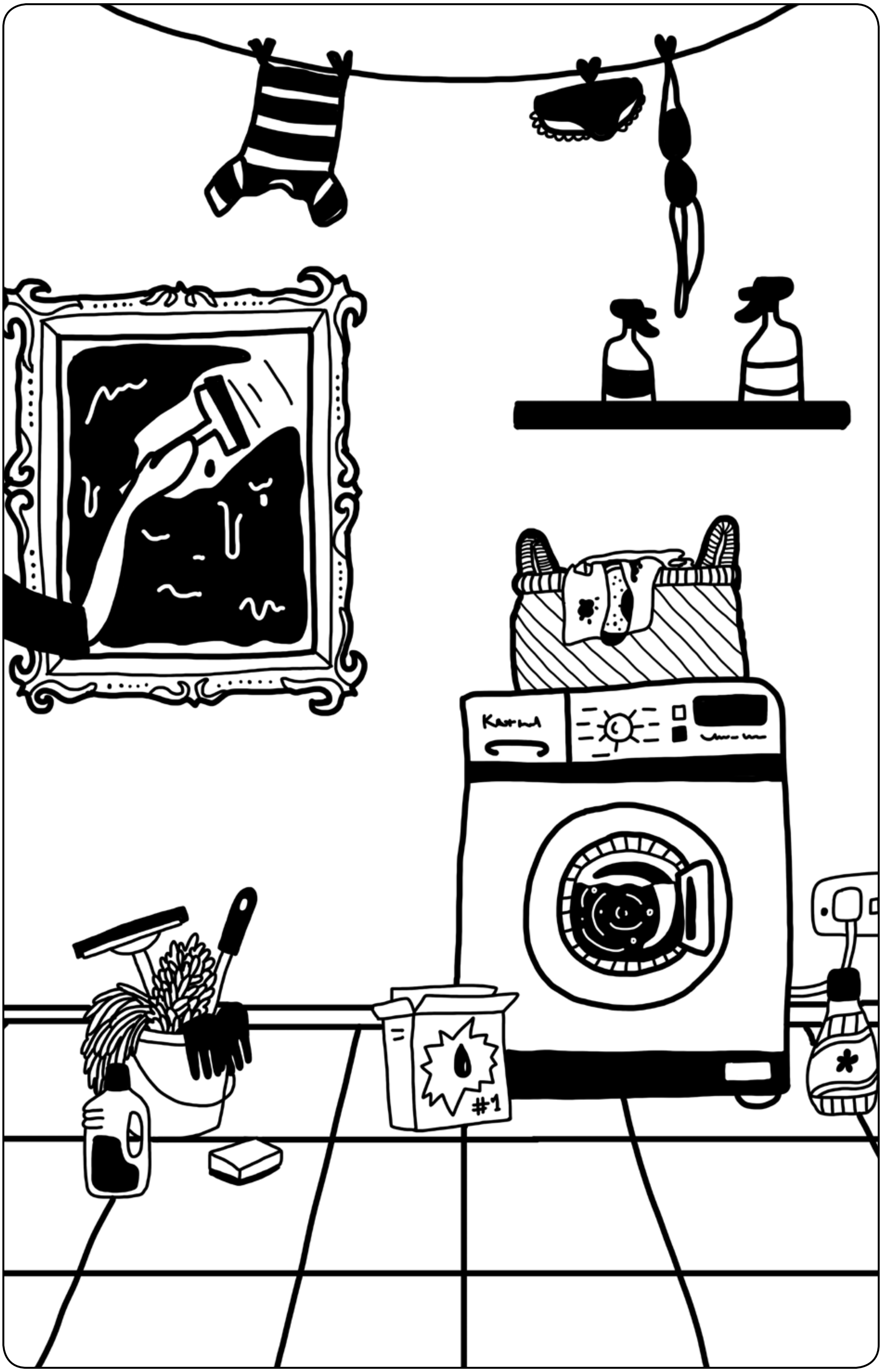
Pupils take a piece of paper and work individually. Everyone writes down one concrete thing that they will do to save water, plus one thing that they found out about water that they will share with their family and friends.

4 Of course these examples are subject to change in time depending on the prices and also the price of water. It is up to the teacher to decide and explain whether a thing can be bought or not and how much they can actually save. Google may help with the current price of water, etc.

Attachment 1



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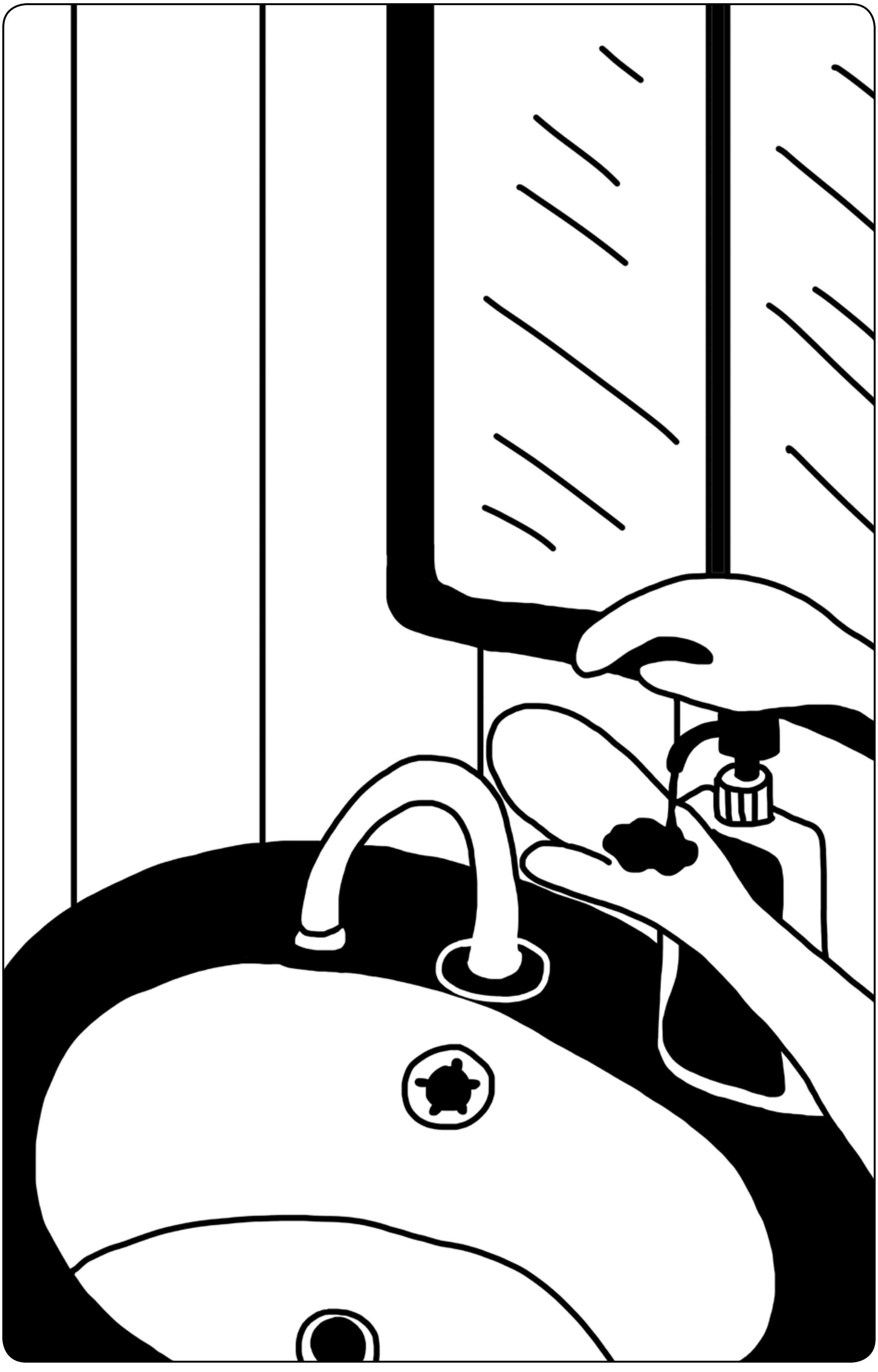

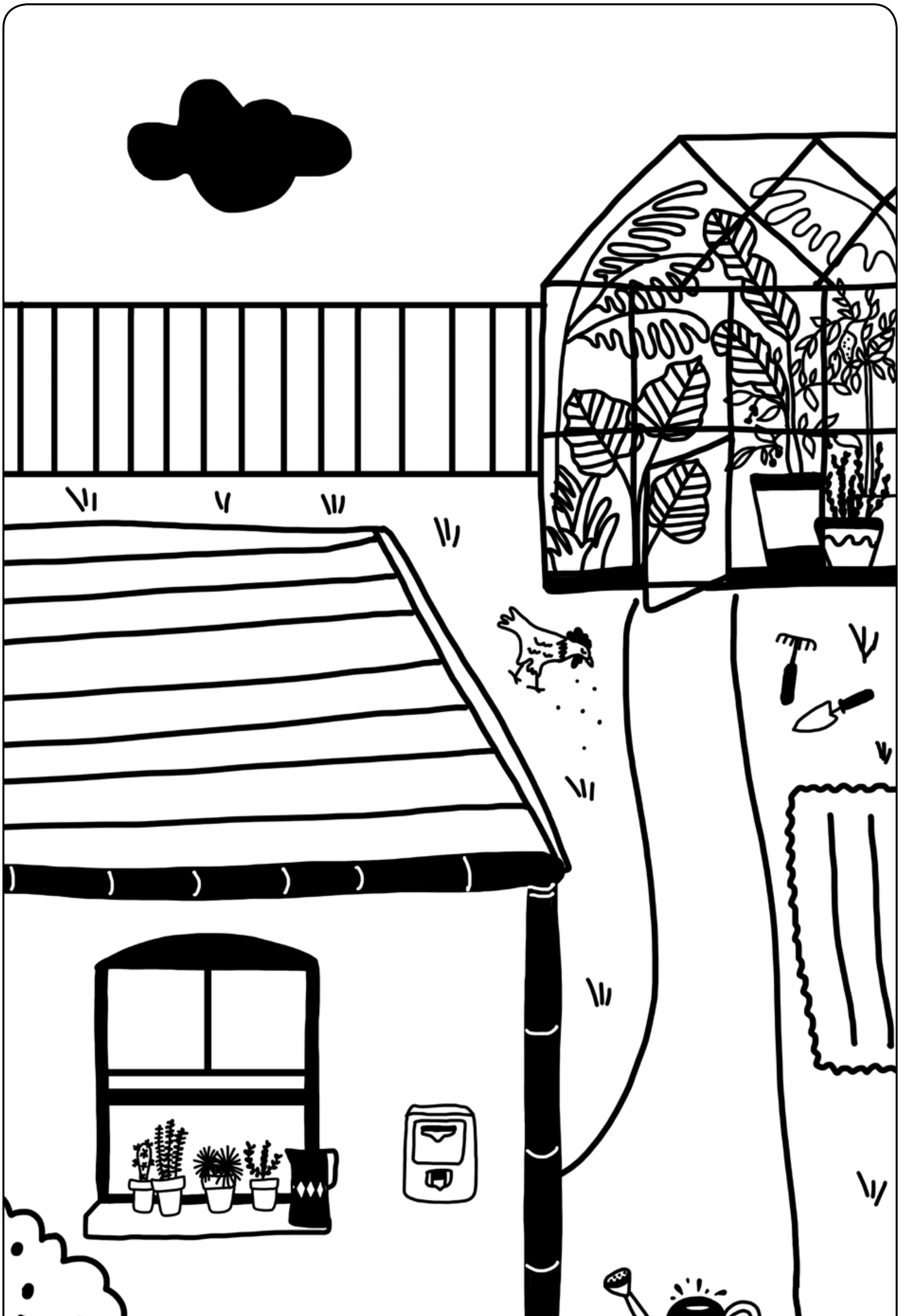

Activity	Water consumption
	
	
	
	

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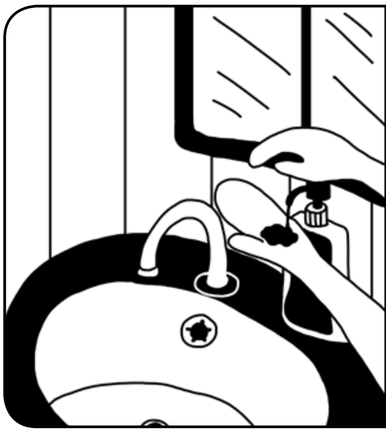	
	

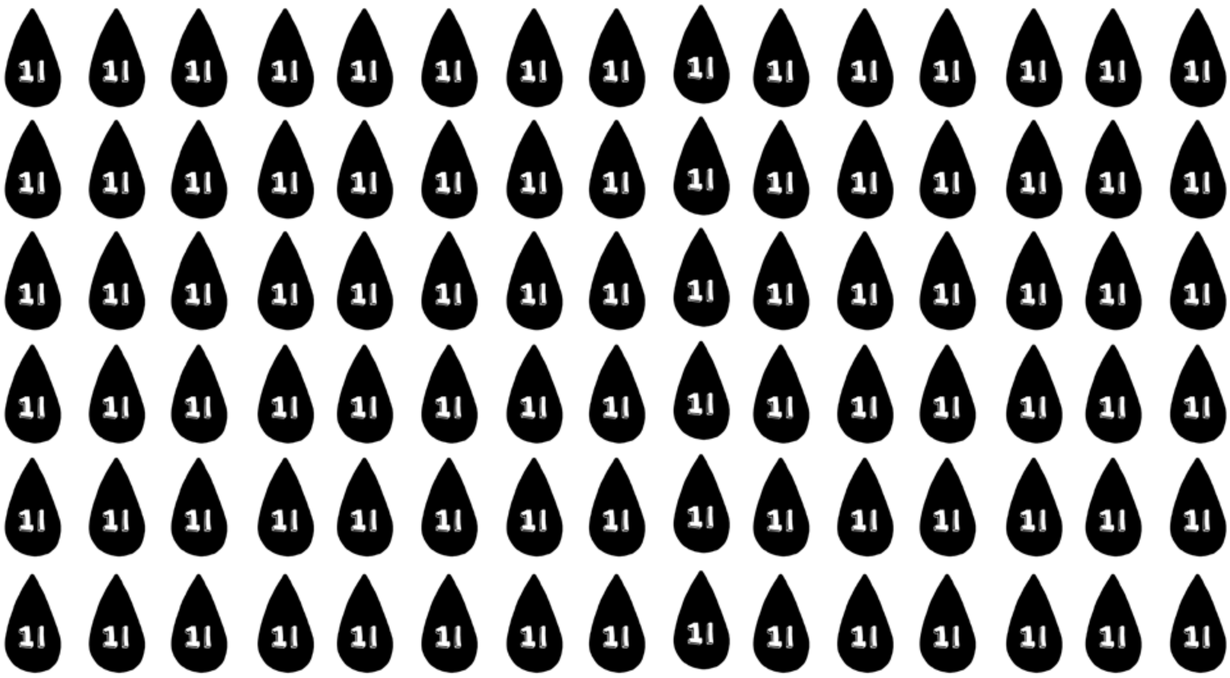
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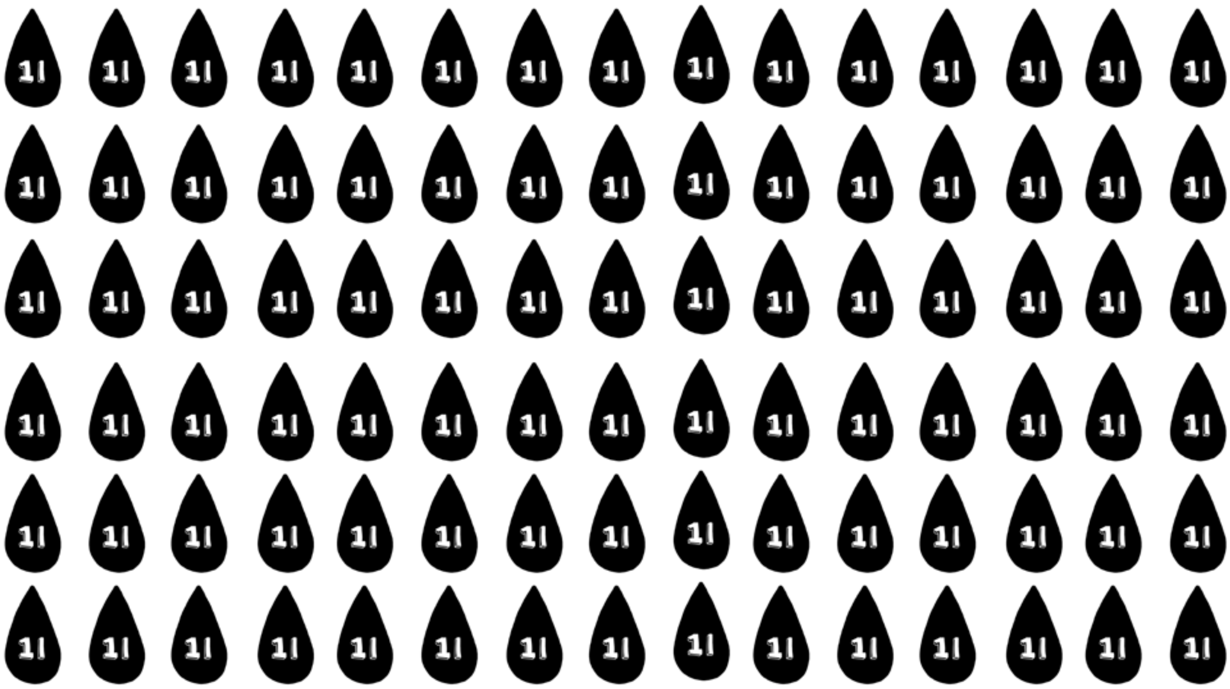
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Attachment 4

Advertisement – Toilet:

Why waste water? With our new improved dual-flush system you can save up to 70% of water! Press the smaller button to use 2.5 litres of water to flush the toilet or the bigger one to use 5 litres of water to flush the toilet.

Why wait? Get your dual-flush system today!

Saving water and money since 1976.

Description of a product from an e-shop – washing machine:

An especially quiet washing machine with various washing programmes and excellent durability.

Specifications are listed below.

Brand Name	**Washer 1-2-3**
Model Info	Jaguar 10.8
Item Weight	80 kg
Product Dimensions	85 × 60 × 61 cm
Installation Type	Freestanding
Colour	White
Access Location	Front loading

Programmes	**Included**	**Water consumption**
Cotton	YES	45 L
Delicate	YES	45 L
Sports	YES	45 L
Eco	YES	35 L
Anti-allergy	NO	45 L

Video – drinking water:

Link: https://www.youtube.com/watch?v=QrzRJM88Okg

Article – washing hands:

Wash Your Hands

Handwashing is one of the best ways to protect yourself, your family, and others from getting sick.

Washing your hands with soap and water is simple and easy. More importantly, it's one of the most effective ways to prevent the spread of germs. Clean hands can stop germs from spreading from one person to another and throughout an entire community—from your home and workplace to childcare facilities and hospitals.

When should you wash your hands?

You can help yourself and others stay healthy by washing your hands often, especially during these key times when germs are likely to get on your hands and can easily spread to you or others:

- **Before**, **during**, and **after** preparing food
- **Before** eating food
- **Before** and **after** caring for someone who is sick
- **Before** and **after** treating a cut or wound
- **After** using the toilet
- **After** changing diapers or cleaning up a child who has used the toilet
- **After** blowing your nose, coughing, or sneezing
- **After** touching an animal, animal feed, or animal waste
- **After** touching garbage

What is the right way to wash your hands?

Follow the five steps below to wash your hands the right way every time.

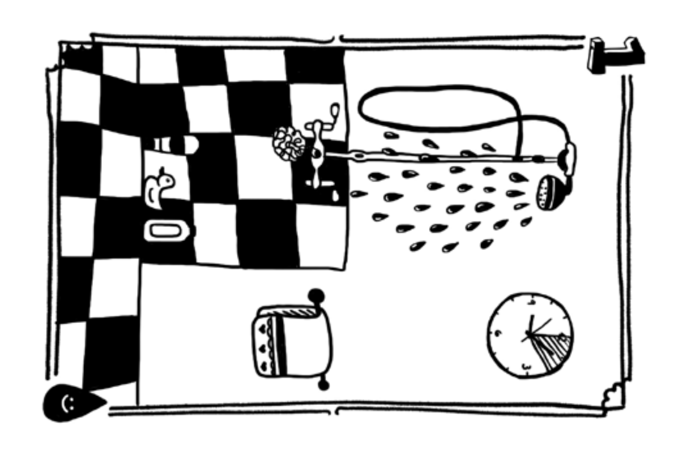
- **Wet** your hands with clean, running water (warm or cold), turn off the tap, and apply soap.
- **Lather** your hands by rubbing them together with the soap. Be sure to lather the backs of your hands, between your fingers, and under your nails.
- **Scrub** your hands for at least 20 seconds. Need a timer? Hum the "Happy Birthday" song from beginning to end twice.
- **Rinse** your hands well under clean, running water with approximately 1 litre of water.
- **Dry** your hands using a clean towel or air dry them.

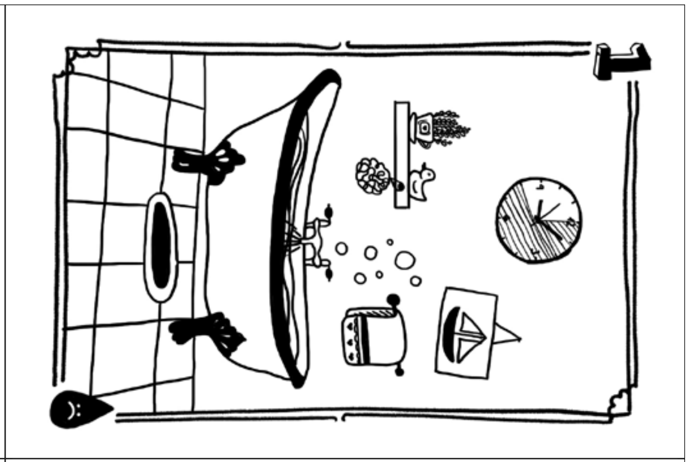
Source: Centers for Disease Control and Prevention (2016) (modified)

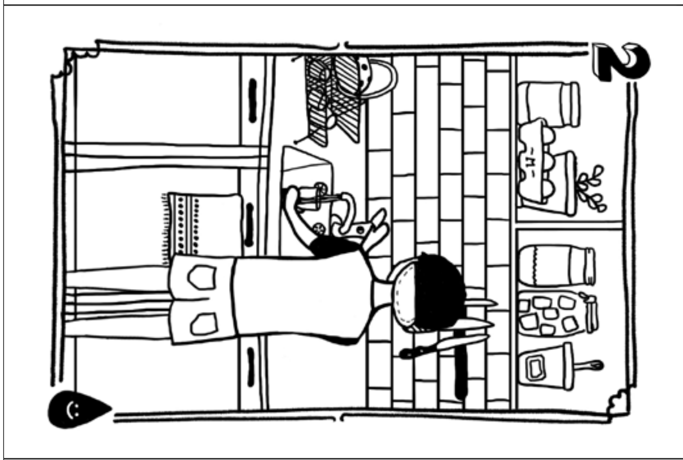
Mathematical example – personal hygiene:

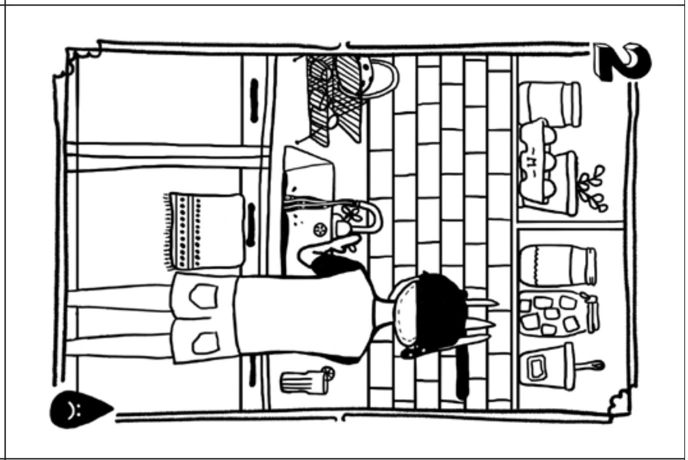
When you're showering, you use one litre every six seconds. How many litres do you need for a 3-minute shower?

