Emma Näslund-Hadley, María Clara Ramos, Juan Paredes, Ángela Bolivar, and Gustavo Wilches-Chaux

Topic 3:

Water to Treasure

Lesson Plans for Children and Youth

Rise Up Against Climate Change!

A school-centered educational initiative
of the Inter-American Development Bank

IDB

Rise Up

Against Climate Change

A school-centered educational initiative of the Inter-American Development Bank

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Rise Up Lesson Plans

Our Climate Is Changing

Energize!

Water to Treasure

Intelligent Consumption

Sustainable Cities for Smart Urban Growth

You Are What You Eat

Ensuring Healthy Environments

Protecting the Land

People Committed to Fight Climate Change

IDB | 2016

Rise Up

Against Climate Change

Rise Up is a climate change education initiative of the Inter-American Development Bank that seeks to encourage children and youth to use their creativity and energy to come up with feasible, sustainable, long-term strategies to mitigate and adapt to climate change. This set of lesson plans is one of nine on different climate change topics that can be used independently or together with the other lesson plans and materials of the Rise Up initiative, including instructional videos, learning games and a Green School Toolkit. Each set of lesson plans includes an introductory text about the topic that can serve as background material for the teacher or as a text for older students. The lesson plans can be used at the primary and secondary levels of education; they are divided into basic, intermediate, and advanced plans to help each teacher determine what activities are appropriate for his or her students. To find all the Rise Up materials please go to **www.iadb.org/riseup**

Emiliana Vegas, Chief, Education Division,
Inter-American Development Bank

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General Introduction to the Lesson Plans

"We are mostly water." True or false? Strange as it may seem, it's true! Our bodies are 75 percent water. In fact, some animals such as jellyfish are up to 99 percent water—about the same amount as a human embryo!

All living things need at least some water, and all also return water to the environment. We renew ourselves constantly through water; if we didn't, we would die.

Basic facts about the Earth's water

Where does water come from? Scientists don't know for sure, but the most widely accepted theory is that most of the Earth's water came from outer space when icy comets hit the planet as it was forming.[1]

Water makes up three-quarters of the Earth's surface. It adjusts to its environment, changing from ice to snow and rain to mist. Its journey is never-ending, driven by the wind, temperature changes, and the energy of the sun, by gravity, and by the movements of the planet. Evaporation and precipitation carry it through the air; while on Earth, it travels through the soil and subsoil before evaporating once more.

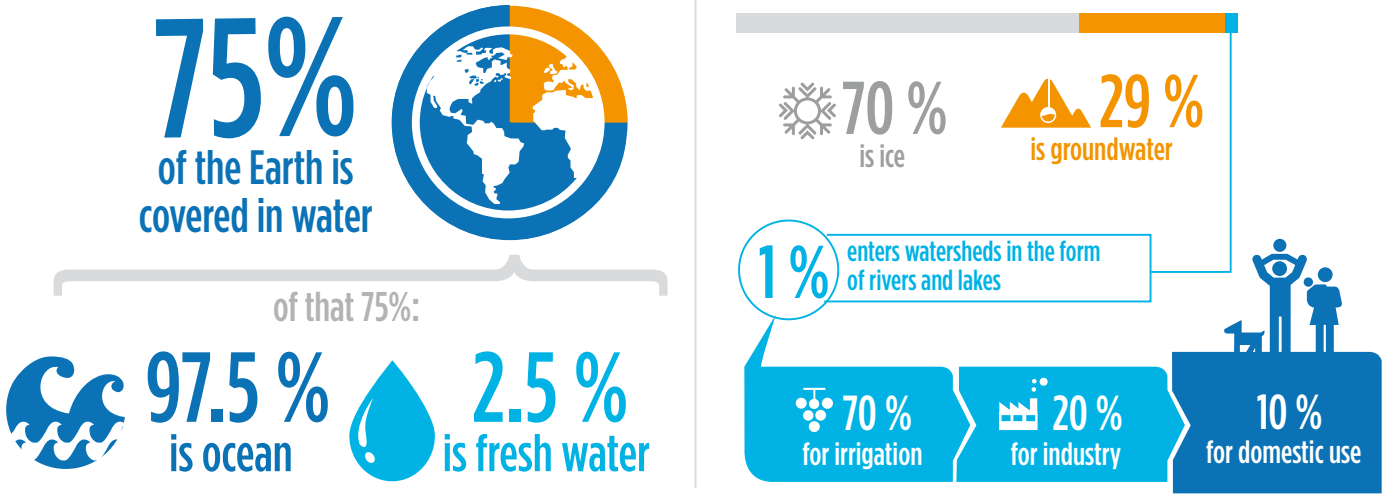
But it also supports life, including the plants that use water from rivers, lakes, marshes, wetlands, and the soil.

There is a lot of water on Earth (a total of 1.4 billion km^3!), but we can use only a small fraction of it because 97.5 percent of it is salt water and only 2.5 percent is fresh (figure 1). Not all of that 2.5 percent is available, either, so living things, including humans, actually survive on just about 1 percent of the total water on Earth![2]

1 Some sources on this subject: http://ciencia.nasa.gov

2 World Water Assessment Programme, United Nations, 2006.

Figure 1. Basic facts about the world's fresh water

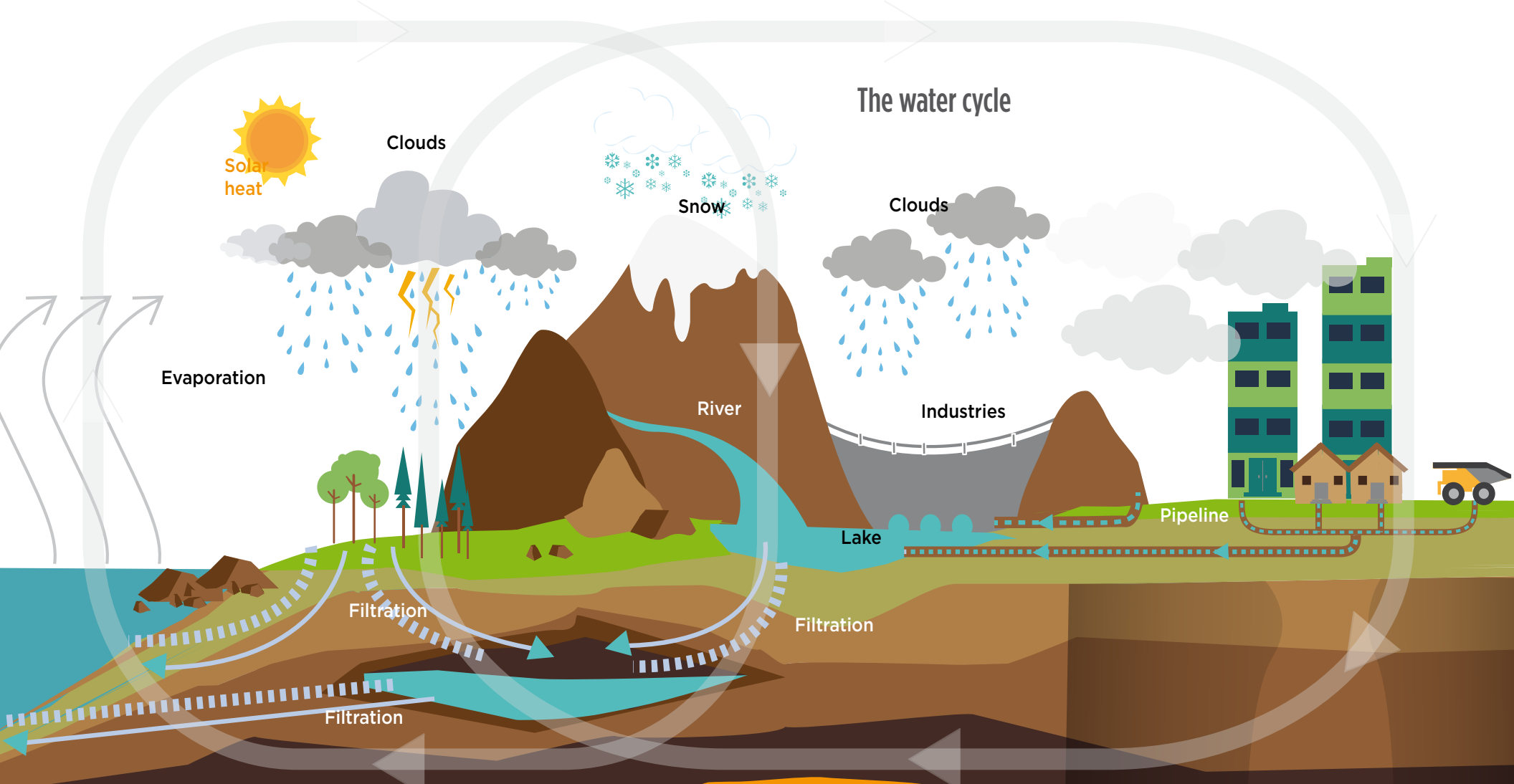


People used to think that it was ok to dump waste into the oceans, since our world has so much water. But now we know that heavy pollution overwhelms the filtering and cleaning capacity of the water cycle; and using oceans as trash buckets is polluting the lakes and freshwater rivers from which we get our water.

