



Water

Water is a **unique component** on our planet. It is also a product that is managed and sold, and as such it is the subject of various economic interests as well as complex social interrelations.

The **majority of the Earth surface** is covered by water, which is why it is known as the “Blue Planet.” Unfortunately, 97 percent of the water on the Earth is salty and cannot be used directly by people. The remaining 3 percent is fresh — meaning essentially “unsalty” — and is found in rivers and lakes, under the surface of the earth, in live organisms, and in glaciers on the poles and high up on mountains. According to research, only 1 percent of the whole amount of water on our planet is being used by people.

Physical and chemical characteristics of water

- Water is both simple and complex. The water molecule consists of just three atoms: two hydrogen atoms and one oxygen, but this structure turns it into a molecule of magical properties.
- Water molecules are attached to each other, creating hydrogen bonds. These strong bonds determine almost every physical characteristic of water and many of its chemical properties.
- Water is the only substance present in nature in three forms: solid, liquid and gaseous.
- Pure water at sea level boils at 100 degrees Celsius and freezes at 0 degrees. At higher elevations, where atmospheric pressure is lower, water's boiling point is lower. This effect explains why it takes longer to boil an egg at higher altitudes.
- Dissolving a substance in water lowers the water's freezing point. This is well known to people who, in order to prevent freezing in winter, scatter salt or add various substances to water to wash car windshields and windows.
- Water is called the universal solvent. It can dissolve more substances than any other solvent. There is hardly a substance known that has not been identified as soluble in the Earth's waters.
- Water molecules, as well as binding to each other, bind to many other substances, such as glass, cotton, plant tissue and soil. This is called adhesion.





Significance for life

- Nearly all substances become heavier and thicker when converted from a liquid to a solid state. Water, however, increases in volume and becomes lighter when it turns into ice. This property is of vital importance for sustaining life in basins during winter.
- A drop of rainwater falling through the air dissolves atmospheric gases. When rain reaches the Earth, it affects the quality of the land, lakes and rivers.
- Water can store huge quantities of energy, which can turn oceans, seas and lakes into giant heat reservoirs. This particular property influences climates in areas situated near water basins. It is also due to its energy-retaining quality that water is widely used for cooling and transferring heat in thermal and chemical processes.
- Water-surface tension is a measure of its surface-film strength. The attraction between water molecules creates a strong film, which among other liquids is surpassed only by mercury. This surface tension permits water to hold up substances heavier and denser than itself. Some aquatic insects, such as the water spider, rely on surface tension to walk on water.
- Water surface tension is essential for the transfer of energy from wind that creates waves. Waves are necessary for rapid oxygen diffusion in lakes and seas.
- In a thin glass capillary, for example, when molecules at the edge reach for and adhere to the molecules of glass just above them, they tow other water molecules at the same time. The water surface, in turn, pulls the entire body of water upward until the downward force of gravity is too great to be overcome. This process is called "capillary action," and it allows a sponge to be used to soak up spilled water. Without this property, the nutrients needed by plants and trees would remain in the soil.
- A large percentage of our blood is water. People must exchange about two litres of water per day in order to regulate their body temperature.



Water resources

- Places where water is preserved on land are called water basins. Fresh water can be found in:
 - rivers, lakes, puddles (surface water);
 - animal bodies, plant stems, fruits and leaves; and
 - under the surface of the earth (underground water).
- The differences in river flow regimes are apparent in western Europe (where flows are at a minimum in summer and late autumn), mountain-fed catchments (where flows are greatest in summer), and eastern and northern Europe (where most runoff occurs during the spring-melt period).
- Many European and Asian river flow regimes are heavily affected by human activities such as water abstraction and damming.
- Underground water is not well explored and is still a challenge for scientists.