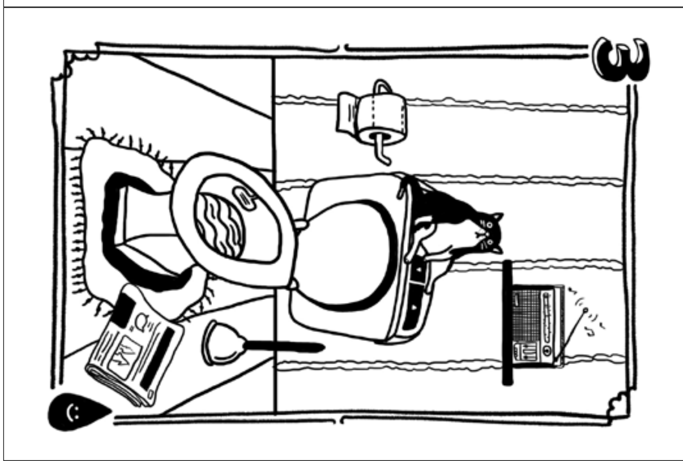
Attachment 5

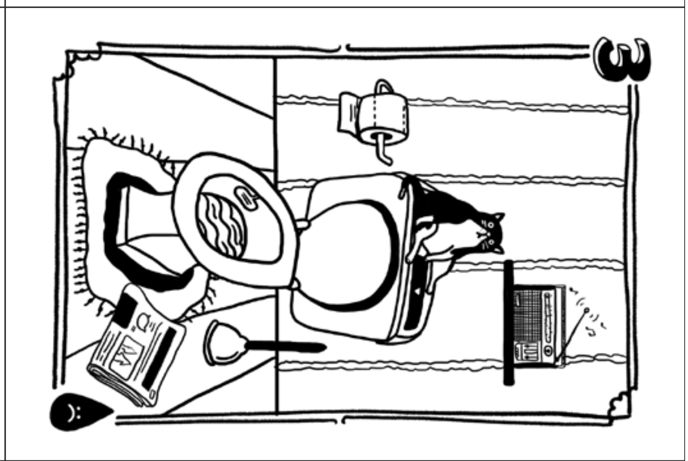


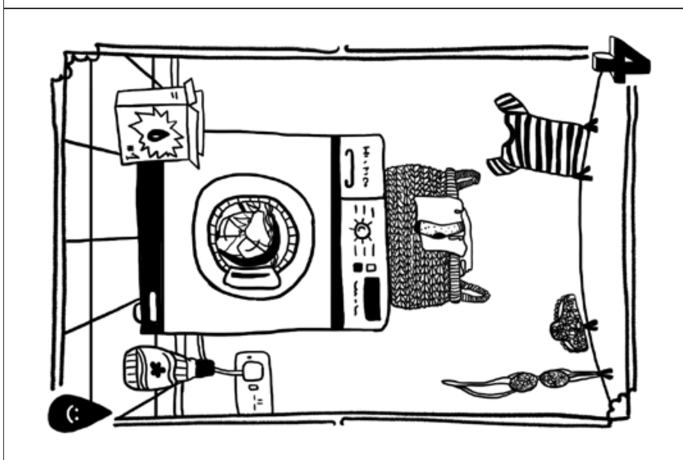


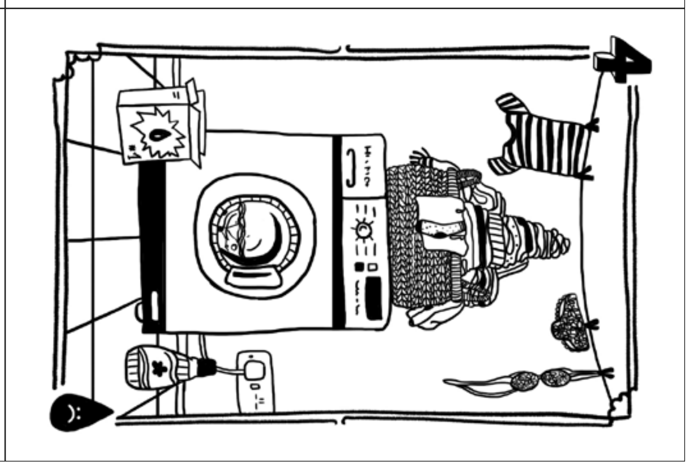












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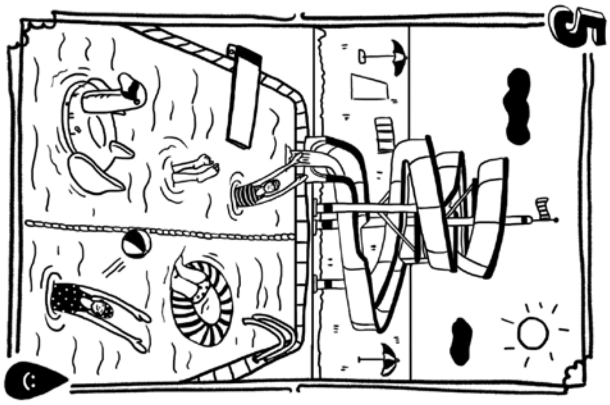

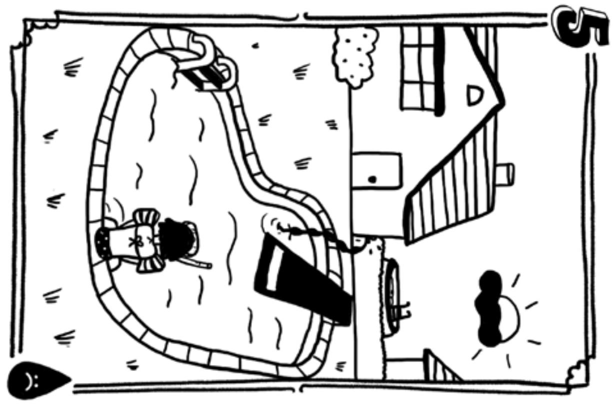

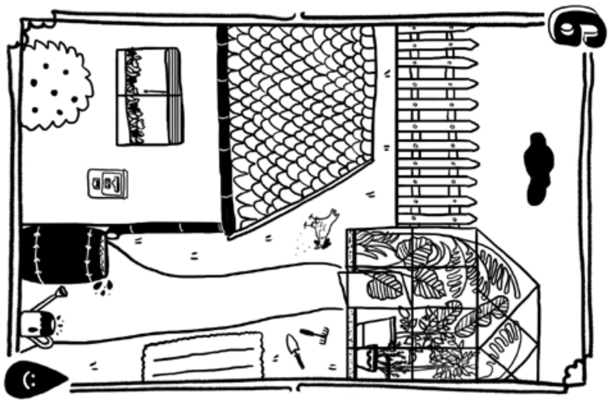

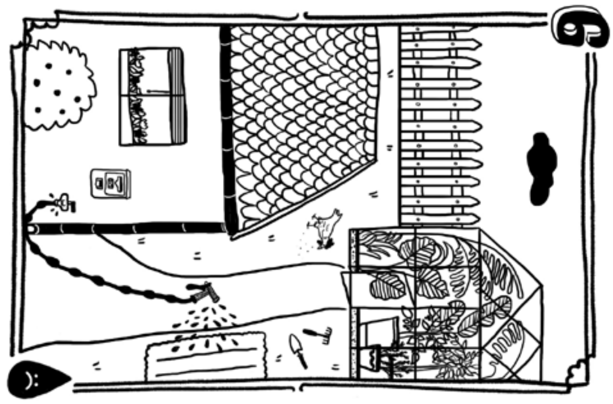

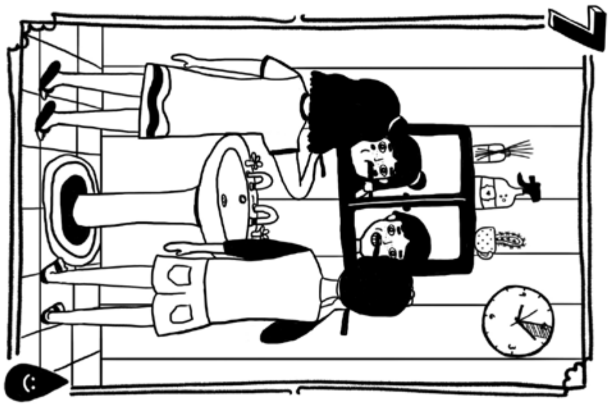

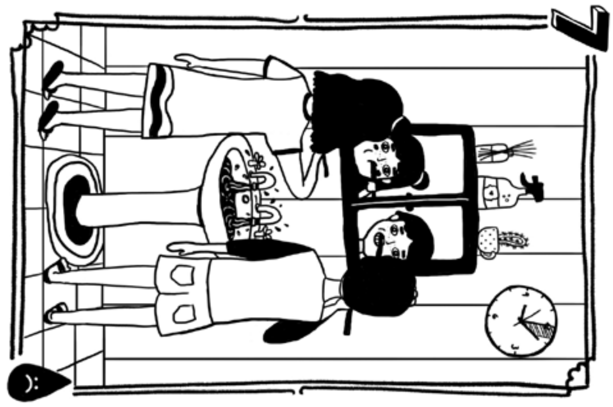

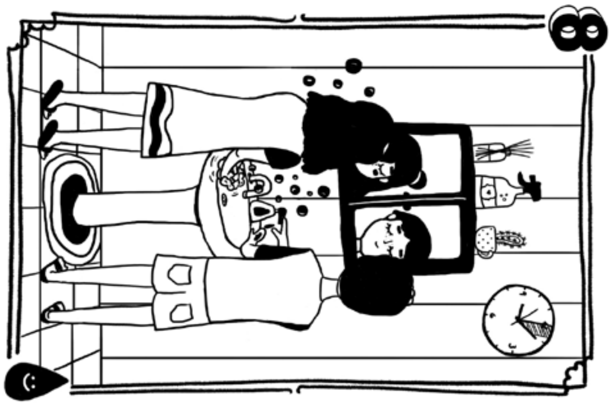

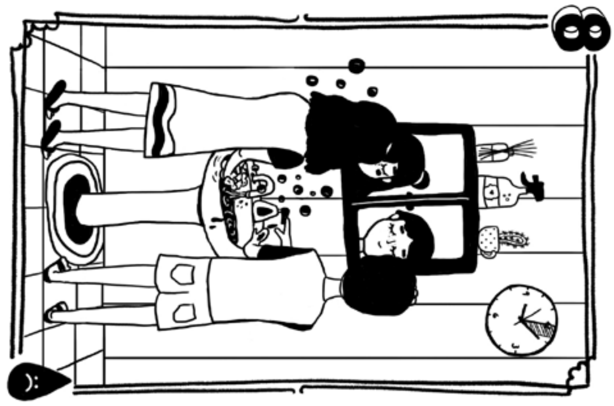

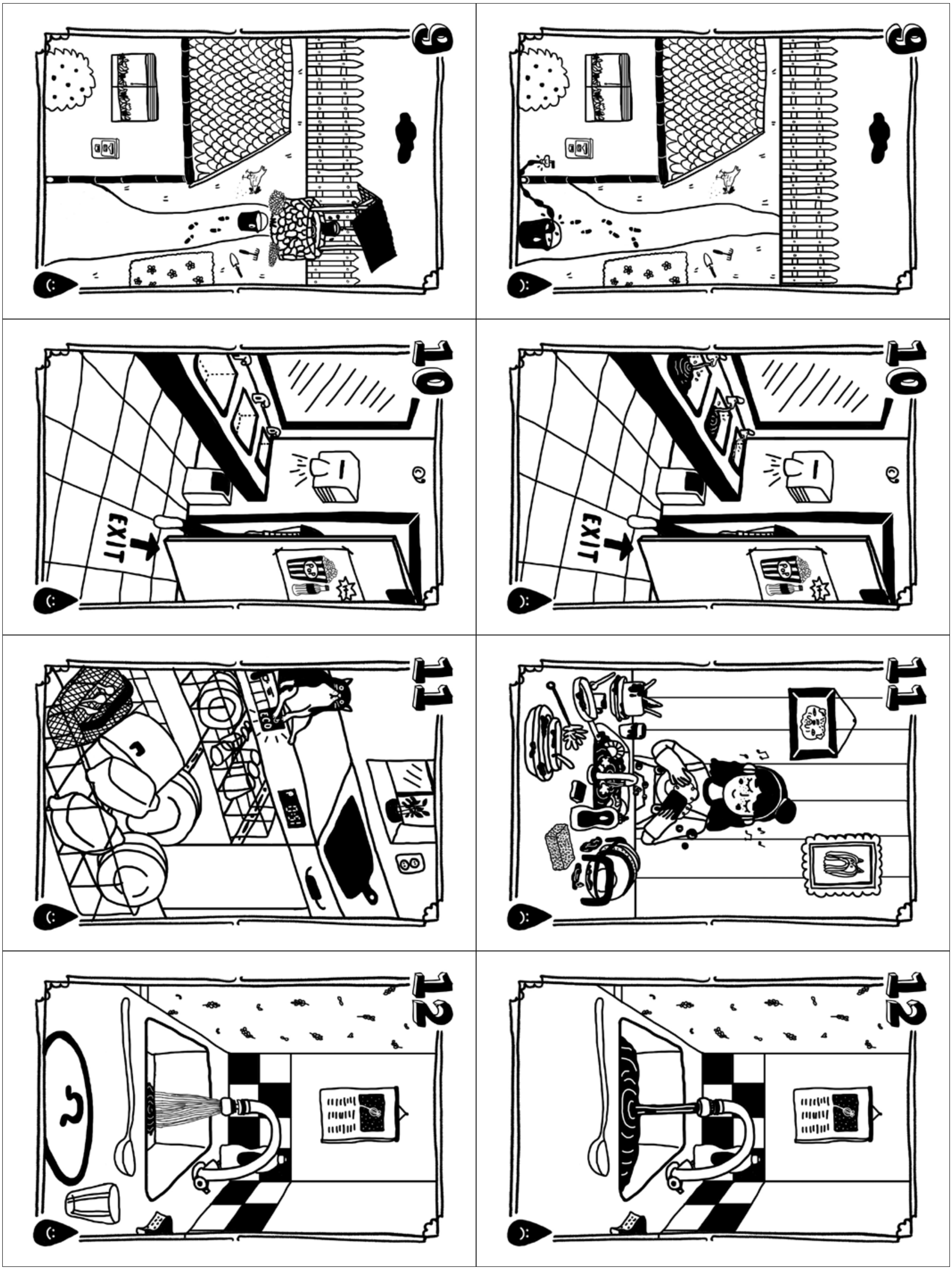
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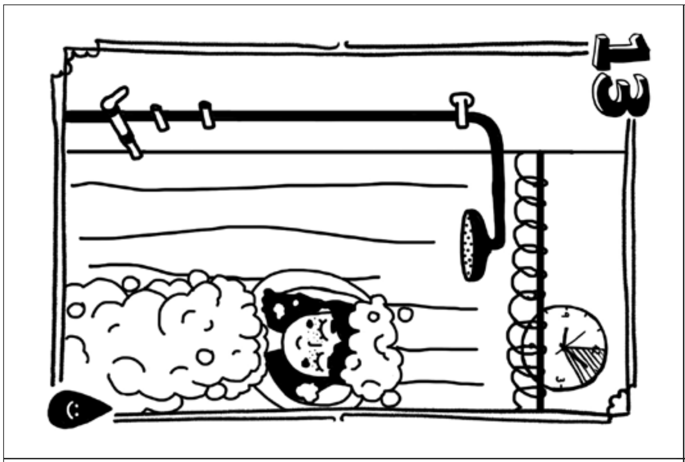
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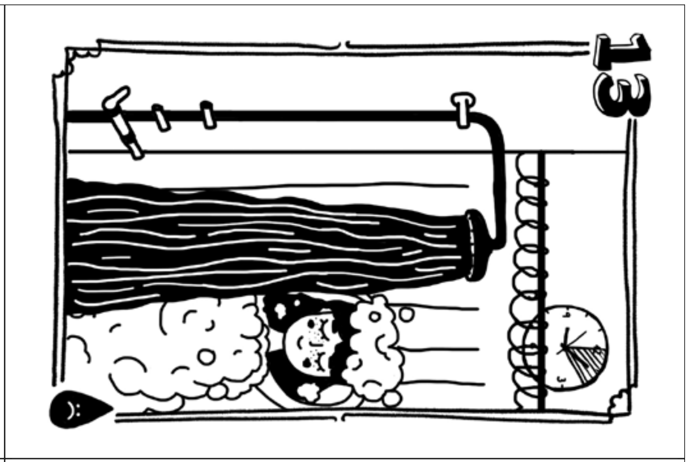
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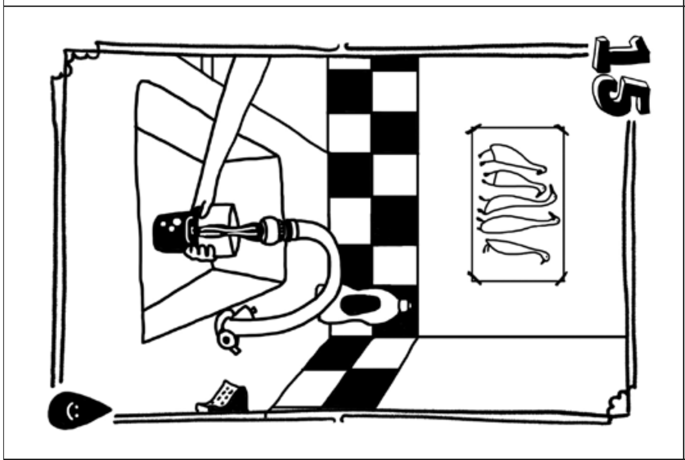
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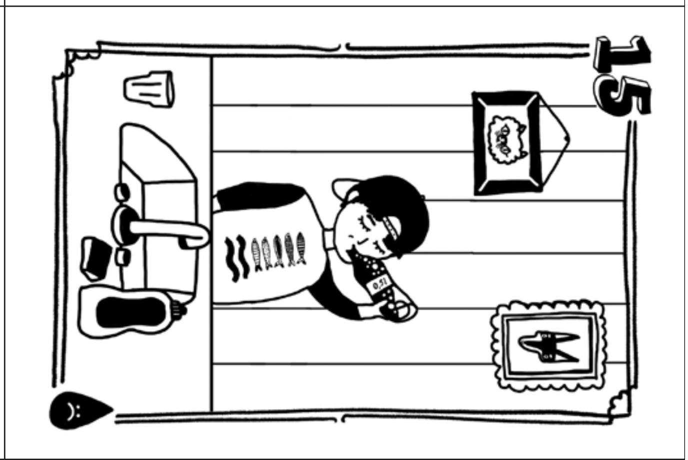
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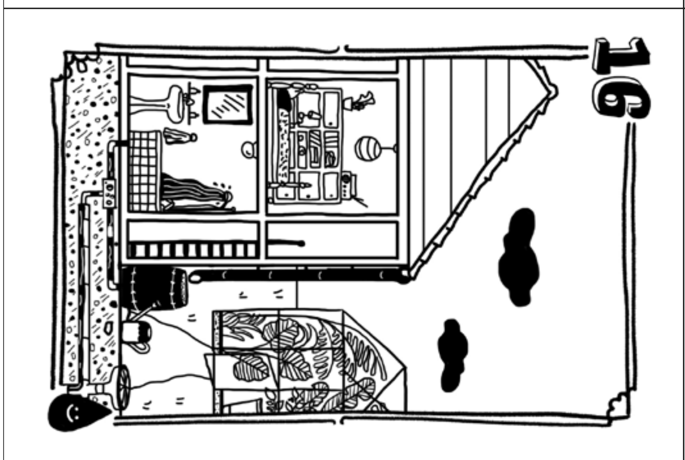
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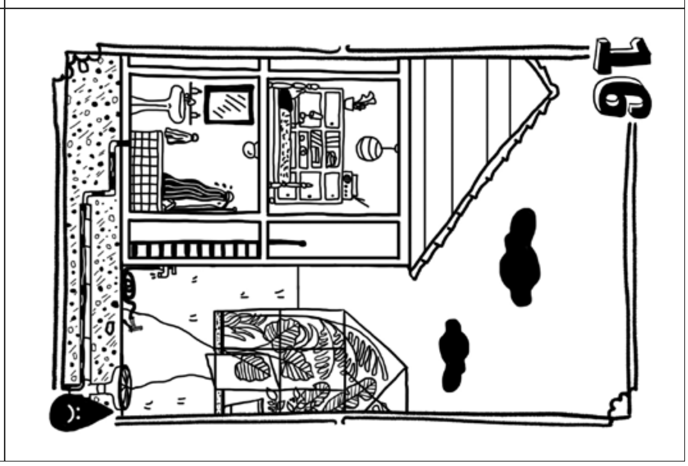
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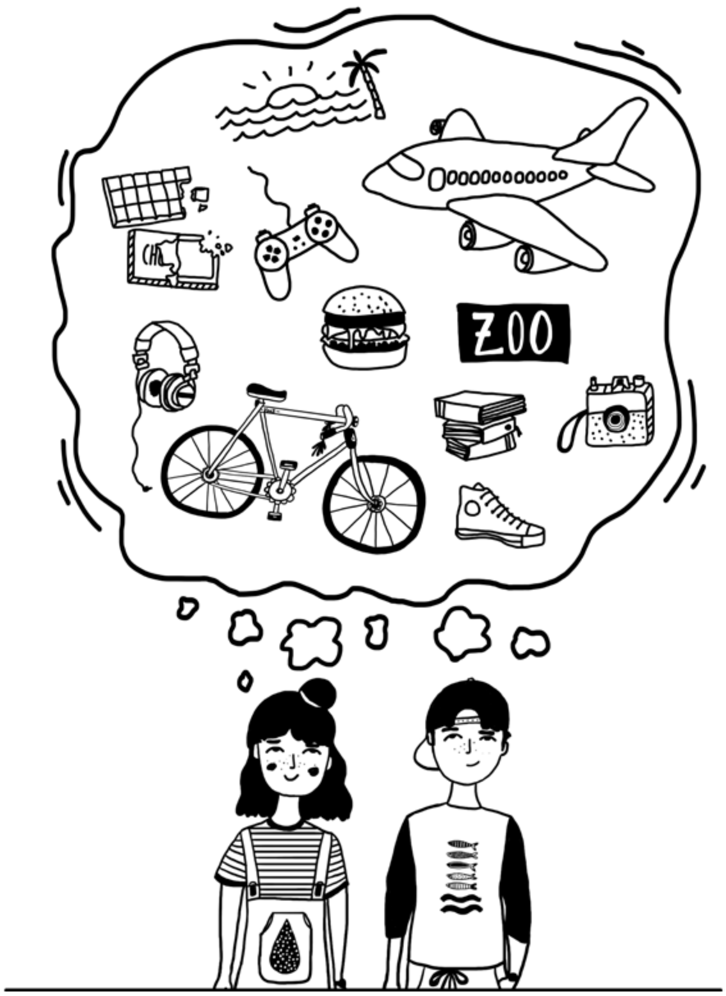
Attachment 6

What we can/cannot buy in one year if we save 20 L per day per person in a 4-member family?

- 1 bicycle
- 4 bicycle helmets for the entire family (2 adults, 2 children)
- 1 family house
- 4–5 family trips to the zoo (2 adults, 2 children)
- 4–6 cinema tickets for the entire family (2 adults, 2 children)
- 1 pair of sports shoes (tennis shoes)
- 1 car
- 1 New PlayStation or Xbox
- 1 Family trip to Disneyland or Legoland
- 2 giant plush bears
- 2 concert or music festival tickets
- 2 video games
- 1 summer vacation
- 3 board games
- 3 subscriptions to favourite magazin
- 3D printer
- 4 children's tennis racket
- 5 sets of headphones
- 1 helicopter
- 5 balls
- 7 regular plush toys
- 8 visits to the bowling alley
- 9 books
- 60 hamburgers
- 130 chocolate bars



Water in the landscape

The main objective of module:

To increase pupils' awareness of and interest in the importance of water in the landscape. Pupils should be motivated to become involved in a myriad of "water" projects in the landscape and take responsibility for their future actions.

Theoretical introduction to the theme:

Water is essential for life. It is the essence of human interaction. Since ancient times, civilizations have prospered or failed in response to water availability. Early people knew that rain supported life and drought brought death. Roughly the same amount of water exists on Earth today as was originally formed on the planet. However, the global demand for water is still increasing at a rate of about 1% per year and it will continue to grow significantly…

In developing the project *Water Agent V 003: Environmental education of pupils in the field of water management,* this module of the handbook focuses on better understanding of the role of **water in the landscape** and achievement of appropriate water management with an emphasis on people's relationship to water. This module provides basic information about the topic of "water in the landscape" together with the consequences. It is divided into a theoretical part (background information) and into three key practical educational blocks/subtopics: *The Water Cycle*, *The River Basin – What Is It?* and *Aquatic Ecosystems*.

The Water Cycle

Did you know that every year, about 420 million billion litres of water evaporate from the ocean into the atmosphere? If the water never returned, the ocean would dry up in 2,500 years. But the water forms clouds and then rains back into the ocean and on the land and this whole process is called the water cycle.

The water cycle (or the hydrologic cycle) is the continuous transfer of water among the sea, land and the atmosphere. This is called the **large water cycle**. The **small water cycle** runs just over the sea (sea – atmosphere) or just over land (land – atmosphere). The water cycle is an infinite cycle with no beginning and no end. Water changes states throughout the cycle between liquid (rain drops, rivers, lakes, etc.), solid (ice) and gas (water vapour). The water cycle is powered by the **energy released from Earth's interior**, **gravity** and the **Sun**. Gravity makes rain and snow fall to the ground and it makes rivers flow from mountains to the sea. The Sun melts ice and *evaporates* water into the air. Water can be *transpired* from vegetation through *evapotranspiration*. Airstreams cause water vapour to rise. As the air cools, water vapour *condenses* to form clouds. The condensed water falls as precipitation in the form of rain, sleet, snow or hailstones. Some of this precipitation is intercepted by buildings and vegetation. Precipitation that is not intercepted flows over the surface of the earth as surface run-off. This is often directed to rivers, which feed lakes, seas and oceans. Most run-off infiltrates into the ground and forms groundwater. Some is stored under the ground whilst other flows through the rocks. Some groundwater changes to surface water through springs.

Water in the hydrosphere is connected by the hydrologic cycle. The hydrologic cycle is not a closed system. There is a huge exchange of matter and energy between Earth and the space that involves a lot of water. Flow velocity and residence times are very different for water in its specific states (Table 1). Water in the hydrosphere persists in particular reservoirs and in various parts of the water cycle for a different time. And this very approximate time also influences how fast the water source can cope with pollution. The shorter the residence time of water in a reservoir, the faster water pollution can be removed (also taking into account the source of pollution). As Table 1 shows, biological waters contained in living organisms are renewed most rapidly. Generally, up to 40% of terrestrial rainfall originates from plant transpiration and other land evaporation.

