Water use in the Danube river basin

4

Water in the household 4.1.

4.1. Water in the household

What do we use water for?

There seems to be water in abundance. Actually, however, in many countries of the Danube basin there are recurring water shortages, as the water resources in the Danube catchment area are differently distributed. As each of us is dependent on water, we have the responsibility to deal with it economically and reasonably. When we use water there are impacts on the environment.

In most household activities water is not consumed but used, and so leaves our houses with numerous organic and inorganic materials in it, which, without the appropriate purification in a water-treatment plant, can pollute the groundwater and the surface water.

Objectives:

The children learn ...

✔ that we are all part of the water cycle.
✔ to recognise the multiple and simple opportunities for saving water and avoiding water pollution through use in households.
✔ to have a positive attitude to saving water and avoiding water pollution.
✔ to understand how water treatment plants work.
✔ that they too can bring about changes (for example in school).
✔ that there are different forms of pollution and how to avoid them.
✔ what effects pollution has on water animals.

Materials:

Activity 1: paper, writing materials; worksheet, "How much water do I need?"
Activity 2: worksheet, "The water house"
Activity 3: measuring jug, paper, writing material; worksheet, "Spendthrift or happy saver?"
Activity 4: large sheet of paper to design a poster, writing materials
Activity 5: used washing- and cleaning-agent bottles
Activity 6: a glass of water, a small needle or paper clip, a drop of washing liquid
Activity 7: three plastic cups with a hole in the bottom, sand, gravel, coffee filters, water with visible contamination (e.g. pieces of paper, tea-bag contents), washing liquid, a suitable glass container

Organisational points:

Duration: 2–3 teaching units
Location: classroom

Activity 1: Group work / discussion
Checking our drinking water

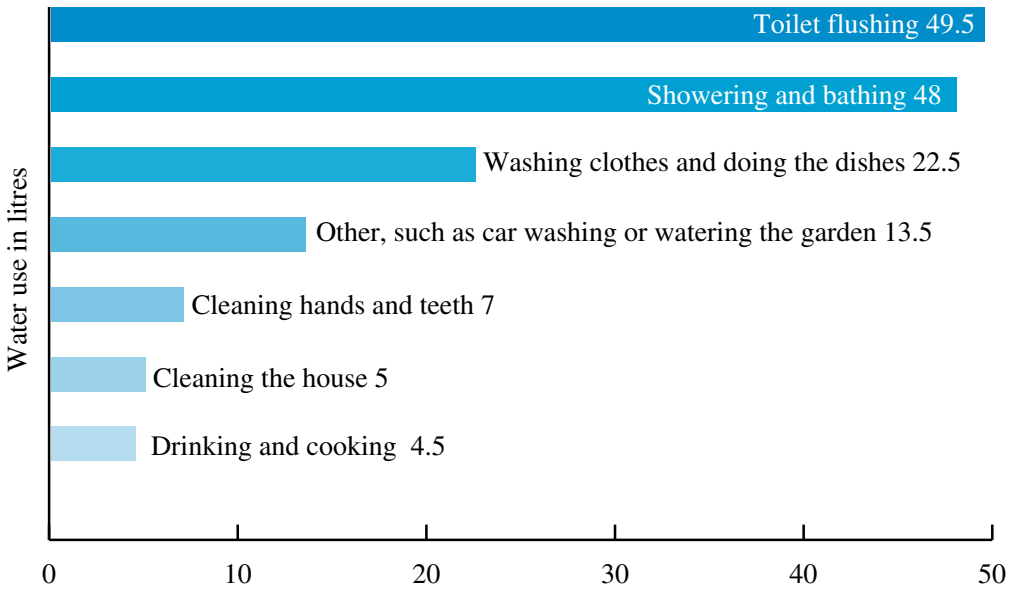
Where does our water come from?

In interviews with parents or relatives the children find out where the water in their municipality comes from. (Groundwater or surface water? Is it purified? Does it taste of chlorine? Is there a reservoir?) The children discuss their findings in class and each child draws the place of origin of the water that the municipality provides on a piece of paper (source, groundwater springs, river).

"How much water do I need?"

The children discuss what purposes they use water for every day and estimate their daily water requirement usage. The estimated quantities can be compared with the average amounts that people use. At home, with the help of their parents, the children check their water requirement usage for one day. The estimated quantities and the quantities used at home are entered in the worksheet "How much water do I need?"

Average amount of water use per person per day
Total 150 litres



Drinking water

On average, each of us consumes approximately 150 litres of valuable drinking water per day. Of this, however, only approximately 3% is used for drinking and cooking. Up to 32% is used for bathing and showering. 15% is used for washing clothes and doing the dishes, almost 33% is used for toilet flushing and 17% for other things such as cleaning the house, washing hands and cleaning teeth, washing the car or watering houseplants and the garden.

Background information

Activity 2: Group work / discussion
Water is running through our fingers

Using the worksheet "The water house", the children find out where one can save water in the household. The possibilities for saving water are entered in the worksheet. Activity 3 encourages children to think about water use.

Activity 3: Experiment
A few more litres of water saved!

When brushing their teeth or washing their hands at home the children place a pot under the tap. They measure and note how many litres of water they use when they let the tap run the whole time and then compare that figure with the number of litres they use when they turn the tap off between soaping and rinsing. The results are discussed in class the next day and the children calculate how much water could be saved by using water carefully when washing their hands or brushing their teeth.

Tip: This activity can be carried out with a volunteer at the washbasin in the classroom. On the worksheet "Spendthrift or happy saver?" the children enter their "water habits".

There are many ways to save water in the household:

- Shower instead of taking a bath. A bath requires some 200 litres of water, showering approximately 40–70 litres. Turn the water off in the shower when you are soaping yourself.
- Repair dripping taps or broken WC flushes immediately. A dripping tap wastes up to 17 litres of water a day and a running toilet flush 50 litres of water a day.
- On the toilet, don't use the whole contents of the cistern, for example by pressing the stop button. (The cistern contains, approx 10 litres.)
- Turn the tap off while you are brushing your teeth or soaping yourself.
- Invest in water-saving models when buying new appliances.
- Only turn on washing machines or dishwashers when they are full. When washing dishes by hand, do not rinse them under running water.
- When washing the car, use a bucket and sponge instead of a garden hose; or drive to a car wash, where the washing water is re-used in a cycle.
- When watering the garden, use collected rainwater to water the plants in the evening. The water evaporates more quickly in strong sunshine so water in the evening.

Background information

Activity 4: Group work / discussion
Is our school saving water?

The children find out about the amount of water their school uses for one day from the person responsible at the school. Then they design a poster showing ways of saving water in the school.

Tip: This poster is suited to making children in other classes aware of the issue too.

Activity 5: Group work / discussion
Everything clean, or maybe not?

Each child writes up on the blackboard one type of water pollution in the household. Then the class discusses what materials are mainly responsible for water pollution and the children try to identify all the different forms of pollution, for example noticeable foam in waterways in their surroundings. They recognise that in the case of household waste water it is mainly food remains or faeces, but also cleaning agents and washing power that harm the groundwater and waterways. Therefore we have to be particularly sparing in the use of washing powder and cleaning agents. Possibly, the different cleaning agents and the warnings on the containers can be demonstrated using the different washing and cleaning agents that have been brought along. The children are encouraged to use alternative cleaning agents at home.

Tip: Washnut, or Indian soap nut, shells (available in organic food shops) can be used for doing the washing.

Activity 6: Experiment
Help, the water striders are sinking!

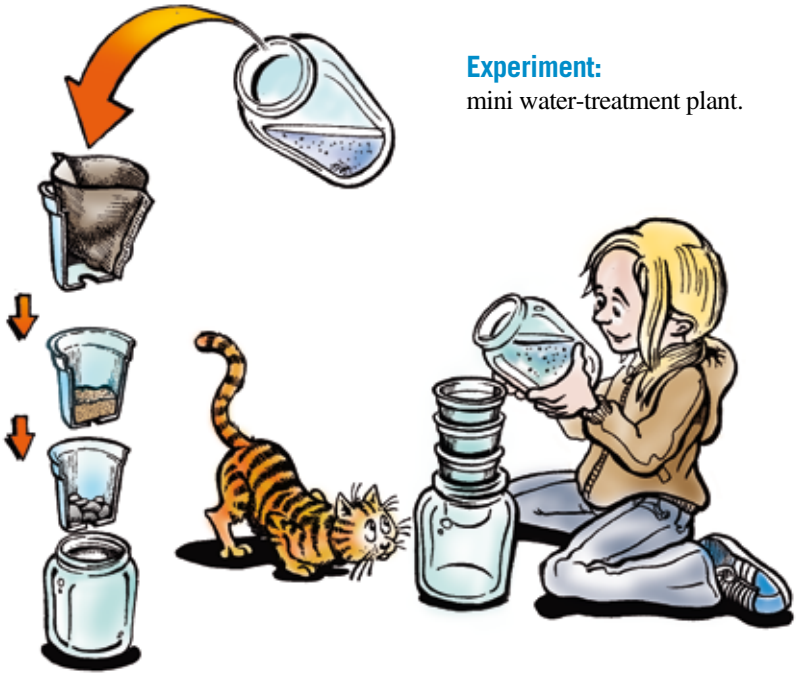
Carefully place a small needle or paper clip on the water surface of a glass of water. Because of the surface tension of the water these objects will float. For the same reason the water striders can move on the water surface. Now a child adds one drop of washing-up liquid and one can see how the needle or paper clip sinks. The washing-up liquid reduced the surface tension of the water, and the children see in a simple way how residues of washing agents in our waste water can harm water animals like the water strider.

photo: E.Kohlenberger/4nature

Water strider: surface tension allows insects to walk on water.

Activity 7: Experiment
The mini water-treatment plant

Under supervision, the children build a mechanical model water-treatment plant in the classroom. The plastic cups, with a hole in the bottom, are filled with gravel, sand and the coffee filters, in that order. Stick the cups inside each other and place them in a glass container. Now, one first pours in water with visible contamination (for example bits of paper, contents of tea-bags) and notice at which layer this contamination is held back. The water is filtered mechanically. Then mix washing liquid with water and allow it to run through. The washing liquid is not removed from the water. It forms foam when one shakes the water. Washing liquids are only broken down in the biological stage of a water-treatment plant with the help of micro-organisms.



Experiment:
mini water-treatment plant.