Human interference

- Water is used for irrigation in the agricultural sector, for industrial purposes, as a heating or cooling element in industrial production as well as for daily purposes: drinking, personal hygiene, cleaning, leisure, etc.
- According to the European Environment Agency, in Europe roughly 33 percent of water abstracted for human use is intended for agriculture purposes, about 29 percent is for use in power station cooling towers, and about 25 percent is for household use (such as taps and toilets). The remaining 13 percent is consumed in manufacturing.
- There are various ways in which people damage the water reservoirs or pollute water:
 - Dumping rubbish into a body of water decreases water quality and destroys aquatic ecosystems.
 - Agricultural activities such as the dispersion of pesticides, fertilisers and other chemical products cause significant air and water pollution.

- Building a bridge or correction of a river's bed may cause changes in the river flow or the underground water level.
- Extraction of sand and rubble from a river destroys the river's banks and increases sedimentation.
- Industrial water discharge in a river without (or with inefficient) wastewater treatment is harmful to aquatic flora and fauna and affects human health.
- Large animal concentrations in intensive pig and poultry farms release a great deal of waste. Discharging this waste into a river without proper treatment can cause death to aquatic flora and fauna and affect human health.
- Spills of petroleum-products and chemicals destroy aquatic ecosystems.
- Rivers are often polluted by sewage and land runoffs.
- Many towns do not possess wastewater treatment facilities. Direct wastewater discharges into rivers destroy aquatic ecosystems.



Lesson plan: Sacred water

Duration	1-2 class periods
Time of year	Any
Place	The classroom
Materials	The Water Cycle pupil fact sheet, note board, a glass of drinking water, a glass capillary, a pot filled with water, a sponge, a carnation, ink
Aims	<ul style="list-style-type: none"> • To teach nature's water cycle • To teach the properties of water and its significance to living organisms
Methods	Demonstration, lecture, discussion, individual work, dilemma solving

Part I: Water cycle

- 1 Bring a glass of drinking water. Ask someone from the class to take a drink from it and say how old they think water is. Explain to the class that water is approximately 4.5 billion years old (the same age as our planet) and is in constant circulation between the Earth and the atmosphere. The sun and the wind make water evaporate from the soil, plant leaves, animal bodies, and from the surface of rivers, lakes and oceans. In this way water turns into vapour. Under certain circumstances the vapour condenses and falls back to the earth in the form of rain or snow. Some of the water reaches streams and rivers, often picking up other materials on its way during its flow. The rain replenishes the rivers and lakes. The rivers in turn flow into the oceans. Part of the rain falls through the soil and becomes underground water.



- 2 Hand out The Water Circle pupil fact sheet and together with the students fill in the names of the various stages of the water cycle.



Part II: Water: a unique component on our planet

1 Tell the students about some of the unique properties of water and its significance to living organisms by discussing the following questions (use the information from the beginning of this chapter):

- How many different physical forms can water exist in? Give examples.
- Why does ice form on the surface of water basins? What is the significance of this property for sustaining life in winter?
- Water can dissolve many substances. Give examples.
- The various substances dissolved in water lower its freezing point. Why doesn't sea and ocean water freeze in winter in the moderate geographical latitudes? What is dissolved in it? Give other examples of preventing freezing in winter from domestic life.
- Water can store enormous amounts of energy. Why are winters milder near the sea, and the summers cooler as compared to the mainland? Give examples from your country.
- Why are waves formed on the surface of water bodies? Where do hurricanes and typhoons start? Give examples of such phenomena from your country or in the world.
- Demonstrate the "capillary action" of water with a suitable glass capillary, mopping up the water with a sponge or putting the stem of a white carnation into water with ink in it (the latter demonstration takes longer). Explain the significance of this property of water for plants. What else goes up with the water?



2 Explain that water is everywhere. Hand out copies of the pupil fact sheet How Much Water is There In ... Have the students follow the lines to learn how much those particular objects are made of water. Discuss the results.