Table 1: Periods of renewal of water resources on Earth

Part of the hydrosphere	Period of renewal
World ocean	2,500 years
Groundwater	1,400 years
Polar ice	9,700 years
Mountain glaciers	1,600 years
Ground ice of the permafrost zone	10,000 years
Lakes	17 years
Bogs	5 years
Soil moisture	1 year
Channel networks	16 days
Atmospheric moisture	8 days
Biological water	several hours

Source: Shiklomanov & Rodda (2003)

The River Basin – What Is It?

About 4 billion years ago, when Earth cooled to below 100 °C, the vapour condensed and it rained and rained and rained. This water poured over the planet's surface and collected in depressions, giving rise to rivers, seas and oceans. Today, there are many large rivers on Earth. Rivers are always changing their channels and they shape the land around them. Now, try to imagine your body: the rivers are like your veins, nourishing and sustaining it. Our body is like a **river basin** – the basic framework of life.

Land and water are ecologically linked in the natural system. We all belong to a watershed (a line defining the river basin) or a **river basin** [in the picture] – a large area of land (drained by a river and its tributaries) from which all the water flows into a large river. River basins have typical features including: a **source** [1] (the start of a river), **tributaries** [2] (smaller rivers flowing into a larger river), a **watershed** [4], a **confluence** [3] (where a river joins another river) and an **estuary/a mouth** a **source** [5] (the start of a river) (an area where a river meets a lake, a sea or an ocean). The river basin can be – based on its gradients – divided into three sub-regions: the upper basin, the middle basin, and the lower basin (including the delta).

The river basin includes all the humans, plants and animals that live in it, and all the things we have added to it. River basins do not respect any man-made boundaries and everything we do affects our river basin. That happens when upstream countries of the river basin affect water quality, quantity, or people of the downstream countries.

Let's look at Europe's second largest river basin, with a total area of 801,463 km² – the Danube River Basin. The Danube River Basin is the world's most international river basin as it includes the territories of 19 countries. The upper part of the Danube (the **Upper Basin** from the source up to Bratislava) is ideal for building hydropower stations due to the river's natural gradient. 59 dams in total have been built along the Danube's first 1,000 kilometres! Can you imagine that the Upper Danube is interrupted every 16 km on average? The **Middle Basin** is the largest of the three sub-regions, extending from Bratislava (Gabčíkovo-Nagymaros hydropower station) to the largest dams along the Danube (Iron Gate Dams I and II) on the border between Serbia and Romania. The lowlands, plateaus and mountains of Romania and Bulgaria form the **Lower Basin** of the River Danube. Finally, the river divides into three main branches (Chilia, Sulina and Sfintu), forming the Danube Delta, and empties into the Black Sea.

However, existing and planned constructions of hydropower stations can cause hydromorphological alterations which have many negative impacts. Such alterations can cause river and habitat interruptions, the disconnection of wetlands and floodplains and can even provoke changes in the natural structure of rivers, including alterations in river depth and width and flow regimes, interruption to sediment transportation as well as interruption to natural fish migration routes.

To understand the water quality of a stream, one must look at the entire area it drains. Nowadays, river basin restoration and protection has become increasingly important.

Types of Aquatic Ecosystems

As we mentioned earlier, restoration and protection of rivers is crucial, but rivers are just one of many different types of **aquatic** ecosystems in the world. These ecosystems include all environments where water is a dominant physical and chemical factor affecting plant and animal survival. **Aquatic ecosystems** are numerous and diverse. They provide several roles and functions, benefiting mankind and giving living organisms different living conditions. They differ in their chemical and physical properties, such as temperature, light, oxygenation, water flow or water pressure. **Aquatic** ecosystems can be classified as either marine ecosystems (including brackish water) or freshwater ecosystems.

According to the US Environmental Protection Agency (EPA), **marine ecosystems** make up approximately 70% of Earth's surface. They are unique because of the suspended dissolved compounds in the water, most notably salt. Organisms as tiny as microscopic plankton and as large as whales inhabit the various types of marine ecosystems. These ecosystems include the **oceans**, **salt marshes**, **coral reefs**, **mangrove forests**, **lagoons**, **seagrass beds** and **the intertidal zone** that stretches onto beaches. Estuaries are another important marine ecosystem where saltwater and freshwater meet to make a brackish mix.

Freshwater ecosystems include different types of flowing waters (**rivers, streams, creeks, brooks**) and still waters (**ponds, lakes, reservoirs, wetlands**). Did you know that less than 3% of the world's water is freshwater? However, people can only access about 1% of that. The rest is frozen in glaciers and polar ice caps, or stored underground. Freshwater ecosystems do not contain the same dissolved substances in the water as marine ecosystems do, so the animals and plants that live there would not survive in a marine ecosystem. Because freshwater does not contain salt, it is more susceptible to freezing and thawing. Freshwater plants and animals have adapted to survive this process. They also have respiratory structures adapted specifically for freshwater and have evolved reproductive and feeding behaviours to survive successfully in their environment.

The Role and Environmental Functions of Aquatic Ecosystems

The role and function of water in the ecosystem is to provide the **lifeblood** of the community. The **physical, chemical** and **biological properties** of ecosystems affect all the hydrological pathways in the water cycle. **Biological processes in a landscape** influence the quality of water and the way it moves through a system, as well as **soil formation**, **erosion**, and **sediment transport** and **deposition**. Soils are critical in controlling the movement, storage and transformation of water. Ecosystems also have **important influence on precipitation** recycling from local to continental scales.

Aquatic ecosystems contain a rich diversity of living species that interact in varied ways by establishing relationships of cohabitation, competition, predation and parasitism. These species cannot survive on their own. To grow, they need energy and food, which they obtain from the outside environment comprising water, soil and atmosphere.

Ecosystem **functions** are defined as a subset of the interactions between biophysical structures, biodiversity and ecosystem processes.

Aquatic ecosystem in good condition can carry out diverse functions:

- **Production functions**, which mostly concern the production of organic matter, the availability of non-renewable resources like water, and mineral substances;

- **Regulation functions** – the way ecosystems function contributes to stabilizing the variability of natural processes (climate, natural risks, etc.) and resource flows (soil water retention). They also play a role in eliminating the transformation of toxins (water self-purification);

- **Organization (or structuring) functions** – these contribute to defining the system's self-organization rules. They involve the physical organization of systems (landscape structuring) and their biological organization (biodiversity);

- **Cultural functions** – the non-material benefits people obtain from ecosystems. They include aesthetic inspiration, cultural identity, sense of home, and spiritual experience related to the natural environment. Opportunities for tourism, interconnection and cultural exchange and recreation are also considered within the group.

Challenges for Aquatic Ecosystems

The challenge we must all face is meeting **demand for water** in a way that does not worsen negative impacts on ecosystems. According to current trends, around two thirds of forests and wetlands have been lost or degraded since the beginning of the 20th century. Since the 1990s, **water pollution** has worsened in almost all rivers in Africa, Asia and Latin America. These trends pose broader challenges from the increased risk of **floods** and **droughts**. Around 30% of the global population is estimated to reside in areas and regions routinely impacted by either flood or drought events. **Wetlands** play a very important role in water extremes. They are like a sponge, thus reducing floods and preventing droughts. Nowadays, droughts do not only occur in drylands, but can also pose a disaster risk in regions that are normally not water-scarce.

Freshwater ecosystems are essential for human survival, providing the majority of people's drinking water. The ecosystems are home to more than 40% of the world's fish species. Despite their value and importance, many lakes, rivers and wetlands around the world are being severely damaged by human activities and are declining at a much faster rate than terrestrial ecosystems.

More than 20% of the 10,000 known freshwater fish species have become extinct or endangered in recent decades. Watersheds, which catch precipitation and channel it to streams and lakes, are highly vulnerable to pollution.

The deterioration of **water quality** is expected to further escalate over the next decades and this will increase threats to human health, the environment and sustainable development. Globally, the most prevalent water quality challenge is **nutrient loading**, which, depending on the region, is often associated with pathogen loading. Hundreds of **chemicals** are also impacting on water quality. The greatest increases in exposure to pollutants are expected to occur in low- and lower-middle income countries, primarily because of **higher population** and **economic growth** and the **lack of wastewater management systems**.

The biggest **threats** to **aquatic** ecosystems include:

- **hydromorphological changes** – change in flow dynamics, regulation of flow regime, change in sediment regime, expansion of invasive species, disruption to river continuity, etc.;
- **pollution** – organic pollution or toxic pollutants (acidification of water);
- **harvesting** – runoff from agricultural and urban areas hurts water quality, draining of wetlands for development depletes habitats;
- **climate change** – may lead to devastating floods and droughts.

Despite progress in improving the quality of the Danube region ecosystems (lakes, rivers, coastal waters and groundwater sources), there are many threats to their long-term health. The top pressures include barriers such as dams, land reclamation, and channelization, which change the flow of rivers or streams; diffuse source pollution such as farm run-off; agriculture land use (fertilisation) and point source pollution such as wastewater discharge from sewers. Non-EU countries are not obliged to meet EU standards on water quality and the prevailing problems in these countries concern the wastewater treatment, sewage system construction and maintenance, sanitation of the waters in small settlements and water pollution from agriculture. The main impacts on surface water bodies are nutrient enrichment, chemical pollution and altered habitats due to morphological changes. Moreover, the climate change impacts have influenced the Central European region recently (floods/droughts).

Impact of Climate Extremes

More often, there are many climate extremes in the landscape. According to scientists, **heat waves**, **droughts** and **flooding** can all affect water quality. They have many significant impacts. Heat waves and droughts dry out vegetation and provide more fuel for wildfires, the smoke from which is a serious medical hazard. Floods resulting from increases in heavy precipitation events or snowmelt can cause overflowing of sewer systems, which are designed to discharge excess wastewater under extreme duress to fill nearby lakes, rivers or other water bodies, causing water quality changes. Flooding of industrial areas or agricultural storage locations can cause chemicals/pollutants to move into nearby river basins, also degrading water quality and even contaminating some residential areas. Low water levels during hot dry periods can also contribute to deteriorated water quality.

Ecological Consequences of Climate Change

The ecological response of freshwater ecosystems to climate change needs to allow interactions between climate change and the many stressors already affecting rivers, lakes and wetlands. These include **water resource management**, **eutrophication**, **acidification**, **toxic substances**, **hydromorphological change**, **river basin land-use change** and **invasion of exotic species**.

The observed and expected impacts, however, differ strongly between ecosystem types (lakes, rivers, wetlands) and climate regions. In temperate and warm-humid regions, freshwater is especially vulnerable to **eutrophication**. Climate change is expected to confound attempts to restore lakes, rivers and wetlands especially through its influence on **water temperature**, **hydrology** and **nutrient balance**. All these environmental changes will further result in significant modifications in the **distribution of species** across ecoregions, higher susceptibility to alien species invasion; and overall biodiversity reduction.

A wide variety of animal species in Europe has moved northwards and uphill during recent decades. Under a scenario of 3 °C warming above pre-industrial levels by 2100, the ranges of European breeding **birds** are projected to shift by about 550 km to the north-east, whereby average range size would be reduced by 20%. **Butterfly** communities (according to CTI) become increasingly composed of species associated with warmer temperatures. A comprehensive review study on amphibians and reptiles found that 20 out of the 21 **amphibians** and 4 out of the 5 **reptilian** species assessed in Europe were already negatively affected by climate change (mainly through population declines and reductions in habitat suitability).

A Europe-wide study of the stability of 856 **plant** species under climate change indicated that the mean stable area of species is decreasing significantly in Mediterranean scrubland, grassland and warm mixed forests. The rate of climate change is expected to exceed the ability of many plant species to migrate, especially as landscape fragmentation may restrict movement.

On the other hand, some species can benefit climate change. One example is the **wasp spider** (*Argiope bruennichi*), which has multiplied its range in central and northern Europe during the 20th century and is still spreading. This range expansion is at least partly temperature-driven. Increasing water temperature will also lead to a change in the food web structure.

The **global water cycle** is also intensifying due to climate change, with wet regions generally becoming wetter and dry regions becoming even drier. At present, an estimated 3.6 billion people (nearly half the global population) live in areas that are potentially water-scarce at least one month per year, and this population could increase to some 4.8–5.7 billion by 2050.

Integrated Water Resource Management

Nowadays, we need new solutions to managing water resources. Ecosystem degradation is a leading cause of increasing water resource management challenges. According to the United Nations Water Development Report 2018, **nature-based solutions (NBS) for water** are one of many important tools to shift to a more holistic approach to water management. They have been used for thousands of years and they are inspired and supported by nature.

Nature-based solutions use natural processes to contribute to improving water management. There are several different types of them, ranging in scale from the micro/personal (e.g., a dry toilet) to landscape-level applications that include conservation agriculture. There are nature-based solutions that are appropriate for urban settings (e.g., green walls, roof gardens and vegetated infiltration or drainage basins) as well as for rural environments, which often make up the majority of a river basin area.

However, there are limits to how NBS can perform. For example, NBS options for industrial wastewater treatment depend on the pollutant type and its loading. For many polluted water sources, conventional grey-infrastructure solutions may continue to be needed. There are examples where nature-based approaches offer the main or only viable solution (for example, landscape restoration to combat land degradation and desertification) and examples where only a grey solution will work (for example supplying water to a household through pipes and taps), but in most cases green and grey infrastructure can and should work together.

Integrated water resource management is a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resulting economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. This process could not be available without international legislative support of strategic documents.

The **Water Framework Directive** (WFD) – 2000/60/EC – is a European directive establishing a framework for Community action in the field of water policy. It is focused on creation of conditions for sustainable use of water resources through their integrated river basin management. In order to ensure the required water quantity and suitable quality for its use under the terms to preserve the natural functions of watercourses, natural ecosystems and landscape, the hydroecological landscape preservation demands are preferred.

Another important document – the **Ramsar Convention** – provides a framework for the preservation and rational use of wetlands and their resources. Slovakia currently has 14 sites designated as Wetlands of International Importance (Ramsar Sites), with a surface area of 40,697 hectares.

There is evidence that ecosystem changes have contributed, over the course of history, to the demise of several ancient civilizations ("great river civilizations" of the Tigris-Euphrates, the Nile, the Indus-Ganges and the Yellow River). A question nowadays is whether we can avoid the same fate. The answer to that question will depend at least partly on us: **Are we able to shift from working against nature to working with it?** We can do a lot even by understanding some basic issues and different actions.

Blocks described below:

(i) The Water Cycle; (ii) The River Basin – What Is It?; (iii) Aquatic Ecosystems

Block 1:
The water cycle

Educational objective of block 1:

Pupils develop an understanding of the water cycle. They realize the connectivity between (adverse) human activities and the water cycle.

Development of values and attitudes:

Understanding of responsibility for our actions and their huge consequences and impacts. On specific examples, pupils apply critical thinking and problem-solving skills.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	The never ending story of water – the goal is to appreciate the age of water and understand the water cycle. *Part 1*	motivational discussion	glass of water	Connection with the dinosaurs/ prehistoric times always catches pupils' attention!	3–5 min	
2	*Part 2*	moderated dialogue, didactic game	poster of Earth with the water cycle, 16 different cards with parts of the water cycle (and different states of water), poster tack	Working with a painted poster and playing the part of the water cycle.	15 min	5–7 min – print the poster from Attachment 1 on A4 or A3 size or even bigger and laminate it; cut out the 16 cards from Attachment 2
3	People can affect the water cycle by different activities.	cooperative group work, critical thinking – providing solutions	poster of Earth with the water cycle, table, chalk	Motivating each other to generate different ideas within the context.	15 min	
4	Message in a drop of water – the goal is to understand connections between the period of water resource renewal on Earth and pollution.	guessing, individual work with worksheets, cooperation in groups	worksheets, 2 m of rope, playing cards with different periods of time, playing cards with different reservoirs/sources of water	Cooperation, trying to find an answer close to the statistics.	10 min	10 min – print the worksheet from Attachment 3 for each pupil; rope, print and cut out the playing cards with different periods of time and with different reservoirs/ sources of water from Attachment 4

Activity 1 *Part 1*

Fill a glass with water. After looking at the water for a few seconds, ask pupils to speculate how old it is. “Children, what do you estimate is the age of the water in this glass?” Today’s water is the same as it was at the beginning of Earth. This water was drunk by the people thousands of years ago, even by dinosaurs in the Mesozoic... The water in this glass is about 4 billion years old (when Earth cooled to below 100°C, the vapour condensed and it rained and rained and rained on Earth’s surface)... And how do we know this? (Because of the existing water cycle.) Let’s go to *Part 2*.

Activity 2 *Part 2*

Notice:
Part 2 follows the same goal as *Part 1* (the same name of the activity); it is interlinked with *Part 1*.

Print or project the picture of the water cycle (example; Attachment 1) – you will use it for Activities 2 and 3.

Source: Based on Immerová (2012)

Print and cut out the cards from Attachment 2. You can see the cards below just for your information.

Solar radiation (sun) warms up Earth’s surface.	A part of precipitation infiltrates (soaks) into the ground.
Water vapour rises from the oceans into the atmosphere.	Water molecules (particles) are in a liquid form.
Water evaporates (gets away into the air) from rivers, streams, and lakes.	Water molecules (particles) are in a gaseous form.
Water evaporates (gets away into the air) from the soil surface.	Water molecules (particles) are in a solid form.
Water transpires (gets away into the air) from vegetation.	Some water remains in a solid form as ice.
Water vapour condenses (liquidizes) and changes into droplets forming clouds.	Water falls on Earth’s surface as snow.
Water falls on Earth’s surface as precipitation (rain and snow).	Groundwater seeps into the beds and banks of rivers.
Some precipitation runs off in streams and rivers.	Permeable (leaky) layers in the basement form groundwater reservoirs.

The teacher may start the activity with information about the percentage of drinking water in the world (0.007 percent of the planet’s water!). Every pupil (or a pair) gets one card with a part of the water cycle or a state of the water (liquid, solid or gas). Pupils read the text on the card, try to find the particular elements/states of the water/water cycle and come to the poster (Attachment 1) to put the card in the right place using poster tack (more options are correct). They continue one by one according to the logic of the consecutive processes in the water cycle. Who starts? Where does it start and end? (They will realize that it is up to them to select the point where to enter the water cycle – it is a neverending cycle with no beginning and no end...).

Tip: Rain seems to be a good starting point of the water cycle. Rain water falls from the clouds on our backyards, roof tops, roads, lakes, and rivers – the whole landscape. If you consider the terms used difficult for a certain pupil age (e.g., molecules, condense, etc.), replace them with simpler ones (e.g., water molecules/particles = "čiastočky vody" in Slovak; condense = skvapalňovať, etc.). This will preserve the accuracy and consistency of terms (in English). You have the tips for simplification written in the table above.

Activity 3

Divide pupils into 3 groups:

- Group 1 will try to identify (find and name) human activities.
- Group 2 will look for negative human impacts (on water itself and aquatic ecosystems, eventually affecting the civilisation).
- Group 3 will try to suggest solutions.

The 3 groups have to cooperate. Make 3 columns on the table/flipchart from the left: Human activities, Negative human impacts, Suggestions/Solutions.

Let pupils come and write down their ideas. First one pupil from group 1, then one from group 2 and finally one from group 3. The other groups (2 and 3) should react to the idea mentioned by group 1. Try to motivate pupils to generate at least 3 different activities. Together with pupils, discuss the suggested solutions.

Activity 4

Each pupil is given a worksheet from the Attachment 3 and the pupils guess (approx. 3–5 min) how long the water stays in different reservoirs and in different parts of the water cycle. Pupils also write their age and in this way they will realize the actual meaning because they can compare their age with the age of polar ice, for example.

Find the right answers in the table below:

Part of the hydrosphere	Period of renewal
World ocean	2,500 years
Groundwater	1,400 years
Polar ice	9,700 years
Lakes	17 years
Bogs	5 years
Soil moisture	1 year
Atmospheric moisture	8 days
Biological water (living organisms)	several hours
Your age	Pupils write their own age

Source: Shiklomanov & Rodda (2003)

After guessing and writing in the table, you can continue with demonstration to strengthen the image of the long periods mentioned in the table. Print and cut the cards from the Attachment 4. Then, place a rope on the floor (to make a timeline) and distribute the cards with different periods of time (periods of renewal). To make it more explanatory for pupils, add a timeline with some famous historic events. Next, try pair the right card with a period of time with the card of the reservoir/source of water – find the right solution all together.

The time period also influences how fast the water source can cope with pollution. The shorter the residence time of the water in the reservoir, the faster water pollution can be removed.

In the table below, you can find correct answers to Attachment 4 together with examples of historic events that will be used for demonstration on the rope representing the timeline: (today = year 2019).

Part of the hydrosphere, source of water	Period of renewal	Example of famous historic event
Polar ice	9,700 years	Stone Age – beginning of agricultural era
World Ocean	2,500 years	Iron Age – Socrates the philosopher
Groundwater	1,400 years	Migration Period / Slavs
Lakes	17 years	Big floods in Central Europe
Your age		
Bogs	5 years	*
Soil moisture	1 year	*
Atmospheric moisture	8 days	*
Biological water	several hours	*

* For: 5 years, 1 year, 8 days and several hours pupils can write their own ideas on the paper and put them on the rope representing the timeline.

Source: Shiklomanov & Rodda (2003)

Examples of questions for a summarization of activity 4 to find out what pupils have learnt from it and whether you have achieved your goal:

- In which state of water is pollution removed the fastest? (Biological waters – in living organisms)
- Why is pollution removed so fast from living organisms? (Usually because of the food web structure; the interactions in a complex system of animals, plants, bacteria and fungi cause that harm (pollution) to any of these organisms can produce a chain effect, endangering the entire ecosystem.)
- Do different lakes have different renewal times? (Of course they do; for example, for Lake Baikal this (very approximate) time is 380 years. All other types of natural waters, e.g., glaciers, groundwater, oceans, etc., are renewed more slowly, possibly over periods of thousands and even tens of thousands of years.)
- Which state of water has the longest period of renewal? (Polar ice – the ice in the tundra and in Antarctica – it may be renewed approximately only over several hundreds of thousands of years, so pollution will remain there for a very long time...).

Human impacts grow every year and cause more and more changes in natural processes, including the hydrologic cycle. These changes bring about alterations to water balance and quality and availability of water resources. Think about it daily.

Block 2: The river basin – What is it?

Educational objective of block 2:

Pupils can understand the "system" of the river basin and they can recognize how the river basin can be changed (natural changes by floods, changes done by human activities) and what the consequences are.

Development of values and attitudes:

Pupils make their own opinion thanks to working with different sources of information and observation. They will recognize that everyone contributes to and is responsible for the water quality in the river basin.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	Create a model of a river basin – the goal is to understand what the river basin is and what a natural river flow looks like from the source to the mouth.	object lesson (observing)	a model of a river basin created by hand: baking tin or big tray, newspaper, adhesive/sticky tape, plastic foil (white or not colourful), sprayer/disperser for flowers, water	Construction of a handmade model of a river basin.	15 min	10 min – material for the model: baking tin or big tray, newspaper, adhesive/sticky tape, plastic foil (white or not colourful), sprayer/disperser for flowers, water, modelling clay
2	Changes in the river basin – To realize how the river basin can be changed and what the consequences are. To recognize that everyone's contribution can be reduced.	moderated dialogue, analyzing (pollution sources), cooperative group work	A model of a river basin created by hand, modelling clay of different colours, pollutants: salt, oil, coffee, washing detergent, symbol of a wetland: sponge, yellow felt/fabric presenting field water, water can/water disperser	Working with different materials, simulating and observing pollution with its impacts on the landscape. Guiding of the activity is on the side of pupils.	20–25 min	10 min – fill small plastic boxes/cans of salt, oil, coffee, washing detergent, sponge, water, watering can/water disperser, modelling clay
3	The river basin and climate extremes – To get to know climate extremes (e.g., heat waves, water scarcity, floods and drought) and their impact on the river basin.	different: 2 short videos (3–4 min), pictures, etc., individual work, final discussion	pencil, piece of paper, pictures of different climate extremes, videos (PC-video)	Work with different sources of information on unfamiliar topics, give pupils an opportunity for making their own opinion.	10–15 min	10–15 min – choose 2 short videos (or use examples) and prepare Internet connection; print the pictures from Attachment 5. Alternatively, find different pictures of climate extremes

Remember: Activities 1 and 2 are connected!

Activity 1 2 possible types of model

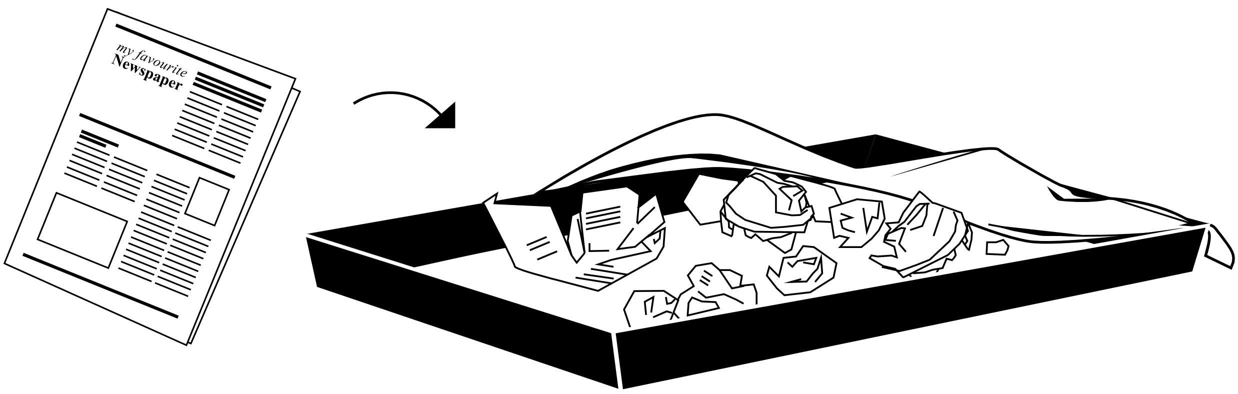
Determine pupils' knowledge of river basins asking them to name several major rivers in continents (e.g., the Amazon in the South America, the Danube, the Elbe and the Volga in Europe, the Mississippi in North America). Where do these rivers originate and end?