The amount of water on Earth is constant. It changes places and states (solid, liquid, gas), but nothing on Earth can make more of it. Ecosystems are water collectors and redistributors but not "producers," since they can't make water. However, neither does water leave the Earth. It's held here by the atmosphere, moving between the tropospheric and the stratospheric limits of the water cycle (figure 2).

As fresh water becomes increasingly scarce on the Earth's surface, people are extracting more and more ground water to supply households, agriculture, industry, and power plants. This has led to declining water reserves and resources on the planet. We need to stop this trend by conserving water as much as we can.

Figure 2. The water cycle



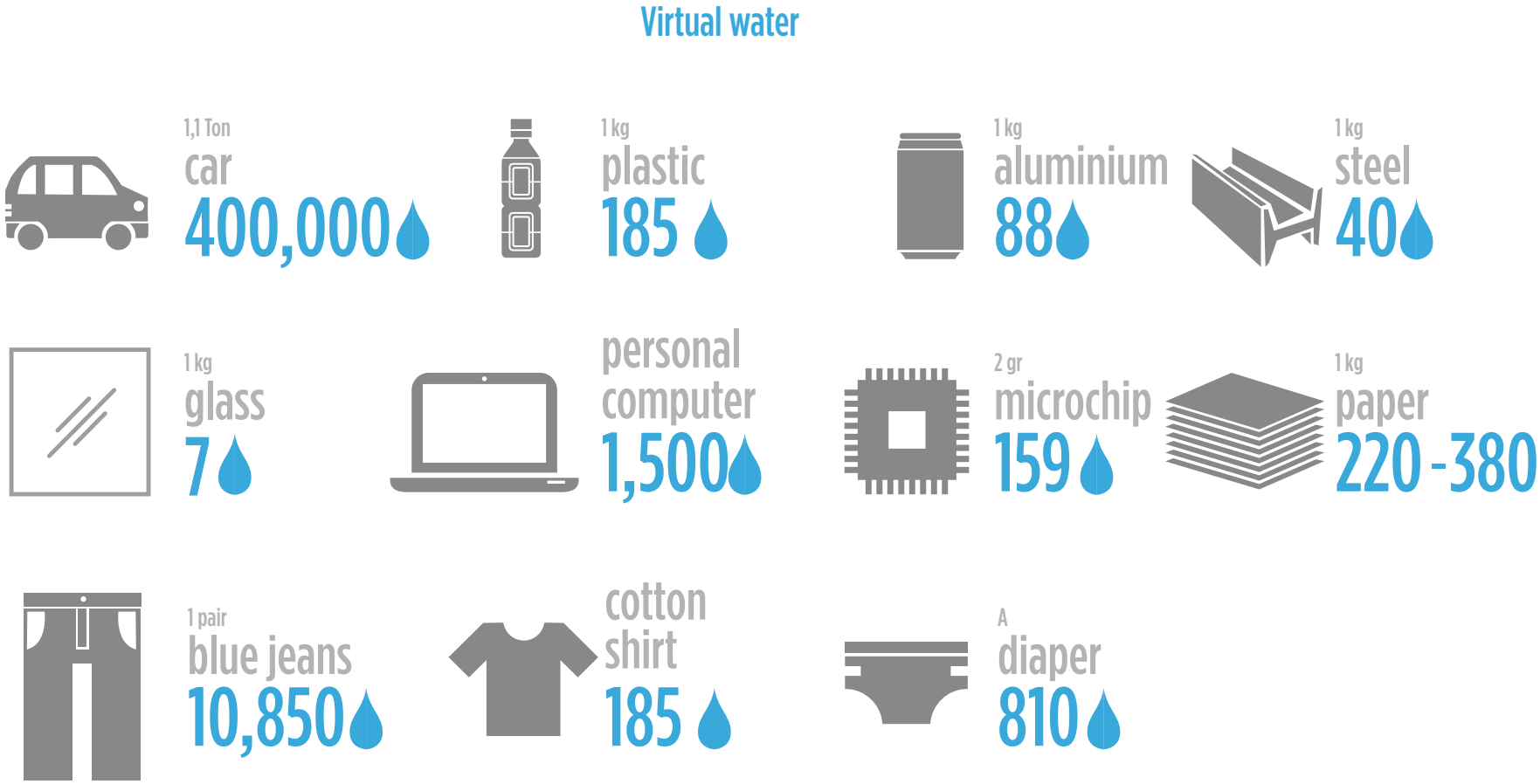
Water and the production of the goods we consume

We all use a lot more water than we think. Besides the water we use for drinking, cooking, washing clothes, and bathing, an enormous amount is needed to produce the foods we eat and the products we use every day.

Figure 3. The amount of water used to produce common products

The Virtual Water Indicator shows the average amount of water it takes to produce various foods and products (figure 3). While they are not exact amounts, the indicators give us a general idea of how dependent we are on water, and why it's so important that we use it wisely.[3]

3 Data are taken from the publication "Agua," from the pavilion under the same name at Expoagua Zaragoza 2008.

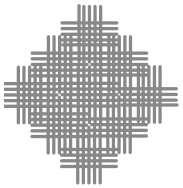


150 gr
hamburger
2,400

1 liter
soda
13,5

1 kg
cement
35

1 ton
oil
10,000

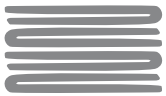


1 kg
synthetic fiber
5,600

A
newspaper
570

250 ml
beer
75

1 pair of
leather
shoes
727



cotton
sheet
9,750

1 sheet of
paper
10

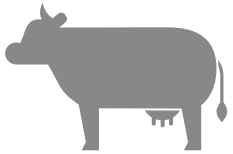
= Liters

1 kg
rice
2,656 💧

1 kg
corn
450 💧

1 kg
potato
160 💧

1 kg
soy
2,300 💧

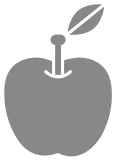


1 kg
beef
15,977 💧

1 kg
pork
5,906 💧

1 kg
chicken
2,828 💧

1 kg
cheese
5,288 💧



An
apple
70 💧

An
orange
50 💧

A
tomato
13 💧

1 kg
papaya
662 💧

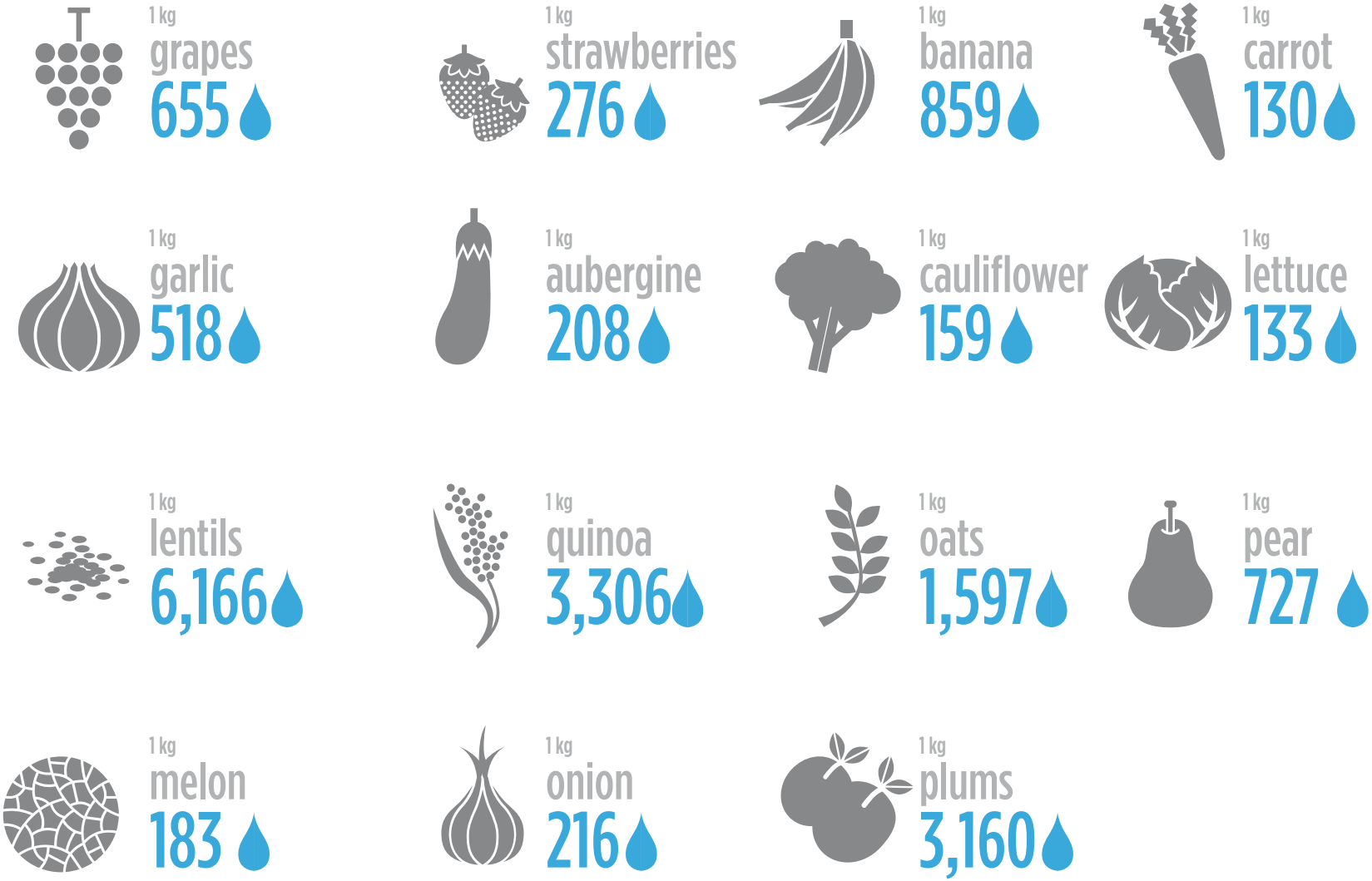
1 kg
pineapple
253 💧

1 kg
avocado
1,284 💧

1 kg
mango
1,583 💧

1 kg
watermelon
160 💧

💧 = Liters



Source: Virtual Water project, www.virtualwater.eu

Climate change and the water cycle

The behavior of the water cycle ultimately depends on climate and varies from place to place and over time. Climate change affects the water cycle by warming ocean waters, changing surface currents and precipitation patterns, and increasing the salt content of the soil and coastal aquifers, affecting marine flora, animal communities, and food for humans. Local factors such as changes in vegetation and geological phenomena such as volcanic activity can greatly affect the water cycle as well. Some effects of climate change on water are summarized in table 1.

