

# 3

## WATER ON EARTH

### YOU WILL LEARN TO...



- Explain why water is so important for life on the Earth.
- Characterise the different bodies of water that are found on the Earth's surface.
- Recognise why rivers and seas are so important to human life.

- Do you know how much of the Earth's surface is covered with water?*
- Is there more fresh water or salt water on the planet?*
- Where can you find water in the form of ice on the Earth?*
- Can you name some of the seas and oceans on Earth?*
- What is the nearest body of water to you? What do you use it for?*

## Final task



### Drop by drop... it's disappearing.

Water is the source of life, but the scarcity of water is one of the biggest challenges facing many societies today.

Spain has great geographical diversity due to its varied climate and relief. In Spain, there is no water scarcity, but rather an unbalanced distribution, which requires hydraulic works such as wells, dams and water channels. However, there is sometimes water scarcity due to pollution and overconsumption.



What would happen if your town experienced a serious drought and your consumption of water was severely restricted? What if there was no drinking water? What measures would you have to adopt? In this unit, you will be part of a panel of experts dealing with water scarcity. You will participate in round-table discussions about these and other questions, to come up with ideas to use and preserve available water sources.

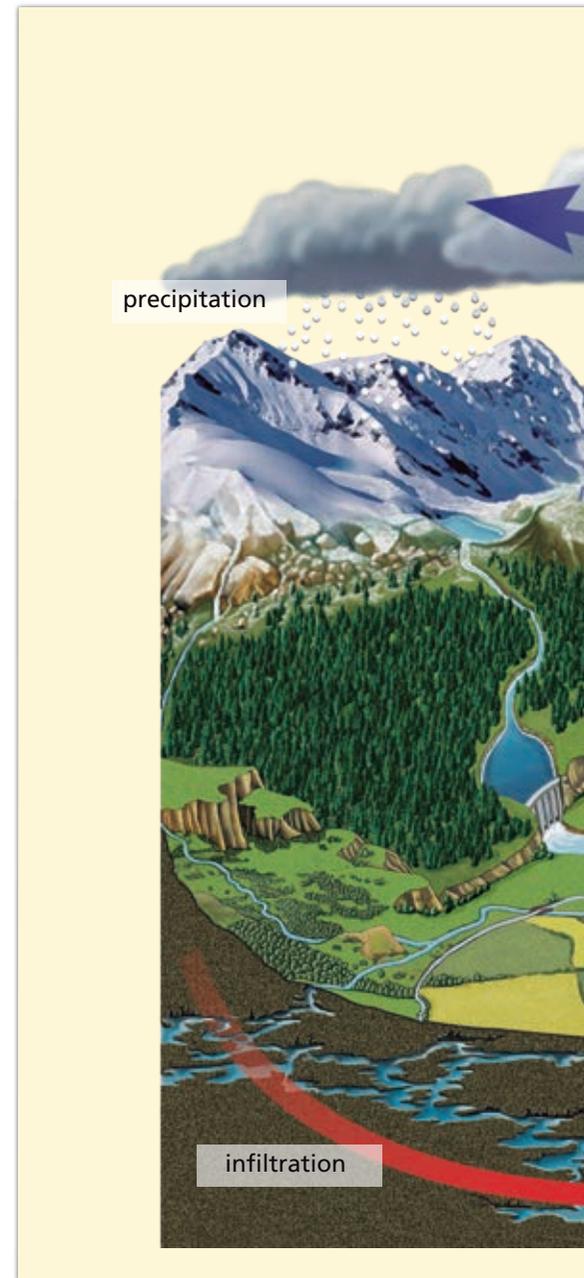
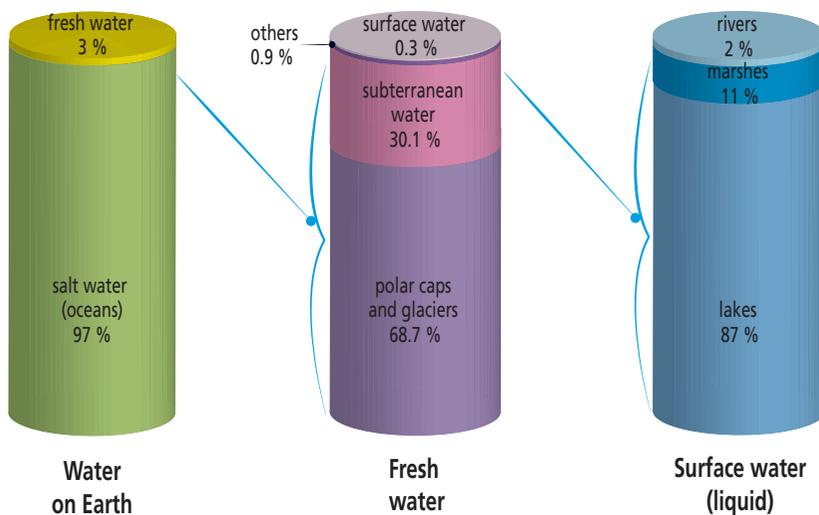
## 1. WATER ON EARTH

Water on Earth is composed of two parts **hydrogen** and one part **oxygen**. Water is mostly found in a **liquid state**, but it also appears as **vapour**, **ice** and **snow**. The combination of all the water on the Earth's surface, both fresh water and salt water, is called the **hydrosphere**.

**Salt water** makes up most of the water on Earth (97%). It is found in oceans and seas. **Oceans** are large bodies of salt water which cover more than two-thirds of the Earth's surface. **Seas** are smaller bodies of water which are surrounded by land on all or most sides.