Alternative 1 — "Baking tin" model

Materials: baking tin, newspapers, plastic foil, adhesive tape, modelling clay, water disperser, scissors

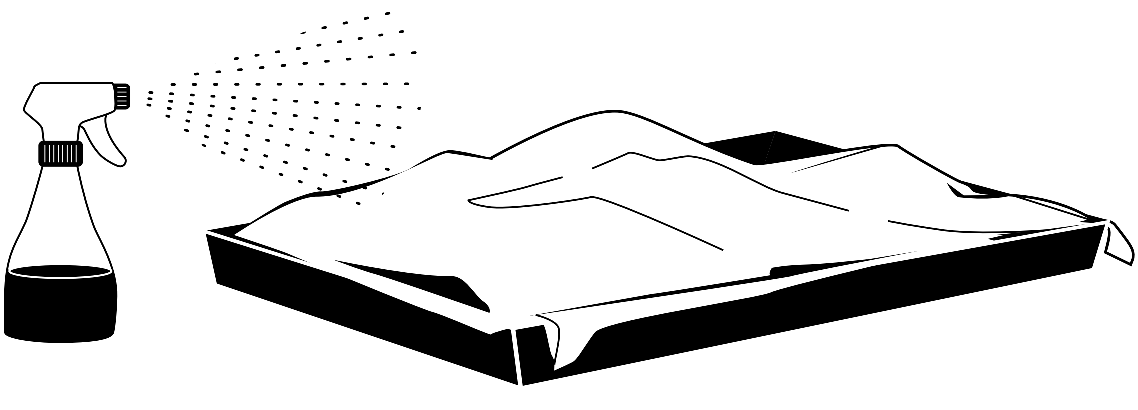
Step 1: Choose one pupil to help you make the model. At the same time, the others get a piece of modelling clay to make some parts of the river basin "natural/artificial elements". Clearly divide the tasks: group 1 makes some trees and animals (fish), group 2 makes buildings (houses, a factory, a water dam), group 3 makes vehicles and other means of transport (cars, a ship).

Now you can continue to make a model with one pupil. Paste crumpled newspaper onto the baking tin/tray to create little hills. Cover the hills with appropriately sized plastic foil (prefer frosted to clear) to create the model landscape. For better adhesion, attach the plastic foil to the side of the tray with adhesive tape.



Step 2: Fill the water disperser with water.

Step 3: Spray the hills covered with plastic to simulate rain. Water will accumulate in depressions/valleys and eventually in a continuous river basin.



Step 4: The experiment explains the meaning of "river basin" and emphasises the importance of rivers as land-forming agents.

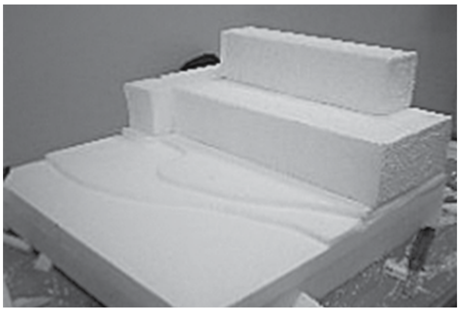
Alternative 2 — 3D plaster/gypsum model

A) Skeleton model production

Materials: One sheet of hardened polystyrene, various rough sheets of plain polystyrene, pencil, ruler, permanent marker, cutter, iron saw, polystyrene adhesive, Duvilax glue, paintbrush, tablecloth**.**

Step 1: Prepare a sketch of the landscape that will help you in modelling. If you decide to make a model that would be a copy of the Alpine-Carpathian model, you can use the photos.

Step 2: The basis of the model, its skeleton, is made of polystyrene. The substrate is hardened polystyrene on which the sheets of ordinary polystyrene are cut. The base polystyrene is to be spread over 4 parts, approximately:



I) 45 cm (Carpathian landscape),

II) 10 cm (meandering flow),

III) 10 cm (regulated flow),

IV) 60 cm (Alpine landscape).

Source: Daphne (2012)

Step 3: Draw a centrifugal meandering flow on part II and a regulated flow on part III. Deepen both troughs to a depth of 1.5–2 cm using a cutter.

Step 4: On the other two parts of the landscape (I and IV), mark with the permanent marker sections that will be covered with mountains as well as places where the lowlands will be spread. In part IV, mark a small lake.

Step 5: Gradually, in both parts (I and IV), make the mountain range. Remove the various thick sheets of plain polystyrene depending on how large or steep mountains you want to model. You can stack layers in a sequence from the finest to the coarsest. If there are steep steps between the individual sheets of polystyrene, smoothen them so that the transition from one sheet to another is smooth.

Step 6: You can use the coarsest polystyrene for the highest mountain range. Cut ridges and grooves into the polystyrene with sharp slits. You do not have to cut the mountains into ideal shapes. They will be covered with gypsum that covers the inequality. Where necessary, chop the model from smaller pieces of polystyrene or use a trimmer.

Step 7: When the skeleton of the model is exposed, gradually add the adhesive to polystyrene and let it dry. Smaller portions may adhere worse. In such cases, try using Duvilax glue.

Source: Daphne (2012)

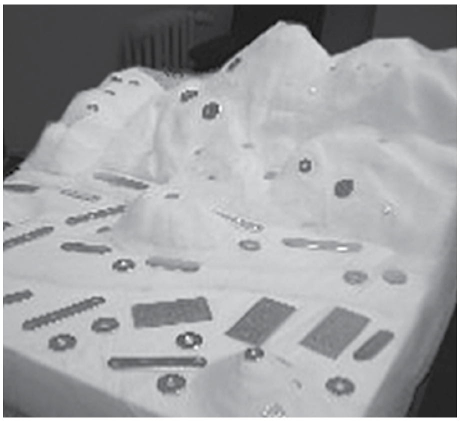
Step 8: When the adhesive is dry and the parts are held together, mark one or two streams from each of the mountain ranges. Then gently cut the troughs with the cutter. Their depth should be such that the troughs do not disappear into the surrounding landscape when you later erase the gypsum.

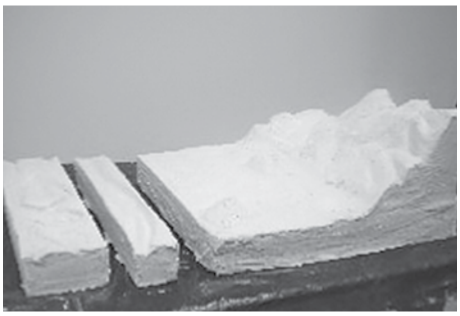
Step 9: Cut the lake with the cutter. Draw it gradually into the weighing bank, up to a depth of about 2 cm.

Step 10: Remove the polystyrene beads that are produced by cutting with a vacuum cleaner or a thicker dry paint brush.

B) Plastering the model

Materials: The polystyrene model frame, gauze, pins, sponge, gypsum, gypsum tray, plastic spoon, water bottle, table cloth, permanent marker, metal strips of various sizes made of a magnetizing material (they can be bought from an ironmonger's/hardware shop or a locksmith's, or you can use old keys or other smaller metal parts instead of strips).





Source: Daphne (2012)

Step 1: The polystyrene skeleton of the model needs to be covered with metal lugs to ensure that removable magnetic figures that we make later will hold to the model better thanks to the magnetic force. At various locations on the model (or on all its parts), stick Duvilax with metal strips. It does not matter if the adhesive does not stick tightly. In the following steps, they will be covered with gypsum that fixes them.

Step 2: All the four main parts of the model need to be overlaid with moistened gauze. To make it adhere better, you can pin it around the edges with pins. Thanks to the moistened gauze, the gypsum adheres better to the surface.

Step 3: In the plastic container, make a medium-thick gypsum slurry. Always make smaller quantities of gypsum so you can apply the material to the model before it starts curing. You will be able to estimate the correct mass density after mixing the first batches.

Step 4: Apply the matted material on the model with a plastic spoon or even with your bare hands. Always try to smooth out the applied layer to eliminate unevenness after drying.

Step 5: Apply the plaster over the entire surface so that the sheets are overlapped in the thin layer. The rivers and lakes may only be covered with a thin layer of gypsum. Be careful not to fill the troughs so that they do not merge with the surrounding landscape. Do not forget to cover both the top and the sides of the model.

Step 6: When all parts of the model are covered with gypsum, let them dry out well.

C) Colouring the model

Material: Previously plastered model, abrasive paper – sandpaper (medium thickness), paintbrush, plastic paint crucibles, white latex paint, tinting paints (you will need primarily green, blue, brown, yellow, ochre, a little red or orange), a brush cloth, colour shades, a bowl of water, table cloth.

Step 1: If there are significant uneven areas on the surface of the model after the gypsum has dried, which can easily be broken off over time, gently brush them off. The saddle must be completely dry during sanding. Then remove the dust from the model using a dry paint brush.

Step 2: Put different shades of colours into the plastic cups by mixing the white latex paint with the tinting paints.

Step 3: Apply paints with a brush. Smooth transitions between different shades can be achieved by tapping the areas of transition between two colours with a good cloth.

Step 4: Colour the sides of the model to brown to symbolize soil as well as the rock that is hidden beneath the surface of the landscape. If you want, you can also play with individual soil layers.

Step 5: After colouring, let the model dry out thoroughly.

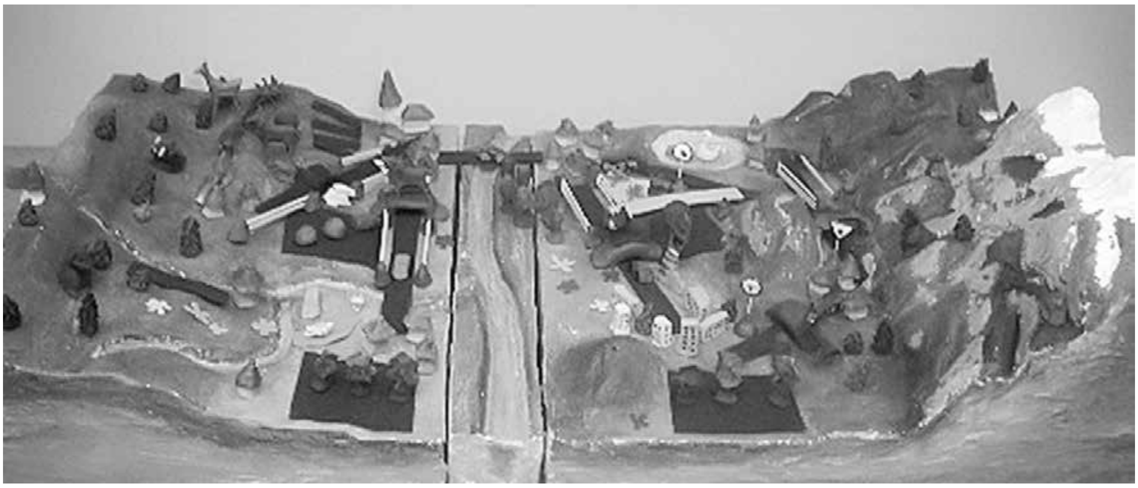
D) Varnishing the model

Material: Coloured model, colourless varnish (ideal for spraying) – one or two cans.

Step 1: Take the model out to fresh air. In a few thin layers, apply a colourless varnish, following the instructions on the varnish cover.

Step 2: Allow the varnished model to sit outside for some time (2–4 hours) until the varnish odour disappears.

Step 3: Store the model covered with a cloth so that it does not gather dust.



Source: Daphne (2012)

Activity 2

Once your river basin model is done, you can continue working with it in the following activity:

The teacher tells a short story and lets pupils make the river basin, i.e., gradually add or remove some natural/artificial elements that they have prepared using the modelling clay:

Source: Daphne (2012)

1. (Before the settlement began) "Once upon a time, there was a river (teacher shows a river basin). For thousands of years, the river had its own life-cycle (describe some natural functions of the river basin: floods in the spring/summer). The river had many tributaries, there were large floodplain forests (place some trees made by pupils) and wetlands (put a sponge near the river, etc.)."

2. (Beginning of settlement) "Later on, people began to move into the area. Where did people build their first homes? On rivers (mostly because of the water). Like you, these people drank water, washed, watered their plants, etc. People kept moving into the area and they started cutting trees for building (mostly wooden) houses." (Pupils take away some trees and add some houses according to the story.)

3. (Beginning of agriculture) "What became of the landscape with human activities? They began to make fields for farming. They also dried wetlands for turning into fields, which meant that some of the wetlands disappeared from the landscape." (Pupils place a piece of yellow felt/fabric representing the field. They can put it instead of the sponge/wetland or they can put it somewhere else and use the sponge to collect some water and pour it on the field/fabric to represent the drying.)

4. (Industrial revolution) "Many people moved from the countryside to cities. They started to build large factories (place a factory made by pupils) and also river dams were built (place a dam made by pupils if they made it)."

5. "The river basin started to change due to the human activity." (Gradually, simulate pollution of the river basin – put washing detergent on some houses – households, put oil on factories, place some cars made by pupils and put road salt on the car, put coffee on the fields as a fertilizer, etc.)

Next, simulate rain with a water disperser. Ask pupils to identify pollution sources and discuss impacts on water in the rivers (e.g., dams – no migration possible for fish, such as sturgeon), groundwater (infiltration), health of the people living in the river basin area, etc.

Questions to discuss: How do human activities upstream affect the river basin downstream? What are the consequences? Discuss more beyond the river basin model. As a follow-up, each group/pupil suggests how everyone can contribute to pollution reduction.

Additional activity:

TAKE ACTION – Pupils can investigate the regulations governing the property in their communities/cities in the river basin. If they believe that the river basin (or at least part of it) is poorly treated or in danger, they can write letters to local government officials supporting environmentally appropriate land use legislation.

Activity 3

Take a watering can full of water and simulate a major flood (as a climate extreme) over the model of a river basin.
What has happened in the river basin and near cities? Do pupils remember a major flood some years ago?

Information for the teacher that may be shared with pupils:

Extreme **flooding** in Central Europe began after several days of heavy rain **in late May and early June 2013**. Flooding and damage primarily affected south and east German states, western regions of the Czech Republic, and Austria. In Passau, Germany, the water levels reached 12.85 m, exceeding the highest recorded historic flood level. In **Slovakia**, the water level during the flood peak on the River Danube (in Bratislava) reached 10.34 m (10,641 m^3/s), which was the new historic maximum. In **Hungary**, they year 2013 saw the highest-ever recorded flood level all along the Hungarian Danube section. The peak flow was 10,640 m^3/s (at Vámosszabadi).

The Central European region (Germany, Austria, Czech Republic, Slovakia, Hungary) faced big flooding in 2002 as well. The **Czech Republic** faced a disastrous flood in **August 2002**. The water flooded 40% of the country. The flow rate of the Vltava River in Prague went up to 5,300 m^3/s (compared to the average flow rate in Prague of 148 m^3/s).

Lately, the **drought** caused by high temperatures and low rainfall since **May 2018**, has been the worst on the recent record for Northern and Central Europe. More than 90 percent of the area of the **Czech Republic** has been affected by drought. Over 72,000 square kilometres are currently affected by a drown-out period of dry weather and lack of rainfall. Extreme droughts reduced crop yields in **Slovakia** by 20–30 percent in 2017. The loss in agricultural crops caused by the extreme drought in 2017 was estimated by farmers in some regions at 37.2 million euros.

Examples of droughts in the Danube River Basin

When	Where	Why
1992/1993	Bulgaria, Hungary	Very hot and dry summer (1992), continued with below-average rainfall until October 1993; very low soil moisture in Bulgaria caused a severe loss of agricultural production.
1996	Bulgaria	Hot and dry summer across the entire country.
2003	Danube basin	Below-average rainfall in combination with above-average temperatures throughout the Danube Basin. In September the discharge level in the lower Danube basin reached the absolute minimum since 1840.
2015	Danube basin	Combination of rain shortage and very high temperatures. Significant drought phenomena were experienced in Austria, Bosnia and Herzegovina, Croatia, the Czech Republic, Germany, Hungary, Moldova, Serbia, the Slovak Republic, Slovenia and Ukraine. Bulgaria and Romania did not report significant droughts phenomena in 2015.

Source: Based on ICPDR (2018)

- What other kinds of climate extremes do pupils know?

Pupils will find information about climate extremes from different sources (videos, pictures), name them and assign their consequences to the river basin. Share the information in a discussion.

Pictures:

- You can find basic pictures in Attachment 5.
- You can find photos of heat waves, water scarcity, floods, drought, etc., on the Internet.

Examples of videos:

https://www.youtube.com/watch?v=pI9ggT0JZNI (3 min)
https://www.youtube.com/watch?v=_Yom8m4F1LQ (4 min)

Note: You can also make a PowerPoint presentation and add suitable pictures and videos to it.

Some examples of questions that could be used for a discussion with pupils about climate extremes (you can find the answers above in this block or in the theoretical introduction):

- What is a climate extreme?
- Which climate extremes do pupils know/see in the pictures/videos?
- Do they remember any recent climate extreme?
- What does it mean for us (people, animals, nature in general)?
- What can we do about it?

At the end, sum up the talk about the climate extremes and their consequences on the board. Around 30% of the global population is estimated to reside in areas and regions routinely impacted by either flood or drought events.

What is **our responsibility** living upstream or downstream (if the river basin is polluted, the river and the groundwater will be probably as well – think about point and non-point pollution sources)? What do floods mean for people, animals, land (**advantages**: necessity for floodplains/floodplain forests – important role of wetlands working like a sponge, thus reducing floods and preventing droughts, and also **disadvantages**: damage to buildings, human health, etc.)? What does drought mean for people, animals, land from the viewpoint of water quantity and quality (water is essential to us; domino effect – the overall impact of drought on an area is always negative except for some short-sighted "business activities")?

Closing the activity:

Do not forget to tell pupils how to behave responsibly as part of the river basin and thereby mitigate impacts of climate extremes.

Block 3: Aquatic ecosystems

Educational objective of block 3:

Pupils develop an understanding of the main aquatic ecosystems and their challenges.

Development of values and attitudes:

Pupils appreciate the value of aquatic ecosystems. They understand that aquatic ecosystems have many important environmental functions, many of them are threatened, and everybody has a chance to protect them. They realize the importance of "taking action".

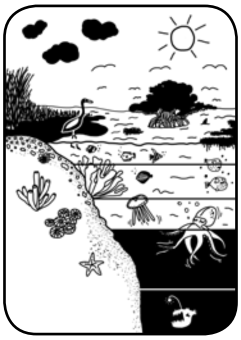
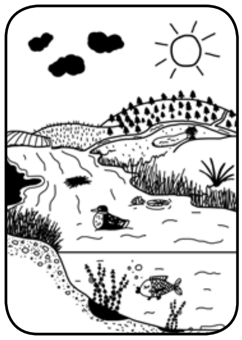
Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	Do you know them? The goal is to get to know main types of aquatic ecosystems (marine and fresh-water) and to under-stand their environ-mental functions.	use of visual elements, discussion	pictures of different aquatic ecosystems, coffee filter (= filter for nutrients/ pollution), sponge (= wetland), house (= home/habitat for wildlife), piece of bread (= food for animals), etc.	Use of 3D aids forms/ supports pupils' imagi-nation.	10 min	Approx. 15 min – print for each pupil or prepare to project a worksheet from Attachment 6 with aquatic ecosystems. You can also find your own pictures on the Internet. Plus: prepare 3D aids: cof-fee filter, sponge, house (toy), piece of bread, etc.
2	Plastic waste pollu-tion. The goal is to identify challenges for marine ecosys-tems.	on-line quiz/ work-sheet, dialogue	PC with Internet connection + projector or worksheet, board/flipchart for writing down threats/challenges	Fascinating facts always catch pupils' attention!	10–15 min	5 min – Internet connec-tion + projector (Attach-ment 7b). If you choose to work more with the topic – copies of worksheet from Attachment 7a for each pupil, board/flipchart
3	Challenges for fresh-water ecosystems. The goal is to iden-tify challenges for freshwater ecosys-tems. On a specific example (river dam), let pupils realize that ecosystems know no bounda-ries.	dialogue, group work	board/flipchart for writing down threats/challeng-es, pictures of a hydropower station and water mill as an example (Attachment 8 or find them on the Internet); mate-rials for building a water mill in groups	Pupils can share their ideas.	15–20 min	5–15 min – print handout from Attachment 8 for each pupil or prepare to project it from the Internet. Additional activities: Alt. 1: Internet connection and materials for building a water mill (in 3 groups): 3 aluminium plates, 3 pairs of scissors, 3 waterproof adhesive tapes, 6 nails, small hammer (to share), 3 wooden cuboids with 3 holes and 3 longer wooden blocks (to be prepared before, e.g., in a technical class), 3 hard wires approx. 20 cm long, pliers (to share) Alt. 2: Print the worksheets from Attachment 9

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
4	Flagship species. Get *to* know diversity of aquatic ecosystems and take your own responsibility for future actions.	individual work	picture of the giant sturgeon, paper, pencil	Show pupils that if they want to protect aquatic ecosystems, they should also know their living natural heritage.	5–10 min	3 min – Print picture of a giant Beluga Sturgeon from Attachment 10 on A4 or A3 size, as a paper pupils can use the other side of the worksheet or text from previous activities.
5	Final activity – take action. See how many solutions can be produced in a group of people and understand that everyone's involvement makes sense and may bring change. For pupils to understand that they are also responsible for their own actions and that they are part of the solution.	Individual work when writing ideas, making the final output together	Piece of blue canvas, papers for timetable and for writing (for pupils – may be in the shape of a fish, drop, etc.), pins or something to attach the timetable and papers to the canvas	Contributing with their own ideas, creating a timetable on the "river"	10 min	10–15 min – Bring a piece of blue canvas, prepare the timetable on the paper, prepare papers for pupils (if you wish you can cut the papers for pupils in different shapes)

Activity 1

Pictures:

- You can use the worksheet from Attachment 6, where you can find a marine ecosystem and a freshwater ecosystem as complex and example pictures.
- Alternatively, you can find your own pictures of specific aquatic ecosystems on the Internet (lagoon, coral reef, mangrove forest, etc.).

Basic theoretical information:

Pupils should know that **aquatic ecosystems** can be classified as either **marine ecosystems** (including brackish water) or **freshwater ecosystems.**

- Marine ecosystems – include the **oceans**, **salt marshes**, **coral reefs**, **mangrove forests**, **lagoons**, **seagrass beds** and **the intertidal zone** that stretches onto beaches. Estuaries are another important marine ecosystem where saltwater and freshwater meet to make a brackish mix.
- **Freshwater ecosystems** include different types of flowing waters (**rivers, streams, creeks, brooks**) and still waters (**ponds, lakes, reservoirs, wetlands**).

More information about this topic is in the theoretical background at the beginning of the module.

With the help of selected pictures, **discuss with the pupils:**

- What is in the picture?
- What is an aquatic ecosystem?
- Which different aquatic ecosystems exist? What do they know about them?
- What are some functions of aquatic ecosystems?

Write their ideas on the board.

You can find out about their environmental functions with the help of 3D examples – pupils can use the 3D tools (coffee filter, sponge, etc.) and suggest other "3D" examples.

Note:
coffee filter (= filter for nutrients/pollution), sponge (= wetland), house (= home/habitat for wildlife), piece of bread (= food for animals), etc.

To speak more about aquatic ecosystems, use information from the theoretical introduction.

Activity 2

Brainstorming:

Try to find out together the threats to **marine ecosystems** and write them on the board/flipchart.

Video and discussion:

Then, ask pupils about plastic waste pollution and show pupils a short video about the Great Pacific Garbage Patch. You can choose from these videos or find another in your language:

Shorter videos: https://www.youtube.com/watch?v=1qT-rOXB6NI; 2 min 57 s (subtitles in English) or https://www.youtube.com/watch?v=vrPBYS5zzF8; 3 min 18 s (in English)

Longer video: https://www.youtube.com/watch?v=YFZS3Vh4lfI; 4 min 59 s (subtitles in English)

Another video: https://www.youtube.com/watch?v=-SHF1w4h3v0; 7 min 30 s (in Czech)
mostly 0–1 min 55 s + later in the video there are concrete examples of how to reduce and avoid plastics. It is more a call to change of our behaviour.

The videos may be a little shocking for pupils. You can add also motivation for the young generation – what we can change and how. There are also inventions made by young people, e.g., "Oceanic plastic waste collector booms" invented by Boyan Slat, aged 19:

https://www.youtube.com/watch?time_continue=23&v=uM-WKF1fIis.

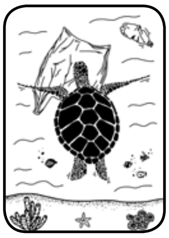
Young people's inventions fascinate the world! Every problem has a specific solution.

More about the topic:

If you consider it appropriate (pupils know about the problem and are interested in it or you would just like to work more with this topic), let pupils work on an online **quiz** or the **worksheet from** Attachment 7a and the picture from Attachment 7b. You can also use the worksheet a week later for reminding about the topic or use it as homework.

- Choice 1 – online quiz: https://kids.nationalgeographic.com/explore/nature/kids-vs-plastic/quiz/
- Choice 2 – worksheet from Attachment 7a (story – pupils are to fill the gaps with the correct words from the list to understand what kind of problems – with their consequences – plastic waste can cause as a source of water pollution). Additionally, you can use the picture from Attachment 7b.