Lesson plan: Water and people

Duration	3-4 class periods
Time of year	Any
Place	The classroom
Materials	1-litre bottle, the test Do You Know Water? the fact sheet The Water I Use..., 2 plastic cups, a long needle, a nail, cellophane tape, a timer (stop watch) the fact sheet Sources of Water Pollution, A4 drawing paper, paints, felt pens
Aims	<ul style="list-style-type: none"> • To help students to see that in their daily routine they can conserve a lot of water • To show students that they can save water with small changes in their hygienic habits • To acquaint students with the various sources of river pollution • To seek ways to protect the purity of water basins
Methods	Lecture, discussion, test completion, individual work, brainstorming

Part I: The dowsers

1 Present to the students Part 1 – A terrible morning, of the story in the fact sheet The Dry Spring.

2 Discuss with the class:

- Why do the villagers have to leave the village? Why is water necessary in people's everyday lives (*for their personal needs: drinking, cooking, personal hygiene, cleaning, washing, water entertainment, etc; and for economic purposes: watering crops, producing various goods and offering services, for transport*)? Write the answers on the blackboard or on a flipchart. Let the students name various examples of water use.
- Discuss why the elders in the village chose dowsers for the important mission of finding a new place to settle. Explain that in historical perspective all settlements of the people have always been linked to water and have always been near to water (seas, rivers, lakes, etc.).

3 Explain that you have to work out the quantity of water each of us needs. To do this, first show the students a plastic or glass bottle of 1 litre. This will make it easier for them to imagine the daily need of different quantities of water. Hand out copies of the test How Much Water is There In..., and after they have completed it, give them the key and discuss the following questions:

- How many litres of water does the average European consume each day? (80-110 l);
- In which cases is water absolutely necessary? (for drinking and for food);
- In which cases can water be used more sparingly?

4 Give the students Part 2 – The new place, from the fact sheet The Dry Spring and comment on what the villagers could choose to do. Ask the children to advise the elders about various ways in which they could save water.

5 Explain that prudent use of water is important because the world is facing a global water crisis. Talk about cases in which water can be used more sparingly. Ask students to come up with their own ideas for saving of water in the following cases:

- preparing food and washing food products;
- washing up the dishes;
- machine washing of clothes;
- watering the garden;
- washing the car.



6 Give several examples using the information in the fact sheet The Water I Use. Hand out copies of the fact sheet and ask the students to prepare homework on their own plans for saving water, which they should discuss with their parents.

Part II: A bit of personal hygiene

1 Explain to the class that with some small changes of behaviour, or with various technical devices, everybody can save water in their daily cleaning habits. Tell the class that you are going to prove this with the help of a demonstration and a mathematical problem.

2 Demonstrate the following experiment:

- Take two identical paper or plastic cups and make the same number of holes in their bottoms (five or six). Use a big needle for one of the cups and a comparatively big nail for the other.
- Stick some cellophane tape to the outside of the cup bottoms.
- Ask two volunteers to fill the cups with the same quantity of water. Afterwards, simultaneously take away the tape from their bottoms. Students watch how long it takes for the water to pour out. Repeat the experiment several times to see the same thing happening again. You could use a stopwatch (timer) to give the experiment a touch of science.
- Tell the students that this represents a simple way to save water in the shower. Nowadays the market offers a rich variety of shower heads, with different functions, and some of them save water in exactly the same way. Tell students to give "expert" advice to their parents when they decide to buy a new shower for their bathroom.





3 Illustrate the following mathematical problem

- Ask the students how many times they brush their teeth each day. Ask a volunteer to go to the sink and show how this is done. (Note: in case there is no running water in the classroom, the student can explain the procedure).
- Set up a discussion on the possibility to have another, more economical way for brushing one's teeth. The brusher turns on the tap only when they have to rinse the brush or their teeth, and turns it off while brushing.
- Tell the class that at first impression this more economical way does not seem to have a significant water saving effect. However, in reality, if everybody practices this small change of behaviour, it can have an enormous effect. To convince the doubters, ask the class to solve the following problem:



Imagine that everybody in your family brushes his or her teeth with the water running the entire time. After you tell them how that you can all save water, they agree to change their habits and let the water run only when they rinse their brushes and teeth.