**Fresh water** is a fundamental part of life for animals and plants, but it accounts for only 3% of the total water on the planet. Most fresh water is concentrated in the form of ice in glaciers, the polar caps and in underground deposits that are not easily accessible to humans.

A very small part of surface water comes from rivers (2%), where most of the water we consume comes from. For this reason, it is essential that we keep rivers clean and unpolluted, and use this important and limited resource responsibly.



### Important

According to the Royal Academy of Exact Physical and Natural Sciences, the **hydrosphere** is defined as 'all the waters that cover the Earth's surface, the external area of the planet where water exists in a gaseous, liquid and solid state (surface or underground)'.

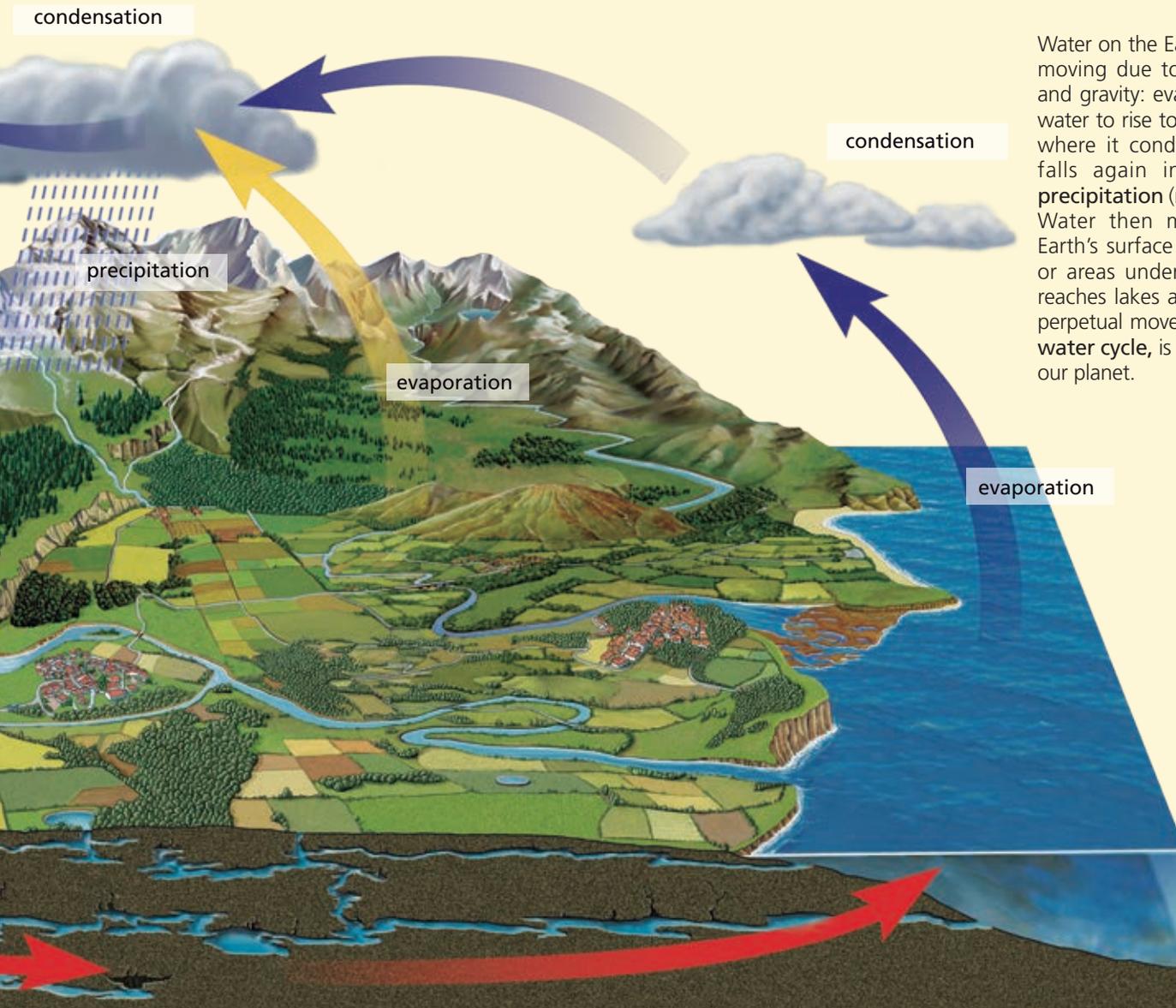
The Earth's hydrosphere also sustains life. Life first appeared in the oceans, in water and a high percentage of all living things is water (between 60% and 75% of the weight of living things is water.)

The Earth's hydrosphere  
Project Biosphere

Ministry of Education, Culture and Sport (Translated)

<sup>1</sup> **hail**: precipitation in the form of ice

## THE WATER CYCLE



Water on the Earth is constantly moving due to solar radiation and gravity: evaporation causes water to rise to the atmosphere where it condenses and then falls again in the form of **precipitation** (rain, snow, hail!). Water then moves over the Earth's surface (rivers, streams) or areas underground, until it reaches lakes and the sea. This perpetual movement, called the **water cycle**, is the key to life on our planet.

### Analyse

1. Read the text and look at the illustration above. Answer the following questions.
  - a) What is the water cycle?
  - b) In what forms is fresh water found on Earth?
  - c) Where does fresh water on our planet come from?
  - d) What are the forms of precipitation?
  - e) Write a definition of a river and a lake. Say if the water in each is fresh water or salt water.