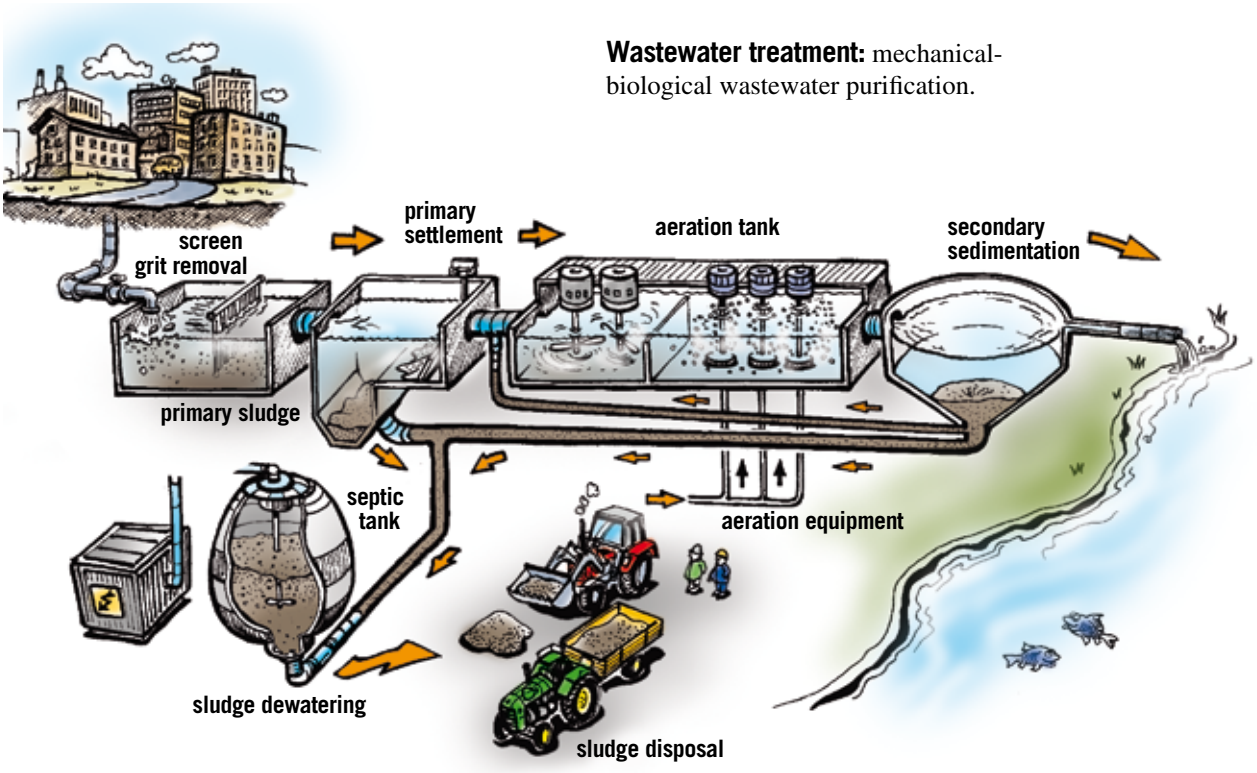
Tip: Go on a school trip to a water-treatment plant.

The children recognise that there is invisible pollution as well as visible pollution and that washing-up liquid cannot be removed from the waste water through mechanical purification.

On the basis of the diagram on page 153 and the worksheet the children discuss the function of a water treatment plant and its stages, and learn that in the biological stage accelerated processes take place that function in a similar way to the natural self-purification power of waterways.

The children ask the town council if the place where they live is linked to a water treatment plant and how many purification stages it has.

Information on CD-ROM: Drinking water
Drinking-water purification
Demands on drinking water
Dripping taps
Our waste water damages the rivers
How does a water-treatment plant work?



Wastewater treatment: mechanical-biological wastewater purification.

In households the use of cleaning agents and washing powders contributes to water pollution

As well as faeces and food remains, household waste water also contains residues of cleaning agents and household chemicals. There is no cleaning agent which does not affect the environment. Residues of cleaning agents can be dangerous for water organisms and waterways. One should therefore use washing-up liquid, washing powder and cleaning agents as sparingly as possible. WC cleaners and descaling agents contain caustic acids. Drain cleaners, oven cleaners and bleaches contain caustic alkalis. Dishwashing powders and washing powders contain active washing substances, above all surfactants, which reduce the surface tension in water and as nutrients lead to the massive increase in algae and to oxygen shortages in the water.

Ways of using less washing powder and household chemicals:

- If the drain is blocked use a rubber plunger.
- Clean the oven while it is still warm.
- Use a micro-fibre cloth to clean dirt without using cleaning agents.
- Do not use a pre-wash programme for lightly soiled washing and do not wash clothing such as pullovers and trousers after only having worn them once or twice.
- Use as small an amount of washing powder as possible and prefer compacted washing powder.
- By using mix-at-home cleaners the amount of detergent needed can be precisely suited to individual needs.
- Use phosphate-free washing powder.
- Products such as toilet-freshener stones, fabric softeners and disinfectants should generally be avoided.
- On no account dispose of household chemicals such as solvents, paints or oil down the toilet.

Alternative cleaning agents:

As substitutes, vinegar, alcohol, citric acid or soft soap can be used to dissolve fat, decalcify and clean smooth surfaces, and baking soda can be used as a scouring agent.

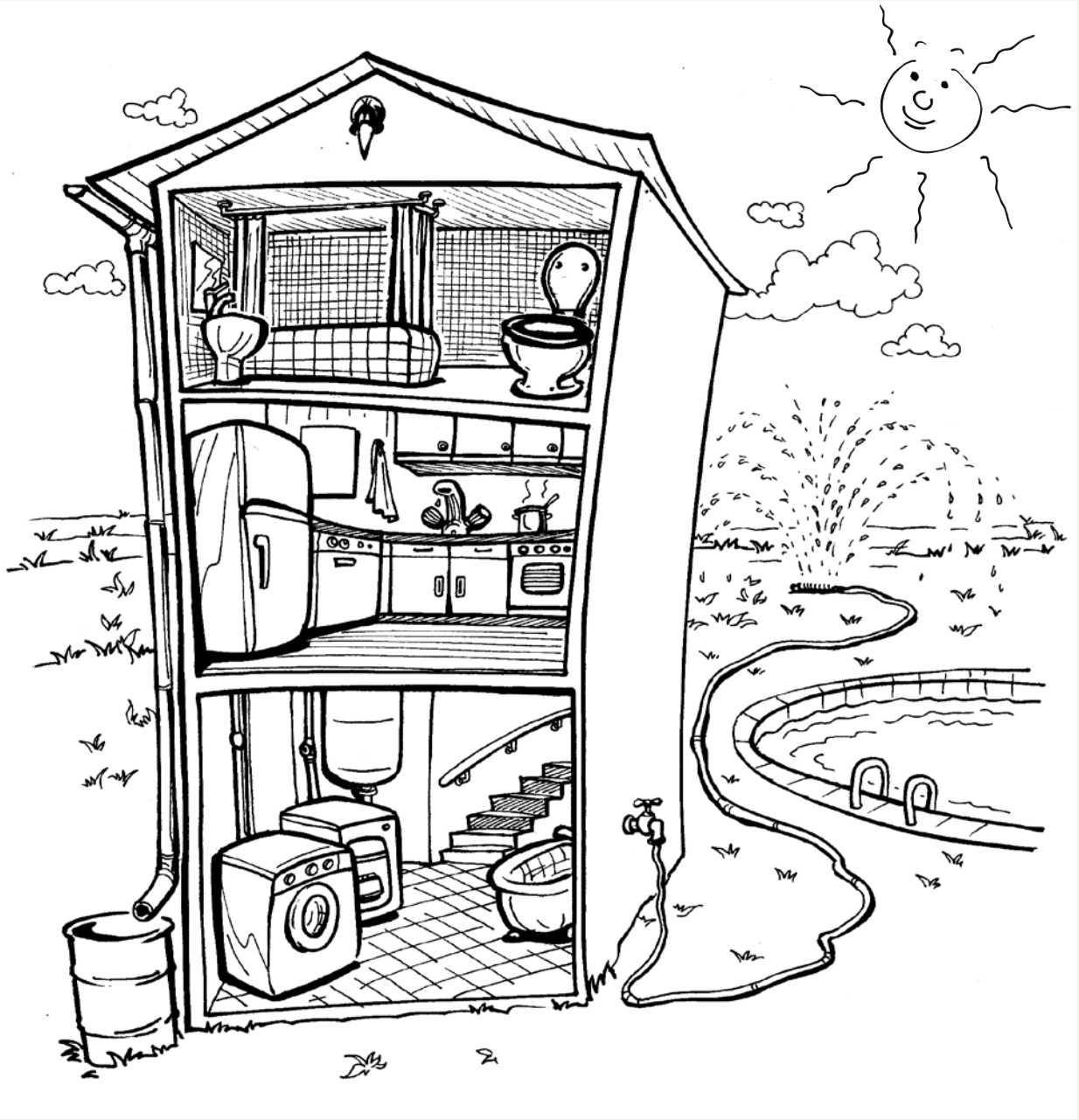
Background information

"How much water do I need?"

What I use water for:	How much water I use for this: (my estimate)	My actual water use:

"The water house"

Find the possibilities where you can save water in this house!



☞ Write your ideas for saving water on the worksheet!

"Spendthrift or happy saver?"

The spendthrift	Happy saver	And you …
… has dripping taps in the bath and kitchen and a running toilet cistern.	… has all dripping and running taps and pipes repaired immediately.	
… always pushes the toilet flush down full.	… doesn't let the whole cistern empty.	
… leaves the tap running when hand-washing or tooth-brushing.	… doesn't keep the tap running when hand-washing or tooth-brushing.	
… doesn't pay any attention to the water consumption when buying new appliances.	… reminds parents to get water-saving models when buy-ing new appliances.	

"What happens in a water-treatment plant?"

Fill in the missing letters or words:

HOW THE WATER-TREATMENT PLANT WORKS

In the first stage mechanical purification takes place. Here, coarse material like gravel and floating poll.....s are removed. Then the material suspended in the water sinks down and forms sl..... on the bottom.

The second stage purifies the waste water biologically, similarly to the way it happens in rivers. Millions of micro..... feed off the toxins and so purify the water.

In a third stage, to get as many pollutants out of the waste water as possible, che.....s are used. These substances bind further materials and thus remove them from the waste water.

Danube tales

The Danube as a red thread between saga and reality

The events of the Early and High Middle Ages are illustrated in the Nibelungenlied. The first part of the story takes place in the kingdom of the Burgundians in Worms on the Rhine: Kriemhild swore revenge after her husband was murdered with the knowledge of her three brothers, Gunther, Gernot and Giselher. The deceased was none other than Siegfried the dragon slayer, who had taken the legendary treasure of the Nibelungs. In the fifth century AD there really was a Burgundian kingdom on the Rhine. In AD 436 it was conquered by Attila's Huns. The Burgundian king was called Gundahar – Gunther.

In the second part of the story the events shift completely to the Danube. Kriemhild gives in to the wooing of Attila, king of the Huns (called Etzel in the song), and following the river moves to the land of the Huns. The wedding takes place on the way in Vienna.

Thirteen years later Kriemhild invites her brothers to visit her, and the Burgundians ride out with an entourage of thousands of armed men and down the Danube, having various adventures on the way. The epic ends with a terrible bloodbath of revenge in the court of Attila and with the death of (almost) all participants.

If one looks more closely at the Danube journey, which is described four times (the suitor travelling from the land of the Huns to Worms, Kriemhild going with her entourage to Etzel, years later Kriemhild's messengers going with the invitation to the Burgundians, and finally the brothers' journey with no return), then the Danube journey becomes a fascinating time journey stretching over centuries. German, Austrian and Hungarian cities mentioned in the song can be identified, as well as most of the people portrayed. Etzelburg lies "on a mountain not far from the bank of the Danube". Evidence that this place is to be found in the Hungarian Esztergom (German, Gran; Slovakian, Ostrihon), where today the powerful cupola of the basilica towers over the bank.

Doing the laundry on the river

Rivers like the Danube and their many tributaries have what is needed for doing large quantities of washing: flowing water for rinsing. In the past, people used to rinse the laundry on small wooden jetties, in special huts, on anchored "laundry ships" or simply on the shore. The cloth was repeatedly beaten with special wooden boards in order to knock out the last remains of the soap from the fabric. Before the invention of the washing machine, doing the washing and rinsing was hard work. In winter, people often had a pot of warm water with them to warm their numbed fingers. Before there was ready-made washing powder to buy, people left the dirty washing overnight in lye (wood-ash leached with water) or soaked in a solution of home-made soap, and the next day it was properly wrung out and beaten. In nature as well, there are plants that produce soapy compounds and form suds in water. They, too, can dissolve dirt, fat or sweat out of the material – in other words, wash.

Suggestion 1: An exciting experiment is to make soapy water from soapwort. The scientific name for the pretty, pale pink flower is *Saponaria officinalis*. You may find it yourself outside or in the garden, or buy it at a chemist's. Shred the roots and cover them in hot water.