Human activity makes a difference, too. For example, dams and irrigation systems divert water from rivers, affecting their natural movement. Human-induced climate change and rising temperatures affect precipitation levels, bringing rainier wet seasons, longer dry ones, and extreme weather events (snowstorms, hail, and hurricanes), ultimately disrupting cloud forests and other ecosystems vital to the water cycle.

Droughts don't happen because there is less water on the planet; rather, they come from changes in its distribution. That's why we may hear that there are severe storms and floods in some parts of the world, while in other parts there are droughts and forest fires.

Perhaps the most devastating consequence of climate change is its negative impact on global water distribution. It's been estimated that if we could find a way to keep water availability fairly constant and regulate precipitation year-round, at least 80 percent of the problems stemming from climate change would be solved. By controlling water distribution and availability, we'd be able to prevent disasters and assure food security, and it would be easier to control the harmful effects of increased temperatures. We'd also be better equipped to treat and limit the spread of existing illnesses as well as to prevent new ones from appearing, given that many diseases are caused by polluted water and water-related disasters. Finally, communities would not be forced to migrate in search of water and fertile land.

Table 1. Effects of climate change on water

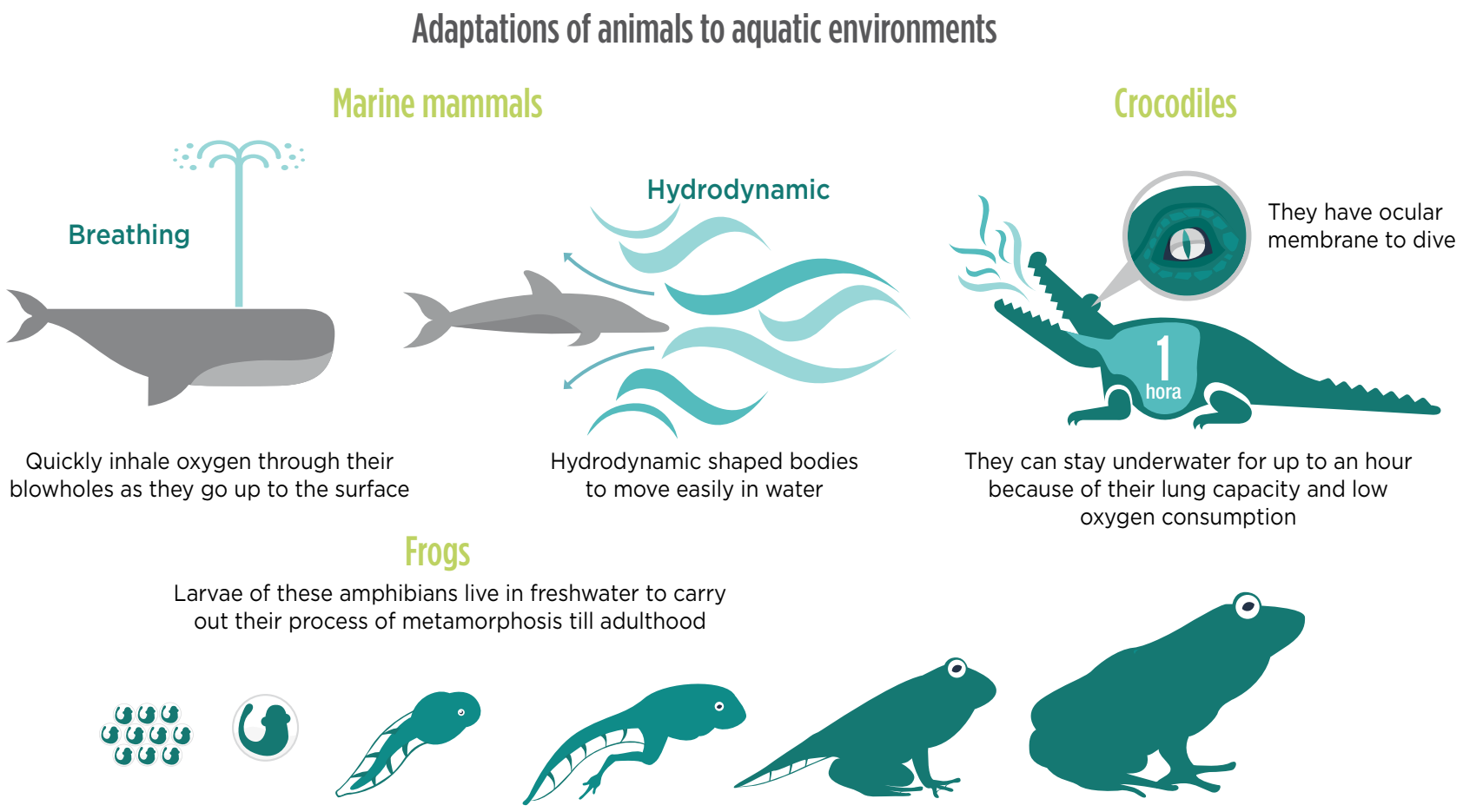
Observed effect	Possible/actual impact
Rising atmospheric temperatures	Glaciers melt, making fresh water more scarce, as seen in some cities in the Andes and throughout Latin America
Rising water surface temperatures	Less oxygen in the water, lower capacity for self-purification More algae
Rising sea levels	More salt in coastal aquifers In southeastern Latin America, the sea level has risen by 2 to 3 mm per year for 10 to 20 years
Changing precipitation patterns and evapotranspiration	Changes in water reserves from changes in water replenishment Less capacity for natural water purification
More variations in precipitation	Harder to control floods and reservoir usage during the rainy season
Increasing evapotranspiration	Less available water; saltier water reserves; lower groundwater levels
More intense and frequent disasters	Floods hurt water quality and the water cycle, increasing soil erosion and adding pollutants to the water Droughts lower water availability and quality, reduce agricultural production, affect human consumption, and increase the risk of fires

Adaptations of living things to changes in the quality and quantity of available water

For eons, organisms have had to adapt to changes in their environment in order to survive. "Adaptation" refers to the process by which organisms transform their habits, way of life, and even body structures in response to environmental changes. These changes are gradually programmed into species' genes and passed down so that future generations have a better chance of survival. For example over time, marine mammals such as dolphins, whales, seals, and sea lions have developed respiratory systems that allow them to stay under water for extended periods of time (figure 4).

However, organisms' ability to adapt to environmental changes is limited because adaptation is a slow, complex process. Below we will explore some of the ways in which plants and animals are adapting to changes that have affected their access to water.

Figure 4. Adaptations of animals to aquatic environments



High temperatures

Plants are smarter than we think. They know that water evaporates quickly, so when it's hot they'll close their pores (or "stomata") during hot spells so they don't lose too much water (figure 5). However, when it's cool and rainy, their pores will open so they can take in more water. Many cacti "hide" underground during exceeding hot, dry periods, returning to the surface when conditions improve (figure 6).

Plants adapt to the conditions of the specific environments in which they live. Thus, the optimal temperature for one plant species may be too cold for a different one. When plants are forced to endure temperatures outside their "comfort zone," they grow very slowly and decrease their production. If temperatures become too extreme, plants will die because they cannot adapt quickly enough.

Figure 5. Stomata

Stomata

During wet periods, the plant will open its stomata, or pores, to drink in water.