2. Look at the diagrams on page 48. Answer the questions.
  - a) Is there more salt water or fresh water on Earth?
  - b) What percentage of surface water is made up of fresh water?
  - c) Where is the major concentration of fresh water on the surface of the planet?

### Create

3. Find out why sea water is salty. Write your conclusions in your notebook.

## 2. OCEANS AND SEAS

Water in the oceans and seas is characterised by temperature and **salinity**. For instance, water is salty in bodies of water in hot climates because **evaporation** is a major factor. The term for water at the polar caps is **glacier** because ice covers the ocean in those areas for most of the year.

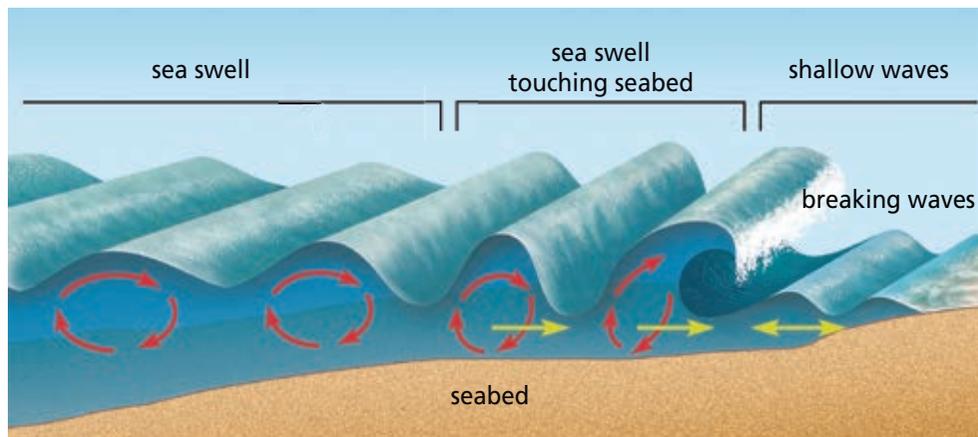
The movement of water in the oceans and seas generates **waves, tides, and currents**.



### 2.1. Waves and tides

**Waves** are a result of the **rising and falling movement** of water because of the pressure of **wind** on its surface.

The surface of water forms small circular movements that break close to the coast because of the shallow water.



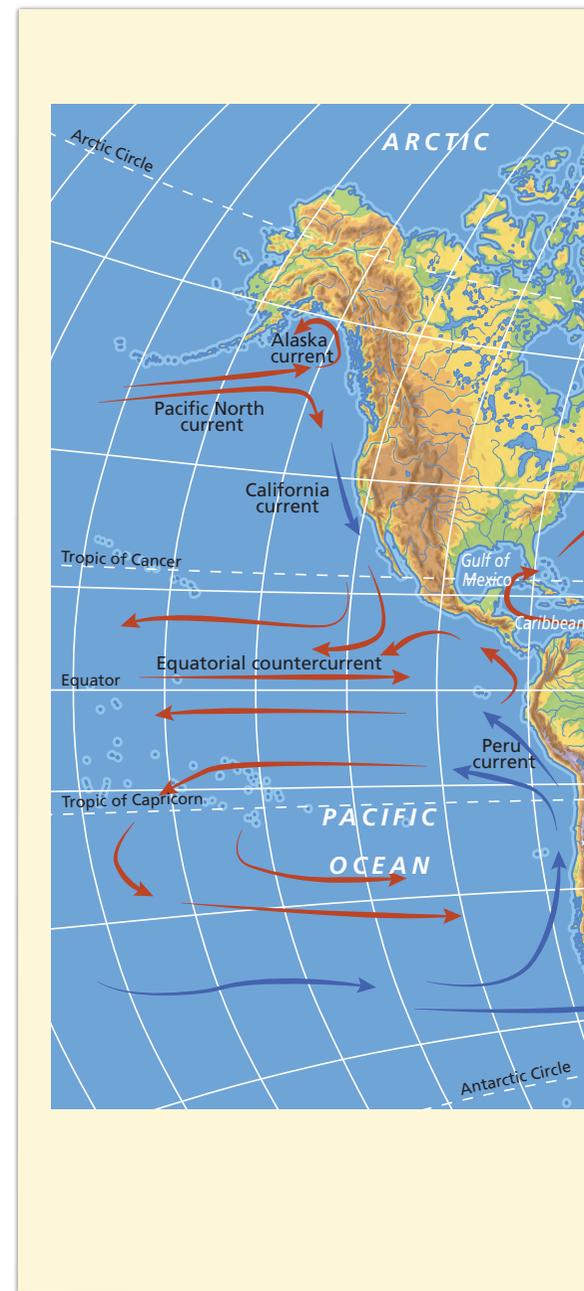
**Tides** are the **periodic changes** in the level of the water in the oceans and seas caused by the gravitational pull of the Sun and the Moon.

On the coast, the sea seems to move in and out once or several times a day. **High tide** is when the water reaches its highest point and **low tide** is when it reaches its lowest point.

### 2.2. Sea and ocean currents

**Sea and ocean currents** are **bodies of water** that, like rivers, move and create enormous circular patterns. They can be **hot or cold**.