Suggestion 2: Chestnuts, which are very popular with children, also have a similar soap agent. Grated finely and soaked in hot water, the fruit produces a foamy lye with which one can attempt to wash a few stains out of some test material.

photo: Alice Thinschmidt

Soapwort: rubbing the leaves in warm water, foam is produced.

Agriculture

4.2.

4.2. **Agriculture**

From the fields onto our plates

Agriculture provides humans with basic foods and is an important source of income for the population in the Danube basin. Varied cultural landscapes make a contribution to the conservation of species diversity.

Agricultural production depends on having enough water to make it possible to grow crops and to supply animals. Water consumption for agriculture is extremely high, though the amount used by individual countries of the Danube basin varies.

By using water and pesticides and through over-fertilisation and intensive animal rearing, agriculture can have a great influence on the water bodies and wetlands in the Danube basin. Wetlands are drained to gain land for farming. Detrimental industrial farming methods can lead to soil erosion and salinisation. One of the greatest challenges in agriculture is to achieve a sustainable form of farming.

Objectives:

The children learn ...

✔ how to make butter.
✔ that industrial farming involves high levels of water consumption and the use of fertilisers and pesticides.
✔ that the purchase of organic-farming products contributes to protecting our rivers.
✔ in playful activities, the consequences of too much nitrogen on the groundwater.
✔ how important rich animal life and intact soil are.
✔ to appreciate organic and local products.

Material:

Activity 1: bread (if possible made with organic ingredients), whipped cream, a small and sealable container
Activity 2: worksheet “Tracking the water in my breakfast”, writing material
Activity 3: worksheet “Have a good think about organic farming!”, writing material
Activity 4: strips of white and coloured paper, sticky tape
Activity 5: components for an earthworm box: box with panes of glass on the side, e.g. an old aquarium, various kinds of soil, gravel, vegetable and fruit waste, dry leaves, earthworms
Activity 6: food and products from organic farming and local products

Organisational points:

Duration: 3 teaching units, 1 excursion to an organic farm
Location: classroom, schoolyard, organic farm

Activity 1: Experiment
We're shaking butter!

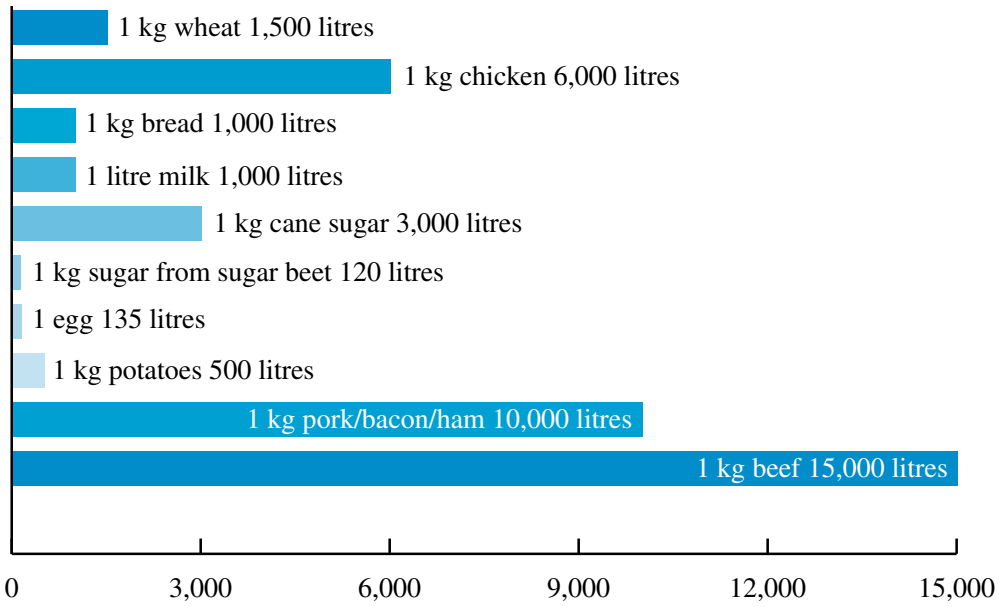
The children produce butter in the classroom themselves. Whipping cream is emptied into a sealable container and the children shake it one after another until the cream has turned into butter.

Then they enjoy eating the home-made butter on bread as a school snack.

Activity 2: Group work / discussion
How much water is there in my bread?

Agricultural products contain an enormous amount of water, which has been taken from surface water or from groundwater. The children estimate how much water is required in the production of particular foods and fill in the worksheet "Tracking the water in my breakfast" at home. Then the estimates are compared with the figures given in class.

Water consumption for the production of various agricultural products



For comparison: a full bathtub holds about 200 litres of water

In addition, at home the children can ask how many kilos of bread, how many litres of milk and how many kilos of meat the family consumes in a week and the water consumption of agricultural products for the whole class can be calculated from this.

Activity 3: Group work / discussion
Have a good think about farming!

The children guess what principles can be applied to organise farming in a more sustainable way. The results are written on the blackboard and discussed in class. With the aid of the worksheet "Have a good think about organic farming!", the children go deeper into the subject.

Information on CD-ROM: The situation of agriculture in the Danube basin

Tip: Quite demanding, therefore more for the older children.

Activity 4: Game
Nitrate fertiliser, too much is too much

Plants need nitrogen to grow. When plants are harvested, the nitrogen bound up in the plants is released and has to be replaced. When farmers fertilise fields, they occasionally use excess fertiliser (liquid manure, mineral fertiliser), which the plants cannot absorb. This can end up in the groundwater or in flowing water. There, the nutrients can lead to blooms of algae or problems with the quality of drinking water.

The classroom or part of the school yard is declared to be an arable area. A small number (about five) children pretend to be plants that are grown in the fields. >>>

On the way to sustainable farming

Forms of production based on the use of fertilisers and pesticides, mechanisation and specialisation (monocultures, intensive livestock breeding) have led to enormous rises in productivity, but they have also created problems. The consequences are the pollution of food, groundwater and soil by pesticides and nitrates as a result of the over-fertilisation of fields, and waste water from intensive livestock breeding.

There can be a decline in natural soil fertility as a result of soil erosion, the loss of biotopes and the reduction of species diversity.

In order to meet the principles of sustainable development in agriculture, one can follow methods of integrated farming.

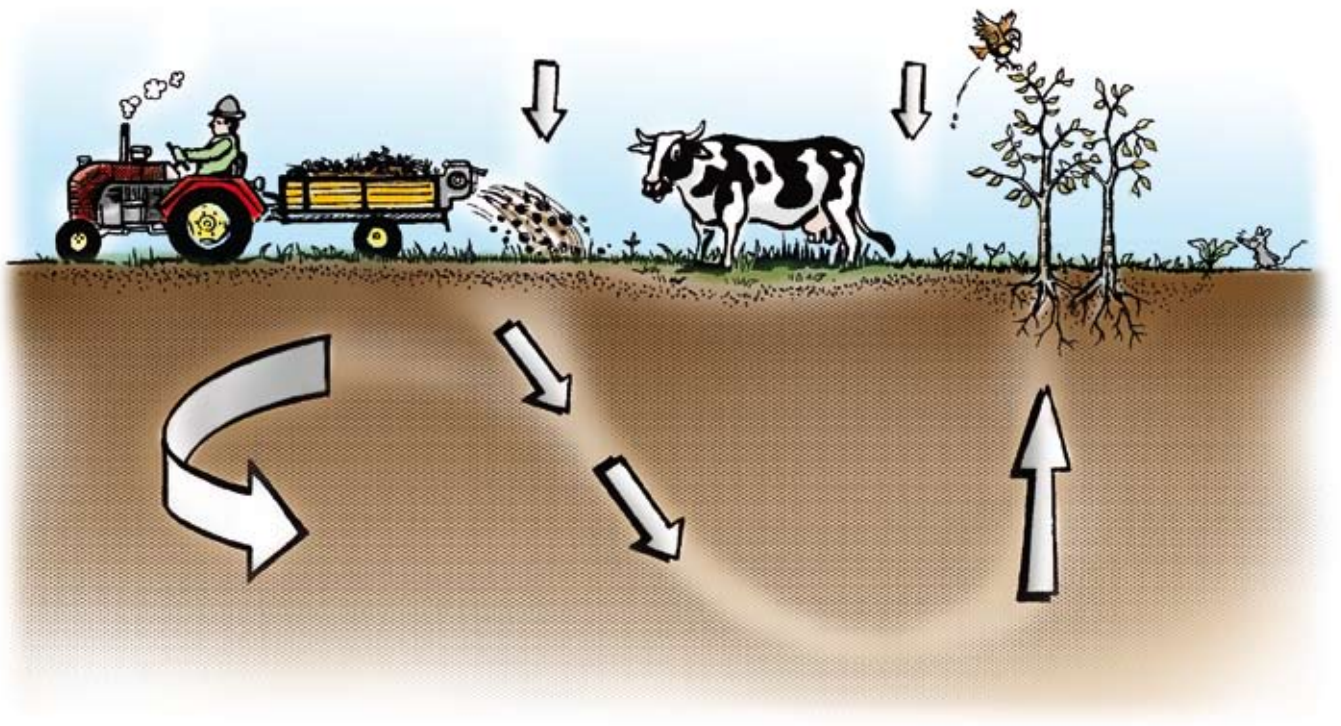
Integrated farming means that pesticides and artificial fertilisers are not used in growing crops. Soil fertility is promoted in harmony with natural processes. Various crops that mutually promote growth are planted in alternate years, e.g. cereals and leguminous plants. Insects, such as some species of beetles and wasps, are introduced as natural helpers for plant protection. Water as a resource is treated responsibly and economically. In livestock breeding, intensive breeding methods are not used, and animal-friendly husbandry is practised instead. Species diversity is increased by combining arable farming and livestock raising in one farm, growing various different types of crop and creating green bands and hedgerows between the fields. Production is increased by promoting natural processes within the farming ecosystem.

Background information

The children can mark themselves with green strips of paper and spread themselves out over the playing area. The other children represent nitrogen molecules of nitrate fertiliser and are marked with white strips of paper with a large N on them. The nitrogen molecules move around between the plants and when they hear a signal each child representing the fertiliser finds a child representing a plant and the two hold hands.

As there are more nitrogen molecules than plants not every child finds a partner. The next time it rains, the superfluous nitrogen molecules are washed out of the soil and end up in groundwater or surface water. The children make the noise of rain together and all the children representing nitrogen molecules who have not found plants gather together in one corner of the playing field. They have got into the groundwater. The nitrogen molecules are taken by the plants and the children who represent the nitrogen molecules go back to the beginning again. For the next round, different children represent the plants and the game starts again.

Tip: The class visits an organic farm and learns about methods of working in organic farming.