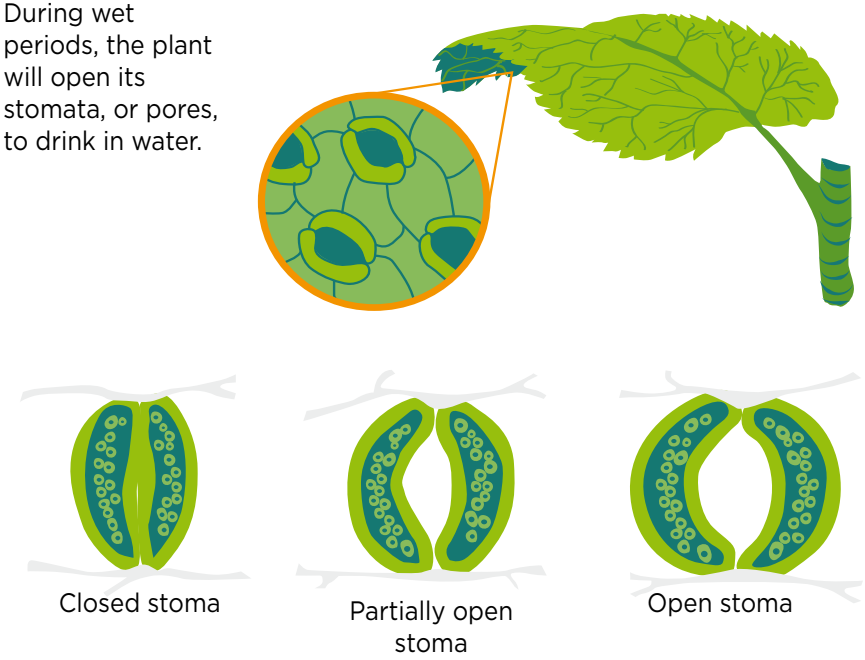
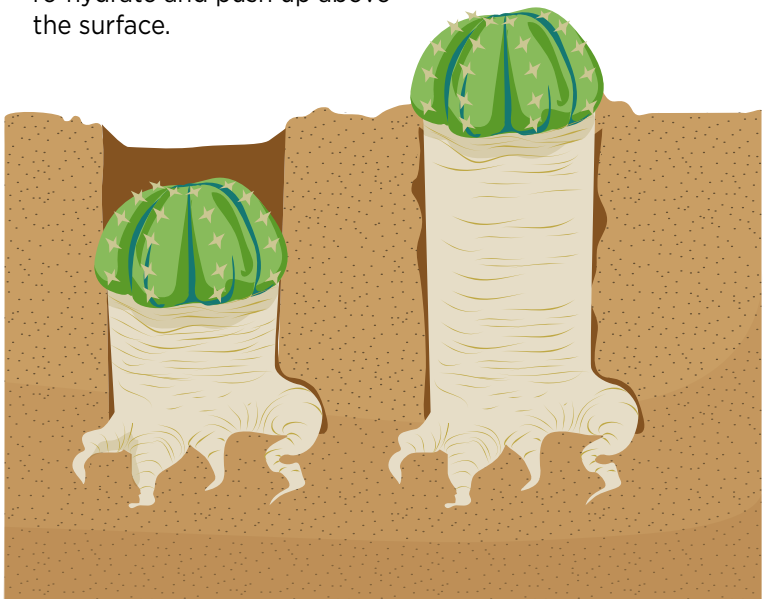


Figure 6. Cactus

Cactus

During dry periods, many cacti shrink below the surface. When water is available, they re-hydrate and push up above the surface.



Changes in rainfall

Rainfall is the main source of water for the soil and one of the most important factors driving crop productivity. Plants can open their pores when it rains; but many cannot withstand long-term droughts or floods.

Climate change has led to changes in precipitation, which has increased in some areas and decreased in others. Since water evaporates quickly in hot temperatures, some plant species in some areas have had trouble adapting to the combination of low water availability in the soil and decreased rain.

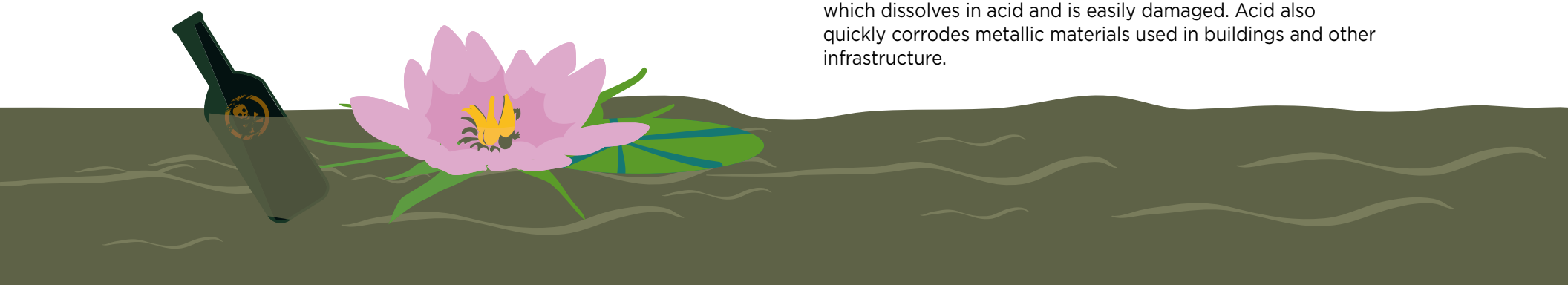
Pollution

A few plants, such as water lilies, can grow in highly polluted environments (figure 7). Others can survive on degraded soils or soils worn out by grazing, agriculture, agrochemicals, or erosion. However, many plants and organisms, including lichens and mosses, are very sensitive to pollution and therefore can only grow in pristine environments.

Figure 7. Lilies

Lilies

Water lilies can grown even in highly polluted waters containing heavy metals such as mercury and lead.



Invisible effects of climate change: Air pollution and acid rain

Recent increases in greenhouse gas emissions into the atmosphere have sped up climate change over the past few decades. This has led to phenomena such as acid rain, one of the many consequences of air pollution.

As water travels through various ecosystems around the globe, it changes states many times. For example, liquid water can evaporate into the gaseous state (water vapor), forming clouds. At lower temperatures, water vapor condenses into rain, providing the soil with water and meeting the needs of living things.

However, when this water vapor combines with acidic pollution from factories and automobiles (which can originate as solid particles, liquid droplets, gases, or a combination of these), the clouds become contaminated (figure 8). The wind can carry these contaminants far away from their place of origin and deposit them as acid rain.

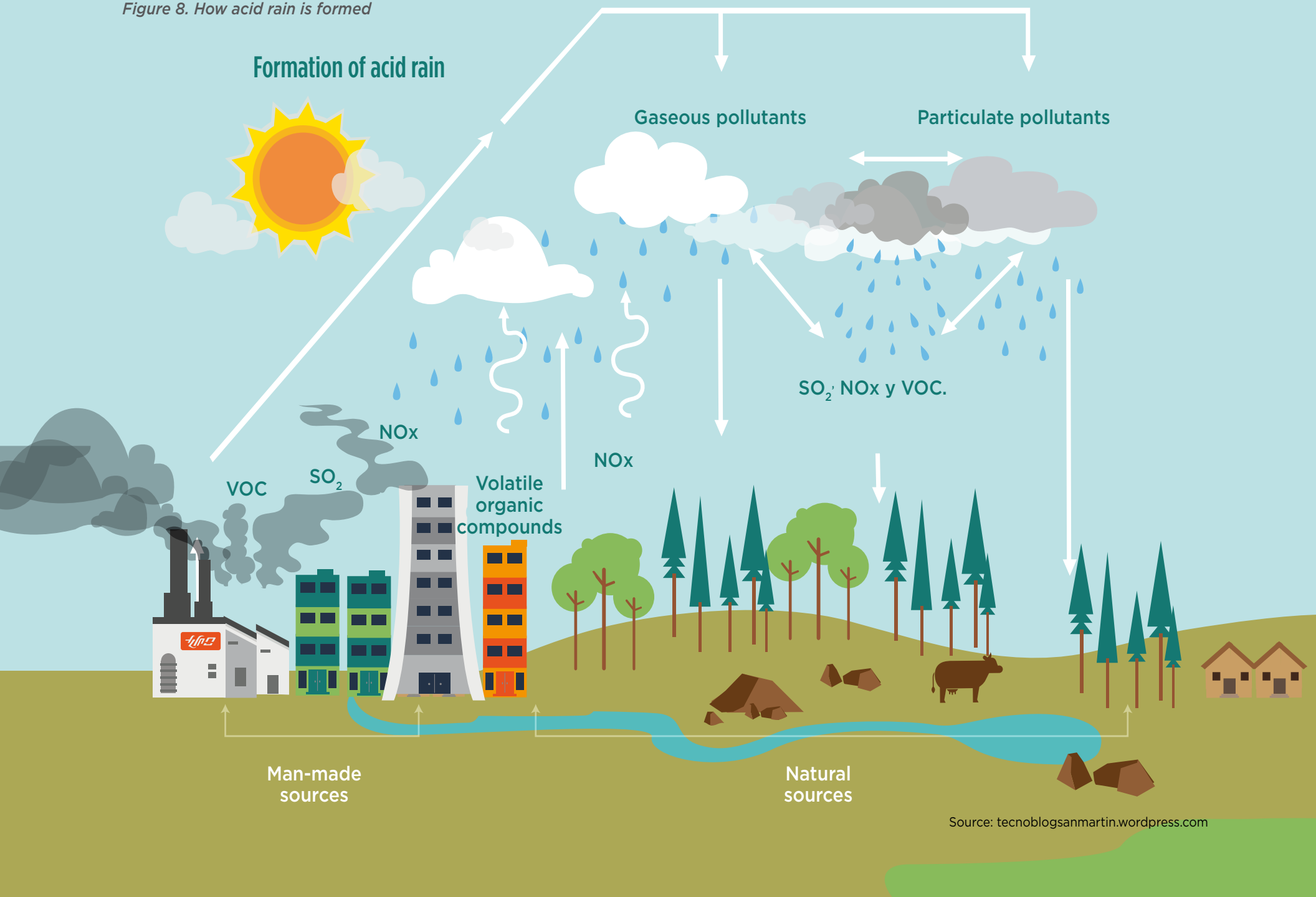
Chemically, acid rain is formed when water vapor combines with **nitrogen oxide** and **sulfur dioxide** from factories, power plants, and vehicles that burn **coal** or petroleum products, forming **sulfuric acid** and nitric acid in the clouds. Dissolved in the water, these chemicals fall to the earth in the form of acid rain.