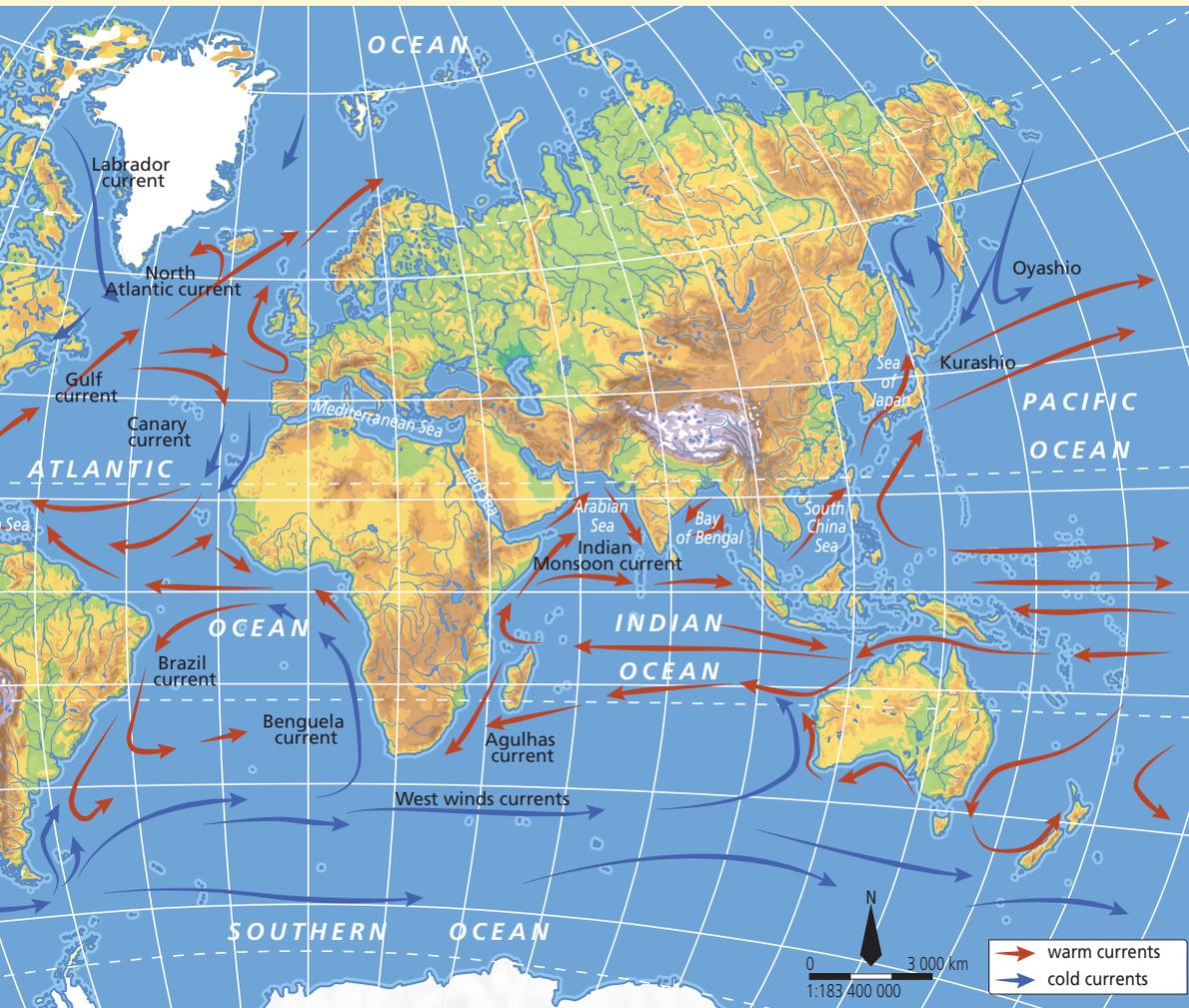
- **Hot currents** cause high temperatures and abundant rain on the coasts where they circulate. One example of this is the Gulf Stream, which originates in the Gulf of Mexico and flows along the coasts of Europe, facilitating settlement and economic activity in the area.
- **Cold currents** lower the temperatures and create deserts because the cold water doesn't evaporate and doesn't cause rain.



#### Did you know?

In Europe, the Baltic Sea has very low salinity, as it is located very far north and there is almost no evaporation. It also receives a lot of fresh water from rivers and glaciers. In contrast, the Mediterranean Sea, which is much further south, in a much hotter region, is much more salty.

## OCEANS, SEAS AND OCEAN CURRENTS



**Arctic Ocean** This ocean borders the coasts of North America, Europe and Asia around the North Pole. It is frozen in winter.

**Atlantic Ocean** This ocean separates Europe and Africa from America. Its main seas are the Caribbean, the Gulf of Mexico in America, and the North Sea, the Baltic, the Cantabrian Sea and the Mediterranean in Europe. The Mediterranean is connected to the Tyrrhenian, Adriatic, Ionian, Aegean and the Black Sea.

**Pacific Ocean** This is the largest ocean. Its main seas are the Sea of Japan, the East China Sea, and the South China Sea.

**Southern Ocean** This surrounds Antarctica. Like the Arctic Ocean, its waters are frozen in winter (summer in Spain).

**Indian Ocean** Located between Africa and southern Asia and Oceania, its main seas are the Red Sea, the Arabian Sea and the Bay of Bengal.

### Understand

- Which oceans are the coldest? Which are found in only one hemisphere?
- Which continents are bordered by the Atlantic Ocean? And the Pacific Ocean?
- Look at the **physical map of Europe**. Which seas border the Italian coasts?
- Look at the ocean currents that flow along the coasts of South America and southern Africa. What do they have in common?
- What sort of current flows past the Canary Islands?

### Analyse

- Locate the Atacama Desert and the British Isles on a map. Find out how ocean currents affect the climates of these areas.