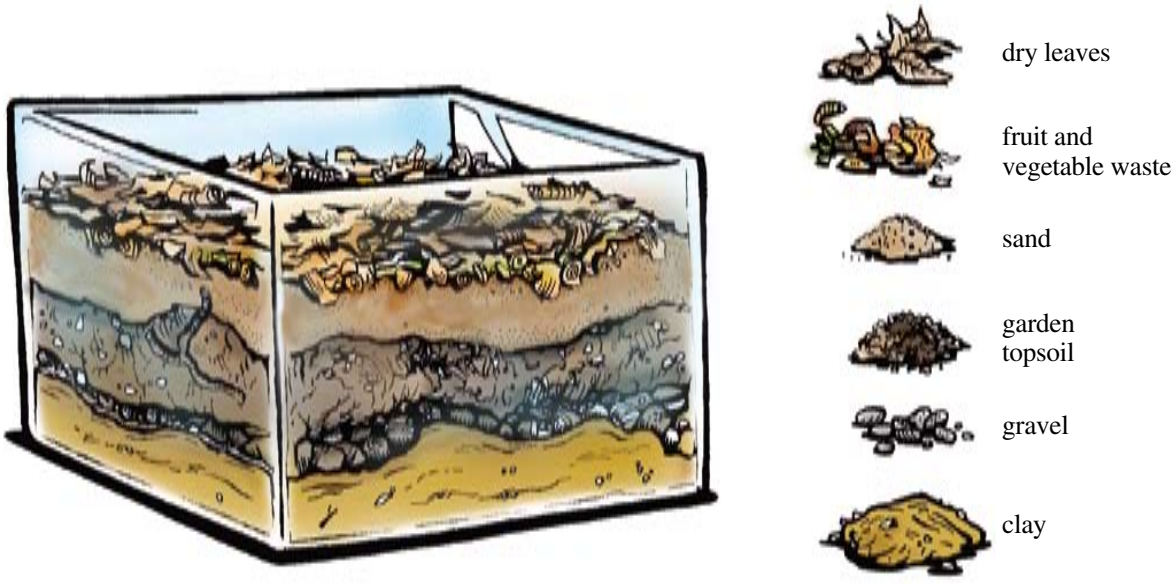
The nitrogen cycle: through organic materials nitrate accumulates in the soil, from where plants feed on it as an important nutrient. When there is over-fertilisation, surplus nitrate remains in the soil and may then pollute the groundwater.

Activity 5: Experiment
Life in the soil, earthworms in action

A lot goes on in soil that is unpolluted by pesticides. The children can observe the activity of the tireless earthworm in an earthworm box. Earthworms live from particles of dead plants; they break up the soil and fertilise it with their excrement.

What do you need for an earthworm box?

- a box with panes of glass on the sides, e.g. an old aquarium
- different kinds of soil, such as clay, sand, garden topsoil
- gravel
- fruit and vegetable waste such as apple peel, lettuce leaves, potato peel, carrots, etc.
- dry leaves
- earthworms



The different types of earth and the gravel are layered on top of one another in the box. The fruit and vegetable waste is stuffed tightly against the panes of glass at different levels in the box and the dry leaves are put in as the last layer. Now earthworms, which one can perhaps find in the school garden, are carefully placed in the box. The earthworm box is covered with a cloth to protect the worms from the light and it is placed in the shade or in a dark, cool place in the school. The worms must always be provided with fresh fruit and vegetable waste and the earth must be kept slightly damp.

Now the children observe the changes in the earthworm box from day to day and see how the worms make passages, mix the different layers of soil, and use up the fruit and vegetable waste. The appearance of worm excrement, recognisable as small piles, is evidence of the fertilisation of the soil by these animals.

Earthworms provide a valuable service in agricultural areas. But living soil can only exist where over-fertilisation and pesticide use is kept within limits.

Activity 6: Group work / discussion

Organic buffet at school. Organic tastes better!

Together with those who are responsible for catering at the school, the children organise a buffet of organic products or sustainably produced regional food and inform their fellow students about the advantages of organic farming.

Information on CD-ROM: Principles of sustainable farming
Irrigation methods

"Tracking the water in my breakfast"

You are sitting in front of your breakfast, eating some bread, perhaps, and drinking some milk. Wouldn't it be interesting to know how much water one needs to produce 1 kilo of bread? Do the breakfast check!

With your parents' help you just have to weigh the amount of each product that you have for breakfast and then estimate the amount of water that is used to produce this product. The next day, you can compare the figures in class.

Your breakfast list (in grams)	Your water estimate (in litres)	Actual amount of water (to be compared in class)
Bread		
Milk		
Sugar		
Eggs		
Cereals		
Ham (pig-meat)		
Other products		

Have a good think about farming!

All the sentences in the list below have something to do with agriculture. Choose the terms that you think go with a kind of farming in which people and animals can live in harmony. Write them on the table.

- chemical fertiliser
- natural fertilisation
- artificial fertiliser
- intensive livestock farming
- natural plant protection by useful insects
- animals have enough space
- few small animals in the soil
- irrigation that is economical with water
- enormous fields with irrigation apparatus that uses a lot of water
- hedges and bushes in the fields
- monotonous fields with only one type of crop
- rich animal life in the soil, e.g. earthworms

Sustainable farming

Danube tales

The Danube as a connection between early cultures. The advance of agriculture along the Danube

Modern research has shown that in the prehistoric and early history of the human race, the Danube did not have the effect of separating cultures. In this early period of human history, the Danube was a guideline of cultural development from the East to the West.

The first impetus for agriculture in the Danube basin in the Neolithic period may have come to Europe and the Mediterranean area from migratory movements following the Danube from the Fertile Crescent (one of the "cradles of arable farming" in the Near East)! Afterwards there were regional variations on this way of life. Seen from a temporal perspective, arable cultures were first found on the lower, then on the middle and finally on the upper course of the Danube. This way of life was for the first time in human history associated with a settled lifestyle, arable farming and livestock rearing.

Due to an improvement in nutritional conditions, there was a sharp increase in the size of the population (the Neolithic Revolution).

Palaeolithic evidence of human activity on the Danube

In the upper course of the Danube, there are numerous flint deposits, which were the essential raw materials for arrow and spear heads, harpoon hooks and scraping knives. These raw materials can be found up to the middle course of the Danube.

Whether the Danube was used as a "transit route" at this time, or how intensive the contacts between the population groups on the Danube were, cannot be said. There are, however, signs of settlement on various places on the Danube going back to the Old Stone Age. For example in the Wachau valley, one of the oldest settlement areas in Austria, the Venus of Willendorf, a figure from the Old Stone Age, some 25,000 years old, was found.

In the caves of the Đerdap gorge on the southern slopes of the Carpathians, traces indicating human activity 20,000 years ago have been found. Both the Wachau and Đerdap Gorge are favoured by micro-climatic conditions and their warm sunny valleys offered good living conditions for our forefathers during the temperature changes of the ice ages. The Danube's abundance of fish was probably an incentive to settle near the river.

Neolithic cultures on the Danube

At Lepenski vir (southern lynchets of the Iron Gate), during the construction of the Iron Gate Dam, the remains of wooden houses were discovered. They were built by the descendants of the cave dwellers of the Djerdap gorge from 8500 BC and suggest they had a settled way of life. These settlements may have been inhabited by early Danube fisher folk and hunters between 8500 and 5500 BC. Relief heads with human and fish-like features were made from boulders (between 16 cm and 70 cm in size) – the earliest works of European sculptors. In all, ten similar settlements were excavated in the Djerdap

gorge; the terrace was thus the centre of a culture that flourished for some 3,000 years.

Arable-farming settlements in the Neolithic era developed primarily on fertile loess areas along the river banks, as in the following examples from the Danube basin.

The Vinča culture, also known as Danubian culture, existed between 5300 and 3500 BC in the Balkans (Serbia, western Romania, western Bulgaria, south-eastern Hungary, eastern Bosnia and the southern Ukraine). The name given to this early European culture is derived from the main place where it is found, Vinča, a village on the Danube 14 km east of Belgrade. Here, traces of arable farming (especially of einkorn grain – a primitive form of wheat), tilling of fields and stock farming (primarily cattle, sheep, goats and pigs) have been found. The people lived in square wooden houses that sometimes had several rooms. For the first time, pottery played an important role.

The Vinča culture is supposed to have already produced a strange early European form of writing, which even today has not yet been deciphered (the oldest deciphered writing system is that of the Sumerians from approximately 3200 BC). Pottery fragments, vessels and figures inscribed with this writing have been discovered in Hungary, Serbia, Romania, Bulgaria and northern Greece.

Hydro power

4.3.

4.3. **Hydro power**

Energy from our rivers

People have used the power of our rivers for many years. In water mills, cereal was milled into flour, and wooden waterwheels drove sawmills and forges. Before the industrial revolution many branches of industry were completely dependent on hydro power. Today, the electricity produced by hydro power is an important part of our energy supply as it uses renewable sources. Dams, however, have a strong effect on rivers and aquatic life forms and they change the landscape. Apart from hydroelectric power, there are many other ways of producing electricity from renewable sources.

Objectives:

The children learn ...

✔ to recognise forms of renewable energy and non-renewable energy.

✔ vividly, how the hydro power of water works.

✔ that everyone can do something for their rivers.

Materials:

Activity 1: paper, sticky tape, writing material

Activity 2: a knitting needle, an empty yoghurt cup, two corks, a thread, scissors, a fretsaw or penknife, sticky tape, a bowl, a bottle of water

Activity 3: a large sheet of paper, writing materials

Organisational points:

Duration: 2–3 teaching units

Location: classroom

Activity 1: Group work / discussion

Does electricity really just come out of the socket?

The children consider what energy sources can be used to produce electricity and write each source of energy they identify on a separate small piece of paper. These sheets are then collected and the individual terms stuck on the blackboard. In a second step, the "forms of energy" are ordered in two groups – renewable forms of energy and non-renewable forms of energy. The teacher discusses with the children what consequences the use of different forms of energy can have, and that renewable sources of energy should increasingly be used in order to sustain natural resources.

Where does our energy come from?

We all need electricity in our daily lives, as sources of light, to cook, to heat and for household appliances. It would not be possible to produce industrial commodities without electricity. Electricity can be produced from fossil fuels, such as coal, oil and natural gas, from atomic energy and from renewable sources of energy. Usually, electricity is produced by rotating turbines that drive a generator.

Renewable energy, what's that?

Renewable forms of energy are inexhaustible natural energy sources, which are constantly regenerated by energy from the sun, unlike fossil fuels, such as coal, oil and natural gas, or atomic energy – which uses uranium as its starting material.

Renewable forms of energy that use sunlight directly are solar heating and solar power. Indirect use of the sun's energy, such as wind and water power, energy from biomass – regenerating raw materials that represent stored solar energy – and geothermal energy are all renewable forms of energy.

Renewable energy creates few or no greenhouse gases, which contribute to climate change. As flood catastrophes and periods of drought are connected to climate change, the use of renewable energy is a way to limit the emission of greenhouse gases that are harming the climate. In the countries of the Danube basin, hydroelectric power provides the biggest proportion of renewable energy. Other forms of renewable energy have not been used so much and are not readily available.

Forms of renewable energy

The sun

Sunshine can be directly transformed into electricity through photovoltaic cells. This effect is well demonstrated in pocket calculators with solar cells.

A further possibility of using sunshine to produce electricity is realised in thermal solar power stations. With the aid of parabolic mirrors, the sunshine is concentrated, water is heated and steam produced, again to drive a turbine.

The fact that a body warms up when the sun shines on it is used to produce hot water. One example of this is the use of solar collectors on the roofs of houses. Pipes in which the water is heated up run through insulating material in order to keep heat loss to a minimum. These pipes can produce hot water at temperatures up to 90 °C.

For example, a garden hose that has been lying in the sun long enough will provide warm water.

There is a limit to the amount of solar energy that is available, because of the varying levels of sunshine and the lack of it in winter, under cloudy skies or at night. Solar cells need a lot of space. >>>

Background information

Wind

The kinetic energy of the wind drives a rotor and can be used to produce electricity through a generator. The performance of wind farms depends on the size of the rotors and the wind speed. With double the diameter of a rotor, the performance quadruples; with double the wind speed, the performance is eight times as much. In the past, the power of the wind from windmills was often used for grinding corn into flour.

Wind power is not always available at the same level and it cannot be put to use everywhere. Seasons and the weather influence how it can be used.

Erecting wind farms also changes the landscape, and can cause local controversy.

Water

Hydroelectric power stations on rivers in the lowlands are called flow power stations. The power of the flowing water is used to produce electricity. The river is dammed by a weir, which produces a fall. The water flows over this fall to turbines, which drive a generator to produce electricity. The water flows through the turbines continually.

Flow power stations can also work in "fluctuation mode". This means that water is stored and there is a larger quantity of water available for electricity production at the times of day when there is a higher energy requirement than normal.