The parameters of the experiment include:

- Your family consists of five members.
- Every family member brushes their teeth twice daily.
- Tooth brushing usually takes about 3 minutes, and the average flow of the water is 2 liters per minute.
- The alternative, water-saving method saves 1 litre per person.

Ask the students to calculate:

- The volume of water used by the family when letting the water run continuously.
- The volume of water used by the family using the alternative method.
- The volume of water that can be saved for a day by your family.
- What would happen if 100 families from your town followed this example?

Key:

- 3 x 2 x 2 x 5 = 60 litres per day**
Explain to the students that if this is done for one year the result will be:
 $60 \times 365 = 21,900$ litres;
- 1 x 2 x 5 = 10 litres per day**
Explain to the students that if this was done for one full year, the result would be:
 $10 \times 365 = 3,650$ litres;
- 60 litres – 50 litres = 10 litres per day**
Together calculate the water saved by a family for one year (18,250 l).
For convenience, round off the figure to 20,000 litres or 20 cubic metres per family.
- 50 litres x 100 = 5,000 litres per day**
Together calculate the water saved by 100 families for one year
1,825,000 l (1,825 cubic metres) or, if you choose to round off, about 2,000 cubic metres.
Explain that with 2,000 cubic metres of water you could fill an Olympic size swimming pool (50 m x 20 m x 2 m).

Part III: Our river

This activity can be done with the class as a whole, or in groups if the class is large.

- 1 Make enough copies of the factsheet Sources of Water Pollution so that after cutting out the separate pictures there is one per student. Give each student a picture and ask him or her to draw part of the river on an A4 sheet of paper and write the source of the river pollution on it. Arrange the sheets horizontally. Tell the students to carefully read the text beside the pictures, which should stimulate them to be creative in their drawings illustrating the sources of water pollution.

- 2 When all have finished, collect the drawings and explain to the class that with their work they have covered a long part of the river, which is a centre of many human activities. In their own way, each activity affects the river's water. Put up the drawings on the note board in a row, supposing that the river flows from left to right. Concentrate on the polluters down the river. Ask each student to tell the class in what way their polluter reduces water quality. Make the class see that all human activities along the river have a negative impact on the quality of its water.
- 3 Explain that for millions of years the river's wildlife — both plants and animals — have adapted to the natural conditions. When human activities change the environment quickly, the wildlife does not have enough time to adapt and soon perishes. Remind the students that along with the rest of the living organisms, people also depend on the purity of the river's water, which they use for drinking, in their household, in industry, farming and water entertainment.
- 4 Ask students to give their suggestions for various activities aimed at protecting the river. Make a list of the most appropriate ideas. Pay special attention to those closely connected to daily habits and routines (*dumping garbage or sewage in the river, damaging its banks, etc.*)



Part IV: Princely tale

The story of *The Little Prince* was first published in 1943 and is the most famous book by the French aviator Antoine de Saint-Exupery, who wrote it while staying in a New York hotel. This timeless classic examines the profound and idealistic issues of life and love. In it Saint-Exupery imagines he has crashed his plane in the Sahara Desert, where he meets a young prince, who is from another world. Through their talks the author reveals his thoughts on the insanity of mankind and the simple truths which people forget when they become adults. More than 50 million copies of the novel have been sold all over the world.

- 1 Ask the students to make a short list of things that are important to them. Have some of them explain their lists.
- 2 Read the extract from *The Little Prince* on page 38 and ask the students to share their impressions. Lead the discussion in the direction of the people's habit of ignoring the simple and beautiful things surrounding us, just because they consider them to be too common and take their presence for granted.

Other activities

- Hand out copies of the test Do You Know Water? and have the students take it individually.
- Ask several volunteers to form a small group and to discuss the dilemma Drop by Drop in front of the others.
- Find out about the water resources in your town or village, and in your country.
- Organise a Day of Water, and present your research. March 22 is a suitable day, since it is the international World Water Day (observed after the initiative that grew out of the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, Brazil).
- Find stories, poems and proverbs about water.
- Make copies of the picture on page 130 and hand them out to the students to colour in.