### Create

- Read the text *The Oceans Compact* on the Internet. Write an essay about the importance of oceans for life and human survival. Include the effect of human activity on the oceans and the solutions proposed to stop their deterioration. Say which solutions you think are best.

## 3. CONTINENTAL WATERS

**Continental waters** are almost exclusively formed by fresh water. As we know, fresh water constitutes only 3% of all the water on our planet. This water is found under the ground (called groundwater) and on the surface (glaciers, lakes and rivers).

### 3.1. Rivers

**Rivers** are continuous currents of water. They don't disappear during dry seasons, which sometimes occurs in streams. Rivers that flow into other rivers are called **tributaries**.

The **flow rate** is the quantity of water that flows in a river at a specific point in its course. The flow rate increases during rainy seasons and decreases during dry seasons. The **river channel** is the space the water in the river occupies as it flows along its course.

The **river basin** is the area drained by a river and all its tributaries and underground springs that flow into it. Small rivers have small basins and low flow rates; large rivers can have basins of millions of square kilometres, and so have high flow rates.

The course of a river has three parts: the upper, middle and lower course.

MOST IMPORTANT RIVERS IN THE WORLD		
River (continent)	Length (km)	Flow rate (m <sup>3</sup> /s)
Amazon (South America)	7 062	230 000
Nile (Africa)	6 756	2 800
Chang Jiang (Asia)	6 300	32 000
Murray-Darling (Oceania)	3 672	760
Volga (Europe)	3 690	8 000
Mississippi-Missouri (North America)	5 971	18 000

In Spain, the Ebro is 930 km long and has a flow rate of 600 m<sup>3</sup>/s.

### COURSE OF A RIVER

#### Upper course

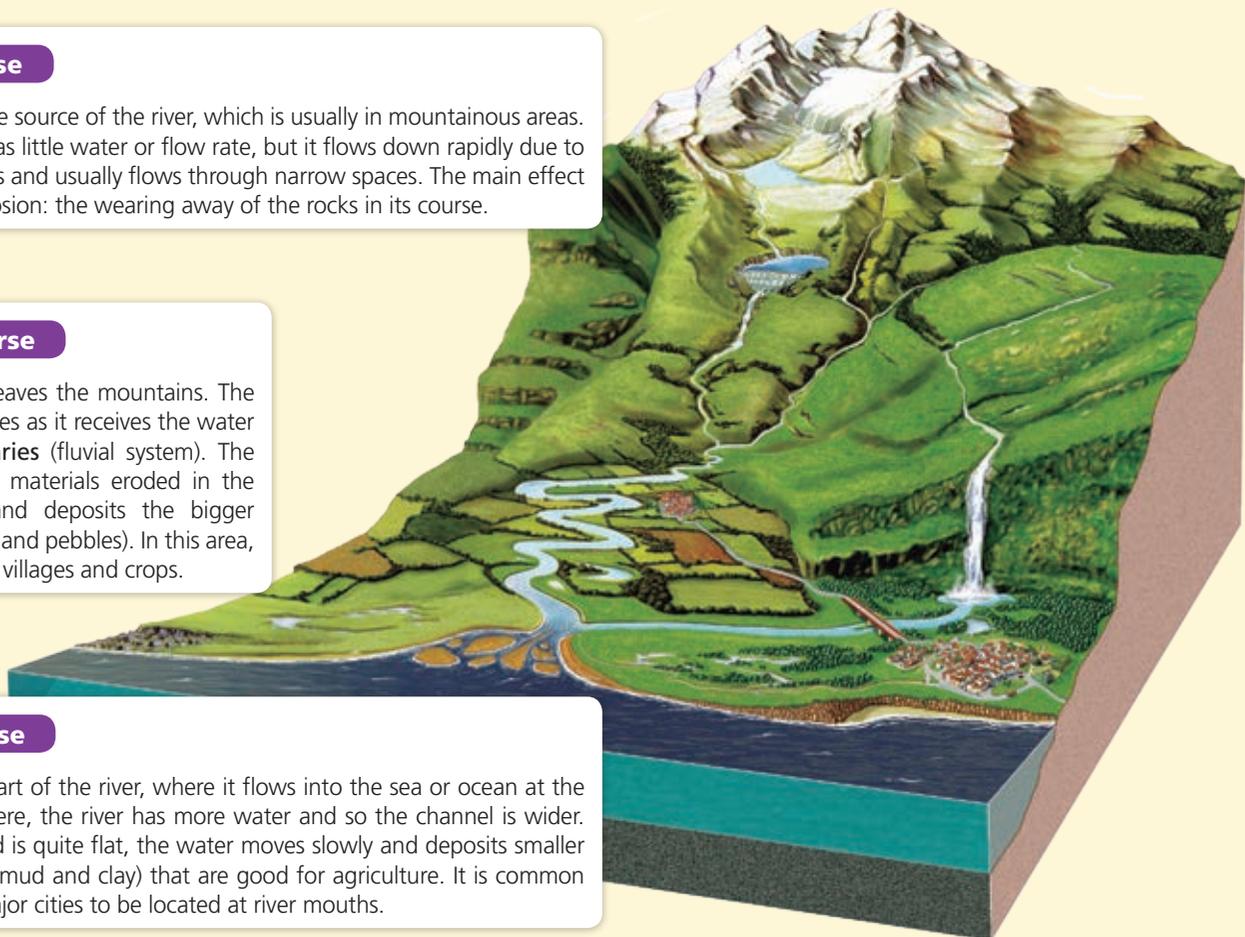
This begins at the source of the river, which is usually in mountainous areas. Here, the river has little water or flow rate, but it flows down rapidly due to the steep inclines and usually flows through narrow spaces. The main effect of the river is erosion: the wearing away of the rocks in its course.