In mountainous regions, reservoir power stations are used, where big dam walls store the water in periods of high inflow, for example when the snow melts. These power stations can be brought into action within a short space of time and then turned off again. The water is diverted through a pressure pipe to a turbine hall, which can also be far away from the dam. Reservoir power stations provide energy during periods of the highest demand, for example at midday or in winter, when the rivers carry less water and water in reservoirs is called on.

Forms of non-renewable energy

Fossil fuels

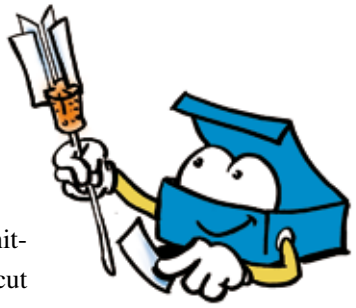
Coal, oil and natural gas are resources that are stored in the earth and which were formed millions of years ago from animal and plant remains. These raw resources exist in limited amounts and cannot be renewed. In electricity production, fossil fuels are burnt in thermal power stations and carbon dioxide, nitrous oxide and other chemical compounds are released. With the heat produced by the combustion, water is heated and the resulting steam drives turbines. Fossil fuels can easily be stored, but the transport and storage of these fuels can lead to accidents, which especially with oil can have serious effects on the environment. Because of the high level of carbon-dioxide emission, the use of fossil fuels contributes to climate change.

Atomic energy

The starting point for atomic energy is radioactive uranium ore, which comes from uranium mines. In atomic power stations, uranium atoms are split and the energy released in the process is used to boil water. The steam drives turbines and the electricity is produced by generators. Radioactive material is produced in all phases of electricity production through atomic energy, and the problem of the final storage of radioactive waste has not been solved. Accidents in atomic power stations can lead to the spread of radioactive contamination of wide areas.

Background information

Information on CD-ROM: Other forms of renewable energy
Hydro power generation in some countries of the Danube



Activity 2: Experiment
The power of water in the classroom

To build a waterwheel, six slits are cut into a cork with a fretsaw or a penknife. A knitting needle is pushed horizontally through the centre of the cork. A yoghurt cup is cut into six parts with scissors and the base cut out. The six pieces of the cup are glued into the slits in the cork. When the glue is dry, the second cork is fastened to one end of the needle by a thread. The waterwheel is laid on a suitable bowl and driven with water from the bottle. One can see the power produced: as the second cork on the thread is raised. The water bottle symbolises the artificial reservoir from which water flows to the turbines in a power station. The waterwheel can also be set up in a stream by laying the knitting needle on two forked branches stuck into the ground.

The movement of the waterwheel illustrates how electric power is usually gained from kinetic energy. It is the same principle as a bicycle dynamo.

Information on CD-ROM: Sturgeon, threatened fish species in the Danube basin

Tip: This experiment also works in the classroom washbasin with water out of the tap.

Tip: The functioning of a power station and the effects on the river can be demonstrated by visiting a hydroelectric power station near the school.

Possible effects of hydroelectric power plants

"So many dams so little river"

Hydroelectric power stations change the course of the river by damming up waterways. In the area of the dam the water is deeper, the river is wider and the flow is slower. By damming up the river, the natural riverbed with its islands and bank-side areas can be destroyed or flooded and the natural alternation of high- and low-water, which is important for the floodplain forests, can be undermined. Floodplain-forest habitats are lost and animal and plant species that depend on the continually fluctuating water level cannot survive.

The river doesn't carry anything any more

If a river is interrupted by dams, the gravel and sand in the river can no longer be transported by the river and the material is deposited upstream of each dam.

Slow current

The reduction of the flow in dams results in fine material being deposited on the riverbed. This blocks up the pores in the riverbed and is problematic for the supply of groundwater, because no water can seep into the groundwater body and the bank area any more.

The deposit of fine material also covers the natural gravel bottom. These changes affect ground-living small animals and current-loving fish, which lay their eggs in the shingle and gravel and lose their spawning grounds as a result of the deposits. A further effect is the loss of the self-purification power of the river.

What happens behind the dam?

Downstream, behind the dam, the riverbed deepens, because the force of the river takes grit and stones with it again. Thus there can be a fall in the water level behind the dam and, as a result, the water table can sink. This has effects on the habitats downstream of the dam – floodplain forests and bank-side regions, for example, may no longer be supplied with enough water. On the Hungarian Danube the depth erosion rate is 1–3 cm per year and on the Austrian Danube east of Vienna the riverbed is worn down at an increasing rate of 3–4 cm per year. Today, expensive attempts are made to prevent the depth erosion downstream of power stations by taking out the soil of the riverbed by bulldozer, as for example east of Vienna.

Migratory fish species

An important effect of dams is that the spawning areas of some species of fish upstream from the dam can be cut off from lower parts of the river and the migration of aquatic life forms is thereby obstructed. For example, sturgeon were unable to reproduce because of the obstacles in their route to their spawning grounds.

photo: DRP/ Victor Mello

Dam: at Bradisor in Romania.

Background information

Activity 3: Group work / discussion

Make a present to your river!

The children consider how they can save electricity and collect ideas on a large sheet of paper. Each child chooses energy-saving measures that they can carry out with the help of a teacher and their parents, and thereby makes a present to the river. The class produces a poster to show other children in the school the presents to the river.

Tip: To motivate the children, certificates for each "present to the river" can be designed. The child's energy-saving measure can be described.

A few ways of saving energy in school and at home

Use energy-saving light bulbs

Always turn electronic appliances off completely (stand-by mode uses a lot of energy)

When looking for new appliances (fridge, washing machine, etc.) advise parents to buy energy-saving products

Put the lid on the pot when cooking

Only open the fridge as briefly as necessary

Let food cool off before putting it in the fridge

Make sure not to leave the house with unnecessary lights left on

Do not cover radiators

Advise parents not to use the tumble drier

Take a short shower instead of a bath

Always operate the washing machine with a full load

Advise parents not to use the hot wash programme nor a pre-wash programme when doing the washing

Turn the heating off when airing the room and leave the windows fully open and only for a short time

Turn the heating down – 18–20 °C in living rooms should be enough

Background information

Danube tales

Ship mills

Rivers have enormous power. And they flow day and night, in summer and in winter. In the past, innumerable water mills used this never-dwindling energy to grind flour from corn in the same way as windmills do in areas with a constant breeze. Usually the mills consisted of two firmly anchored parallel ships,with a large paddle wheel between them. The water flowed under the wheel, pushed the wide paddle boards of the wheel forward and thereby turned it. One of the two ships was the milling ship, with a wooden house containing the heavy millstones, the gears and, up on top, the funnel to fill in the corn. This is also where the miller's family and their assistants lived. The second ship bore the other end of the heavy mill axle. In some areas on the Danube one can still visit old or reconstructed ship mills as museums. However, they have completely disappeared from the landscape and no longer have any economic function.

Suggestion: Find a broad, flat stone as a base, and a smaller one with a flat side for grinding. The children should attempt to produce fine flour from the cereal grain using only the force of their own hands.

More information on ship mills can be found on the CD-ROM.

photo: Moritz Böswirth

Ship mill: on the Danube one finds some rebuilt ships mill used as museums.

Earlier "danger spots" of the Danube and their modification through technical alterations of the Danube during the 19th and 20th centuries

Since the age of absolutism in the 18th century, bodies of water, watercourses and immediate bank-side zones of inland watercourses have generally been considered the property of the state (a principle that remains valid today). As inland traffic on the upper and middle Danube increased by leaps and bounds in the 18th century and the people of the Enlightenment no longer wanted to leave the fate of the Danube boatmen in the hands of St Nepomuk, the river course was geographically mapped and investigated for navigability. To this end, Maria Theresia, queen of Hungary and Bohemia and wife of the Austrian emperor Franz I, set up a shipping and navigation directorate. They started adjusting the river course, usually through small interventions, some of which were only moderately successful.

In the second half of the 19th century, the Danube became the focus of technological advance. Within a few decades, the appearance and often also the course of the river changed as a result of enormous technological effort. Dams, canals and groynes were built; harbours, moorings and bridges erected. Sometimes these regulation measures assumed gigantic proportions.

Thus, many danger spots for navigation, such as rapids and obstructing rocks (e.g. Strudengau, the Iron Gate) were rendered harmless. Since the end of the 1950s, innumerable power stations have been built on the upper and middle course of the Danube. Apart from their main task of providing electricity, they enable free passage for ships as a result of regulated water levels.

Example, Strudengau (Lower Austria):
In 1773, the first blasting was untertaken in the area of the Greiner rapids in order to ease passage. Only in 1885 was it possible to remove the small island of "Hausstein" completely and thus eliminate the dangerous rapids. Thanks to the backwater from the Ybbs-Persenbeug power station, built after the Second World War, the Strudengau finally lost its terrors for navigation.

Example, Iron Gate (Serbia/Romania):
The passage through the Iron Gate was first eased in 1834/35. The results of this first blasting were modest, however, and at low water, travellers and goods had to bypass the rocky narrows by travelling on the road parallel to the river, built in the mid 1840s (thus ending the year-round navigability of the Danube). The regulation works carried out from 1860 to 1896 converted the Iron Gate into an enormous construction site. A new bed for the Danube was built, which was intended to be navigable for large ships during low water. The power station at the Iron Gate, completed by Yugoslavia and Romania in 1980, raised the water level by up to 30 metres and finally removed difficulties this passage held for shipping. The negative environmental effects of the construction measures on the Danube were enormous, however. Ecological changes and losses were inevitable.

Navigation

4.4.

4.4. Navigation

Rivers as traffic routes for people and goods

Since ancient times people have used rivers as ways to travel or to transport goods long distances. Whereas travelling overland was often a cumbersome and not seldom a dangerous affair in the past, rivers offered relatively safe and comfortable connecting routes.

Along the Danube, trade routes and wealthy merchant towns grew up, such as Passau, Esztergom, Mohács, Novi Sad, Vidin, Galați and Sulina on the Black Sea.

Navigation increasingly adapted waterways to its needs. For example, since the beginning of the modern age rocks and other obstacles in rivers have been removed, sometimes blown up, in order to make narrow stretches passable or to deepen the main channel.

These interventions have affected the condition of rivers. Today, an attempt is made to find ways to make shipping more environmentally friendly. By carrying out environmental impact tests, potential transboundary damage can be estimated and averted, and it is possible to take the conditions on the river into account using new types of ship.

Objectives:

The children learn ...

✔ why ships float.

✔ how ships have to be built in order to be more environmentally friendly.

✔ to create boats from dried reeds.

Materials:

Activity 1: a bucket of water, plastic bag, a container filled with water, plasticine, kitchen scales

Activity 2: a large container filled with water; several empty, rectangular, open, equally sized plastic packing boxes; several equally heavy weights or building blocks as cargo; sticky tape; strips of paper; writing material; tape-measure; paints

Activity 3: dry reeds, thread of natural fibre, scissors, paper

Organisational points:

Duration: 2 teaching units, 1 excursion to a river

Location: classroom, on a river

Activity 1: Experiment
Why do things float?

Objects that are lighter than water float, that is clear. Ships that carry heavy loads are nowadays mostly made of steel. Steel is heavier than water. Why do ships nevertheless float?

All objects displace a certain amount of water and experience buoyancy: the children test this by putting one of their arms in a plastic bag and then putting it in the bucket filled with water. They see how the water in the bucket rises and they feel the pressure that the water exerts on their arms in the plastic bag. Archimedes, the great Greek mathematician, discovered that it is precisely this force that allows things to float. Whether an object floats or sinks depends on how much water it displaces, that is, on its spatial content, its volume. >>>

Navigation in the Danube basin

Shipping in the Danube basin has a long tradition. In the past, traded goods were largely transported by ship.