The correct answers to the worksheet in Attachment 7a in the order:



PLASTIC WASTE POLLUTION

A sea turtle is swimming in the water and sees a white thing floating near the surface. "Yum!" it thinks. Chasing after its dinner, the turtle swallows the item. But the floating thing is a plastic bottle that could make the sea turtle sick or dead.

This sea creature isn't alone: Over ..*700*.. species of marine animals have been reported to have eaten or been entangled in plastic. Did you know that there is a so-called *Great Pacific Garbage Patch*, between Hawaii and California? It is the largest collection of floating trash in the world. But you can also help stop that from growing.

What's the problem with the plastic?

Plastic is usually made from *oil and natural gas*. A kind of plastic that is used only once is called *disposable plastic*. It makes up almost half of all plastic trash! The problem is that most of us use and then toss away more plastic than we need: things like (write at least 3 different things) ...*e.g., grocery bags, drink bottles, straws, food wrappers, plastic packaging around toys*

Where does the plastic go?

That's a lot of trash. Scientists think that .*8.8 million* tons of plastic ends up in the ocean every year. How does it get into the sea? Plastics left on the ground as litter are often blown into *creeks and rivers*...., eventually ending up in the ocean. And because plastic trash is different from other types of waste – it doesn't .*decompose* back into nature like an apple core or a piece of paper – it stays in the ocean forever.

What can I do about it? (Suggest some ideas about what can you change in your daily life about your use of plastics)

....
....
....

Source: National Geographic (2018)

Helpful information for the educator for Activity 2 — plastic waste pollution

Some concrete tips for explaining the problem with plastics to pupils:
Ecologists and activists have been vocal about the problem of plastic pollution for years: plastic pollution invades our communities as litter, harms wildlife, and 8.8 million tons of it end up in our waterways and oceans every year. Many people believe the current generation of pupils will solve the growing problems of plastic pollution and global warming. But how do we talk to kids about these global problems? You can use these resources to help kids have fun and learn about protecting our home:

- *National Geographic for Kids* – an interactive learning tool which offers a lot of learning opportunities, from lessons and quizzes to games and educational videos,
- Activity Book: Be an Ocean Guardian – a book backed up by the National Oceanic and Atmospheric Administration; very comprehensive, containing abundant information about the ocean and why it is so important to minimize plastic pollution,

Source: Plastic Pollution Coalition (2018) and National Geographic (2018)

Activity 3

Use the handout from Attachment 8 or prepared pictures from the Internet to support the ideas and the discussion below.

Brainstorming:

Try to find out threats to ***freshwater* ecosystems** and write them on the board/flipchart.

Discussion:

- Ask about river dams (hydropower stations). Do pupils know a big river dam/hydropower station in their surroundings? Ask pupils if dams are important and why? Use one specific example (e.g., show a picture of the Gabčíkovo-Nagymaros dam on the River Danube from the Internet. Pupils can write concrete examples of stations next to the picture of the general hydropower station that they have on the handout.
- Are there any alternatives to using water energy? You can mention and show picture of the traditional water mill in the worksheet or on the Internet. You can also speak about concrete examples (e.g., water mill in Jelka, Slovakia).

Discuss more about concrete threats to freshwater ecosystem:

- What's good and what's bad about hydropower?
- What can we change?
- Don't forget: Every problem has a specific solution.

More theoretical information for the educator to Activity 3:

Hydropower stations = big change to the river ecosystem – create several problems:

- fish population declines (because of the lower water levels),
- stop migration of big fish (e.g., giant sturgeons),
- other animals and plants lose their natural habitats,
- pesticides, fertilizers and industrial pollution are concentrated in the lake,
- the level of the freshwater reservoir drops and becomes contaminated,
- many farmers downstream (e.g., on the Hungarian side at Gabčíkovo hydropower station) lose access to water for irrigating their crops.

Generally, **dams** degrade water quality, degrade the river and block fish movement upstream (also downstream for the sturgeon *Huso huso*). Construction of big dams (together with the Iron Gate Dam) – hydropower stations – was one of the main causes of stopping migration of the giant **sturgeons** (*Huso huso*) from the Black Sea upstream for reproduction.

Additional activities:

If you have time to continue with the topic, choose the appropriate alternative for your class below.

Alternative 1:

Let's support less harmful ways of development of water energy. Let's create one of them!

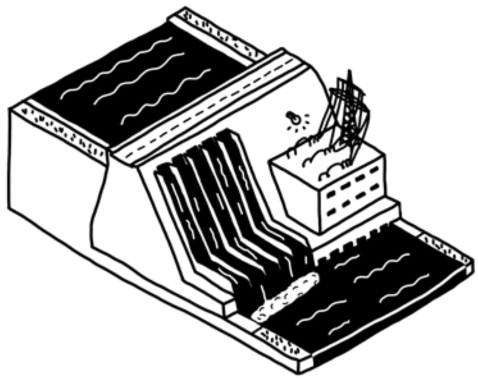
Divide pupils into 3 groups. Each group will have 1 aluminium plate, scissors, waterproof adhesive tape, 2 nails, a small hammer, 1 wooden cuboid with 3 holes and 1 longer wooden block (to make a pylon) prepared before (e.g., in a technical class), hard wire approx. 20 cm long, and a pair of pliers.

Now show this video:

https://www.youtube.com/watch?time_continue=100&v=hKalwhnCIfE
and let pupils make the water mill.

Alternative 2:

Read and discuss with the pupils the text about the Gabčíkovo – Nagymaros hydropower station. You can find it in Attachment 9.



Rivers meet a variety of human needs – freshwater for drinking, transportation, hydropower for industry and households, irrigation for agriculture and habitats for ecosystems. Sometimes, rivers also make borders between countries, which can lead to complications and conflicts for economic, environmental or political reasons.

The Danube River forms a part of the border of Slovakia and flows for nearly 2,800 kilometres from its source in the Black Forest in Germany to the Black Sea on the coasts of Ukraine and Romania. The Danube River Basin is the second largest in Europe, after the Volga. Its extent (the river basin covers almost 777,000 km^2) makes the Danube River a vital source to the ecology and economy of Central Europe.

A large floodplain between Slovakia and Hungary used to be full of biological diversity with frequent nutrient-rich floods feeding the forests and cropland. Fish and migratory birds were abundant in these wetlands. The wetlands are critical in the Danube's ecosystem and act as natural filters, clearing pollution out of the water. This floodplain is a natural environment for forests and about 5,000 species of fauna and flora. The area is considered a large freshwater reservoir. In 1977, Hungary and former Czechoslovakia agreed to build a system of dams and canals in this area. This decision led to a major international conflict that has not been resolved for more than forty years.

The Gabčíkovo hydropower station, with an installed capacity of 720 MW, generates about 7–10% of the annual electricity consumption of Slovakia. Between October 1992 and December 2016 it generated more than 54 million MWh of electricity.

While the Slovak government praises its benefits in the form of green energy generation as well as better flood protection and navigability of the river, environmentalists point out its impact on the Danube ecosystem.

Source: National Geographic (2012)

Activity 4

Educator to pupils: Do you remember any problems caused by hydropower stations to fish? Yes! There are many species in danger because of them. Did you know the term/name “flagship species”? Do you know any? I would like to mention one of them for you (show picture – Attachment 10) – the giant sturgeon *Huso huso.* Did you know that these fish, up to 8 meters long, were contemporaries of dinosaurs and are still living in the Danube Delta? Talk about the **flagship species of the Danube** (already mentioned in Activity 3 in connection with dams) – the giant **sturgeon** (*Huso huso*) – and show a picture of it from Attachment 10.

Theoretical information for the educator to Activity 4:

Flagship species – threatened species of plants or animals which are used by conservation organizations or projects as their ambassadors to draw attention to their circumstances and help drive conservation efforts to generate support and improve their status. At some level, these threatened species end up representing other endangered species existing in their ecosystem. They could be any of three categories: international, cultural or ecological flagship species.

Sturgeons used to migrate thousands of kilometres (1,800 km!) for many years from the Black Sea upstream (as far upstream as Vienna, even Germany) for reproduction. You can demonstrate the distance and the location of the Danube river using maps, e.g., Google maps. The giant sturgeons are the biggest freshwater fish in the world and represent a natural heritage of the Danube River Basin. Their dramatic decline (due to dams and overfishing) in the last decades has become an issue of basin-wide importance that received attention of the Danube countries and the European Commission.

Taking action: Now, have pupils take a piece of paper and a pencil and work individually. Everyone will write down one proposal – a kind of CHALLENGE to take action for themselves/other people – why should we be interested in aquatic ecosystems?

- EXAMPLE CHALLENGE – TAKE ACTION: Do not save extinct dinosaurs, but those living! What is important for fish is also important for people. Only a healthy river ecosystem can provide all ecosystem services (aesthetic, self-cleaning, flood protection, energy, etc.) to the full. It’s even something that the river provides us for free…

Activity 5

You will need a piece of blue canvas (symbolising the river) and a timetable.

Firstly, make a timetable (e.g., from paper) with a long line and time data: today – in a week – in a month – in a year.

Everybody gets a piece of paper (the paper might be of different shapes, e.g., like a fish, etc.), writes their name + **own ideas** (What can **you** do for protection of aquatic ecosystems in your landscape: country, city and family?) on it and stick/pin it under the right time data (according to the timetable above) in the “water” (a piece of blue canvas).

Then, the whole class can see how many things can be done if everyone is involved.

Poster of Earth with the water cycle (example)

Attachment 2

Playing cards on the water cycle (before using the cards, cut them into pieces):

Solar radiation (sun) warms up Earth’s surface.	A part of precipitation infiltrates (soaks) into the ground.
Water vapour rises from the oceans into the atmosphere.	Water molecules (particles) are in a liquid form.
Water evaporates (gets away into the air) from rivers, streams, and lakes.	Water molecules (particles) are in a gaseous form.
Water evaporates (gets away into the air) from the soil surface.	Water molecules (particles) are in a solid form.
Water transpires (gets away into the air) from vegetation.	Some water remains in a solid form as ice.
Water vapour condenses (liquidizes) and changes into droplets forming clouds.	Water falls on Earth’s surface as snow.
Water falls on Earth’s surface as precipitation (rain and snow).	Groundwater seeps into the beds and banks of rivers.
Some precipitation runs off in streams and rivers.	Permeable (leaky) layers in the basement form groundwater reservoirs.

Try to guess the right period of renewal of water resources on Earth! Choose from the options below.

Part of the hydrosphere	Period of renewal
World ocean	
Groundwater	
Polar ice	
Lakes	
Bogs	
Soil moisture	
Atmospheric moisture	
Biological water (living organisms)	
“Your age”	

- several hours
- 2,500 years
- 5 years
- 8 days
- 9,700 years
- 1 year
- 1,400 years
- 17 years
- “your age”

Attachment 4

Table 1

Part of the hydrosphere, source of water	Period of renewal
World ocean	2,500 years
Groundwater	1,400 years
Polar ice	9,700 years
Lakes	17 years
Bogs	5 years
Soil moisture	1 year

Table 1

Atmospheric moisture	8 days
Biological water	Several hours
Your age	....

Table 2 – Examples of famous events from history

Iron Age – Socrates the philosopher	Migration Period/Slavs
Stone Age – beginning of agricultural era	Big floods in Central Europe

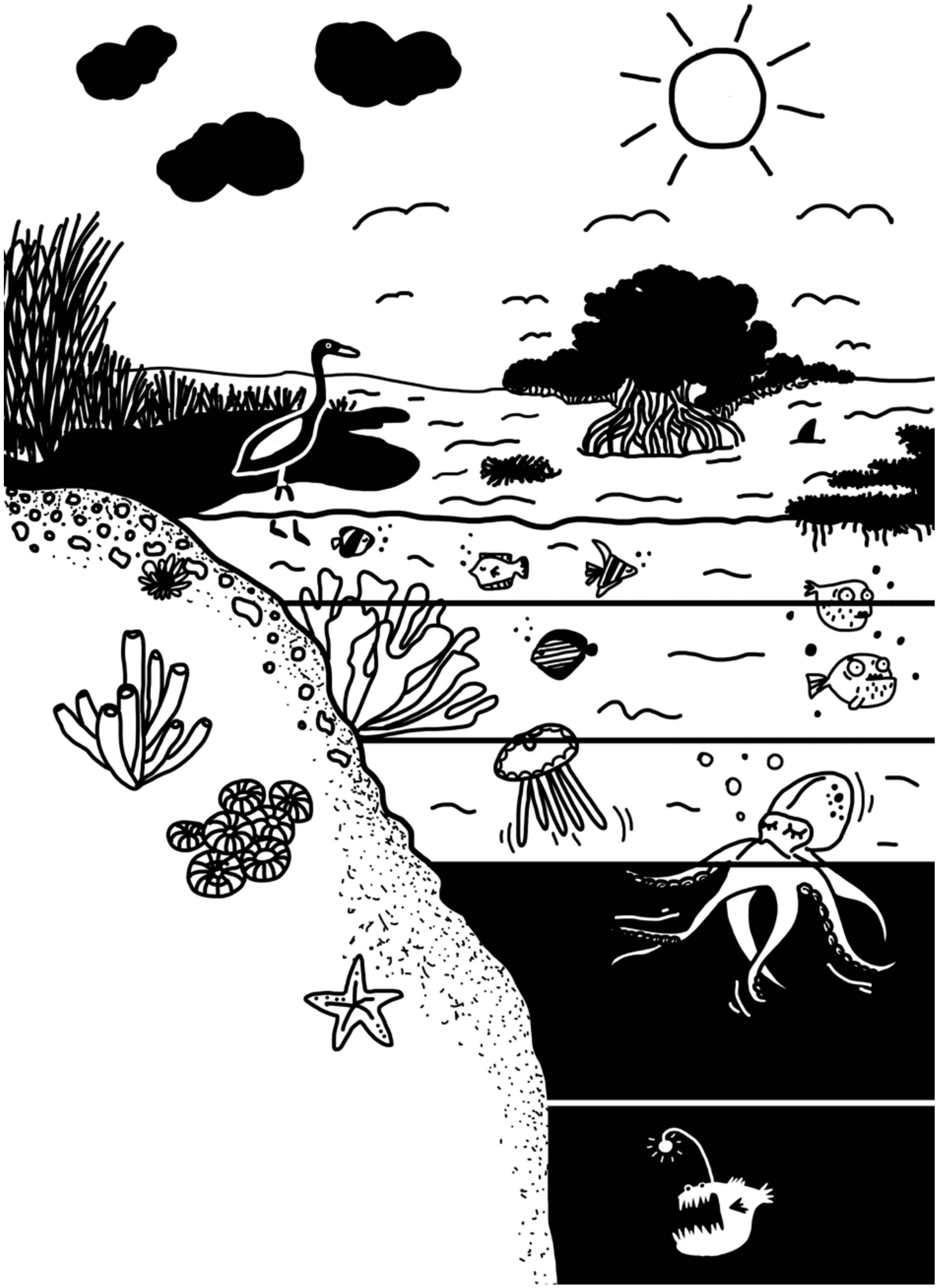
Attachment 5

Drought, water scarcity, heat wave

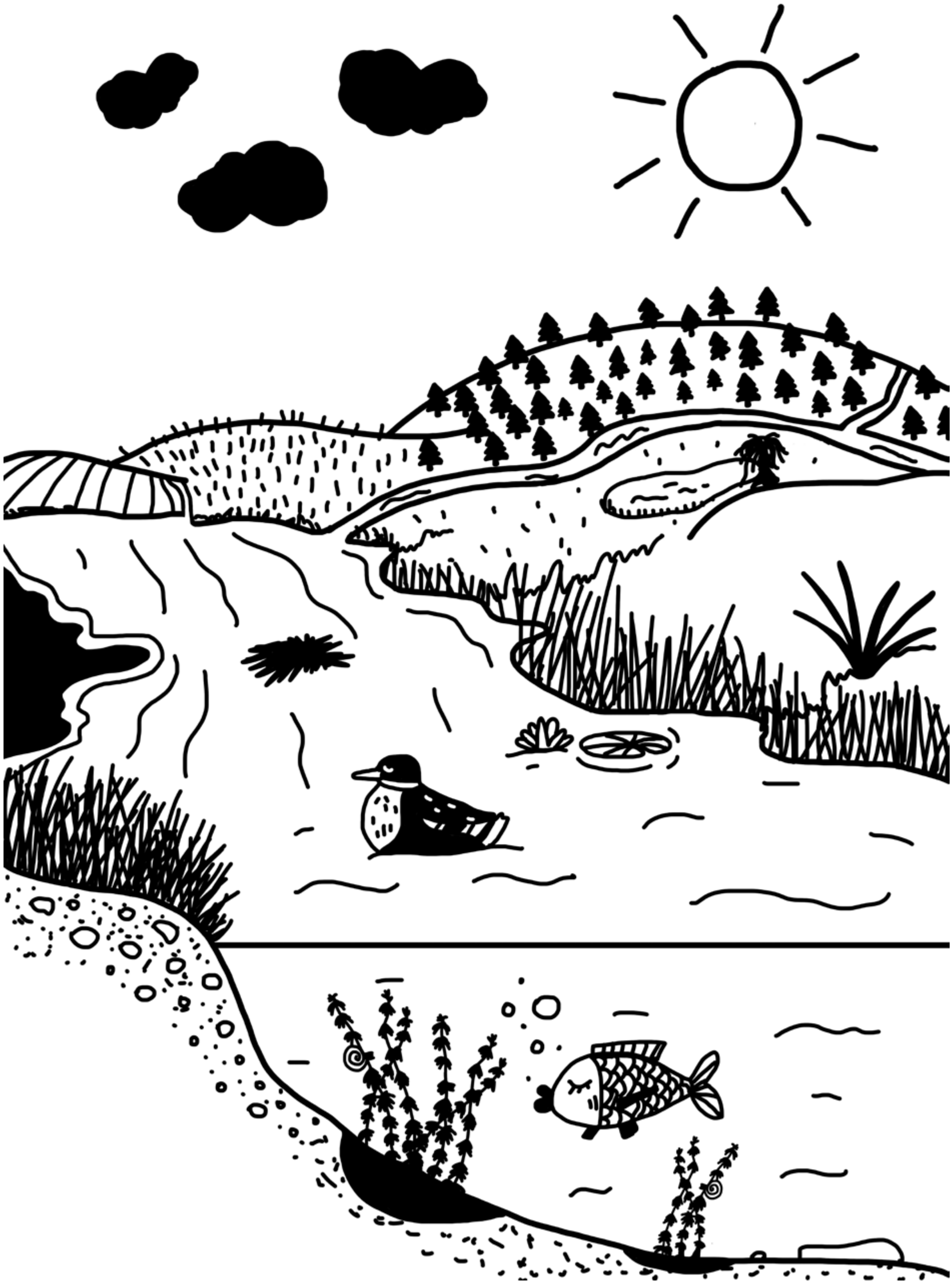
Floods

Attachment 6

Marine aquatic ecosystem



Fresh aquatic ecosystem

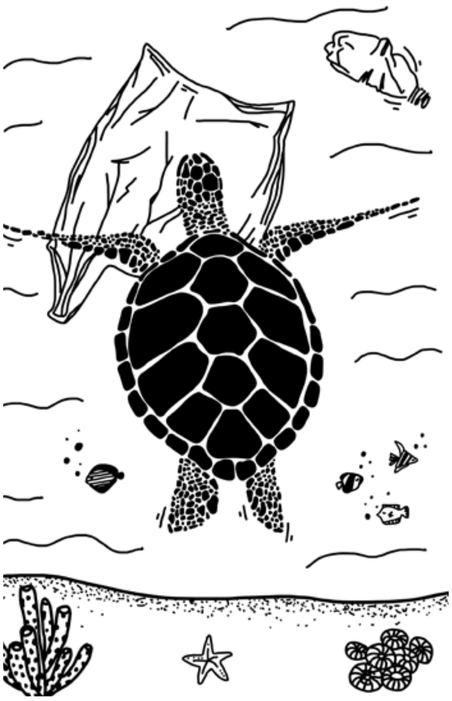


Attachment 7a

Fill the gaps with the correct word from the list below:

PLASTIC WASTE POLLUTION

A sea turtle is swimming in the water and sees a white thing floating near the surface. "Yum!" it thinks. Chasing after its dinner, the turtle swallows the item. But the floating thing is a plastic bottle that could make the sea turtle sick or dead.



This sea creature isn't alone: Over ..... species of marine animals have been reported to have eaten or been entangled in plastic. Did you know that there is a so-called ...., between Hawaii and California? It is the largest collection of floating trash in the world. But you can also help stop that from growing.

What's the problem with the plastic?

Plastic is usually made from ....**.** A kind of plastic that is used only once is called ....**.** It makes up almost half of all plastic trash! The problem is that most of us use and then toss away more plastic than we need: things like (write at least 3 different things) ....
....

Where does the plastic go?

That's a lot of trash. Scientists think that .... tons of plastic ends up in the ocean every year. How does it get into the sea? Plastics left on the ground as litter are often blown into ...., eventually ending up in the ocean. And because plastic trash is different from other types of waste – it doesn't .... back into nature like an apple core or a piece of paper – it stays in the ocean forever.

disposable plastic, 8.8 million, creeks and rivers, 700, oil and natural gas, decompose, Great Pacific Garbage Patch, (e.g., grocery bags, drink bottles, straws, food wrappers, plastic packaging around toys)

What can I do about it?

(Suggest some ideas about what can you change in your daily life about your use of plastics)

....
....
....

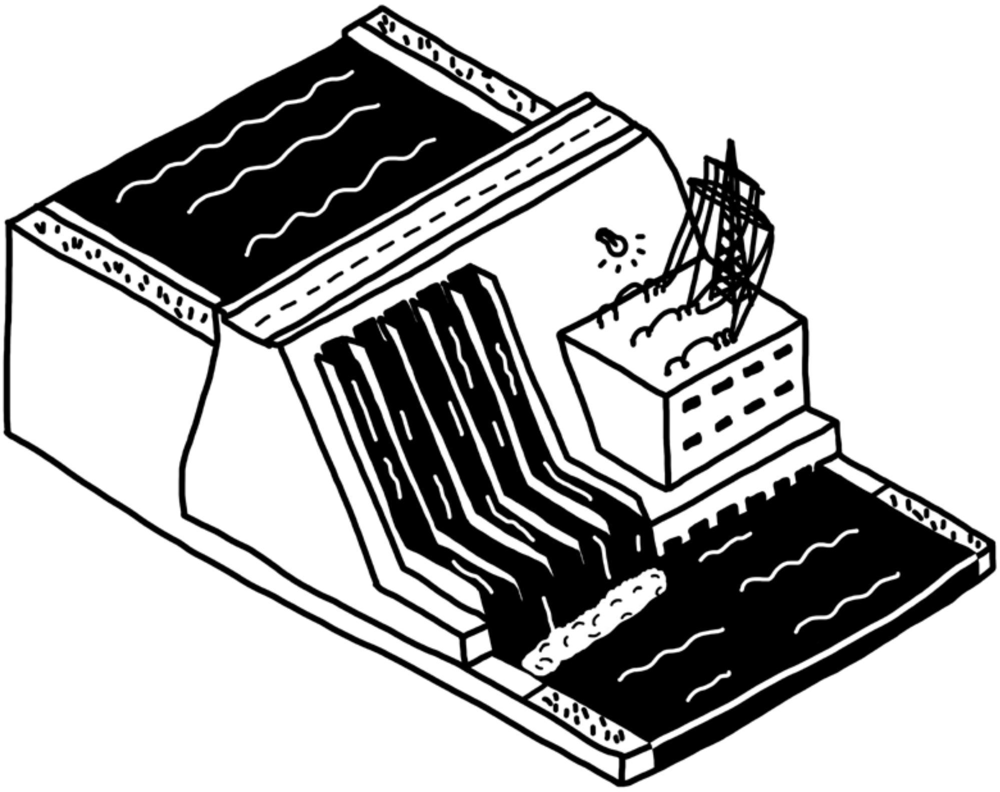
Source: National Geographic (2018)

Great Pacific Garbage Patch

SAVE THE WORLD — STOP TRASHING OUR OCEAN

Attachment 8

Traditional water mill (Example: Jelka on the River Danube, Slovakia)



Hydropower dam (Example: Gabčíkovo on the River Danube, Slovakia)

The Gabčíkovo-Nagymaros hydropower station

Rivers meet a variety of human needs – freshwater for drinking, transportation, hydropower for industry and households, irrigation for agriculture and habitats for ecosystems. Sometimes, rivers also make borders between countries, which can lead to complications and conflicts for economic, environmental or political reasons.