Acid rain negatively affects crops in multiple ways. It hurts plant growth, weakens leaves, and causes leaf loss. It also depletes the soil of nutrients and increases levels of metals such as aluminum, which hamper plant transpiration and photosynthesis and make them more vulnerable to pests.

Acid rain makes the water in lakes, rivers, and seas more acidic, preventing the normal development of aquatic life and even killing some nitrogen-fixing micro-organisms, flora, and fauna.

It can also damage buildings and sculptures built with limestone, which dissolves in acid and is easily damaged. Acid also quickly corrodes metallic materials used in buildings and other infrastructure.

Figure 8. How acid rain is formed



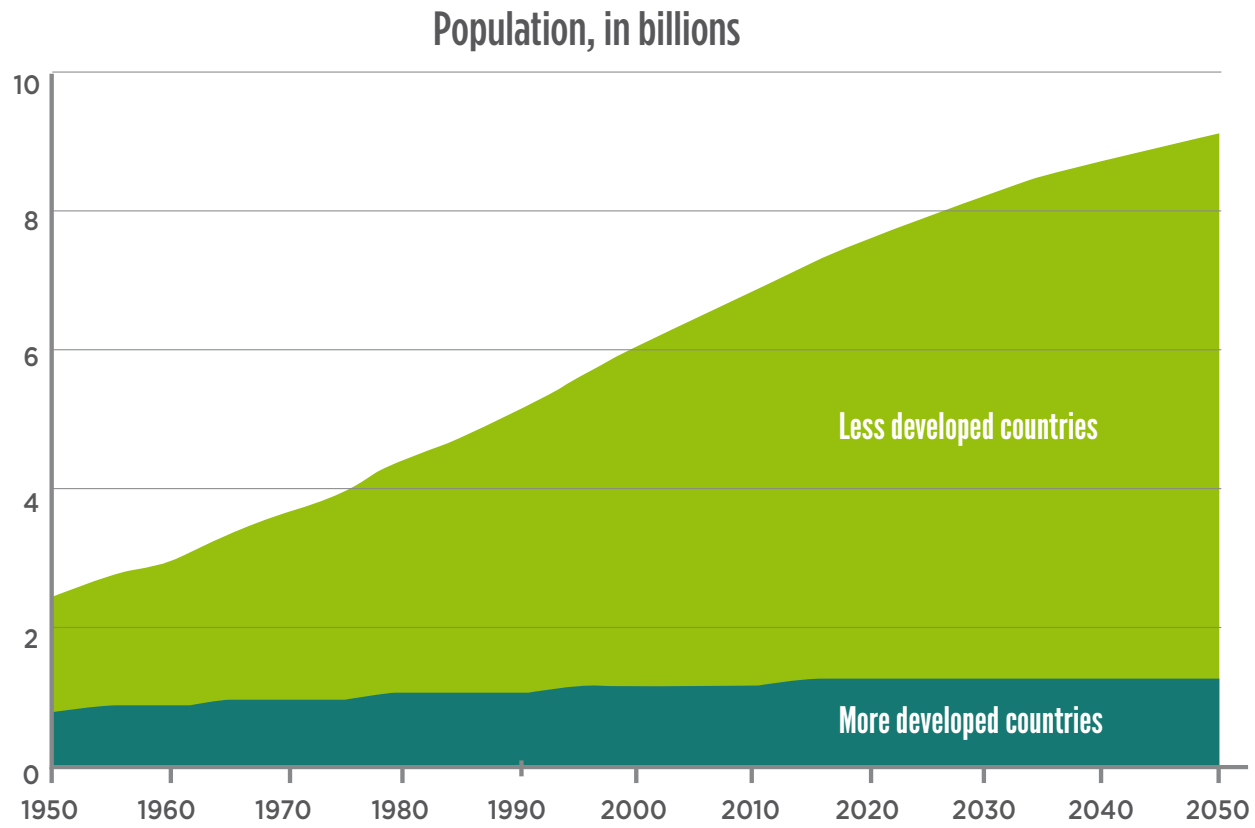
Source: tecnoblogsanmartin.wordpress.com

More humans, more changes in the water cycle, more consequences

While some water-cycle changes are natural, many have been associated with human activities, including economic development and excessive population increases. In fact, the past 50 years have seen an increase in changes due to human activity. The main causes are overexploitation of water, pollution, and altering the surface of the land—all of which ultimately contribute to climate change.

As changing precipitation patterns affect groundwater levels and water availability around the world, and as the Earth's population continues to grow (figure 9), the demand for water will also increase. In addition, water demand will also grow as industries and agriculture try to meet the needs of a growing population.

Figure 9. Recent and projected growth in the world's population, 1950–2050



Source: United Nations Population Division 2008.

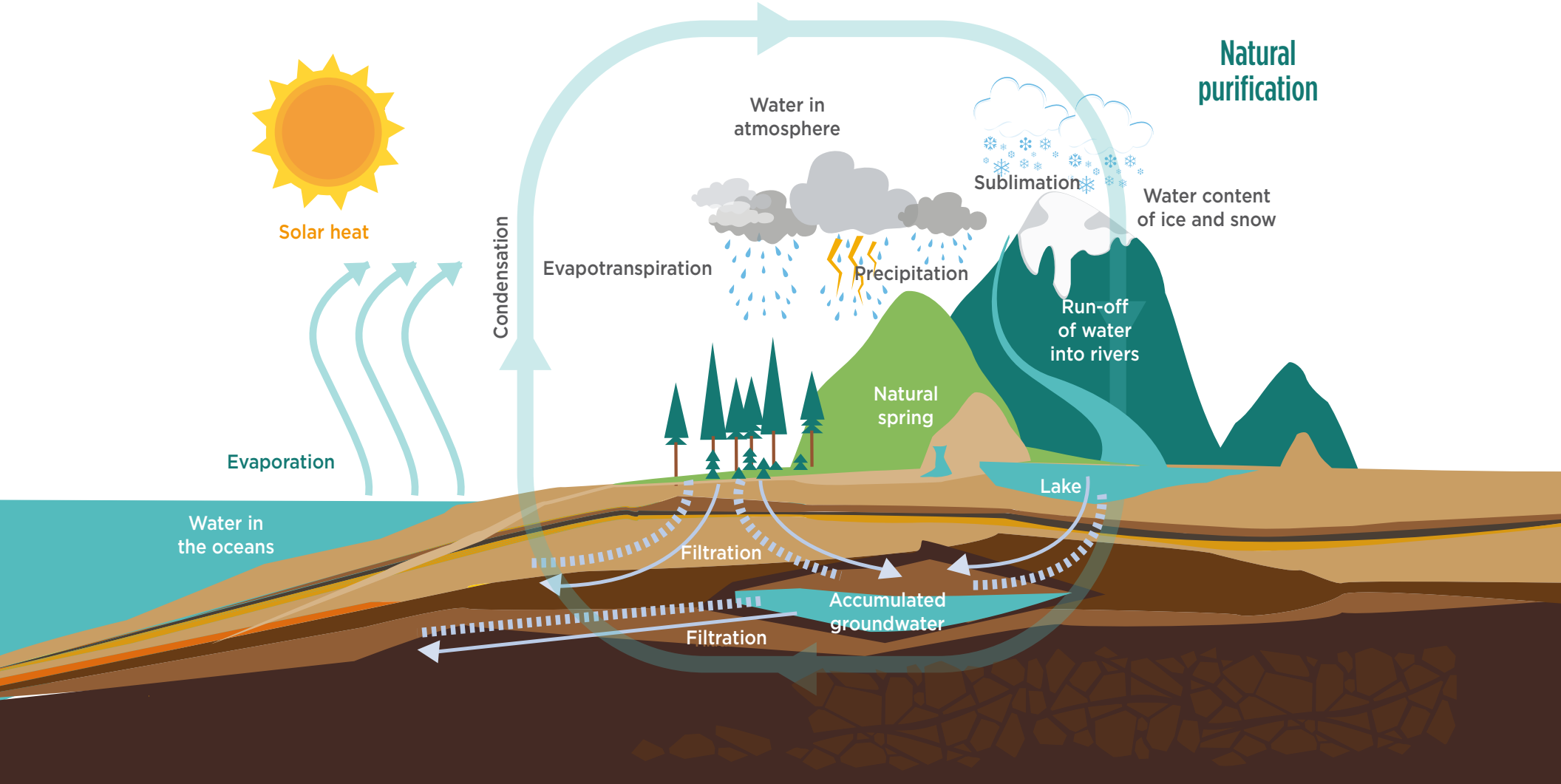
More people also produce more waste. Since humans have never invested enough in waste management, much of this waste ends up in wetlands and rivers. Even landfill waste pollutes the water when dissolved substances get filtered into the groundwater.