Even in prehistoric times, the Danube was very important as a traffic and transport route. In Roman times, the Roman outposts on the northern border of the empire were provided with goods that were transported on the Danube. At the time of the Germanic migrations, the Danube was the most important east–west connection and in the centuries that followed played an important role for long-distance trading.

Before the emergence of steamships, rafts and wooden ships sailed downstream, were then dismantled at their destination, and the wood was sold. Only larger ships were hauled upstream again by horses. With industrialisation, the traffic on the Danube increased and in the 19th century the first river construction measures were put in place, such as regulation, straightening and deepening the river in order to make shipping traffic more efficient. The landscape on the river started to change.

Rivers were and are important trading routes through Europe. The Danube is navigable from Ulm to the Danube delta, where it flows into the Black Sea, and from Kelheim, at river kilometre 2,411, it is an international waterway for 87% of its length. Ships can moor in 78 harbours on the Danube. Locks are used to allow shipping to pass by power stations and weirs. Artificial waterways for shipping were also built: the Rhine–Main–Danube canal (built from 1960 to 1992), which links the Danube basin through the Rhine to the North Sea, the Danube–Tisza–Danube canal system (completed in 1977) in Serbia, and the Danube–Black Sea canal (completed in 1987) in Romania.

The navigable stretches of the Danube basin are the Danube itself and the lower courses of some of its tributaries. In the upper Danube catchment area, the Tisza is navigable for 70% of its course, the Sava for 50%, the Morava for 30%, the Drava for 20%, the Váh for 20% and the Rába for 10%. Some tributaries of the Tisza, thus the rivers Bodrog, Mures, Körös and Bega, are navigable for short stretches.

Today, increasing numbers of tourists travel on the Danube in passenger ships and enjoy the natural beauty and rich cultural heritage of the Danube basin (in 2007, 123 passenger ships registered on the Danube). It is important for tourism that beautiful and spectacular riverine landscapes are preserved (for example the Wachau valley in Austria, and the Danube delta in Romania and Ukraine).

Background information

The children make balls of plasticine and check with the kitchen scales that these balls all weigh approximately the same.

One plasticine ball each is put into a container filled with water, and because the plasticine ball is heavier than water it sinks.

In a second step, the children form small bowls out of their plasticine balls and place them on the surface of the water. The plasticine bowls float, because they have a greater volume than the balls have, and although they are the same weight as the balls that previously sunk, the bowls displace more water than the balls. Exactly the same principle allows a ship made of steel to float.

Activity 2: Experiment

We're building new ships for the Danube!

In order to minimise changes to the Danube one can build wide, shallow-draught ships that do not sink so deeply into the water and which can also navigate shallower stretches more easily.

Each group (or each child) receives three plastic packing boxes. One box remains as it is; two are stuck together side by side along the longer side. Now, using a tape-measure, draw lines on two strips of paper at intervals of one centimetre.

The strips are stuck on the side of the two types of ship as depth gauges. The two different models of ship are put into the container full of water and each loaded with the same number of building blocks or equally heavy weights. Using the depth gauge, it can be seen that with the same load the wider ship does not sink so deeply into the water. Because the wider model of ship is better adapted to conditions of the Danube, the river does not have to be artificially deepened. The children can paint this ship model with animals and plants of the river. In modernising the shipping fleets on the Danube care is taken nowadays to develop and use more shallow-draught ships. This makes it possible for them to navigate the shallow stretches of the Danube and some of its tributaries.

Information on CD-ROM: Important channels in the Danube basin
Examples of projects to develop the Danube for navigation

Development of the Danube for navigation

In the course of the development of trans-European networks for transport, the European Union is planning to promote inland navigation. In order to increase transport capacity, the general conditions for navigation are to be ameliorated – working conditions in the shipping industry are to be improved, the fleet and harbours modernised, and obstacles to navigation, such as stretches that are too shallow, removed. There are plans to further develop the navigation channel of the Danube to a length of more than 1,000 km. Some of these stretches include the last free-flowing sections of the river, such as the river section in the border area between Romania and Bulgaria, where the river course still contains hundreds of natural islets with a diversity of habitats.

Some attempts are being made to adapt the river to navigation by deepening the navigation channel. However, in terms of sustainable development, the ships should instead be adapted to the river.

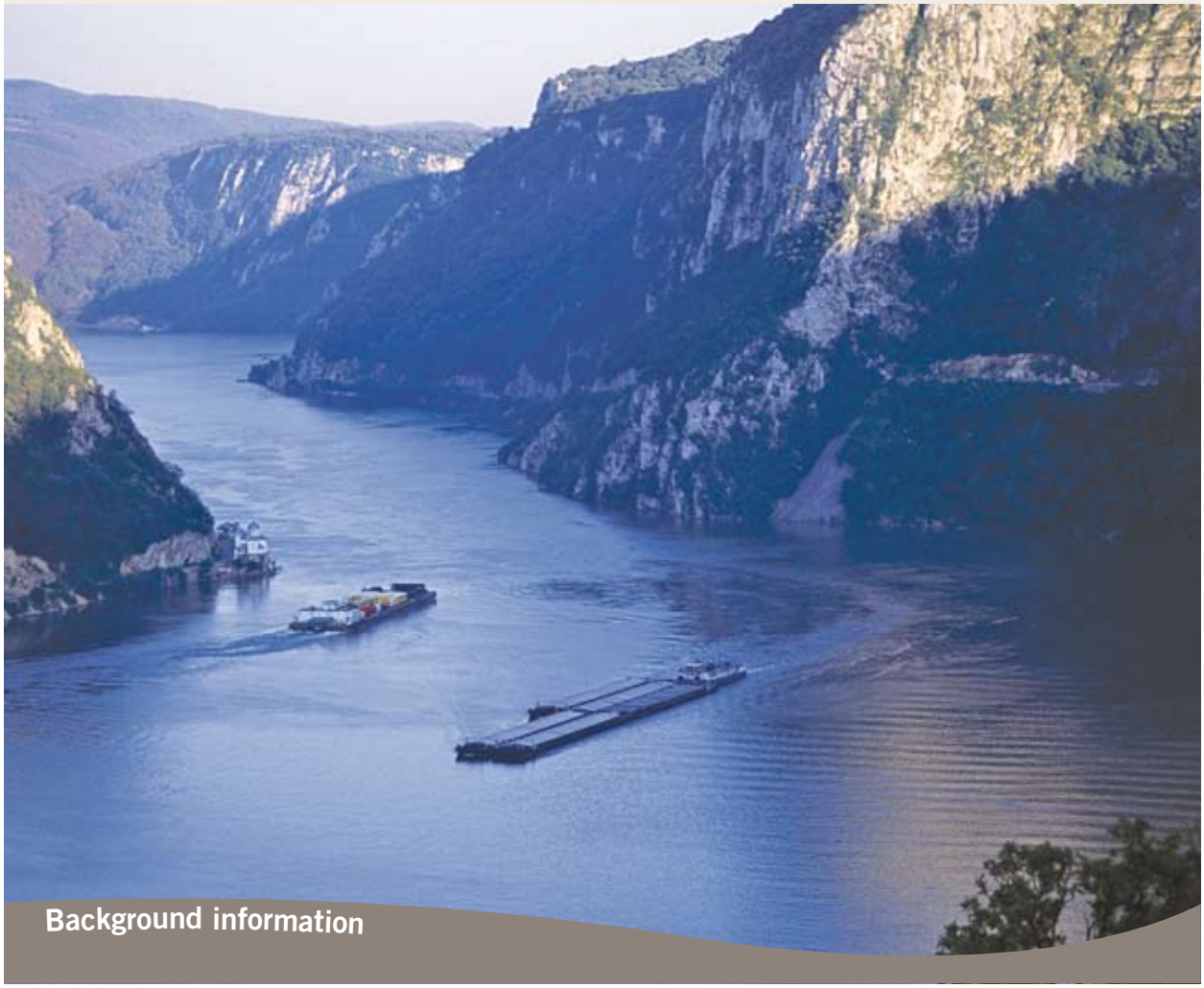
The plan to shift freight transport from the roads to rivers would have some positive effects, such as reducing exhaust emissions. With one litre of fuel, a ship can travel 1 km while carrying a load of 127 tons – with the same amount of fuel, a lorry can only transport 50 tons over the same distance.

In any case, environmental impact assessment must be carried out for all construction projects, which should take into account all consequences for the entire Danube catchment area.

Only if the needs of nature and navigation – ecology and economy – are discussed equitably, can sustainable solutions be found that will satisfy all sides.

Shipping: cargo ships passing the Iron Gate.

photo: DRP/ Victor Mello

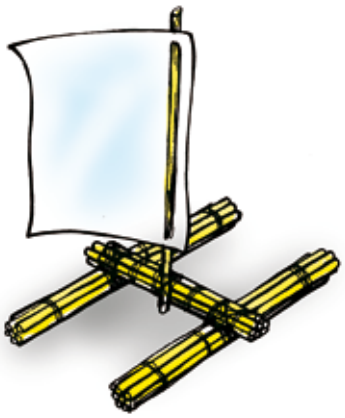


Activity 3: Creative design

Reed boats for the regatta on the river

The dried reeds are cut into approximately 20-cm-long pieces. The children each bind a handful of reeds with the string at each end, so that they are in bundles. Now the children lay two bundles vertically in front of them and bind them using a third bundle, which they lay horizontally on the first two bundles and attach with the string. The reed catamaran is finished. A single reed is stuck in the central bundle as a mast and a piece of paper is used for the sail.

Tip: If the reed boat is to be floated on a river where there is also shipping traffic, the children can note how many ships go past during the time they are at the river and what flags the ships are sailing under, what sort of noise they make and what happens on the banks as a result of the wash.



The future of freight transport on the Danube

Cargo ships on the rivers of the Danube basin mainly transport bulk goods. The use of goods such as coal or fertiliser is stable, though there is competition to transport it by rail. Packaged, high-quality products that have to get to their destination flexibly and quickly have so far usually been transported by road.

In order to make inland navigation profitable, and also to reduce the exhaust emissions caused by road transport, an attempt is being made to shift freight transport from the road to shipping. The use of container ships, roll-on–roll-off ships that can take articulated trucks, better service and the latest information systems in the harbours and locks – as well as versatile, more flexible cargo ships – can all contribute to this.

On the Rhine it has already been shown that it is possible to transport high-quality products on inland waterways. If there is increasing demand, growing numbers of shallow-draught ships can also be used. This would make discussion of the development of the shallow stretches unnecessary.

Background information

Danube tales

Downstream navigation

At some times in the past, the Danube, as well as other rivers, offered the only possibility for travelling. Routes or roads overland were arduous, dangerous, difficult or just not available.

From a historical viewpoint, Danube navigation has some special features. One of these is that for the descent (downstream), easily built "one-way vehicles" were often used, which were usually sold at their destinations. In 1781, the Berlin bookseller Friedrich Nicolai went by ship from Regensburg to Vienna. He had bought it for 55 guilder and was able to sell it in Vienna for 18 guilder. It was not unusual that a ship was broken up after it was sold, to be used as firewood or timber for construction; wood was always a much sought-after commodity in the towns. Or it was sailed further downstream, sometimes even as far as the Black Sea. Ships that were towed back upstream were well built and were sometimes used for decades.

Suggestion: Build ships of various materials (with or without historical models). A nice ending to such craft projects is to launch the boats together on the Danube or on another river or lake.

photo: Verein Donauschiffer

"Sieberin": This type of ship was used for the transport of salt.

Industry

4.5.

4.5. **Industry**

Water is part of everything

We use industrially produced items every day, for example, as paper, medicines, household chemicals, furniture, cars or food. Water is used in the production of all these goods and, if it is not sufficiently purified, the resulting waste water pollutes our waters. In addition, many factories need water as a coolant for production, and this is then released as warm water into the waterways. The industry has recognised its responsibility and is taking steps to reduce water consumption and to purify waste water more effectively.