DILEMMA Drop by Drop

You visit a friend and in the yard you see that his father, a hose in hand, is about to start washing the family car. You decide to:

- offer to help him;
- suggest that using a bucket of water and a brush to wash the car would save a lot of water;
- suggest that the car be taken to a carwash;
- say nothing, because you are shy and besides you think it is none of your business;
- do something else.



TEST Do You Know Water?

	TRUE	FALSE
1 Less than 50 percent of the surface of the Earth is covered in water.	<input type="checkbox"/>	<input type="checkbox"/>
2 On Earth, water is available in two physical forms.	<input type="checkbox"/>	<input type="checkbox"/>
3 Water can hold a huge amount of energy.	<input type="checkbox"/>	<input type="checkbox"/>
4 When various substances are dissolved in water, the freezing point of the water rises.	<input type="checkbox"/>	<input type="checkbox"/>
5 Only 3 percent of the water that people use is of vital importance.	<input type="checkbox"/>	<input type="checkbox"/>
6 It is wise to use drinking water to water gardens and wash down the pavement.	<input type="checkbox"/>	<input type="checkbox"/>
7 It is wise to use running cold water to cool things down.	<input type="checkbox"/>	<input type="checkbox"/>
8 The main polluters of water are industry and water transport.	<input type="checkbox"/>	<input type="checkbox"/>
9 Without water the Earth would be a desert planet.	<input type="checkbox"/>	<input type="checkbox"/>

Answer key: 1. False 2. False 3. True 4. False 5. True 6. False 7. False 8. True 9. True



FACT SHEET The Water Cycle



Evaporation As water is heated by the sun, it evaporates and rises into the atmosphere as invisible vapour.

1



Transpiration Water vapour is emitted from plant leaves by a process called transpiration.

2



Condensation As water vapour rises, it cools and condenses. It becomes a liquid again or turns directly into a solid (ice, hail or snow). These water particles then collect and form clouds.

3



Precipitation Precipitation, in the form of rain, snow and hail, comes from clouds.

4



Runoff Runoff is the visible flow of water into rivers, creeks and lakes as the water stored in basins drains out.

5



Percolation Some precipitation and melted snow moves down through the soil, percolates and infiltrates through cracks and pores in soil and rocks.

6



Groundwater Subterranean water is held in cracks and pores. It can be tapped by wells.