Growing populations also take up more space and need new buildings and infrastructure. This translates into invading more wetlands, diverting rivers and streams, clearing forests and changing natural land surfaces, and ultimately, drying up water resources.

All of this increases the likelihood of more natural disasters. For example, deforestation makes floods and landslides more likely because it removes the roots and plants that previously held the soil in place. This means that when it rains, the soil is more easily displaced.

It also threatens the water cycle's natural purification capability (figure 10), which relies on gravel and sand in the soil to filter many of the dissolved particles out of rainwater as it makes its way into the ground.

Figure 10. Natural purification of water



Water pollution and human health

Water pollution and the deterioration of aquatic ecosystems, whether from human activity or climate change, directly threaten human health. Many of today's diseases are water-related. Some are waterborne; others originate in the water; still others are borne by vectors such as insects or animals that live in or close to water. Finally, some are associated with water shortages.

Diseases are often transmitted by water contamination, either from human or animal waste or the dumping of chemicals. In fact, polluted coastal waters cause more than 1.2 billion cases of gastrointestinal disease and 50 million cases of respiratory and other diseases each year—among them diarrhea, cholera, typhoid, hepatitis, and meningitis. Most of these cases are preventable with improved water quality or treatment.

Insects or animals, such as mosquitoes that breed and live in polluted waters, transmit vector-borne diseases. Some examples are malaria, dengue, and yellow fever. Global warming is allowing insects, and the diseases they carry, to migrate to new areas as these become warm enough to permit their survival.

Diseases linked to water shortages stem from a lack of fresh, drinkable water. Examples of such diseases include trachoma and contact dermatitis.

Working together to slow climate change and its effects on our water

Before the middle of this century, tropical forests in the eastern Amazon will become savanna, and many species may become extinct. In drier areas, arable land will become salt flats or steppes. Access to fresh water will decrease.[4]

We already see evidence of this change: deforestation, extinct species, more frequent and intense natural disasters, droughts in some areas, and frequent rain and flooding in others. At the same time, our region is home to densely populated cities, and there is a growing demand for more energy, food, and products, which increases both the need for water to supply agricultural and industrial activities, as well as the level of pollutants. Given this reality, it's not surprising that so many people are concerned that soon there won't be enough water for everyone.

The challenge lies in heeding lessons from the past and working together to slow climate change and to address the consequences for our water. This means talking to our families and friends so everyone will understand the danger and the need to conserve water and use it carefully. It also means supporting measures that will address and reverse the damage that has already been done, such as policies that support water conservation and environmental protection, as well as investments in technologies that clean and restore our water.

Many people believe that the fastest way to behavior change is through financial incentives. Policy makers have used this idea to promote environmental conservation by charging fees for environmental services.

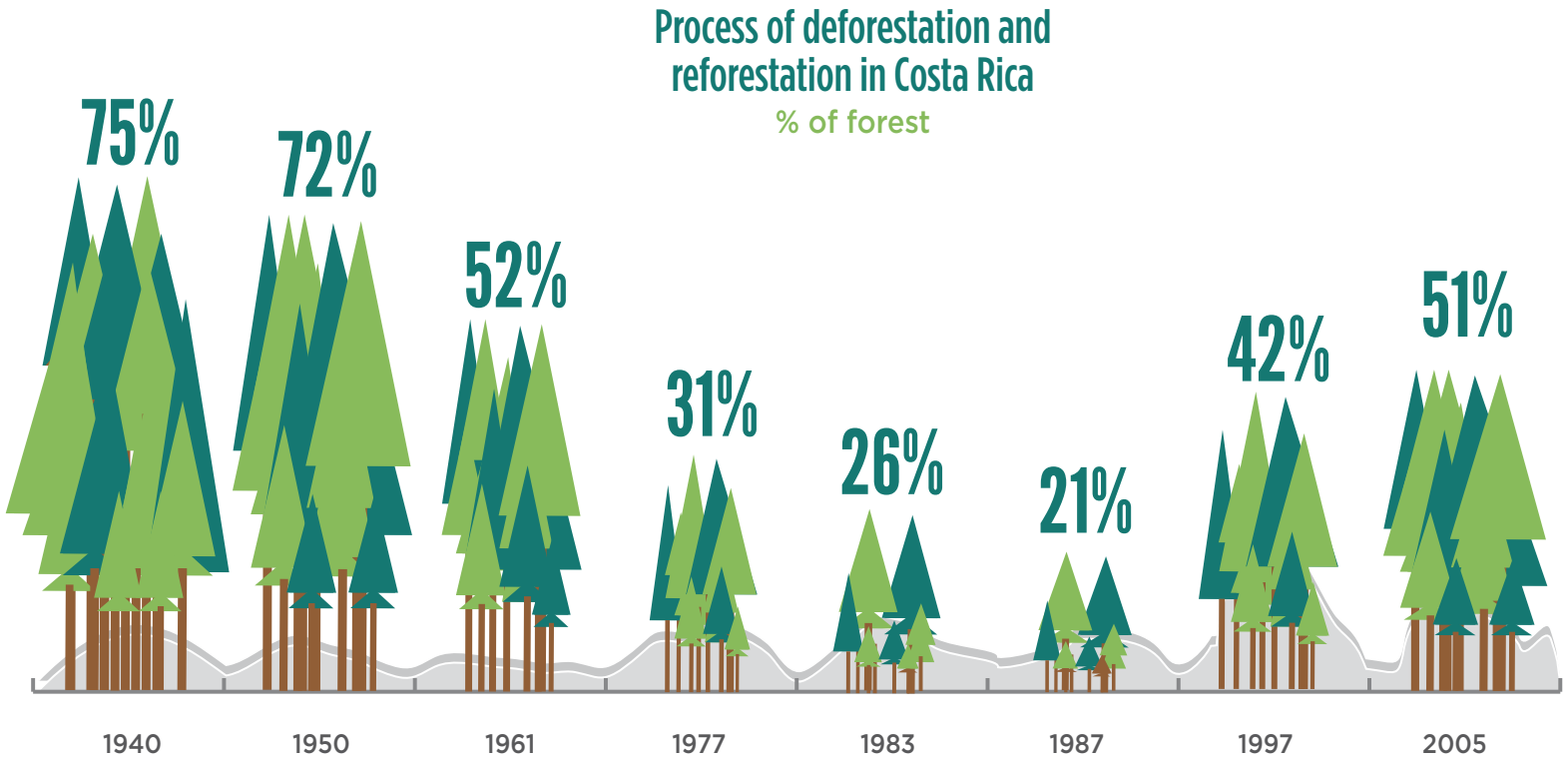
What are environmental services? They are the benefits we get from nature's ecosystems, such as soil formation, climate regulation, oxygen production, food supply, water resources, and forest protection.

Let's take a look at how the system of environmental service fees works in Costa Rica. Starting in 1940, Costa Rica began experiencing major deforestation (figure 11). To address this problem, the country adopted a national conservation policy 20 years ago that rewarded people for conserving the country's ecosystems by restoring and preserving its forests.

In 1996, the Costa Rican government launched a reforestation and water conservation campaign and began stricter enforcement of the country's forestry law. The law's main objectives are to lower greenhouse gas emissions, protect water resources and biodiversity, and maintain the country's natural beauty in order to promote tourism. The government also created FONAFIFO, a legal entity under the Ministry of Environment and Energy that can enter into agreements and work nationally and internationally on protecting the country's ecosystems. Its main objective is to collect fees in return for environmental services provided by small and medium forest producers.

4 "World Divided by Somber Report on Climate Change," La Nación (Costa Rica), April 8, 2007, reporting on a symposium held in Beijing by the Intergovernmental Panel on Climate Change.

Figure 11. Deforestation and reforestation in Costa Rica



Source: http://www.fonafifo.go.cr/.

What are these services? They include carbon fixation and sequestration, water conservation, the protection of biodiversity, sustainable development of the lumber business, and preservation of the country's scenic beauty. The entire world benefits from services such as oxygen generated by Costa Rica's forests. The country also benefits, since preserving ecosystems prevents natural disasters. Communities benefit from tourism, and landowners earn income from businesses made possible through conservation.

Taxing fossil fuel use by energy production companies and individuals through environmental service fees is a major source of revenue. Water consumers also pay taxes, which are used to preserve the environment and ensure water availability and quality. Costa Rica even has a forest regeneration business, funded by foreign multinationals, to counter greenhouse gas emissions emitted by other countries. The funds collected are used to manage parks and to help rural communities manage and conserve their forests. They are also used for watershed management and environmentally friendly energy production.

International organizations such as the World Bank and the Global Environment Fund and some countries, including the United States, have paid environmental service fees to Costa Rica by canceling debts owed by the country. Private enterprise also plays an active role in the project, generating a significant percentage of the investments in environmental care. Thanks to all of these efforts, forest cover in Costa Rica grew from 21 percent of the country's total area in 1987 to 51 percent by 2005.

Flying in to Costa Rica

Did you know that travelers to Costa Rica make a payment upon entering the country for the greenhouse gas emissions caused by air travel from their place of origin? Their payments support reforestation, watershed and park management, environmentally friendly energy, and more.

Lesson Plans at the Basic Level

1 Basic lesson plan 1: Traveling water!

General objective

Observe the flow of water and discuss where it is found on Earth.