Among the most important branches of industry in the Danube basin are the paper industry, the food production industry, the chemical industry, the fertiliser industry, the metal-working industry and mining.

Objectives:

The children learn ...

✔ that water is contained in almost all industrial products.

✔ what effects industrial waste water can have on water bodies.

✔ that they can contribute to the reduction of pollution of our rivers by buying particular environmentally friendly school materials.

✔ that by using the most up-to-date technology industrial plants are able to reduce their water consumption, their quantities of waste water and their emission of pollutants.

Materials:

Activity 1: worksheet “On the trail of the hidden water”, writing materials

Activity 2: worksheet “Water protection starts with the pencil”, writing materials

Activity 3: 10 old newspapers, a shallow vessel filled with 10 litres of water, a wooden spoon or a mixer, a rectangular frame with an insect screen or mesh stretched across it, cloths for drying, confetti, dried flowers or similar for decoration

Activity 4: writing materials, poster paper

Organisational points:

Duration: 3 teaching units

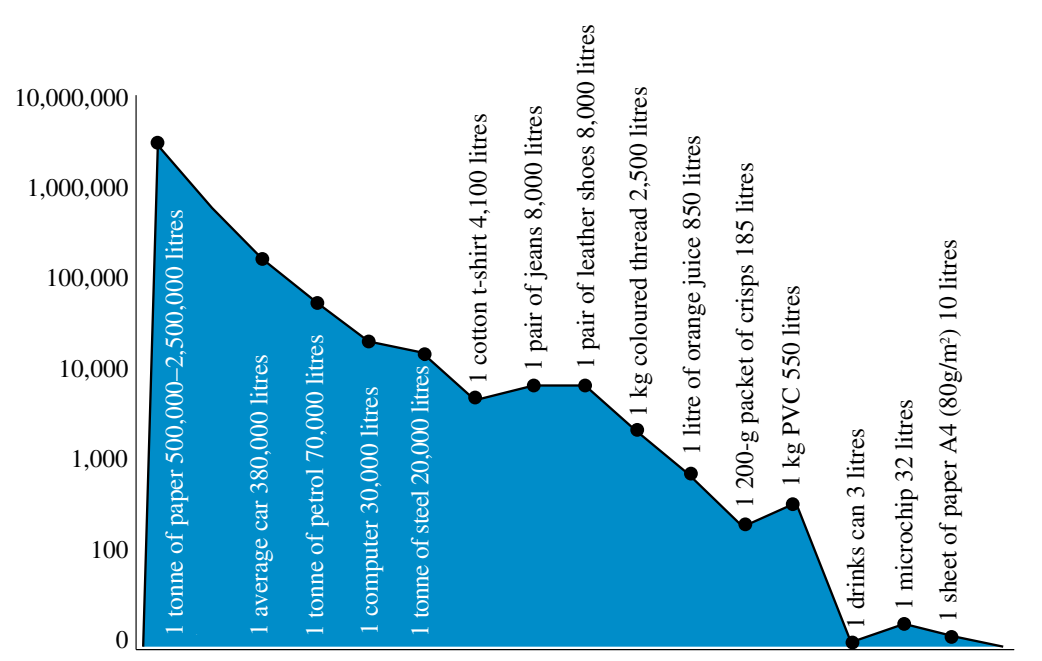
Location: classroom

Activity 1: Group work / discussion
On the trail of the hidden water

The children take the worksheet "On the trail of the hidden water" and match the water quantities with the products illustrated. The results are discussed and compared.

Water is often hidden in products where one would not expect it at all. Thus, for example, 380,000 litres of water is used in the production of an average car.

Water consumption in industry



Water consumption by industry accounts for 22% of the world-wide use of water. 70% of water use is for agriculture and 8% is used in households.

Every year, industry uses 7.9 bn cubic metres of water from the Danube basin. In addition to this there are another 15.4 bn cubic metres of water just for cooling purposes.

In many branches of industry water is one of the basic raw materials. It is used as the basis for the production of drinks for example. Water is very important as a working material in washing, as a solvent, for hydraulic transport and as a coolant. In Hungary, for example, 95% of water used in industry is used for cooling purposes.

Different products require different amounts of water, but only a few products need less water than their own mass. Most industrially produced products use from ten times to a thousand times as much water as their own mass during their production.

The quality of the products depends on the good quality and purity of the water that is used. In special cases, water has to be specially treated to a very high level before it is used in industry. The highest demands on water quality are in food production, paper production and the textile industry. For example, cooling water should be low in hardness-formers such as hydro-carbonates, so that scale does not form during warming and cooling.

Industrial plants cover their water requirements in part from the public grid, from drawing factory water from surface-water bodies, or from their own wells.

Background information

Activity 2: Group work / discussion

Be clever and use environmentally friendly school materials

In school it is important to work with environmentally friendly materials. In the worksheet "Water protection starts with the pencil", the children compare the suggestions on environmentally friendly school material with the things that are actually used in class. Then there is a discussion of what things one can sensibly buy jointly in order to make work in class more environmentally friendly.

Activity 3: Experiment

New for old: we make recycled paper

The children cut off the unprinted margins from the pages of 10 old newspapers and shred the paper into fine pieces. The scraps of paper are then put into a large bowl with 10 litres of water and stirred continuously with a wooden spoon (it is much more effective to do this with an electric mixer but not very environmentally friendly...). The remains of the newspapers dissolve into a pulp.

Using a home-made ladle frame or one bought in a hobby shop, some of the pulp is carefully ladled out. The pulp is spread out inside the frame by shaking it or using a smooth piece of wood. Now the children lay a cloth over the pulp in the frame and carefully press the water out. The whole thing is put on a table with a cloth underneath it and the frame is removed. While the paper is still damp, it can be decorated with

The effects of waste water from industry

Waste water from industrial plants gets into waterways either indirectly through the sewage system or directly through outflow into rivers.

Waste water from industry can contain organic pollutants, such as fat and carbohydrates, and nutrients such as nitrogen and phosphorous. These can lead to the over-fertilisation of water bodies and the sapping of oxygen levels through the decomposition process – which again leads to a change in the communities of life forms in the water bodies.

The waste water of industry affects the amount of heavy metals such as cadmium, lead, mercury, nickel or copper that is in the water of the Danube basin. Oil and other hydrocarbons, acids, alkalis, sulphur compounds and other chemicals such as solvents or dyes also come from industrial waste water.

Such dangerous materials are poisonous for water organisms and some are broken down only very slowly or not at all. Some materials, such as heavy metals, accumulate in animals and plants and can become very highly concentrated in the end consumers in the food chain, for example in fish and then in humans.

When cooling water is pumped back into waterways it usually has a higher temperature than the water in the rivers. Artificially heated water reduces the level of oxygen dissolved in the water. This encourages the mass reproduction of algae and can endanger the biological balance of the river, as animals and plant species that are adapted to low water temperatures and high oxygen content disappear.

Background information

confetti, dried and pressed flowers or something similar. Several pages of paper can be made in this way, and the paper is allowed to lie for several days to dry. The cloths with the sheets of paper can also be laid on top of one another and pressed with heavy books. Then put the sheets for drying on newspaper.

In this way children recycle used paper and get an understanding of recycled products made from waste paper.

How is paper made?

Especially in school, paper is used all the time. Large quantities of water are used in the production of paper and there are often environmentally damaging substances in the waste water from paper mills.

Paper largely consists of cellulose fibres a few millimetres in length; in addition there are mineral fillers to improve quality, and glue to make the paper colourfast. The raw material for paper production is primarily wood. Coniferous woods such as pine or fir and deciduous woods such as beech or poplar are used.

Waste paper is an increasingly important initial product when making paper and cardboard. First the paper fibres are recovered and made into a felt. To this end, the cellulose fibres are separated from other materials in the wood – lignin and hemicellulose – and the wood pulp is processed into cellulose.

In cellulose production the wood is ground down and then treated in various processes for several hours using chemicals and water. Depending on the treatment, sodium, sulphite or sulphate may be used in this process. The pulp is bleached using chlorine, oxygen or hydrogen peroxide. Then it is treated with fillers and glue, and has the water removed from it in paper machines. It is dried out on long sieves. In these machines the final web is produced, which is smoothed and rolled out.

The effects of papermaking on the environment

Papermaking from cellulose leads to the release of sulphur compounds. This can be identified from the typical "rotten eggs" smell. Fibres that are lost in the treatment process get into the water bodies and in decomposing there they consume oxygen that is essential to some wildlife, for example fish. The chemicals and other pollutants used in bleaching paper can end up being carried into rivers with industrial waste water. These can include very long-lasting poisons that are biologically degradable only with difficulty, or not at all.

It can also be done differently: papermaking from waste paper

Waste paper is broken down by soaking it in water and pollutants removing from it. Dyes and fillers are removed from this fibre pulp and disposed of as hazardous waste. Bleaching is done with hydrogen peroxide. In some recycled papers there is no bleaching at all and there is an emphasis on closed water cycles in the production process.

When recycled paper is made without chlorine bleach this helps to protect the rivers, and fewer trees are used in its production, compared with making "normal" paper from fresh cellulose.

Background information

Activity 4: Group work / discussion

What do industrial enterprises do for the water bodies?

The children consider what industrial plants are based in their surroundings and gather information from the businesses about the measures used to protect water bodies. The results can be displayed on a poster.

Information on CD-ROM: Chemical accidents in the Danube basin

Possibilities for industrial enterprises to protect water bodies

Production techniques that use natural resources and raw materials such as water efficiently, and reduce the emission of pollutants, help to improve the quality of water. Apart from this, industrial plants that convert to more environmentally friendly forms of production can often reduce the production costs of their goods. If pollution has not been allowed to develop, it saves the cost of removing it – which is what happened in the past and still often happens in production today. Modern industrial plants tend to use water in a closed cycle and above all to re-use cooling water. Toxins such as heavy metals can be removed from the waste water and recycled into the production process.

Many paper-manufacturing plants already have their own three-stage water-treatment plants.

In general, it should be standard practice to use the best available technologies to integrate environmental protection.

Background information

"On the trail of the hidden water"

How much water do you think it takes to produce the items illustrated below?

380,000 LITRES

10 LITRES

30,000 LITRES

8,000 LITRES

185 LITRES

"Water protection starts with the pencil"

Look at this list and tick the environmentally friendly school materials that you use in class.

Drawing paper made from recycled paper	
Wooden extension handle for pencils and coloured pencils	
Ink pot for re-filling a pen, instead of ink cartridges	
Unvarnished wooden ruler	
Large refill bottle for glue	
Unvarnished coloured pencils	
Exercise books made from recycled paper	
Solar-powered pocket calculators without batteries	
Glue without solvent	
Erasers without PVC	
Paintbrushes with wooden handles	

Danube tales

The Middle Ages on the Danube: the Danube as a trade route and robber barons as beneficiaries

In the course of the 12th century, the upper course of the Danube developed into a vibrant economic region. Most of the traders between southern Germany and Hungary used the Danube as a convenient trade route. Many Danube cities owe their economic flowering to the purposeful promotion of them by their rulers who granted them the rights to duties and tolls, rights of minting, rights of establishment and rights of preemption. From the upper course of the Danube trade route, primarily iron, wood, skins, furs, wool, parchment and the like were transported, as well as salt, of which great quantities were shipped down the Inn.

From the south, although in smaller quantities, goods from the Orient, such as velvet and brocade materials, cotton, dyes, glass, spices (cinnamon, sugar, pepper and saffron), incense and relics, were transported by caravans over the Balkans to Belgrade and from there upstream to the major trading cities. Long-distance trade with India and Greece was carried out via the Danube; however, this route was cut off when the Ottomans occupied and closed the middle Danube in the 16th century. As a result, the Danube lost its importance as a trade route. The main routes for central European trade shifted from central Germany over the Alps to northern Italy and the Mediterranean.