#### Middle course

Here, the river leaves the mountains. The flow rate increases as it receives the water from its **tributaries** (fluvial system). The river **transports** materials eroded in the upper course and deposits the bigger materials (gravel and pebbles). In this area, there are towns, villages and crops.

#### Lower course

This is the last part of the river, where it flows into the sea or ocean at the **river mouth**. Here, the river has more water and so the channel is wider. Because the land is quite flat, the water moves slowly and deposits smaller materials (sand, mud and clay) that are good for agriculture. It is common for ports and major cities to be located at river mouths.



### 3.2. Lakes and groundwater

Lakes are inland bodies of **still water**. Small lakes are called **ponds**.

Lakes can be fluvial, when they originate from water from rivers; glacial, or coastal when they are formed from sand bars.

**Groundwater** is found in large deposits under the Earth's surface, called **aquifers**. Groundwater flows into rivers, lakes and springs. It is extracted using **wells**.

### 3.3. Glaciers

**Glaciers** are large **bodies of ice** that cover the polar regions or mountain summits<sup>2</sup>.



Aletsch Glacier (Switzerland)

The largest glacier is Antarctica, a continent covered with ice, located around the South Pole. It holds the largest concentration of fresh water on the planet. There are also large frozen areas of land around the North Pole and Greenland.

Large blocks of ice break off from these bodies of ice, called **icebergs**. They are moved by the ocean currents. Only 11% of an iceberg shows above the surface of the water.

Glaciers are also found in the mountains. They slide down the slopes, dragging rocks, sand, and mud and depositing them where the ice melts. These areas are called **moraines** and make natural dams<sup>3</sup> that create **glacial lakes**.

#### Did you know?



The largest lakes in the world are found in North America (Superior, Huron, Erie, Great Bear), in Asia (Aral, the Caspian Sea, Baikal) and in Africa (Victoria, Tanzania).



<sup>2</sup>**summit**: mountain top.

<sup>3</sup>**dam**: barrier that forms a water reservoir.

#### Analyse

- Look at the table on page 52, showing the major rivers of the world. Which is the longest? Which has the highest flow rate?
-  Look at the illustration on page 52. Listen and identify the courses of the river
- In Europe, the only places where there are glaciers are in the highest mountains, such as in the Alps, the Scandinavian Peninsula and Iceland. Can you explain this?

#### Create

- Find out why the Amazon and the Congo, one of the biggest rivers in Africa, have the highest flow rates and also have a very consistent and regular flow of water all year round. Write your conclusions in your notebook.
-  Read on the Internet about *The most accessible glacier in Norway (Nigardsbreen)*. Relate what the text says with what you already know about glaciers. Write an essay about glaciers.

## 4. THE IMPORTANCE OF RIVERS AND SEAS FOR HUMANS

**Rivers** and **seas** have been essential to human development, and still are today. The majority of the **world's population** lives on the **coasts** or next to **rivers**.

Humans, like plants and animals, need fresh water to live. This water comes mainly from rivers. For this reason, most cities are located next to a river. For example, Toledo – the **Tajo**; Sevilla – the **Guadalquivir**; Zaragoza – the **Ebro**; Rome – the **Tiber**; Paris – the **Seine**.



Alcántara (Cáceres), Roman bridge over the Tajo River and dam

However, many cities are located at the river mouth in order to have access to a port and have contact with people who live inland, further up the river. For example, Lisbon – the **Tajo**; Valencia – the **Turia**; New Orleans – the **Mississippi**; Alexandria – the **Nile**; Buenos Aires – **Río de la Plata**.

Rivers form valleys covered with sediments that they deposit, fertilising the land. People settled in these valleys and agriculture developed. The oldest civilisations grew around big rivers: Egypt, next to the **Nile**; Mesopotamia, along the **Euphrates** and the **Tigris**; India, on the banks of the **Ganges** and the **Indus**.

Rivers also provide energy for human activities. In the past, water was used to power mills. Today, water is used to produce electricity in hydroelectric stations. Rivers are also used as a means of communication when flow rate and depth allow navigation. Water is also extracted for use by industry and for recreation, such as water parks and gardens.

Like rivers, seas are closely connected to human activities and history.

The main activities related to the sea are:

**Navigation** Since the beginning of history, the sea has been used for travel, for exploring the world, trade or war.

Today, it is used mostly as a means to transport people and merchandise (transatlantic ships, oil tankers and cargo ships).



**4breed:** produce animals from existing ones.

## USING THE SEAS

**Fishing** In addition to fishing boats, today, there are marine farms which breed<sup>4</sup> fish or shellfish.



**Energy** In coastal areas, waves and tides are used to produce electrical energy. Wind farms are also installed on coasts to use wind energy for the same purpose.



**Mining** In ancient times, salt was extracted from artificial ponds on the coast. Salt was so valuable that some towns used it as a method of payment (this is where the word 'salary' comes from, the payment a person receives for doing a job). In Spain, there are salt flats in Torrevieja (Murcia).



**Leisure and sports** Today, this tourism is becoming increasingly important: beach tourism, holiday cruises, sailing and scuba diving.

### Understand

16. Look at a **map of Europe**. Notice that the major cities in the continent are next to or near a river. Explain why.

### Analyse

17. What type of products are extracted from the sea? What are they used for?

### Create

18. Where are the cities of Buenos Aires, New Orleans, Cairo, Vienna and Sevilla located? Indicate the continent each one is located on, which river they are next to, and which body of water the rivers flow into.