Class activity 1: Game—Searching for water

Objective	Time	Place
Observe the flow of water and discuss where it is found on Earth.	30 minutes	Classroom

Materials

» 11 "Searching for Water" picture cards (figures 12–22) and clues sheet (table 2)

Class preparation

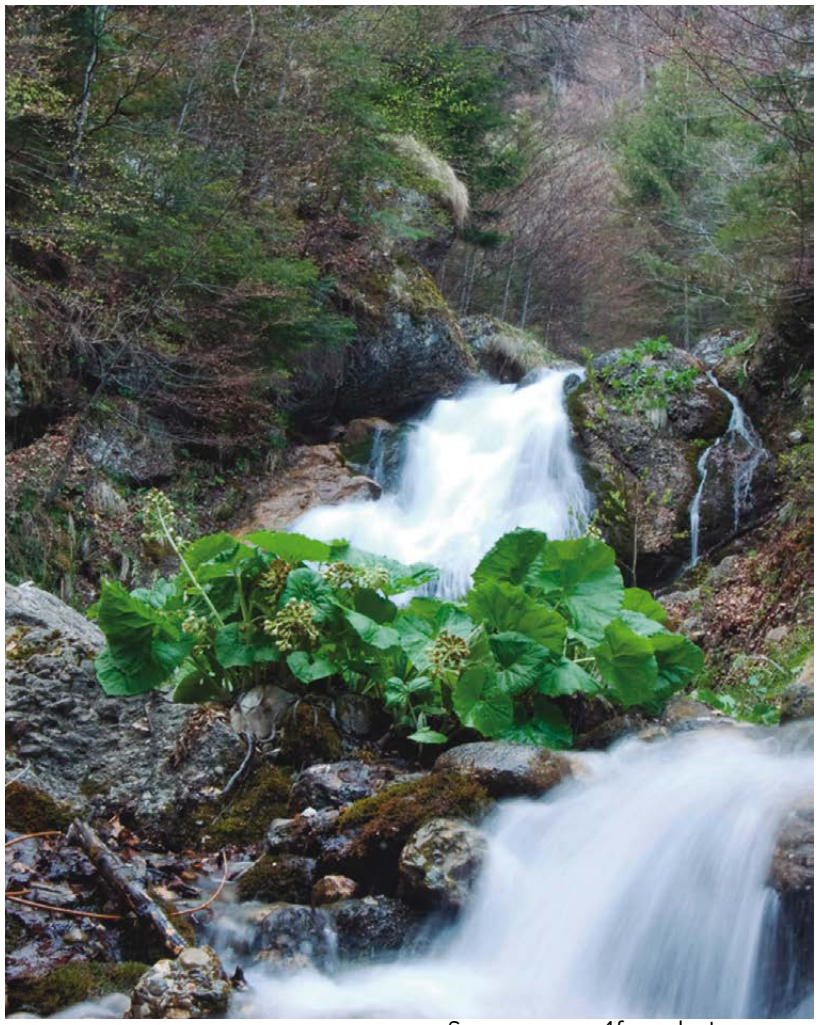
» Print the pictures and cut as necessary into individual picture cards.

» Print the clues for finding water on the planet.

» Organize the classroom so there is space in the middle.