7



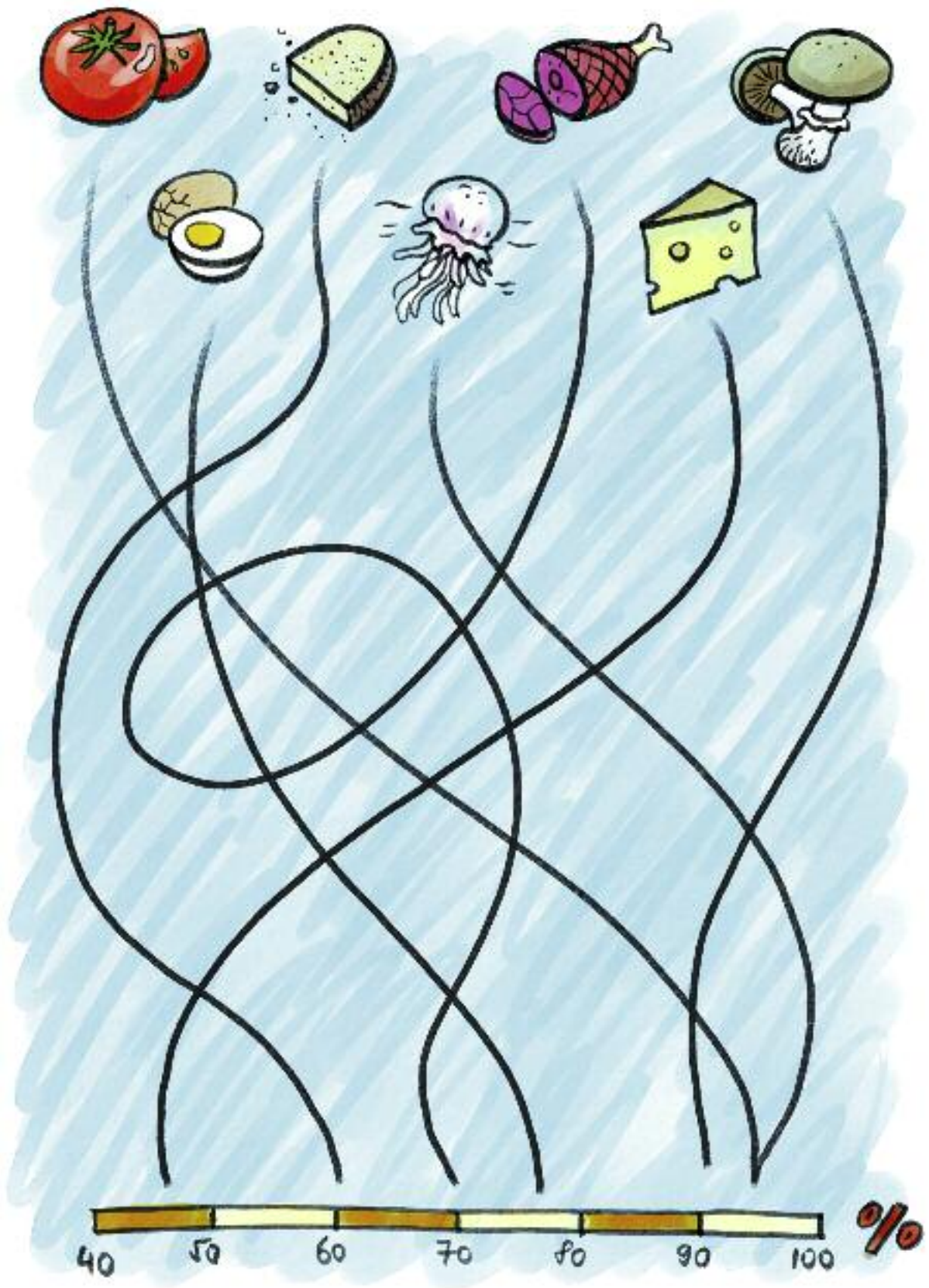
Water table The water table is the level to which water rises in an open well.

8



FACT SHEET

How Much Water is There In. . .





FACT SHEET

The Dry Spring



Part 1 – A terrible morning

One day the people in a small village woke up to find something terrible had happened. The only water spring they had, which sustained the life of the village, had run dry. The village elders got together and thought for a long time. They decided that they had no other choice but to leave the village, which had been their home for ages. They would have to settle somewhere else. They announced they would send three dowsers to find a new place for their future village.



Part 2 – The new place

After a long search the dowsers came upon a place suitable for a new village. The place was calm, the soil was fertile, but the spring they found was small and it could only give each villager 150 litres of water per day. The dowsers came back home and told the people what they had found. The elders gathered again and again began racking their brains. What should they do? Could they get along with so little water?



FACT SHEET The Water I Use

Personal hygiene



- Don't leave the water running while you are brushing your teeth or washing your hands and face.
- Think what you would rather do: take a bath (100-200 litres) or a shower (about 80 litres).
- Don't throw rubbish in the toilet.

Cleaning



- Before washing up, scrape the scraps off of the dishes.
- Don't soak the dirty dishes under running water — fill the sink with water instead. This saves 50 percent of the water you need.
- Use the full capacity of the washing machine.
- Pre-soak soiled clothes in a separate washbasin with water and washing powder.
- Use a bucket with soapy water to clean the car and only use the hose at the end.
- Wash balconies while it is raining.
- Use a broom to remove fallen leaves instead of a hose.

Cooking/drinking



- Put the plug in the sink when you wash fruit and vegetables.
- Don't chill food or drinks with drinking water.
- If you want to have colder water from the tap, don't wait for a long time for the water to run until it is cold, but rather keep a bottle in the fridge.