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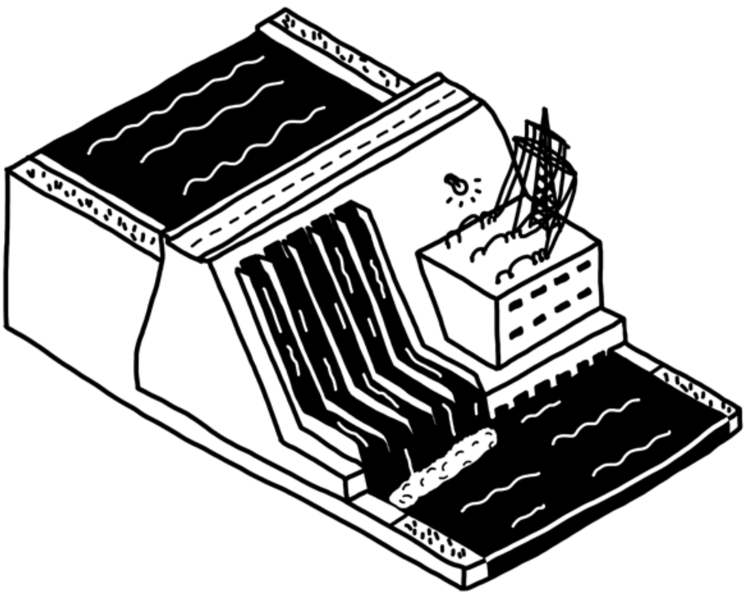
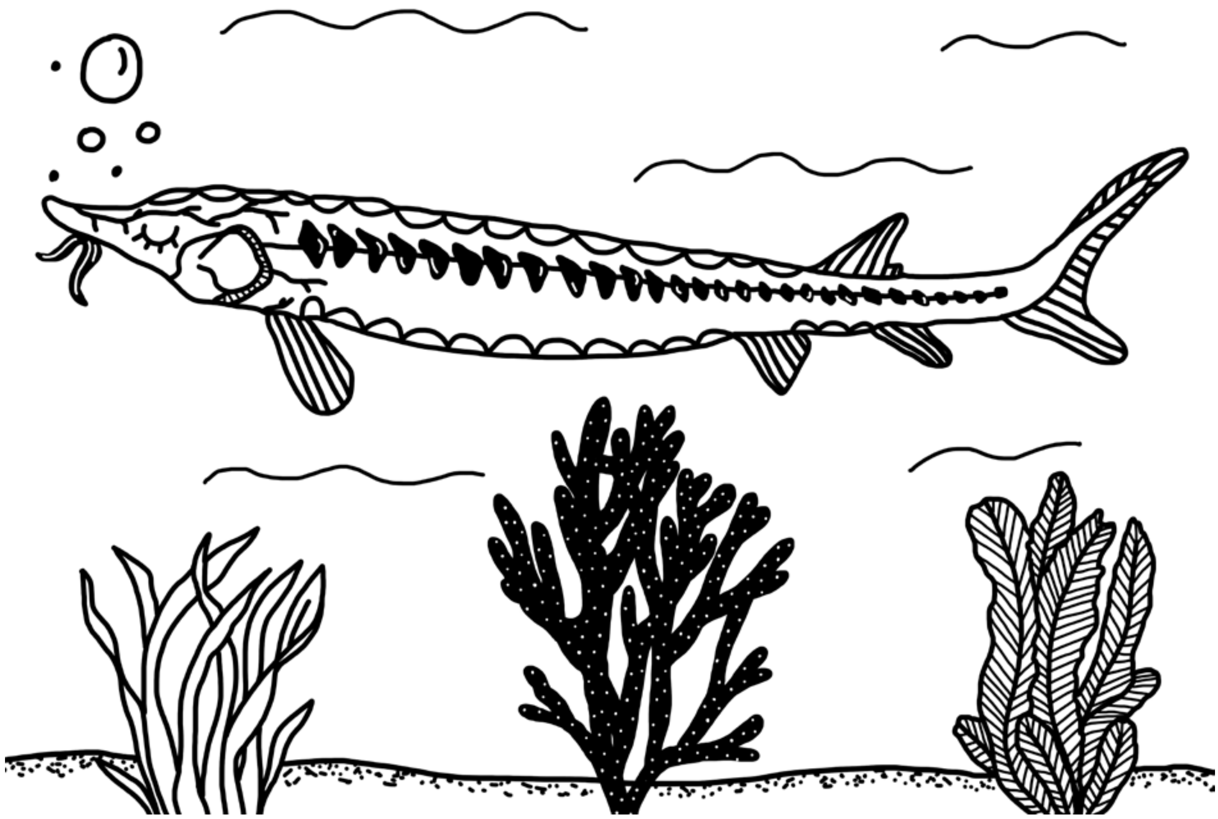


Hydropower dam

Source of the text: National Geographic (2012)

Attachment 10

Beluga Sturgeon



Water in the city

The main objective of module:

We need to increase the awareness of pupils that water is important everywhere, especially in the area where they live. They have to be motivated to handle water with respect and find their own role in water saving.

Theoretical introduction to the theme:

Access to clean water in underdeveloped countries in the 21st century is a challenge. In many cases in the world, people cannot get clean drinking water of adequate quality. This also involves proper hygiene. In countries where hygiene conditions are guaranteed, they do not have to fear the quality of drinking water. About 3% of Earth's water resources are freshwater, which may be suitable for drinking. However, only a small part of it can supply drinking water (surface water and groundwater). Ensuring clean water and hygiene is one of the most important pillars of child development. Nowadays, about 2.1 billion people have access to safe, clean drinking water, while 4.5 billion people do not have clean water supply (WHO, 2017). Thousands of pupils die every year in poor hygiene conditions. There are countless diseases that can be fatal to them. By building clean drinking water, basic hygiene and public health systems, and hand washing with soap, 88% of diarrheal diseases could be prevented (WHO, 2004). Regular hand washing can save more lives than any vaccine or medical intervention.

Safe and clean drinking water, adequate **sanitation** and **hygiene** are essential for human life. Approximately 4–5 litres of water are required daily for a young child to survive: to drink, eat, bathe, and provide basic hygiene conditions. This would be roughly four times higher for proper development. Unfortunately, even this amount of water cannot be reached in every part of the world as easily as we do. We can call ourselves lucky in Europe because clean drinking water flows into our apartment through secure pipe networks. Drinking water is often also called tap water, because in many EU countries (such as the Czech Republic, Slovakia, Poland and Hungary), the water quality is very good, sometimes even better than the quality of bottled water. Based on Wanner (2018), an average European resident uses between 78 and 300 litres of water a day (89 litres in the Czech Republic, 96 litres in Hungary and 79 litres in Slovakia), and even a dripping tap can drain up to 40–120 litres of water in a day. In some parts of Africa and South America, you have to walk for several hours to the nearest catchment area to get safe drinking water. Women and pupils participate mostly in carrying of water, which takes a lot of energy and time.

In addition to safe drinking water, wastewater disposal is extremely important because hygienic conditions cannot be ensured without sewerage. Sewerage is one of the costliest utilities, and this explains why in the Middle Ages, sewerage lagged behind water supply. This fact explains that the development of sewer networks has progressed very slowly. Nowadays, 2.8 billion people in the world have access to fixed sewerage, while 946 million people are still living in non-sewered, inadequate hygiene (European Union, 2010; Environment Protection Authority Victoria, 2006). By providing adequate drinking water and hygiene, 50 percent of child deaths could be prevented (Watkins, 2006).

Due to the effects of **climate change**, environmental challenges are hitting our planet more severely. Among critical symptoms, water-related problems can be considered the most crucial. According to United Nations estimates, in 2050, there will be approximately 500 million people alone in Sub-Saharan Africa without adequate daily clear water. However, water-related environmental challenges are also occurring in Europe in the form of wasting, pollution and ineffective use of water resources; thus, water scarcity affects at least

11% of the European population and 17% of the EU territory according to estimates of the European Union (2010). Moreover, it is also declared that 20–40% of Europe's available water is being wasted due to leakages, ineffective saving technologies, unnecessary irrigation, dripping, household inefficiencies, etc.).

Water management requires much more cautious developments that also take into account the effects of climate change. The question arises, what can people do against wasteful treatment of water, according to the current practice? Pure water is of growing value and cannot be replaced with anything else! We should respect and appreciate it!

Sanitation and water treatment

More and more pollutants are coming to our knowledge of the quality of water resources, thanks to increasingly sensitive analytical methods. Many chemicals are used by mankind in crop production, and many pharmaceuticals are used in animal husbandry, and more and more products are used to preserve or restore human health. Excess chemicals in the environment pollute surface and groundwater, which are the foundations of drinking water resources. Different residues in the environment are called micro-contaminants, as they are present in micro-quantities. Their presence is detectable, but its long-term effects are not known at this time. The interactions between non-degradable active substances or pollutants discharged from different organisms are not known, so we cannot say how they affect the ecosystem. When introduced into wastewater treatment plants, these substances cannot be filtered out even by modern wastewater treatment techniques, so they return to the water cycle. Because most of the micro-pollutants are not biodegradable, they permanently affect the quality of our water resources.

Nowadays, more and more attention is paid to micronutrients in the water, which are released into the environment by splitting of released plastics. In addition, many cosmetics contain microspheres, which are also plastics. There are also many micro pieces of natural fibres that can also be categorized as micro-plastics. These micro-particles in the surface waters get into the bodies of fish, where they cannot decompose, people eat these fish, so these plastic parts can get into our body. No living organism can digest these pollutants (Gerencsérné et al., 2018).

All in all, we can say that increasingly sensitive quality control methods allow us to detect new and new pollutants. It is important to note, therefore, that the purity of our water resources can be best preserved if we place great emphasis on prevention and environmental protection.

How can water be treated, how is drinking water produced?

(Theoretical basic information about water treatment in the city)
Complex treatment can be very diverse, it can include several treatment processes, e.g.:

- filtration (through a grid) for removing bigger stones, pieces of plants, feathers, etc.;
- aeration: to help remove manganese and iron compounds. Air is blown into the water through a pipe with small holes;
- settling for removing solids: suspended solids are hard to remove, special chemicals need to be dosed, which help them stick together and then settle down in large tanks;
- fine filtration: to remove very small, also microscopic particles. Filtration material can be gravel, sand, very fine sand, coal, etc. Activated carbon can also be part of the filtration step; it has got very large surface with lots of holes in it (the surface of 1 g of activated carbon can be as large as half of a football stadium);
- disinfection: very important to kill all the bacteria and viruses which can be present in the water, so the consumers will not get ill.

For the final water treatment method specialists need to plan the exact technology based on the water quality and the environmental and health legislation.

Water collection

Generally, the water consumption is growing on Earth, due to the growing need of industry and agriculture, and also the growing human consumption. Since the overall amount of water on Earth in not growing, we will have to focus on water saving and alternative water collection methods. We can start using and re-using greywater and rainwater as well. But what is it?

Greywater: Part of that is relatively clean wastewater from the households. It can come from the baths, sinks, washing machines and dish washers.
Rainwater can also be greywater. With the re-use of greywater, the freshwater consumption can be reduced. It can be used, e.g., for washing clothes, having a shower or bath, flushing the toilet, washing the car, watering the garden, etc.

Similarly to greywater we can talk about:

- black water: containing fecal contamination, and
- yellow water: containing urine contamination.

The most common use of greywater (best for it is separately collected rainwater) is garden or grass watering. Since it contains elements only at low concentrations, so the hardness of the water is also low, this water is ideal for different plants in the garden and also in the house (Environment Protection Authority Victoria, 2006). Reusing wastewater has become a good way to solve this problem, and wastewater reuse is also called recycled or reclaimed water.

It is not recommended to consume rainwater directly since it can contain contamination (particles, microbes, chemicals, etc.) which can cause different diseases. There is existing technology for purification of rainwater but usually it is not available for household use. So we should avoid direct rainwater consumption or its use for food preparation.

In the case of rainwater harvesting, it can be carried out on a small scale from the roofs, for example in households. It can be used in buildings, e.g., as greywater for flushing toilets, then it gets into the wastewater system and is treated. We can also use it for watering of parks, green places, and indoor plants.

Water and hygiene

Insufficient water and hygiene kills more people than weapons (Watkins, 2006). In some parts of the world, there is little or no awareness of good hygiene practices and their role in reducing the spread of disease. However, it is often the case that even when people do have knowledge of good hygiene behaviour, they lack the soap, safe water and washing facilities they need to make positive changes to protect themselves and their community.

Access to improved water and sanitation facilities does not, on its own, necessarily lead to improved health. There is now very clear evidence showing the importance of hygienic behaviour, in particular hand-washing with soap at critical times: after defecating and before eating or preparing food. Hand-washing with soap can significantly reduce the incidence of diarrhoea, which is the second leading cause of death amongst pupils under five years of age. In fact, recent studies suggest that regular hand-washing with soap at critical times can reduce the number of diarrhoea bouts by almost 50 per cent.

With regard to the importance of hand washing, we can highlight illnesses caused by invisible viruses and bacteria that can be prevented by thorough hand washing. Examples include: pneumonia, trachoma, scabies, skin and eye infections, and diarrheal diseases such as cholera and dysentery (UNICEF, 2016).

Blocks described below:

(i) Sanitation – Water Treatment; (ii) Water Harvesting; (iii) Water and Hygiene

Block 1: Sanitation — water treatment

Educational objective of block 1:

Pupils learn about the importance of wastewater treatment and their potential. What pollutants can get into our water and where? How can we protect nature from pollutants of different origin?

Development of values and attitudes:

Through specific examples, they acquire critical thinking and problem-solving skills.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	Where does drinking water come from? Different water types will be mentioned. Pure water and polluted water will be compared.	motiva-tional discussion	Two glasses of water: one with tap water, another with surface water	To see the difference between tap water and surface water	3–5 min	1–2 hours – prepare two glasses, first filled up with tap water and the other one with surface water (from local river, lake…).
2	Summarization of different water pollutants, where they come from, what types we distinguish. What do we call micro-pollut-ants? The goal is to decide what is more dangerous: visible or invisible pollution?	motiva-tional discus-sion and game	To show visible and invisible pollution: two glasses of water are necessary, salt crystals, sugar crystals, and a tube of pharmaceutical material – e.g., probiotics. Papers for pupils, magnet or tape	Guessing, trying to find the answer to the pollution parts.	15 min	5–10 min –bring a glass and fill it with tap water. Bring con-taminants, papers for pupils, mag-net or tape. Make sure that pupils have draw-ing imple-ments.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
3	Pupils participate in an experiment to understand the process of water treatment through making pure water from dirty water.	group work, self-made water filter	Filter material – sand, gravel and cotton or carbon – should be well-washed and dried. Bottle of dirty water for the experiment (with sand, leaves,…). Plus: Version 1: 2 plastic bottles, knife or scissors, coffee filter paper, spoon Version 2: 1 plastic bottle, 3 plastic cups, knife or scissors, coffee filter paper, spoon	Experiment – production of pure water	25 min	30 min – collect all the necessary materials for the water treatment experiment.

Activity 1

Bring two glasses of water – one glass of surface water and one with tap water. Use them to discuss the differences with the pupils and start the topic of water sources, water pollution and water treatment.

Examples for discussion:

- Where does drinking water come from?

  Answer: well, surface water, river. We can say drinking water comes from the tap, tap water also originates from these types of water.

- What types of water do you know?

  Answer: surfaces water, well water, groundwater, sea water, purified water

- Where do we get our drinking water?

  Answer: From the nearest river, lake, or well.

- What sources can they have?

  Answer: river, brook, lake

- Do you know where we get our tap water?

  Answer: From the nearest river, lake, or well.

- Do we get drinking water from surface or groundwater?

- How does water get into the tap?

Discussion about the origins of water – water comes from surface water or groundwater. If it is not clear enough, then different water treatment steps are necessary (e.g., filtration, disinfection, etc.). We can refer to the water cycle, different water sources, as is written in the introduction.

Activity 2

We need two glasses of tap water. To the one glass of tap water we can add different soluble salts, such as natural salts, sugars, which can be found naturally in surface waters. We can also add contaminants, such as some kind of suspended probiotic or a sample of soluble pharmaceutical material. To the other glass of water, we can add insoluble parts, e.g., microplastics – small particles from pupils' clothes. In the two glasses of water presented, we can see the difference between the visible and invisible pollution. Which pollution can we imagine in the water? Where does it come from? What are its effects?

Discuss with the pupils:

- What happened with the water in the first glass?
- What happened with the water in the second glass?
- What is the difference?
- Would you call both pollution? Why?
- Etc.

You can talk more about pollution:

- What pollutants can occur in water?

  Answer: plastic, sand, iron, drugs, bacteria, viruses, metals, etc.
- Can we see all these pollutants?

  Answer: no, there are some invisible particles that can pollute water
- Are there invisible contaminants?

  Answer: yes
- Have you heard of micro-pollutants? Can drugs, chemicals, etc. get into the water?
  How and in which way?

  Answer: from people, animals, industry
- What happens to plastics in the environment?

  Answer: they are not degradable, but disintegrate and become smaller
- Where can plastics get into the environment?

  Answer: through littering
- How to prevent plastics from entering the seas and oceans?

  Answer: sea currents bring plastic pollution to the shore, some of which can be collected
- What can we do for our nature to get less polluted?

  Answer: prevention is the most important, that means that we do not pollute the environment around us, we do not litter, etc.

After the discussion, you can create together a map of one lake in the region of the pupils' country (you can draw any lake they know).

- The teacher draws a lake on the blackboard.
- The teacher asks the pupils – What are the pollutants in the lake? *(Pollutants can be: parts of plants, trees, grass, animal parts, feathers, fur, plastic cups, bottles, foils, bags, food leftovers, etc.)*
- Pupils then draw small pictures about the possible pollutants *(it can be anything the pupils think is polluting but you should check it before they draw it).* Pupils then fix the pictures of pollutants on the blackboard with magnet or tape.
- The map of micro-contaminants shows the origin of the pollution. Great emphasis should be placed on prevention and correct collection of waste.

After that, the teacher together with the pupils sum up the questions mentioned before again – what pollutants are, what they cause, what we should do for prevention, etc.

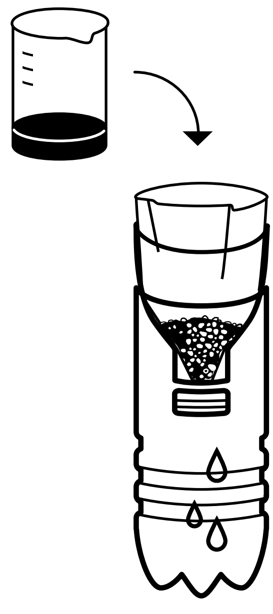
Activity 3

There are naturally occurring substances (e.g., sand, gravel, activated carbon, tuff…) that are able to bind pollutants in water due to their physicochemical properties, thus cleaning contaminated water. In many cases, however, the use of such filters is not sufficient, e.g., water used in the pharmaceutical industry must be of high purity, which means that no substance (e.g., salt or hardness ions) can occur outside the water molecules. Not only chemical purity but also biological purity should be taken care of. The water must not contain any bacteria or viruses. The water used for drinking water must not contain any harmful pathogens, which is why it is necessary to disinfect the water network.

How do you clean up dirty water? Not with dish soap! You need a filter material, a device that removes impurities, like dirt from water.

Experiment: Making a home water purifier with pupils

Alternative 1



Material: 2 plastic bottles, knife or scissors, coffee filter paper, spoon, filter material – sand, gravel and cotton or carbon

The water filter is prepared by hand (with adult help) using different filter materials (sand, activated carbon, etc.). What is the difference between the inlet and outlet water?

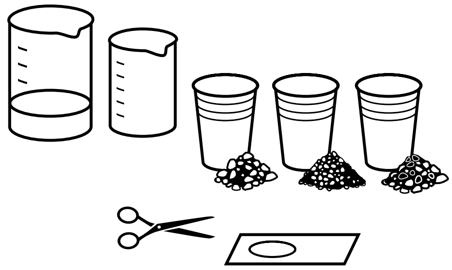
Step 1: Take the plastic bottle, cut it in half, turn the top of the bottle upside down.

Step 2: Put filter paper (or coffee filter) in the top.

Step 3: The filter material will be different, e.g., gravel, sand, (activated) carbon, etc.

Step 4: Pour dirty water (with sand and pollutants, parts of leaves, etc.) on the top of the sand or carbon, wait while it flows down. At the end the filtered water will be much cleaner than the original wastewater.

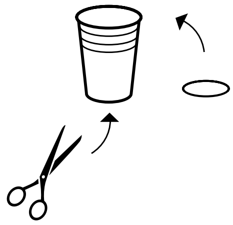
Alternative 2



Material: 1 plastic bottle, 3–4 filter cups, knife or scissors, coffee filter paper, spoon, filter material – sand, coarse and fine gravel, (activated) carbon (granules or powder, ground coffee beans)

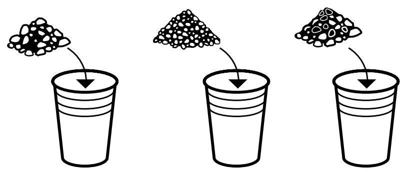
Step 1: Supplies for home water purifiers should be those that can be found in our home or environment. If you have plastic cups of different sizes, one of which can be inserted into the other without falling into it, it can also be used.

Step 2: The bottoms of the plastic cups are punched with scissors.



Step 3: The pierced cup is placed in a dotted glass and then rinsed filter material is inserted. It is recommended that the filter materials be washed thoroughly with clean water before use and then dried. The filter material may be: coarse gravel, fine gravel, sand, activated carbon granules, powder-based activated carbon, coffee beans.

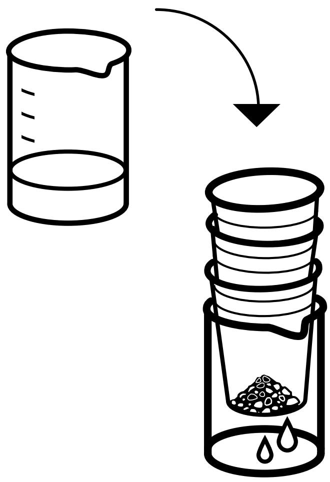
Step 4: The filter materials are layered in order of decreasing size. Below is the rough gravel, then the fine gravel, sand and granular activated carbon. It is worth making this assembly even without sand, because it is difficult to wash the sand so well that it does not pollute our water even more. If you want to work with coffee grounds, you need careful preparation. We need to wash the filter material with clean water several times. A filter paper layer is placed in the upper cup of the filter housings. The filter paper can be either a folded hand towel paper or a household filter paper, or a coffee filter.



Step 5: Dirty water is poured into our equipment. The contaminated water can be, e.g., puddle water. In the event that our water is discoloured, e.g., with beetroot or red wine, and activated carbon is used in our filter media, the colour is filtered out of the solution.

When working with transparent containers, we can compare contaminated and filtered water. If your device is not transparent, transfer the filtered water and contaminated water to a transparent container.

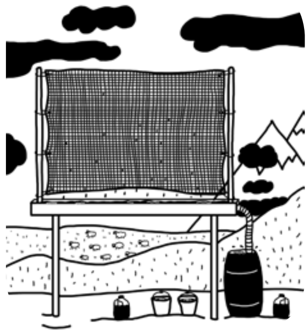
Step 6: Result: The water obtained is apparently pure but can be filled with bacteria so it is not suitable for drinking.



The teacher should sum up the experiment with pupils:

- What have they seen?
- How does it function?
- Why cannot they drink the water?
- How does it work in real water treatment? Why is it important?
- Etc.

Block 2:
Water and rainwater collection



Educational objective of block 2:

To learn about water harvesting/drainage systems in cities, how to support water saving in urban areas, possibilities and problems of water and rainwater collection, alternative new water harvesting methods around the world to show why it is important to keep green surfaces in cities from the point of view of water management.

Development of values and attitudes:

Through specific examples, they acquire critical thinking and problem-solving skills.

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	What happens to water/ rain in cities? The goal is to think about paths of water in the city, what kinds of water are available in cities and how it can be handled.	group work, motivational discussion	worksheets with questions and possible answers (Attachment 1), scissors	Cooperation, trying to find the right answers	15 min	5 min – print Attachment 1.
2	Use of rainwater and greywater. Searching for differences and possibilities in water saving and reuse	motivational discussion	glass of dirty surface water, glass of water collected from the tap after hand-washing with soap and glass of clean tap water, pictures with greywater and rainwater (Attachments 2 and 3)	Discussion and argumentation about the importance of water saving and reuse	10–15 min	30 min – Bring three glasses with different types of water (see column Educational aids), print or show pictures from Attachments 2 and 3.
3	Alternative water harvesting possibilities from around the world are presented to show how hard it is to collect water where not enough is available.	discussion, small experiment	pupils work in pairs, picture from Attachment 4, pieces of towel from different materials (cotton and synthetic), glass of water	To see how much water can be collected with a piece of towel	15–20 min	30 min – Print Attachment 4 for pupils in pairs, cut about 40 × 40 cm piece of cotton and synthetic materials, 2 glasses of water, a tray for each pair

Activity 1

With the pupils together talk about different water types, water harvesting and possible wastewater collection and treatment possibilities in cities.

The class is divided into 3 groups; each group gets one question (Attachment 1). They have to think it through for 5 minutes, then they talk and explain what they think – which answers are right or wrong (in each group the answers can be all right, all wrong, or mixed). You can see the right answers below.

The questions with right answers are as follows:

Question 1: *Where do we get water from in cities?*

a) *from the tap*

Right: Tap water can originate from surface or groundwater, go through a purification system, and then people (consumers) get it through the tap in the household or in a public space. For drinking purposes, we can use tap water, but it has to be clean, free from harmful materials.

Surface water can be from, e.g., rivers, lakes or even the sea. Groundwater can be water from different wells. Both of them are originally clean but need some treatment technology steps (so we do not get sick).

b) *from the rivers/lakes/canal*

Right: It is not recommended to drink directly from surface waters because people can get different diseases, but they can be used for watering plants, parks, or flushing toilets.

c) *in case of rain we can harvest it*

Right: We can collect rainwater in the household. Just like groundwater it is originally clean but it washes different pollutants out of the air. It can also be polluted from the collection system so without purification and disinfection it is not recommended to drink it. It can be also used as surface water, e.g., for watering plants.

Question 2: *How can we use water types in cities (rainwater, tap water)?*

a) *we can drink rainwater and tap water without any further treatment*

Wrong: Tap water is supplied in cities and different settlements, it can be used for personal consumption – drinking, washing, cooking, for cleaning purposes (shower, bath) and the flushing of toilets. Indoor tap water is distributed through indoor plumbing, which has existed since antiquity but was available to very few people until the second half of the 19th century, when it began to spread in popularity in what are now developed countries. It always has to be proper for drinking purposes (see Question 1, answer a), it has to be clean, we can consume it in Europe. Although usually it is potable, different water quality problems are possible (which do not have health effects). Household water treatment systems are available for this (European Union, 2010): these can be, e.g., water filter jugs, or water filters under the sink.