Some of the numerous castles on the Danube owned the toll rights to Danube shipping and thus profited from the merchant shipping. However, this was apparently not enough for some knights who increased their wealth by acting as robber barons, seizing and plundering merchant ships. They are said to have stretched iron chains across the shipping lane of the river and thus prevented ships from sailing further. One can assume that they were by no means squeamish in their methods. One of the supposed robber baron castles is Marsbach Castle on the Schlögen bend (Austria). Aggstein Castle in the Wachau valley (Austria) also became a robber baron's fortress several times, owing to its strategically favourable situation. In the 13th century, there are said to have been also bands of robbers in Golubac Castle at the Iron Gate (the Danube gap through the southern Carpathians).

Suggestion: The children read the sagas together and, to visualise the areas, mark the sites of action on the Danube poster. Then there is a discussion about whether there are similar stories in your region.

Suggestion: The children find out what goods are transported primarily by river today.

Numerous sagas tell of the dreadful robber barons, see additional texts on CD-ROM.

photo: TOS-Tourism Organisation Serbia

Fortress: Gobulac castle near the Iron gate in Serbia.

Unknown foods and spices

As a trade route, the Danube has always served for the exchange of goods among the people of all the countries of the Danube. This intermixing also affected the inhabitants themselves, and their languages and naturally their art, culture and customs of everyday life, such as what they ate. Unknown foods, necessary ingredients such as salt, coveted drinks and foreign spices were transported by ships from the east to the west and the other way round.

The story of the aubergine

In the 1530s traveller Hans Dernschwam mentioned a completely unknown shiny, dark purple vegetable he had encountered on his journey to Constantinople (Istanbul) on the Black Sea.

It was to take at least another 400 years, however, before the aubergine was actually used in the kitchens of the two westernmost Danube countries, Germany and Austria, and again this happened via the Danube. The following story recounts this. In the period from around 1900 up until the 1940s and 1950s, the "Bulgarian gardeners" left their mark on Vienna. Not only did their goods come by ship, but so did their seasonal labour.

In the 1930s, Petar pop Nikolov, a travelling gardener from the area around Târnovo in Bulgaria, offered the still unknown purple fruit on the Austrian markets. In order to be able to sell them at all, he himself prepared them for people at the market, and at the same time handed out recipes for them.

Suggestion: If one wants to save water when watering the garden, the ingenious canal system of the Bulgarian gardeners is a good alternative to the hosepipe and is still used in some private gardens in the Mediterranean **(see the explanation on the CD-ROM)**. Perhaps there is a place in the school garden that is suitable for this method of irrigation.

Flood protection

4.6.

4.6. **Flood protection**

With the river, not against it!

People in the Danube basin have experienced flooding and high water since time immemorial. Floods are natural processes that are part of the water cycle. However, the use of valley bottoms for settlement and infrastructure can lead to a lot of damage, or catastrophes in cases of extreme flooding. The elimination of natural flood retention areas through river regulation, flood defences and hydro power also contributes to this.

The object of sustainable flood protection is to protect people and property and at the same time to retain natural riverine landscapes. In addition to constructing flood-protection measures, it is also sensible to use natural inundation areas for flood protection. If rivers and wetlands have the space they need, the flood damage will be reduced.

Objectives:

The children learn ...

✔ to regard floods as a natural occurrence.

✔ that flood damage can be worsened through poorly considered human interventions.

✔ that technical flood protection is important but that natural inundation areas contribute to flood protection a great deal.

Materials:

Activity 1: writing materials, worksheet "Animals and plants on the river need floods to survive!"

Activity 2: two kitchen sieves, gravel, pieces of turf (take it off with a spade a few cm thick), 2 buckets, writing materials

Activity 3: poster paper, writing materials

Organisational points:

Duration: 2 teaching units

Location: classroom

Activity 1: Group work / discussion
Flooding is quite natural!

Regular floods are important events in unspoiled riverine landscapes. The plants and animals of the river are therefore adapted to recurrent floods.

The children fill out the gap text in the worksheet "Animals and plants on the river need floods to survive!" and learn about the effects of floods on natural river courses.

How do floods arise? Where does all the water come from?

Floods can be triggered by melting snow and rainfall. On rivers that have their source in the high mountains there is flooding in summer (e.g. on the upper course of the Danube), as at this time of the year the snow in the mountains is melting. Lowland rivers, which rise in lower mountains, are characterised by spring flooding (e.g. Morava, Prut). Flotsam and drifting ice, which float in the rivers during warmer weather in the winter, can block the watercourse and lead to flooding. In the mountains, flash floods can develop in smaller watercourses. Apart from this, mud and gravel slides can be triggered by heavy rainfall.

Floods are important for floodplain forests

Recurrent floods play an important role for the animals and plants of the river and they shape the landscape. A constant alternation between flooding and dry periods is characteristic of floodplain forests.

During floods, suspended material is deposited in the inundation areas and floodplain forests, thereby fertilising the soil. Floodwaters flush deposited material out of the side arms of the river and hollow out the banks, which then become steep, crumbling edges. In this way an important habitat is created for kingfishers, bee-eaters and sand martins, which build their breeding holes in the banks. Trees are undermined and roots exposed. This creates vantage points for cormorants, kingfishers and species of heron. Islands develop as breeding areas for birds and germination beds for plants. Ponds are created and serve as spawning grounds for amphibians. Flooded meadows are used as resting places by water birds and waders. Fish use flooded floodplain forests for feeding and breeding areas.

Natural inundation areas are important for people

Unspoiled floodplain forests are collection areas for floodwater and lessen the consequences of flooding. Floodplain forests and any natural inundation areas function like sponges. They absorb enormous amounts of water and release it only slowly. Floodplain forests are important groundwater reservoirs and contribute to groundwater filtration. Water seeps through the floodplain forests and is purified by the layers of soil and the plants.

Floodplain forests reduce the speed of the current during flooding and keep back mud. They humidify the air, absorb carbon dioxide and contribute to keeping the air clean.

Regularly flooded floodplain forests are nurseries for many species of fish. A good fish catch in rivers depends on these natural spaces. Floodplain forests are important recreational areas for people.

Background information

Activity 2: Experiment
The water-retention capacity of different soils

The children fill a kitchen sieve with gravel. Then they fill a second kitchen sieve with gravel and also lay pieces of turf (take it off with a spade some cm thick) on top. Now both sieves are placed over a bucket and one litre of water is poured first over one and then over the other sieve. Using stopwatches, the children measure how long it takes the water to flow through the different soil types. After all the water has flowed through the sieve, the children use a measuring jug to check the amount of water in the buckets. The measurements are noted and compared. The water flows faster through the sieve that only contains gravel. Approximately the same quantity of water is to be found in the bucket as was poured in earlier. The water takes longer to flow through the sieve with gravel and pieces of turf, and less water ends up in the bucket.

Soils with vegetation have the function of water reservoirs and so can contribute to flood protection.

Activity 3: Group work / discussion
Floods concerns us all!

With the help of the teacher and parents, the children collect information on their municipality's flood-protection measures.

Are all the rivers and streams regulated or are there natural flowing waterways and inundation areas? What did the municipality look like a hundred years ago? Are there areas in the municipality where houses have only been built after the river was regulated? Have any renaturation measures been undertaken on the rivers in the region and are there measures for ecological flood protection? What information can the municipality provide on flooding?

Once the results have been collected, the children design a poster and give a presentation to their fellow students on floods and its function in nature. They describe the technical and ecological flood-protection measures.

Tip: There is more information on flooding and more activities in chapter 5.2.

Information on CD-ROM: Flood-protection measures in the Danube basin
The effects of flood-protection measures on water bodies
Ecological flood protection on the Sava

Floods as a danger to people

Flood catastrophes take human life and cause damage worth millions of euro. In recent years there have been recurrent devastating floods in the Danube basin.

The flooding can endanger the drinking-water supply, if toxins from cesspits, chemical plants, oil storage tanks and waste dumps get into the water. Houses, roads, and electricity and telephone lines are destroyed.

People's behaviour can make it more likely that a flood will occur, for example when they build houses in areas at risk of flooding. As a result of river regulation, such as straightening and confining rivers behind dikes, through deforestation of mountain woodland in the catchment area, by sealing soil (by concreting over roads), and by building new houses which need sewage systems, the water flows off the ground faster and floods are ever more frequent and more severe. People in endangered areas also have less time to prepare themselves for floods.

What can be done?

Technological flood protection measures – dikes, valley barriers and collection basins – are important measures in flood protection. However, in order to provide sustainable flood protection, the natural water-retention power of unspoiled wetlands should be incorporated in planning. The best protection against floods is to provide as much space as possible for natural inundation areas.

Protective construction measures are an important component of flood protection. As far as possible, however, human intervention in natural processes should be reversed. Clean rainwater, for example, should be able to seep directly into the ground, and not be directed into the rivers through the sewage system. The river and its inundation areas can be given more space through renaturation and shifting flood-protection dams further back, so the water can take an alternative route and flow off as slowly as possible. Warning systems can be established to inform people in endangered areas of flooding as early as possible. People who live in areas with a high risk of flooding will have to be informed of the danger in good time. Houses should not be built in areas that are likely to flood. Material damage during floods is now greater than it was previously when there where floods at equally high water levels, as people are building ever closer to the water. Everyone living in high-risk areas must be involved in the flood-protection measures and also show their own initiative. We must learn to live with floods, to use inundation areas and to use technical flood protection measures.

Floods know no boundaries, and so flood-protection strategies and measures must be coordinated across state boundaries.

photo: ICPDR/ Igor Liska

Flooding: damage occurs throughout the Danube basin, for example in Bratislava or...

photo: Apele Romane/ Elena Talpau

...in Romania.

Background information

"Animals and plants on the river need floods to survive!"

Insert the right words in the text.

As a result of floods, fine mud is carried into the flood-plain forests and functions as _____ for the plants. The power of the flood creates steep banks that among other things are important for _____ because these small blue and red birds can build their breeding holes there. Tree roots that have been washed out by floods offer birds such as _____ good places from which they can fish. Fish such as pike and carp need flooded bankside zones and meadows to lay their _____ You see, floods are important for the survival of animals.

kingfishers

eggs

fertiliser

herons

Danube tales

Upstream navigation: towing

It was always easy to float downstream on the Danube with the current. In the other direction, at least in the upper course, the ships had to be towed, which was hard work. When the water level was high enough, the side arms and quiet inner sides of big river bends were used for towing. In the middle and lower course of the Danube, where it is wider, it was also possible to sail "uphill".

Donkeys were too weak and too slow for towing and oxen were difficult to transfer from one side of the river to the other, as one often had to change banks if rocks or other obstructions blocked the way. Horses were best suited for the work and were trained to jump obediently onto the swaying "horse boards" when a crossing was necessary. The size of the team of horses depended on the water level, the speed of the current, the type of the ship and its load. Old descriptions talk about boats being towed by between 10 and 60 horses.

In many countries people were used to tow boats, often in feudal or forced labour. When they towed, people or horses walked the towpaths that still exist on many sections of the banks. The first steamship in Austria with only 60 (!) horsepower and without horses harnessed to it started from Vienna to Linz in 1835. It took 55 hours for the stretch of approximately 210 km.

Suggestion: The towing power then and now can be easily compared using the physics measurement of "horsepower". The children are to find out by interviewing a ship's crew or from literature or the internet how much power the tugs use going upstream today. Can one also differentiate between types of ship today? What was the towing power in around 1800 and what is it today? How long does a tug need to travel of comparable stretch today?

Find a description of "towing" on CD-ROM.