Irrigation



- Don't use drinking water to water the garden — use a well or rain water collected in advance.
- Water houseplants with water you had used to rinse clothes or dishes.
- Avoid watering when it is windy or hot, which is when water evaporates fastest.
- Use drip, which irrigation saves a great deal of water.
- Cover watered areas with straw or leaves to limit evaporation.



FACT SHEET

Sources of Water Pollution

**Ships, motorboats and jet-skis**

Water sports pollute the water with oil and petrol.

**Fertilisers and agricultural chemicals**

Fertilisers and pesticides pollute lakes and rivers when water washes soil off of farmland.

**Animals and farms**

Waste from farm animals often ends up in water bodies without being properly treated, killing plants and animals and harming human health.

**Sewage water**

Wastewater treatment centres can cause water pollution if they are not operating properly.

**Litter on beaches**

Poorly regulated beaches can quickly fill up with rubbish.





FACT SHEET

Sources of Water Pollution (continued)



Changes to the riverbank

Building bridges and changing riverbanks can alter river flows and groundwater levels.



Open mines and collieries

Extraction of sand and rubble from a river destroys the river's banks and increases sediment pollution.



Acid rain

Acid rain damages rivers, lakes and the fish and plants that live in them.



Industrial discharge in rivers

Industrial water discharge in a river with poor wastewater treatment is harmful to aquatic animals and plants and can harm human health.



Cars

People sometimes wash their cars next to a body of water and dump the used petroleum products in it.



FACT SHEET

Sources of Water Pollution (continued)

**Refuse dumps**

Dumping rubbish into a body of water decreases its quality and destroys aquatic ecosystems.

**Building sites**

The use of paints, oil and other chemicals at building sites can pollute water bodies.

**Poachers**

Illegal fishing and hunting techniques can harm water quality and destroy water ecosystems.

**Military activities**

Military activities can change the shape of the land and cause severe pollution of water basins.

**Heavy rains**

Rivers are often polluted by sewage and land runoff caused by heavy rains, floods and other natural disasters.





FACT SHEET

An Excerpt from *The Little Prince*

by Antoine de Saint-Exupéry



The well that we had come to was not like the wells of the Sahara. The wells of the Sahara are mere holes dug in the sand. This one was like a well in a village. But there was no village here, and I thought I must be dreaming . . .

“It is strange,” I said to the little prince. “Everything is ready for use: the pulley, the bucket, the rope . . .”

He laughed, touched the rope, and set the pulley to working. And the pulley moaned, like an old weathervane which the wind has long since forgotten.

“Do you hear?” said the little prince. “We have wakened the well, and it is singing . . .”

I did not want him to tire himself with the rope.

“Leave it to me,” I said. “It is too heavy for you.”

I hoisted the bucket slowly to the edge of the well and set it there — happy, tired as I was, over my achievement. The song of the pulley was still in my ears, and I could see the sunlight shimmer in the still trembling water.

“I am thirsty for this water,” said the little prince. “Give me some of it to drink . . .”

And I understood what he had been looking for.

I raised the bucket to his lips. He drank, his eyes closed. It was as sweet as some special festival treat. This water was indeed a different thing from ordinary nourishment. Its sweetness was born of the walk under the stars, the song of the pulley, the effort of my arms. It was good for the heart, like a present. When I was a little boy, the lights of the Christmas tree, the music of the Midnight Mass, the tenderness of smiling faces, used to make up, so, the radiance of the gifts I received.

“The men where you live,” said the little prince, “raise five thousand roses in the same garden — and they do not find in it what they are looking for.”

“They do not find it,” I replied.

“And yet what they are looking for could be found in one single rose, or in a little water.”

“Yes, that is true,” I said.

And the little prince added:

“But the eyes are blind. One must look with the heart . . .”

I had drunk the water. I breathed easily. At sunrise the sand is the colour of honey. And that honey colour was making me happy, too. What brought me, then, this sense of grief?

Irene Testot-Ferry, translation