Rainwater is not that clean (see Question 1, answer c); it cannot be consumed without further treatment.

b) *separate rainwater collection is good for watering plants, can be used for irrigation of parks, gardens, and also it can be applied in fountains*

Right: Rainwater can be collected separately in the households and also in cities. In the case of household collection, we can keep it in different water containers, from where it can be used as irrigation water. If the house is built with divided water collection systems, then rainwater can be used as greywater: typically it can be used for flushing the toilet or in the garden.

In cities we have to approach the problem from two points of view: using rainwater, and treatment of wastewater (originating from rainwater).

- Rainwater can also be collected and used in public buildings and parks, it can be used for irrigation, or can be applied in fountains.
- As for wastewater treatment systems: in the case of heavy rains or storms, it is very useful to have a separated wastewater collection system because this wastewater contains pollutants at much lower concentrations, so it is easier to purify it.

c) *tap water can be used anywhere without limits for any purposes*

Wrong: tap water can be used for personal consumption, personal hygiene, gardening, etc. But there are areas of the industry where tap water is not clean enough, and needs further purification steps. This can be, e.g., pharmaceutical industry, power plants, etc., where very stringent regulation is necessary.

Question 3: *What happens to rainwater and used water (waste water) in the city?*

a) *all water is discharged into the fields*

Wrong: All of the wastewater has to be treated and then discharged to receiving surface waters, reservoirs; usually it is not discharged into the fields. The treated water has to meet different, strict quality parameters which are checked regularly. In the case of separate rainwater collection systems in the city the treatment is much simpler, and can be used in the fields for watering purposes, but not all of the treated wastewater can be discharged into the fields.

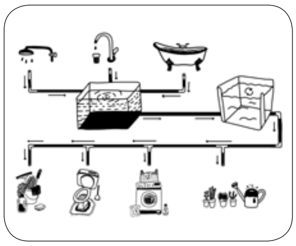
b) *water is collected and treated in wastewater treatment plants*

Right: Most of the water gets into the sewer system, which can be found everywhere in cities. In the sewer system, household wastewater, industrial wastewater, and sometimes rainwater is mixed. If the system is separated, then rainwater is collected separately, and only wastewater is treated in a multi-step wastewater treatment system. The effluent (purified water, but still not appropriate for consumption) of this treatment is discharged into the environment through a surface watercourse. The by-product of the system is further treated and then the sludge is used in the land or has to be disposed of.

c) *rainwater is always collected separately and household/office wastewater is treated separately*

Wrong: Unfortunately, a separated wastewater sewer system does not exist in each city. In many cities and towns, combined sewer systems can be found, where the relatively clean rainwater is mixed with the heavily contaminated household or industrial wastewater. This way the wastewater volume is much greater and also the treatment costs are higher.

Activity 2



The teacher has three different glasses of water (surface, after hand-washing, tap water) and two pictures (Attachments 2 and 3) to support pupils' imagination and illustrate the topic.

The class is divided into two groups; each group gets one picture:

- Group 1: picture of rainwater (Attachment 2),
- Group 2: picture of greywater (Attachment 3).

The teacher first shows the pupils the tap water, then the clean surface water (model for rainwater) and the water after hand-washing (model for greywater). They have 5–10 minutes to understand the picture and then each group presents the other group what they have found out. Then, they can discuss what their pictures have in common.
The teacher facilitates the process and tells pupils the names of the water: rainwater, greywater and also discuss with the pupils why it is good to use these types of water for some activities.

Tip: You can also show the pictures from Attachments 2 and 3 on the projector.

Activity 3

In several parts of the world, people are not as lucky as to have surface or groundwater from which drinking water can easily be extracted. They can alternatively harvest water from the air. The air contains water everywhere, at different concentrations.

The activity starts with the basic question to pupils: *What do we call it if there is water in the air?* Right answers are: *fog, frost, rime, rain, snow, sleet* (mixture of snow and rain). If the air is humid, people can also feel it, but even if we do not feel it, there is still some water in the air, even in the deserts.

Show pupils the picture from Attachment 4.
In the picture you can see how water is collected from the air. They use a large mesh of tight material (usually polyethylene), which collects fog droplets and should be wind-resistant. On 1 m² it can produce 3–15 litres in one day; usually they are 30 m² large, so one family can get 100–450 litres of water in one day.

It works more effectively if:

- it is close to lakes or the sea,
- it is at least 1000 m above sea level,
- there is at least 90 days of fog precipitation per year,
- there is wind with the fog so the air can blow through it.

You can continue with the experiment:

Step 1: Stretch the piece (40 × 40 cm) of material and pour 0.1 dl water on the natural cotton.

Step 2: After that, pour the same amount on the plastic material.

Discuss: Which of the materials keeps more water inside it?

Experience: This is also how fog collection works – the small water particles from the air condensate on the fabric and stay in it until it flows down from the material (towel). Natural cotton keeps more water, while the plastic material can hold less water.

Note: This experiment needs some cleaning as the water may be on the floor.

Block 3:
Water and hygiene

Educational objective of block 3:

Unfold the connection of water security and healthcare in urban areas

Development of values and attitudes:

Self-interest in the preservation of good water quality

Part	Activity and its goal	Teaching method	Educational aids	Motivational elements	Time	Preparation in advance
1	Importance of hygiene is demonstrated using a simulation game. The goal of the activity is to show the importance of hand washing as a basic preventive solution. Diseases can spread quickly. Based on discussion, pupils know that water and sewage management are key aspects of healthcare problems.	Simulation	Toothpaste/baby powder/magnesium for climbing/chalk powder	Playing simulative game makes the demonstration of disease spreading much easier.	20 min	5 min – Bring educational aids.
2	Viruses and bacteria are not the same. Bacteria help us sometimes, while viruses have only negative impacts on the body. Also the treatment differs. This content will be covered using video and discussion.	Dialogue, Watching a short film	Video, picture from Attachment 5	Using pupils' experience and discovering the real process	10–15 min	5 min – Find/prepare a video and picture from Attachment 5
3	Hygiene is not only about water. Hygiene is a complex process linked to causes, consequences, solutions and the environment. The goal of this activity is to summarize the basic hygiene rules in the form of pictures for younger schoolmates.	Dialogue, drawing, creating a product	Paper, pencils, etc.	Activity is on the side of the pupils, they can draw as they fancy.	15–45 min	5 min – Papers, pencils and other materials for pupils (they may have their own)

Activity 1

Good hygiene practices are very important in preventing the spread of different diseases. The basic is hand washing. In some parts of the world, the level of hygiene is still very low. This state is mostly connected with access to water, because water is very important in hygiene.

Game

With this game, it is possible to demonstrate the spread of bacteria and viruses and the spread of non-hygienic processes.

Step 1: Somebody brushes his hands with dirt. This dirt represents virus. It could be done with toothpaste; therefore, it could be good to use gloves. You can also use baby powder, magnesium for climbing or chalk powder as a "virus".

Step 2: The one with the "virus" on his hands then does his job: catches the handle, touches the table, holds the pencil, shakes hands with his friend, etc.

Step 3: Everybody touched by the pupil with virus – also having the "virus" on his hand after the handshake – is then also doing the same job (Steps 1 and 2). It means doing the same things that the first one did and also shaking hands with others, and also the other pupils in the room continue to do it.

End of the game: The "virus" is very quickly in the whole class.

If you play the game without gloves, it is necessary to count with more time for the washing.

The result of the game shall be further discussed with pupils using question such as, How to face the spreading? What can we do to avoid such situations? How to protect ourselves? Etc.

Additional activity: The teacher discusses with pupils the hygiene situation in the world – water-related urban and rural diseases and healthcare problems to emphasize the importance of water and sewage management.

Activity 2

The experience gained in Activity 1 can be further developed using film watching. Many YouTube videos are focused on the spreading process in a more theoretical way. In this context, it is also important to explain differences between viruses and bacteria.

As an input, use video (e.g., **https://www.youtube.com/watch?v=O7iaPos8a90**) and the picture from Attachment 5. Continue with discussion based on pupils' current knowledge. In the next step, develop their knowledge of new facts.

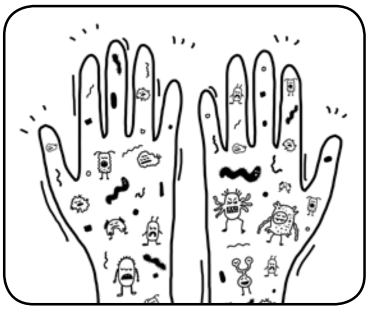
As is written in the introduction, many contaminants are invisible. Ask pupils for examples, what is going on in their minds? Have they ever heard of viruses and bacteria?

Most pupils know that viruses and bacteria are invisible, they occur almost everywhere, and they can name many diseases. They come in many varieties; many of them already existed when there were no bigger creatures on Earth. But how do they differ if they produce diseases with similar symptoms?

When we hear about viruses and bacteria, pupils usually think of bad things, infections and illnesses. Do you have an idea of how many bacteria live in our body? We can say that 1–3 kg of bacteria live in an average human body, but they are also beneficial. Would you have thought that more than ten times as many bacteria in your body live as many cells in your body? And at any given moment, more bacteria are moving in a single person than there have ever been people on Earth?

The first thing to hear is that bacteria are usually said to spread diseases. The massive bacterial army bustling in our body is mostly not against us, but is really essential for the healthy functioning of our body: for example, it helps digestion, plays a role in detoxifying the body, and participates in the production of immune substances. While bacteria also have a beneficial effect, viruses only have negative impacts on the body.

The difference between bacteria and viruses is also crucial in defending them. While outside the body, general hygiene requirements apply: we wash or disinfect hands. However, we cannot acidify or burn the pathogen once inside the body: we have to attack it specifically. In the event of bacteria, we can do this with antibiotics that destroy the pathogens. However, in contrast to bacteria, drugs are mostly ineffective against viruses, with only agents that interact with the host cell and the virus.



Activity 3

The topic of hygiene can by defined by many proper words such as: viruses, bacteria, hand washing, brushing, soap, clean, vomiting, health, body, microbes, prevent, ill, dirt, pure, safe. You can start this activity with sorting of words into different categories, e.g., causes, consequences, solutions, environment, processes.

You can easily find the connection between hygiene processes and a healthy life. The teacher presents pupils with the hygiene rules.

Hand washing is only the basic rule, which is connected with washing hands after going to the toilet, before preparing food or before eating food. The other important ones are:

- washing the body every day,
- brushing teeth,
- changing and washing clothes,
- etc.

In context of hygiene rules, there are also lots of self-care mistakes. You can find many videos where these mistakes are explained.
You can watch, e.g., https://www.youtube.com/watch?v=AyZ6LjDLe14.

This video mentions the 7 most common mistakes:
Covering your mouth with your hand when coughing, clipping your fingernails, lining your lower eyelashes on the inside, picking your nose, washing with shower gel every day, using too much toothpaste, using too much hair balm.

Part of this activity is Call for Action. Pupils take a piece of paper and work individually or in groups. The task is to paint pictures or create collages or other types of art that illustrate different hygiene rules. The target group are younger schoolmates, who cannot read any text. What can pupils do for their health? The form of results depends on time you provide pupils for creative activity.

The results can be placed in corridors or used in other forms to raise awareness of all pupils in the school about hygiene.

Attachment 1

Question 1: *Where do we get water from in cities?*

a) *from the tap*

b) *from the rivers/lakes/canal*

c) *in the case of rain we can harvest it*

Question 2: *How can we use water types in cities (rainwater, tap water)?*

a) *we can drink rainwater and tap water without any further treatment*

b) *separate rainwater collection is good for water plants, can be used for irrigation of parks, gardens, and it can also be applied in fountains*

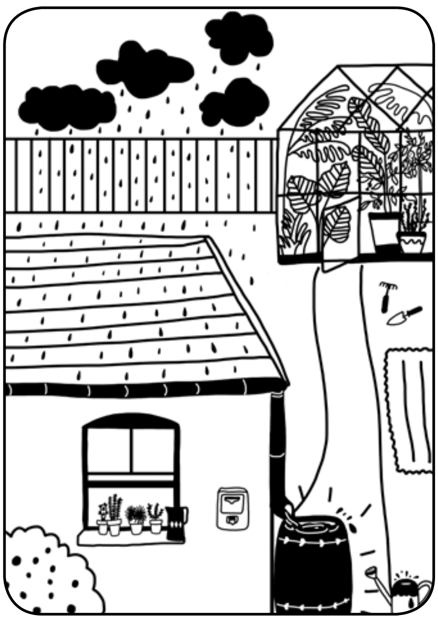
c) *can be used anywhere without limits for any purposes*

Question 3: *What happens to rainwater and used water (tap water) in the city?*

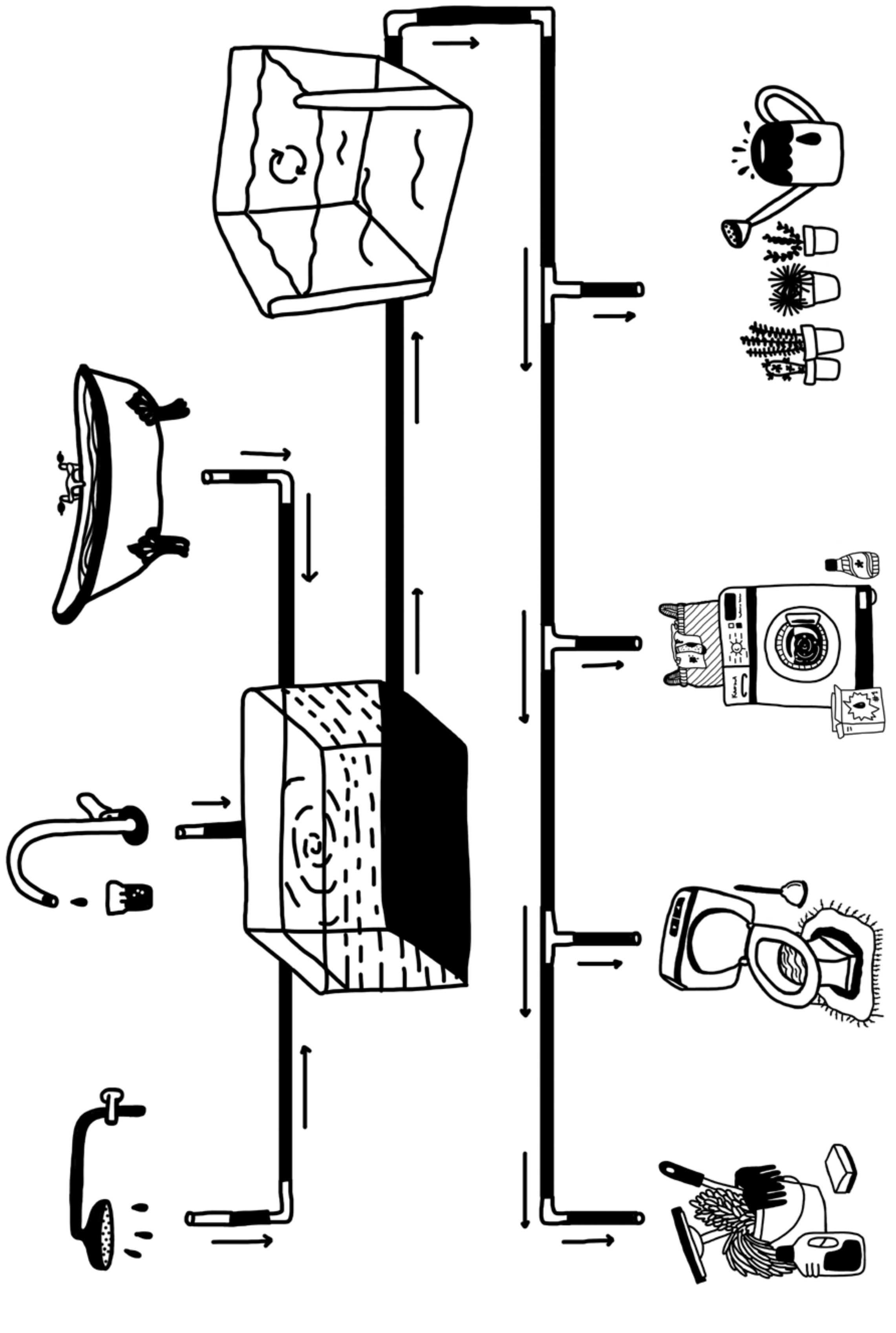
a) *all water is discharged into the fields*

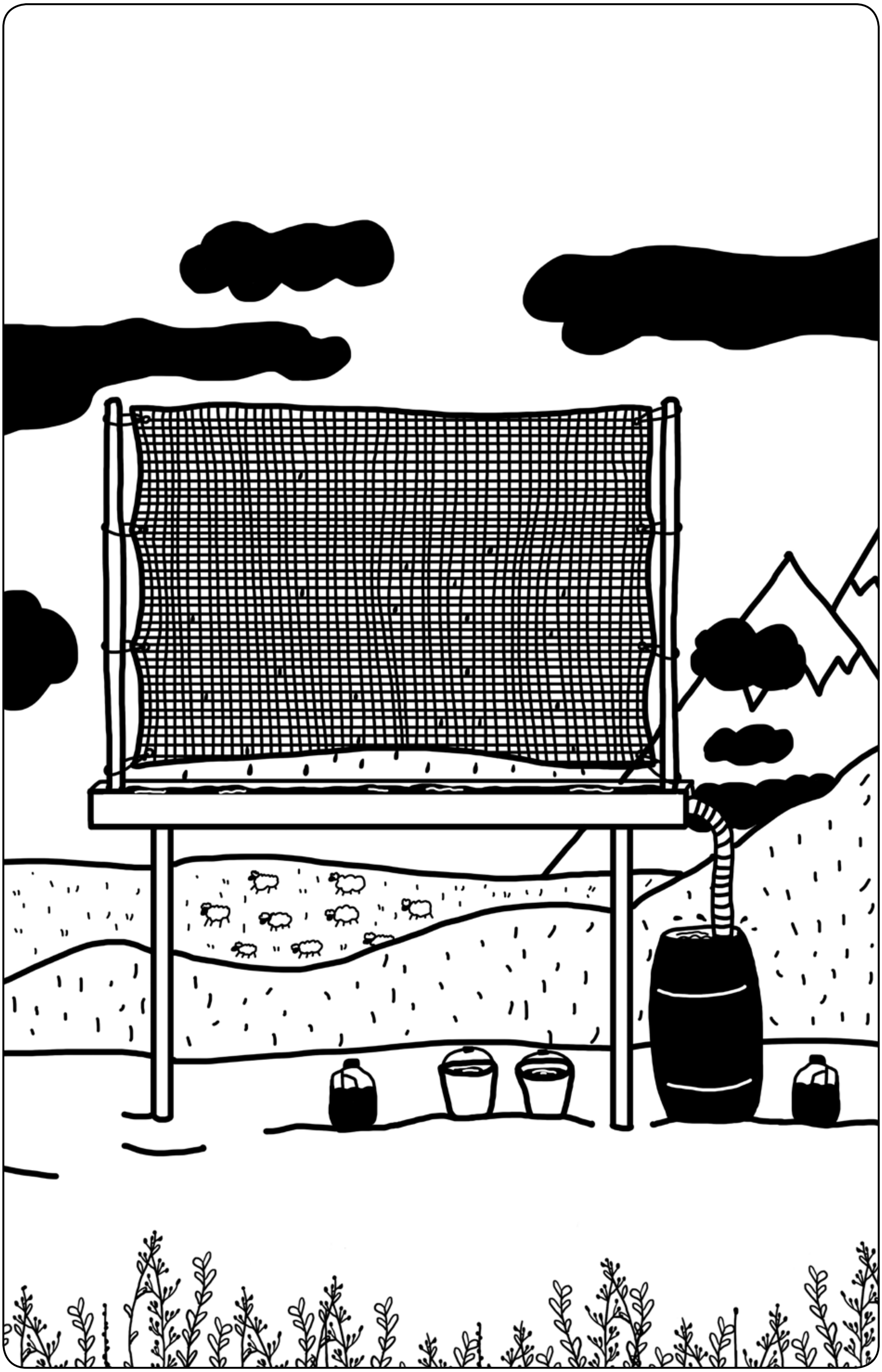
b) *water is collected and treated in wastewater treatment plants*

c) *rainwater can be collected separately and household/office wastewater is treated separately*

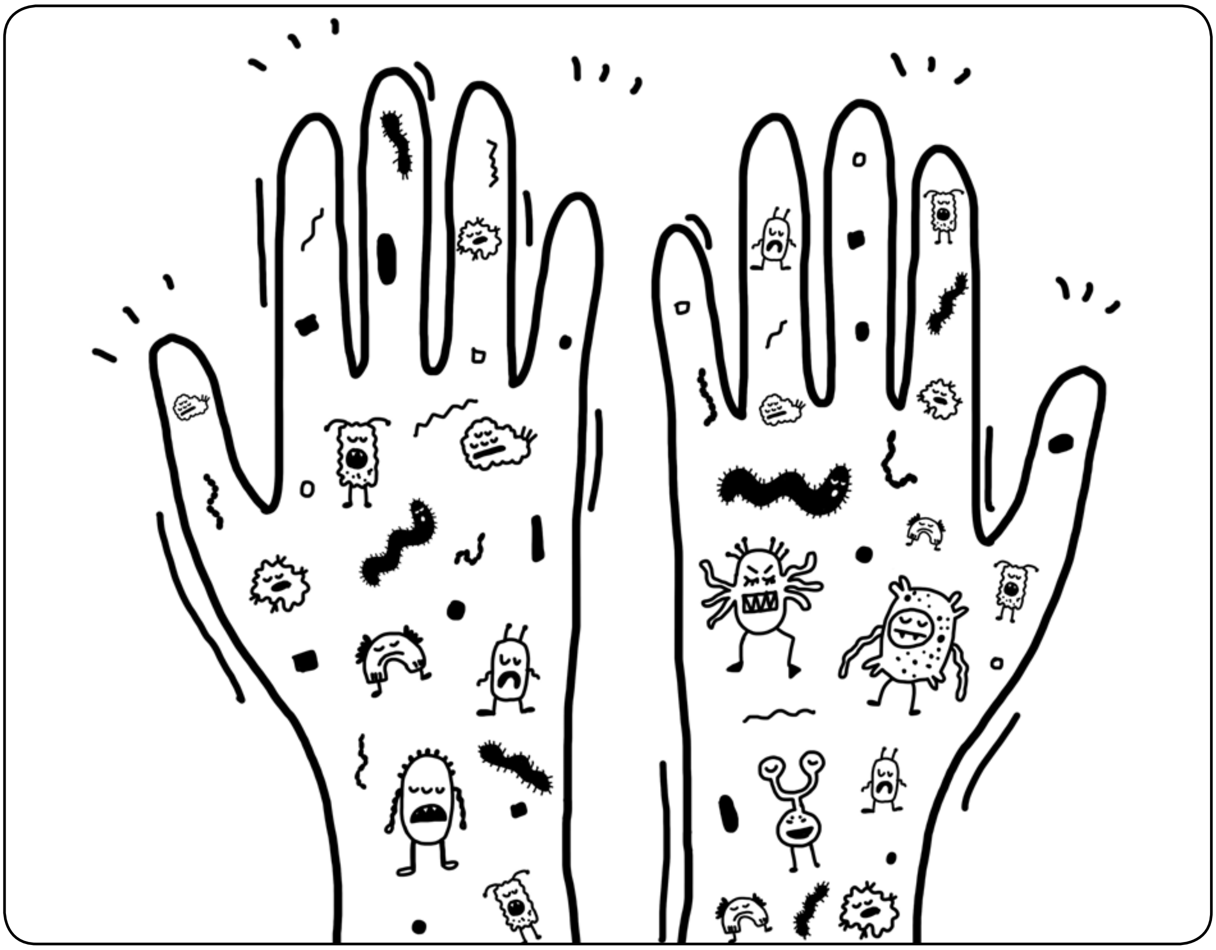


Attachment 3





Attachment 5



Water and cooperation: Two games

As a concluding and crosscutting activity we have prepared two games for you and your class. Both games should convey the same message to the children: "Cooperation matters". The key message is also part of the name of the first game.

Game 1: Drought in the city — Cooperation matters!

City residents obviously face two basic problems connected with water. A situation where there is too much water – that means floods. On the contrary, the other situation represents drought. In both cases technical solutions solve the problem only partly. Cooperation of local people plays an important role.

The first game simulates the situation in a village or a small town affected by drought. Without cooperation, the amount of water in a water reservoir will be used much faster than in the case of responsible consumption.

The game takes 45–90 minutes; the duration depends on the time provided for discussion and on pupils' behaviour during the game. If they are already responsible, then the game lasts a bit longer. The pupils play the role of families which consume water for different purposes. They decide whether they need a certain volume of water or not. Their behaviour influences the amount of water in a common reservoir and the thus the period in which the town's residents can survive with only their own water resources.

The game consists of two rounds plus one optional round. You can find the rules below. What is important to know before you play it:

The aim of the first round is to make children experience how quickly they can run out of water or that they really can run out of it if they behave irresponsibly. So, you should not talk so much about saving water before the first round, and do not stress the water situation in the city more than is necessary. Of course, they will have some information from the introduction to the game, but it is important that they run out of water relatively quickly in the first round. It makes a good basis for the second round. Therefore, the groups are not allowed to communicate with one another in the first round. The consumption is discussed only within each group.

When pupils run out of water, it opens a space for discussion – why has one group saved and another wasted so much? How to save the water longer next round?