The Guadalquivir River flowing through Sevilla

## 5. RISKS AND PROBLEMS RELATED TO WATER

Water scarcity and extreme excess of water are both dangerous. A long absence of water can cause people and animals to die and the disappearance of vegetation. However, a sudden excess of water can cause damage to people and crops.

### 5.1. Flood disasters

Serious floods are often caused by summer or autumn storms, or when heavy rain falls in the mountains, or there is a rapid melting of snow. These rains last a very short period of time in mountain areas, but fall very quickly because of the steep incline, and they can destroy homes, infrastructure and crops.

Flood disasters also occur because of extreme weather phenomena such as **hurricanes** or **tornadoes**. In the summer months in Southeast Asia, **monsoons** occur. The summer rains last for months and cause slow, continuous flooding that covers crops and cities.

### 5.2. Water scarcity

Water scarcity occurs when there is very little precipitation or when humans extract more rainwater than the amount that has fallen, which seriously alters the level of water in rivers and lakes.

Today, there are extreme cases, such the Aral Sea, in Asia, which was one of the largest lakes in the world and is now almost completely dry. Lake Chad In Africa, on the edge of the Sahara Desert, is a similar case: in the 1960s it was 25 000 km<sup>2</sup> and today it is less than 1 000 km<sup>2</sup>.

In the coastal areas of the Spanish Mediterranean, the enormous demand for water used for intensive agriculture, tourism and golf courses has caused the depletion of underground aquifers that feed rivers and wells. This has serious consequences for the population.



### Important

*Water scarcity now affects all the continents. Nearly 1.2 billion people (almost one-fifth of the world's population), live in areas where there is a physical scarcity of water, while 500 million are nearing this situation...*

*There is enough drinking water on the planet to provide for the seven billion people who live on it, but the water is distributed unequally, wasted, polluted and not managed sustainably.*

*Water, the source of life 2005-2015  
Department of Economic and Social Affairs, United Nations*

#### Understand

19. Look at the image of the flood on the right and answer the following questions.

- Where does this type of disaster occur?
- Why does it occur?

#### Create

20. Write an essay explaining the consequences of an extended drought on the economy, on people and animals in an agricultural region.

21. Find out about major floods that have occurred in Spain. Explain their causes and consequences. Write the results of your research in your notebook. Add your personal evaluation of these events.



Flooding due to the overflowing of the river Ebro (Navarra)



### The oceans and seas

- The oceans and seas cover two-thirds of the Earth's surface. The oceans are the **Atlantic**, the **Pacific**, the **Indian**, the **Arctic** and the **Southern**.
- The movements of the water in the seas and oceans are **ocean currents**, **tides** and **waves**.



### WATER ON THE EARTH

- All the water on the Earth makes up the **hydrosphere**.
- Most of the water on Earth is in a **liquid state**, but it also appears in the form of **vapour**, **ice** and **snow**.
- Most of the water on Earth is **salt water** and is found in the **oceans** and **seas**.
- **Fresh water** is essential for animal and plant **life**, but it is only 3% of the total water on Earth.
- **Rivers** hold a very small percentage of the surface water on Earth. As rivers provide the water we consume, it is essential that we keep them in good condition, without polluting them, and that we use this scarce resource responsibly.

### Continental waters

- Continental waters are rivers, lakes, groundwater and glaciers.
- **Rivers** are continuous currents of water.
- **Groundwater** is created by enormous deposits under the Earth's surface, called **aquifers**. Water is extracted from wells.
- **Lakes** are large bodies of permanent still water.
- **Glaciers** are large bodies of ice that cover the polar regions and mountain summits.



### The importance of rivers and seas for humans

- **Rivers** were fundamental to the development of the first civilisations.
- Most major **cities** are located next to a **river**.
- The **seas** are important **means of communication** and provide important resources for the **development** of human societies.

### Risks and dangers related to water

- Both the scarcity and the excess of water can cause **disasters** (**floods** and **droughts**).
- Floods can cause serious damage to towns, villages and crops. An extended drought can cause the death of people and animals and the disappearance of vegetation.



22. Find Europe on the map below and locate the following seas and rivers:

- |                 |                  |
|-----------------|------------------|
| 1. Baltic Sea.  | 4. Black Sea.    |
| 2. River Rhine. | 5. North Sea.    |
| 3. Volga river. | 6. River Danube. |

26. Look at the map of Europe, or another with more detail. Follow the course of the Danube River. Identify:

- the countries the river crosses
- the cities located on its banks
- the sea it flows into



23. On the map above, you can see that Europe has many rivers. Explain why. Where are the longest European rivers? Explain why.

24. Look at the map on pages 50 and 51. Why are there cities on the northern coasts of the European continent, but not on the far northern coast of North America?

25. Make a fact file in your notebook with the differences between the upper, middle and lower courses of a river. Include the following factors:

- Flow rate
- Incline and speed
- The main action of the river in each course (erosion, transportation or sedimentation)
- Uses (if there are any)

Include a drawing of a river and its different courses.

27. Look at the photo of an area of Aragón. What has happened? What caused it? What damage does it cause?





28. Look at the photo and answer the questions.

- Where is this type of lake found?
- Where is its source?
- Where are there many lakes like this in Spain?



29. Look at the image below and find out about the formation shown.

- What it is called?
- Where are these formations found?
- How is it formed?
- What percentage of its mass is above the surface of the water?
- What historical disaster was caused by one of these formations?