The aim of the second round is to survive longer with the same amount of water. In the second round, the groups can communicate, cooperate, agree on a consumption limit, etc. They should be able to play longer with the same amount of water thanks to their cooperation and responsible behaviour. In the rules, you can find out when to stop the game. But remember that they should succeed in the second round. (If they do not succeed, please discuss with them what happened, why cooperation did not work, etc.)

To conclude: It is necessary to discuss the differences between the two rounds with the pupils:

- What made the difference?
- Why did they survive longer?
- What helped?
- How did they save water?
- What have they learnt from it?
- Etc.

Optional round: You can also add an optional round, which is mainly a discussion about the savings and behaviour during the drought. What are other possibilities to save water besides those used in the game?

When you use this game, it is necessary to think about your class in advance: How may the pupils behave during the game? What could the experience of playing it give them?
This game is a highly suitable tool for every class to motivate pupils for the topic, to show them its importance, to conclude the knowledge from the modules and to discuss a lot of things connected to the topic of water (e.g., different behaviour of each group during the game and its consequences or analogies in reality, efficiency of cooperation in the second round and in reality, other possibilities for savings, etc.). However, it all depends a lot on your class – if your pupils are responsible or not. It will influence the game process and it is up to you as an educator to work with it in the class:

- If you know that your pupils are very responsible, it is important to think about using the game. Maybe the first round will take very long and there will be no time for the second round. It does not matter that much. You can also start a discussion – for example, about the different behaviours of each group (some saved water, some wasted it, why, what did it mean for the game and reality), etc.
- In the case of a responsible class, you can also adjust the game by reducing the amount of water in the town reservoir or in their own reservoirs.
- If you know your class does not take water scarcity and drought seriously, this is a very good tool for working with pupils' attitudes to water. Pupils can really experience the consequences of irresponsible behaviour in this game and change their mind.
- Very often, you will have a group in the game that will save water and another group that will waste it. It is important to be prepared to facilitate this discussion with respect. It should lead to the conclusion that we all need water equally and so we are equally responsible for it.
- Be careful: the aim of the game is not to punish someone who has wasted water. It is about simulation of a drought situation, which some villages in our countries have already faced in the recent years. The aim is to raise awareness and to emphasise the role of cooperation and sharing of resources.

Tip: Write the most important rules of the game on the blackboard so the pupils can see them anytime while playing.

Introduction for pupils:
The game is set during one hot summer. Players find themselves in a small town which is situated in the mountains. There is a small river close to the town in which water flows only in the ice-melting period and during rains; otherwise, the river is dry. The only year-long source of water is an underground water reservoir which is supplied by groundwater. But this summer is unusual: there have been no good rains so far. The water level in the reservoir is falling but citizens have no fear. The reservoir has never been full, and they have survived. Sometimes there came a small rain and some amount of water was refilled. But this year has been hot for many summer weeks, the temperature is rising, and no one can survive without water…

Game rules:

At the beginning of the game, the class is divided into five teams (each team represents one household). After that each team is given five cards with different types of consumption, which can be found in Attachment 1 (1 × Necessary, 2 × Usual, 2 × Bonus), a water consumption sheet from Attachment 2 (on which the teacher marks consumed water each time the team goes to get water) and money from Attachment 3 (12 × banknote with the value of 50, 13 × banknote with the value of 20, 9 × banknote with the value of 10). The teacher prepares the town reservoir, which can be projected from MS Excel and fields are coloured as water is consumed, or it can be printed out and the teacher crosses out fields as water is consumed and shows it to pupils after each round, or the teacher can draw the reservoir on the blackboard. A possible execution of the chart is in Attachment 4. It depends on the teacher and the technical equipment of the venue where the game is being played. Attachments 2 and 4 have to be printed again for each new game.

The game contains 5 cards which show different reasons for water consumption. **Necessary** (60 litres) consumption includes water needed for survival. The other two consumption items show **usual consumption**, which can be limited if needed: Bath (30 L, additional consumption beyond showering) and Washing machine (30 L). The last two consumption items represent **bonus consumption**, which is connected to filling the family pool (150 L) or regular watering of the garden lawn (30 L). These purposes express something above the standard.

The game begins in a situation with 3000 L of water in the reservoir. The same situation applies to the second round. For the sake of simplicity and to avoid big numbers, each household consists of one member. With this simplification it is not necessary to recalculate the types of consumption based on team members, or more precisely, household members. Each type of consumption is counted only once in every round.

The game should be played twice and different rules are applied during the first play than in the second play. The rules and the differences are described below. A recommended third game is not another play but discussion on what can be changed in order to extend the survival time with the town reservoir.

First game:

Before the beginning of the first game, the teacher announces that communication is possible only within each team and communication with other teams is prohibited. In the first game, pupils should not be able to agree on any tactic. Teams are told that they should consume at their own discretion and needs. They should consume water for things they consider appropriate. The game is based on a situation in which only one water source is available.

In each round, each team chooses which types of consumption cards they want to use with the following restrictions:

- The necessary water consumption has to be used. You cannot survive without water, it is necessary for drinking, basic hygiene, cooking, etc.
- **Both kinds of the usual consumption cards can be used only once every two rounds** (two days; most people do not use the washing machine or take a bath every day) and can be used at the same time. If they are used at the same time, the next round the team cannot use the usual consumption cards at all. It is good to mark in which round the team used a specific card of usual consumption. For example, write the round number next to the usual consumption used on the water consumption sheet so no one gets lost on when they used the usual consumption.
- The swimming pool is one of the bonus consumptions and can be used only once every three rounds. As with the usual consumption, it is good to write the round in which the pool was used on the water consumption sheet.

After each team chooses how to use the water (which kind of consumption to use), one representative goes to the teacher's desk. He/she takes the consumption cards that their team wants to use, the money needed for buying the water (the water and the money are in a 1 : 1 proportion – for necessary consumption of 60 L you have to pay 60, for 150 L you have to pay 150) and the water consumption sheet where the teacher writes down (from left to right) how much water they used in this round, how much they used for each consumption and if they used some water from their own water source. It is good to explain that money used for water cannot be used for other purposes.

Teams can use their own water source with a volume of 210 L. Water from this source can be used in multiples of 30 L. When a team wants to use its own water source, they simply bring less money – they will lower the cost by the amount of water used from their own water source. In a situation where a team wants to use some consumption cards and does not have enough money and does not have enough water in their water source, there are two solutions: the first is to bring more money and pay for the consumption, the second is to lose one bonus/usual consumption card.

After each round (in which teams choose how much water they use and how they use it), the teacher calculates how much water is left in the town reservoir and tells the pupils.

The game continues until all the water in the town reservoir is consumed (it should not take that long because if everyone uses a lot of water it will be quickly gone). A situation that is most likely to happen is that a team goes to get water and there is not enough water in the reservoir to meet all their consumption needs. In this situation, the team satisfies its necessary consumption and other consumption if there is enough water for it and the game ends (some teams lose the opportunity to buy water). The game also ends in case there is some water in the reservoir but not enough for the next team's necessary consumption.

End of the game: At the end, the water consumption sheets are compared – which team used the highest amount of water and for what purposes. This should followed by an analysis why they were able to survive only for this long.

Second game:

The second game goes in the same way as the first one, only with the below changes:

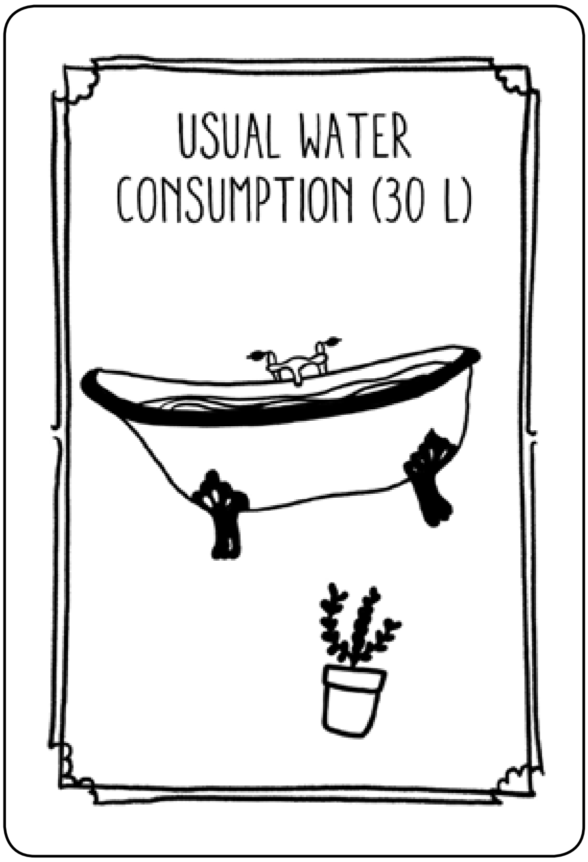
- At the beginning, tell the pupils that they can discuss some strategies for how to survive droughts without consuming all the water.
- New possibilities are added for this purpose – "Ordinances". Ordinances set water limits for teams which "cannot" be exceeded in that round (there are four limits: 240 L, 120 L, 90 L, 60 L, and the teacher prints them for pupils or projects them; see Attachment 5). These limits should help teams to not exceed a threshold, of course someone can exceed this threshold and that is cause for inspection to come. At the end of each round, the teacher rolls one six-sided die and if he rolls one, the inspection comes. When the next round starts and teams come to get water, the teacher looks at the amount of water consumed (in the leftmost column); if the amount has exceeded the limit set by the ordinance, the team has to pay a fine of 50 money. The fine is paid in the next round when choosing and paying for the consumption.
- At this moment, it is important to show an effort to save water and the teacher can end the game if the teams have survived more rounds than in the first game but if the next round would exhaust the town reservoir (in the first game they survived for four rounds, in the second game they are in their sixth round and the water would be depleted in the seventh round, so the teacher can end the game and the teams win the game).

The end of the game includes the same comparison as after the first game. It is good to compare the first and second games – what they did differently and where they saved water.

The goal is to show that cooperation and coordination of activities including experience from the past have a big impact on solving problems such as droughts and water shortages.

Third game (voluntary activity):

The game is not played again; instead, pupils discuss together with the teacher what to do in the case of drought and what other possibilities could be added to the game so that the water lasts longer. Pupils can be creative and think of other elements for the game that would lead to greater savings.

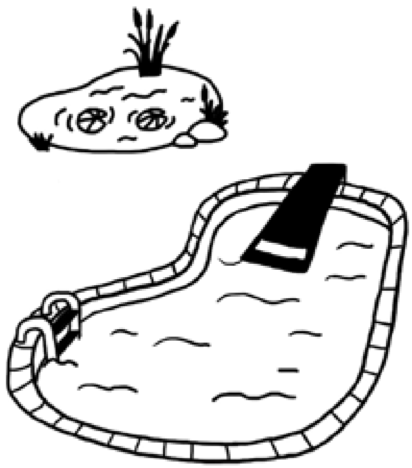

USUAL WATER
CONSUMPTION (30 L)


NECESSARY WATER
CONSUMPTION (60 L)


USUAL WATER
CONSUMPTION (30 L)

BONUS WATER
CONSUMPTION (30 L)

BONUS WATER
CONSUMPTION (150 L)



Attachment 2

Water consumption sheet

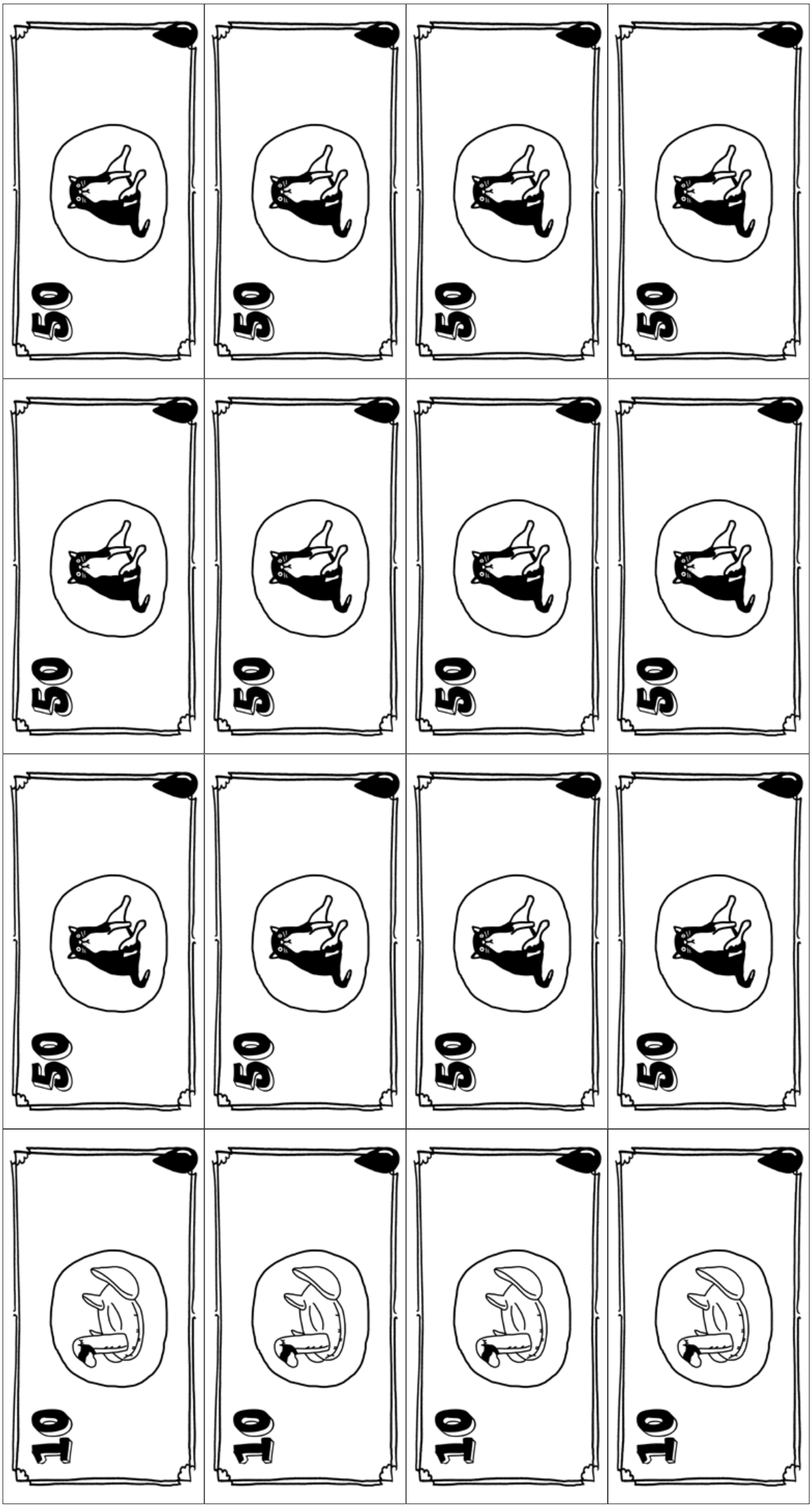
Team:

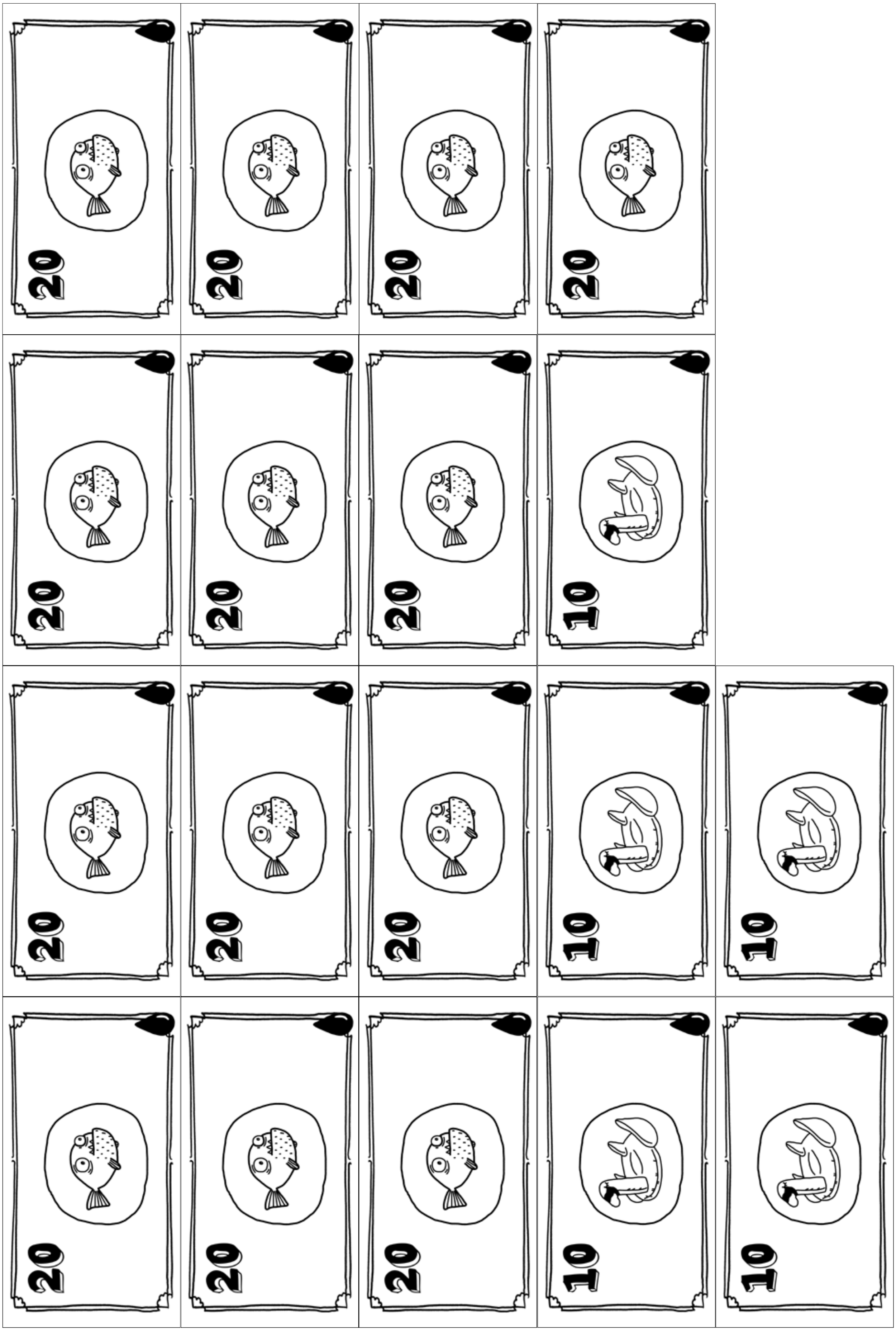
	Consumption per round
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	

	Necessary	Usual – Washing machine	Usual – Bath	Bonus – Garden	Bonus – Pool
600					
570					
540					
510					
480					
450					
420					
390					
360					
330					
300					
270					
240					
210					
180					
150					
120					
90					
60					
30					

Own reservoir
210
180
150
120
90
60
30

Attachment 3




20
20
20
20
20
20
20
10
20
20
20
10
10
20
20
20
10
10

Attachment 4

4000									

3000									

2000									

1000									

Attachment 5

	Water limit assessment:	Check when ordinance is in effect:	Fine when you are caught:
1.	Limit of < 240 L	Roll: 1	50
2.	Limit of < 120 L		
3.	Limit of < 90 L		
4.	Limit of < 60 L		

	Water limit assessment:	Check when ordinance is in effect:	Fine when you are caught:
1.	Limit of < 240 L	Roll: 1	50
2.	Limit of < 120 L		
3.	Limit of < 90 L		
4.	Limit of < 60 L		

	Water limit assessment:	Check when ordinance is in effect:	Fine when you are caught:
1.	Limit of < 240 L	Roll: 1	50
2.	Limit of < 120 L		
3.	Limit of < 90 L		
4.	Limit of < 60 L		

	Water limit assessment:	Check when ordinance is in effect:	Fine when you are caught:
1.	Limit of < 240 L	Roll: 1	50
2.	Limit of < 120 L		
3.	Limit of < 90 L		
4.	Limit of < 60 L		

	Water limit assessment:	Check when ordinance is in effect:	Fine when you are caught:
1.	Limit of < 240 L	Roll: 1	50
2.	Limit of < 120 L		
3.	Limit of < 90 L		
4.	Limit of < 60 L		

Game 2: Don't lose a drop

This game can be used to support not only cooperation in the field of water but also cooperation in the class.

You will need:

- a glass of water
- strings
- rubber bands

The aim of the game: Pupils should work together and move the glass of water from one place to another without touching the glass and without pouring water out of it.

Information for the teacher:

- You can choose and mark a start and a finish anywhere in the class or outside. The distance should be realistic.
- The pupils should use rubber bands to fasten strings to the glass and then use the strings to carry the glass. It means they will stand around the glass holding the strings and carry the glass together with the help of the strings to the set finish line.
- It is important to think about the level of cooperation in the class before you do this. If you think it is necessary, divide roles, help them with the task, etc. If you think they could argue a lot, you should be prepared enough to facilitate it or if you think they are not ready for it you should not do this activity with them. Otherwise, it could discourage them from the cooperation, which would be counter-productive.

After the activity: Please remember to discuss and reflect the experience with the pupils:

- How did it go?
- What have they learnt from it?
- How was the cooperation? What worked? What did not work? Why?
- Why did they play it? What have they found out?
- What is the connection with the topic of water?
- Why is cooperation important (in life, in water-related issues, etc.)?

The conclusion is of course up to your class but it should be close to the topic "Cooperation matters". When we talk about water, it is in fact necessary.

Note: If you want, you can make more groups and make them compete in this task. But do not forget to emphasize cooperation again and discuss things such as why one group made it and the other one did not, what helped the group to finish the task, etc.

Glossary

Bacteria – infections are caused by bacteria

Biological water – water included in living organisms such as plants and animals

Brackish water – salt water, usually a mixture of seawater and freshwater

Condensation – the process by which a vapour becomes a liquid

CTI – Community Temperature Index: a measure of the rate of change in community composition in response to temperature change

Drinking water – water that is proper and safe for human consumption

Ecohydrology – an integrative science that focuses on the interaction between hydrology and biota. It seeks to reinforce ecosystem services in modified landscapes to reduce anthropogenic impacts. Holistic approaches that manage hydrology and biota aiming to achieve sustainability in both ecosystems and human population and improve integrated water resource management

Ecosystem – a community held together by complex interactions between the biotic (living elements such as plants, animals and organisms) and abiotic (such as soil, water, air, sunlight and climate) factors in a given area

Effluent – water contaminated by sewage

Estuary – an area where a river meets a sea or an ocean, typically with brackish water

Eutrophication – an excessive plant and algal growth due to the increased availability of one or more growth-limiting factors needed for photosynthesis, such as sunlight, carbon dioxide, and nutrient fertilizers

Evaporation – conversion of a liquid into a vapour

Evapotranspiration – a mechanism for maintaining the upward capillary flow of water in plants from the soil to the canopy, controlled primarily by atmospheric vapour pressure deficit and solar radiation

Filter media – various materials used for water purification, e.g., active coal, gravel, sand etc.

Flowing water – any kind of moving water, such as a run, creek, brook, river, spring, channel or stream; a lotic ecosystem

Greywater – domestic wastewater besides wastewater containing human feces (originating in the household from sinks, bath, shower, washing machines, etc.)

Groundwater – water beneath the surface of the earth, which is in direct contact with the geological medium

Hydromorphology – the physical characteristics of the shape, boundaries and content of a water body; the term is used in river basin management to describe the hydrological and geomorphological processes

Hygiene – activities to maintain health, e.g., hand washing

Integrated water resource management – a process which promotes coordinated development and management of water, land and related resources, in order to maximize the resulting economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

Micropollutant/microcontaminant – organic and inorganic pollutants that occur in nature in micro-quantities

Mouth – the end of a river where it flows into the sea, another river or a lake

Nature-based solutions for water – solutions inspired and supported by nature that use or mimic natural processes to contribute to improved management of water

Rainwater – water originating from rain, which can be collected

Rainwater harvesting – collecting rainwater for different uses, e.g., for irrigation

River basin – a large area of land (hills, valleys and lakes) that drains into a large river

River basin land use – human activities such as farms, towns and industry in the river basin

Sanitation – reduction in the number of microbes in objects and the environment by means of detergents

Source – the start of a river; a spring on a hillside, a lake, a bog or marsh. A river may have more than one source

Surface water – water on the surface of the planet such as rivers, lakes, oceans

Still water – a body of standing water, ranging from ditches, seeps, ponds and seasonal pools to basin marshes and lakes; a lentic ecosystem

Tap water – purified water which can we generated from surface water or groundwater using various treatment methods

Transpiration – water absorbed by plants is evaporated into the atmosphere mostly via leaves

Viruses – small microbes which can infect different organisms, causing illnesses

Wastewater – polluted waters produced by various uses

Wastewater treatment – various technological solutions for cleaning contaminated water

Water cycle (or hydrologic cycle) – the paths water takes through its various states – vapour, liquid and solid – as it moves throughout Earth's systems (oceans, atmosphere, groundwater, streams, etc.)

Watershed – a smaller area of land that drains to a smaller stream, lake or wetland. There are many smaller watersheds within a river basin

Water treatment – a purification process that removes contaminants from water or prepares water for special uses (e.g., industrial water)

Wetland – land where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities

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https://www.youtube.com/watch?v=QrzRJM88Okg

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Module: Water in the Landscape

Drought and floods:
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Plastic waste pollution:
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https://www.youtube.com/watch?time_continue=23&v=uM-WKF1flis.

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https://www.youtube.com/watch?time_continue=100&v=hKalwhnCIfE

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