30. Copy and complete the sentences in your notebook.

- The quantity of water that is carried by a river at a specific point in its course is called the \_\_\_\_\_.
- Salt water constitutes \_\_\_\_\_ % of the water on the planet. It is found in \_\_\_\_\_ and \_\_\_\_\_.
- The movements of water in the seas \_\_\_\_\_, \_\_\_\_\_ and \_\_\_\_\_.
- Floods can be caused by extreme weather phenomena such as \_\_\_\_\_ and \_\_\_\_\_.

31. Read the following text about a natural disaster which had catastrophic consequences. Analyse the phenomenon and explain how it was caused and how it could have been avoided.

On 7th of August, 1966, a summer storm hit the town of Biescas (Huesca) located in a valley in the Pyrenees. The Arás torrent, next to *Las Nieves* campsite, increased its flow rate very quickly as a result of the 160 mm of rainfall produced by the storm in a very short time. The flood that was caused pulled masses of rocks and trees along with it, down the steep slopes and valleys.

In the end, the water destroyed the campsite causing 87 deaths and 183 people were injured in one of the worst flood disasters in Spain ever.



32. Read the following quote by Arthur Clarke, British author of *2001: A Space Odyssey* and write comments.

*How inappropriate to call this planet Earth, when it clearly should be called Ocean.*

33. Write a paragraph explaining your thoughts on how we use water and its importance for humans and for life on Earth.

# Drop by drop... it's disappearing

Imagine that in the area where you live there is a period of prolonged drought and that the supply of drinking water may soon be at risk. You are going to form a round table of experts to examine the situation and propose different measures of conserving and using the available water.



In big groups or individually

## MATERIALS

- Card or continuous paper
- Felt-tip pens
- Notebooks
- Computer with Internet access

## Preparation



Form teams of experts of four or five students. Each one represents a specific segment of the population or people who work in services that use water. These could be:

- A farmer who needs to water his crops.
- The manager of a water park who needs water to fill the swimming pools.
- A family who needs water to drink, clean the house, wash clothes, shower, ...
- The town hall that needs water for the gardens, streets and fountains.

## Procedure



1. Begin by reflecting on the need for water in the world. If you can, find out about the United Nations Millennium Development Goals. Goal 7C is related to access to drinking water.
2. Look for information on the importance of water in general for our society. For example, news related to water scarcity in Spain and the areas which have been most badly affected throughout history and the implications, especially in the summer months, when there is more risk of drought and forest fires.
3. Decide which group of the population or service that uses water your group will represent. Then, analyse the consequences of water restrictions. For example:
  - Farmers would lose crops that would put their livelihood in danger.
  - Water parks and public pools would close, which would affect our leisure activities and our enjoyment at the hottest times of the year.
  - The lack of water to drink, to clean homes and for personal hygiene could affect our health.



Information about uses of water:

<http://inicia.oupe.es/gf1ebi0303>

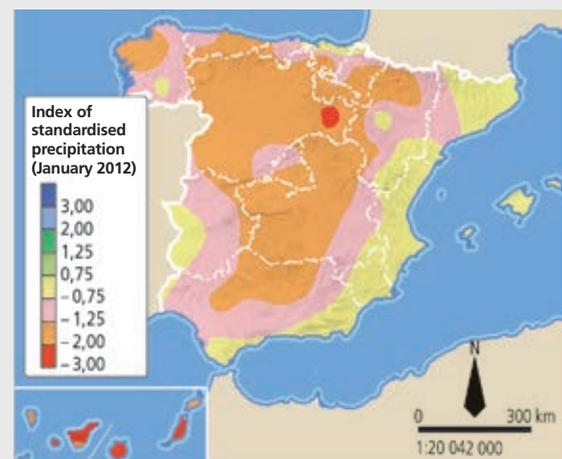
Information about the Millennium Development Goals:

<http://inicia.oupe.es/gf1ebi0304>



*Water is essential for the survival and well-being of humans, and it's important for many sectors of the economy. Water resources are distributed unevenly in space and time, and are overused due to human activities. How can we satisfy a demand that grows every day?*

*Summary of the second report from the United Nations on the development of water resources in the world: Water, a shared responsibility*



Source: <http://inicia.oupe.es/gf1ebi0305>





- Find out which types of water resources there are in your area (fresh water that is found in rivers, streams, aquifers, reservoirs, lagoons, etc.), and investigate how it is exploited and how much water is supplied. For example, do you know why dams and reservoirs are built?
- Find a water treatment or wastewater treatment plant near your town, make notes on how it works, and reflect on the importance it has for daily life.

Example of how a water treatment plant works:  
<http://inicia.oupe.es/gf1ebi0306>



- Look for examples of misuse of water and think about ways that help to resolve or reduce the dangers of the situation, so that people can continue using it as a basic resource that can be shared and conserved.



## Communication and Publication



With the information obtained, each group will make a poster with images and texts showing the importance of water in our daily life and the methods we can take to use and conserve it. Include the most original and creative slogans your group has written. The posters will be exhibited in the classroom and later a round table will be formed to share the information obtained. One student will take notes and make one list of the measures each group proposes to save water. This list will be hung next to the posters, visible to everyone.



## SELF-ASSESSMENT



- List the uses of water.
- What relationship does water have to our health?
- Explain where drinking water comes from and how it gets to your home.
- What arguments would you use to convince someone of the importance of not wasting water?
- Make a list of possible actions that can be taken to make use of and conserve water resources where you live.
- Which of the posters that the groups have made do you like the most? Why?
- What have you learned from the posters and the information presented by the other groups at the round table?
- How did you work in your group? How have you contributed to the success of the task?