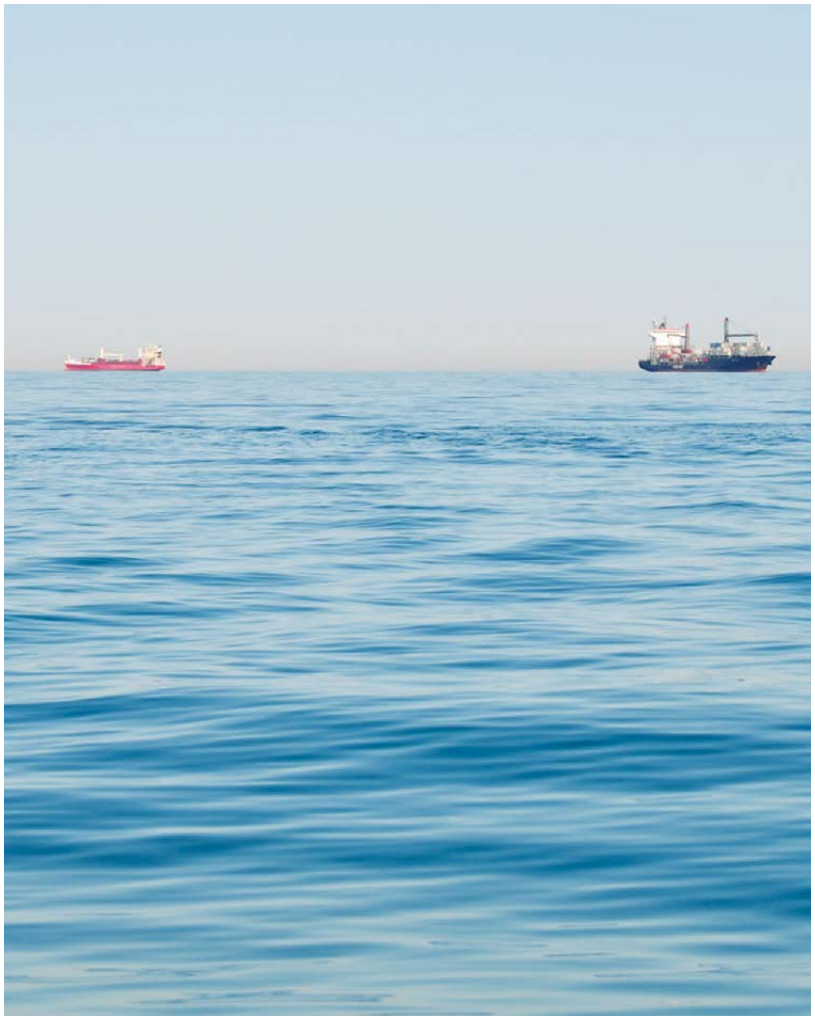
"Searching for Water" picture cards

Figure 12. Picture card 1



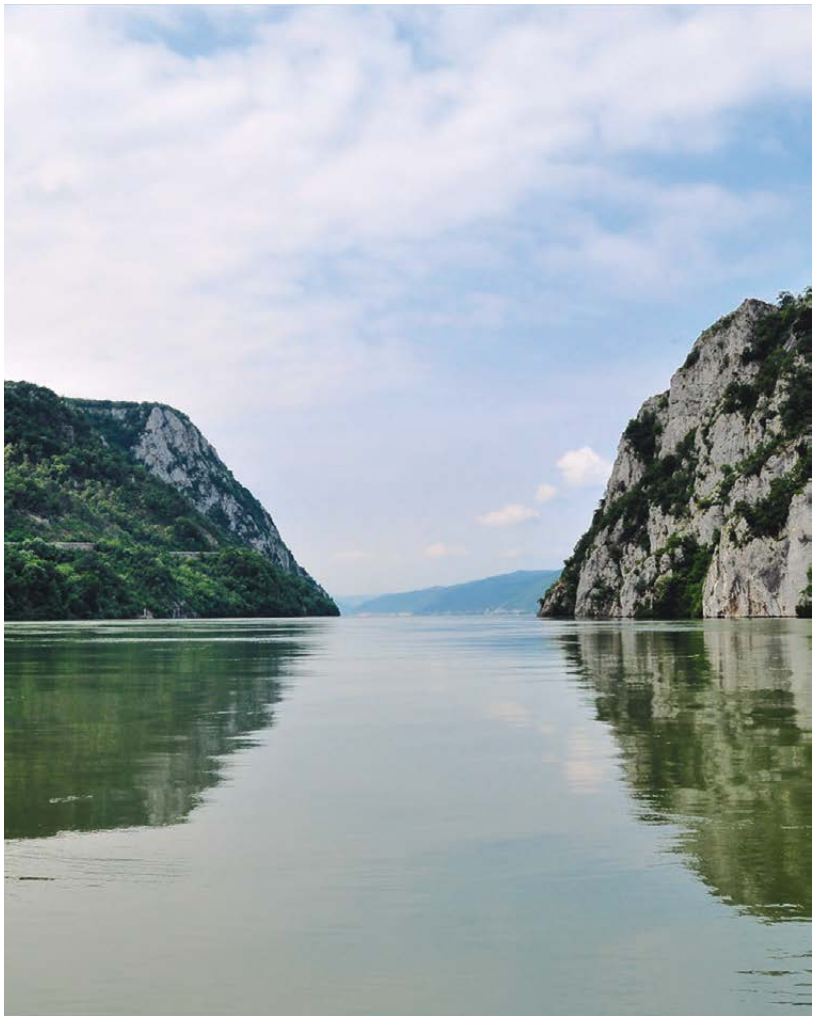
Source: www.4freephotos.com

Figure 13. Picture card 2



Source: www.4freephotos.com

Figure 14. Picture card 3



Source: www.4freephotos.com

Figure 15. Picture card 4

Photo by Felipe Antonio

Figure 16. Picture card 5

Photo by Patricio Mena Vásconez

Figure 17. Picture card 6

Photo by Bluemangoa2z

Figure 18. Picture card 7

Photo by Martin St-Amant

Figure 19. Picture card 8

Photo by Martin Roca

Figure 20. Picture card 9

Photo by Edal Anton Lefterov

Figure 21. Picture card 10

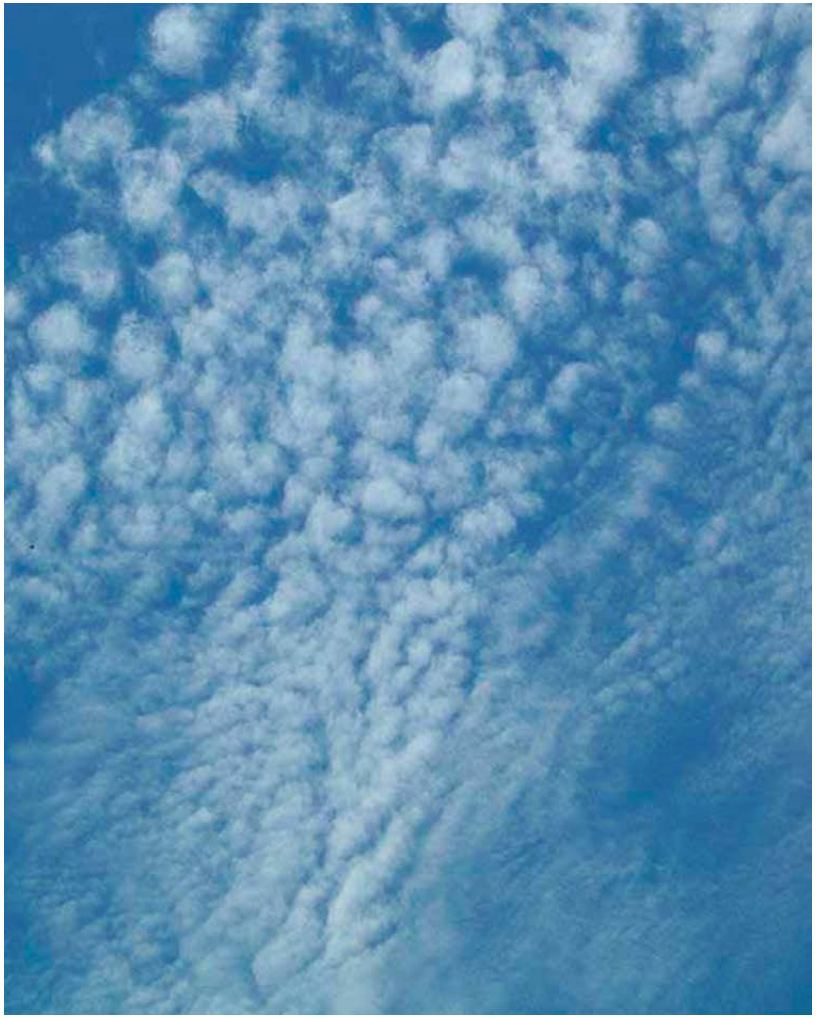


Photo by Luisa Flores

Figure 22. Picture card 11

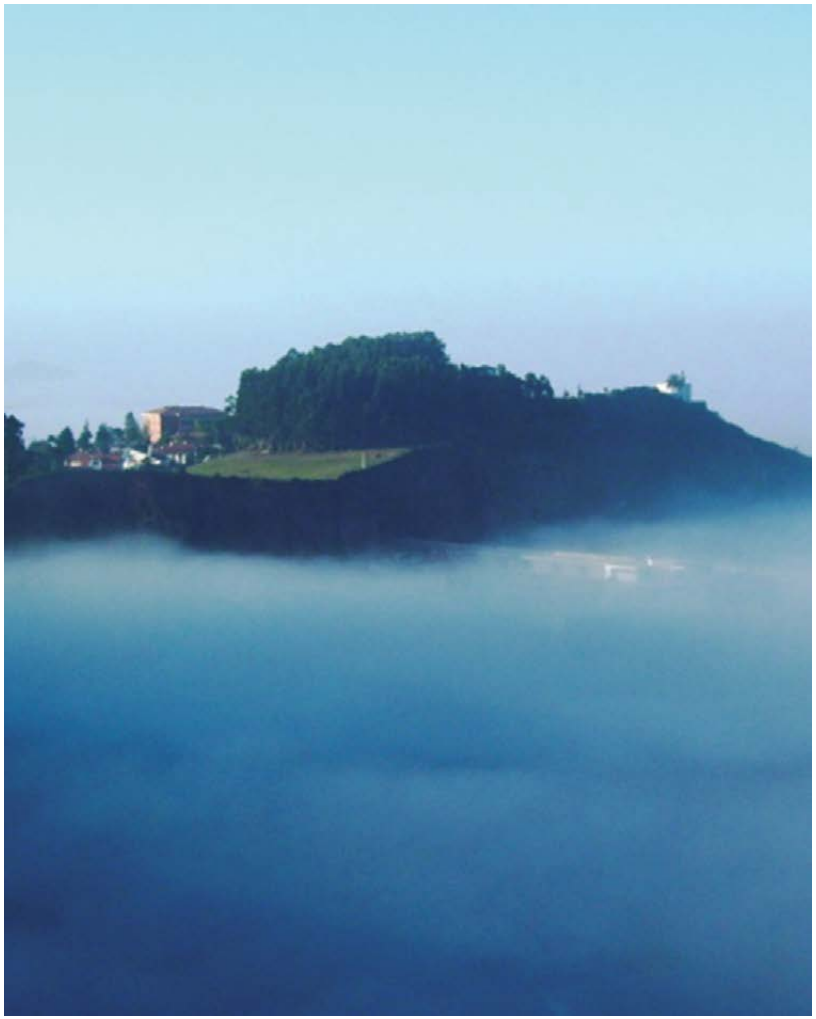


Photo by Ardosantos

Table 2. Clues for finding water on the planet

Rivers
- » Comes from the mountains
- » Always running
- » Freshwater
- » Curved paths
- » Water is in the liquid state

Oceans and seas
- » Surround us
- » Full of life
- » Salty
- » Like mountains of water
- » Water is in the liquid state

Lakes
- » Surrounded by land
- » Can travel by boat
- » Have fresh, brackish, or salt water
- » Water is in the liquid state

Wetlands
- » Absorb and hold water like sponges
- » Have many reeds
- » Birds love them
- » Many aquatic plants grow there
- » Water is in the liquid state

Moorlands
- » Are water reservoirs that absorb and accumulate water
- » Found above 3,000 m
- » Plants there have “coats” or hair for protection from the cold
- » Water is in the liquid and gaseous states

Groundwater
- » Almost never visible; some gets stored for a long time and is called fossil water
- » Protected by the soil
- » Is a water reservoir
- » Water is in the liquid state

Glaciers
- » Don’t look like water
- » Some float
- » Penguins love them
- » Water is in the solid state

Snowy peaks
- » On tall mountains such as the Cocuy (Colombia), Aconcagua (Argentina) and Huascaran (Peru)
- » Can ski down some of them
- » Water is in the solid and liquid states

Rain
- » It comes from above and looks like the sky is crying
- » Made up of many drops
- » Water is in the solid and liquid states

Clouds
- » In the sky
- » Have many shapes
- » Look like cotton
- » Water is in the gaseous state

Mist or fog
- » Made of many water droplets that move with the wind
- » Are not rain clouds
- » Disappear when the sun heats the Earth

Box 2. Moorlands

Moorlands are ecosystems in the highlands of South American countries such as Colombia, Venezuela, Ecuador, and Peru, and in small parts of Panama and Costa Rica, where plants, animals, and microorganisms coexist and connect with each other in very dynamic and diverse ways. Other areas like Malaysia, East Africa, Bolivia, Mexico, the Eastern Himalayas, and Hawaii have characteristics similar to the moorlands of Central and South America but are classified as humid tropical high mountain ranges. Most moorlands are located more than 3,000 meters above sea level.

Moorland temperatures change dramatically from day to night, and the winds influence the structure and behavior of living things. The vegetation is stunted and it can retain water and withstand temperature variations. The fauna is generally dark in color, which allows it to retain heat. The soil is rich in organic matter. It retains, filters, and distributes water to lakes, rivers, and streams.

Step by step

» Engage the class in "the search for water." Ask students where water can be found on Earth and what type it is. List their ideas on the board.

» Ask students about the water's state (liquid, gaseous, solid) at each site.

» Tell students that this game is about finding places where water is found. Put the picture cards of rain, clouds, rivers, oceans and seas, lakes, wetlands, groundwater, glaciers, snow-capped peaks, and moorlands (box 2) in the center of the room.

» Tell students that you will give them clues (table 2) and their job is to identify the corresponding picture. You can also do this in the form of a riddle.

» Once all the places are uncovered, ask students where they would expect to find solid, liquid, or gaseous water.

» Ask: How does the water get to each place? Does water move from one place to another? Why is it found in different states? Have you been to any of the places where water is found?

» Summarize: Water takes on different forms depending on its location and the temperature, and it often changes form.

Class activity 2: Experiment—How does water travel? Does water recycle?

Objective	Time	Place
Understand how the water cycle works.	1 hour preparing and explaining the experiment, plus one week of follow-up	Outdoors

Materials

» Each group must have the following: A clear, deep plastic bowl or container, a large plastic bag, a large rubber band, a small potted plant, sand, soil, small stones, a small container of water, a ruler, a marker, a pencil, and a blank table in which to record their follow-up observations.

Preparation

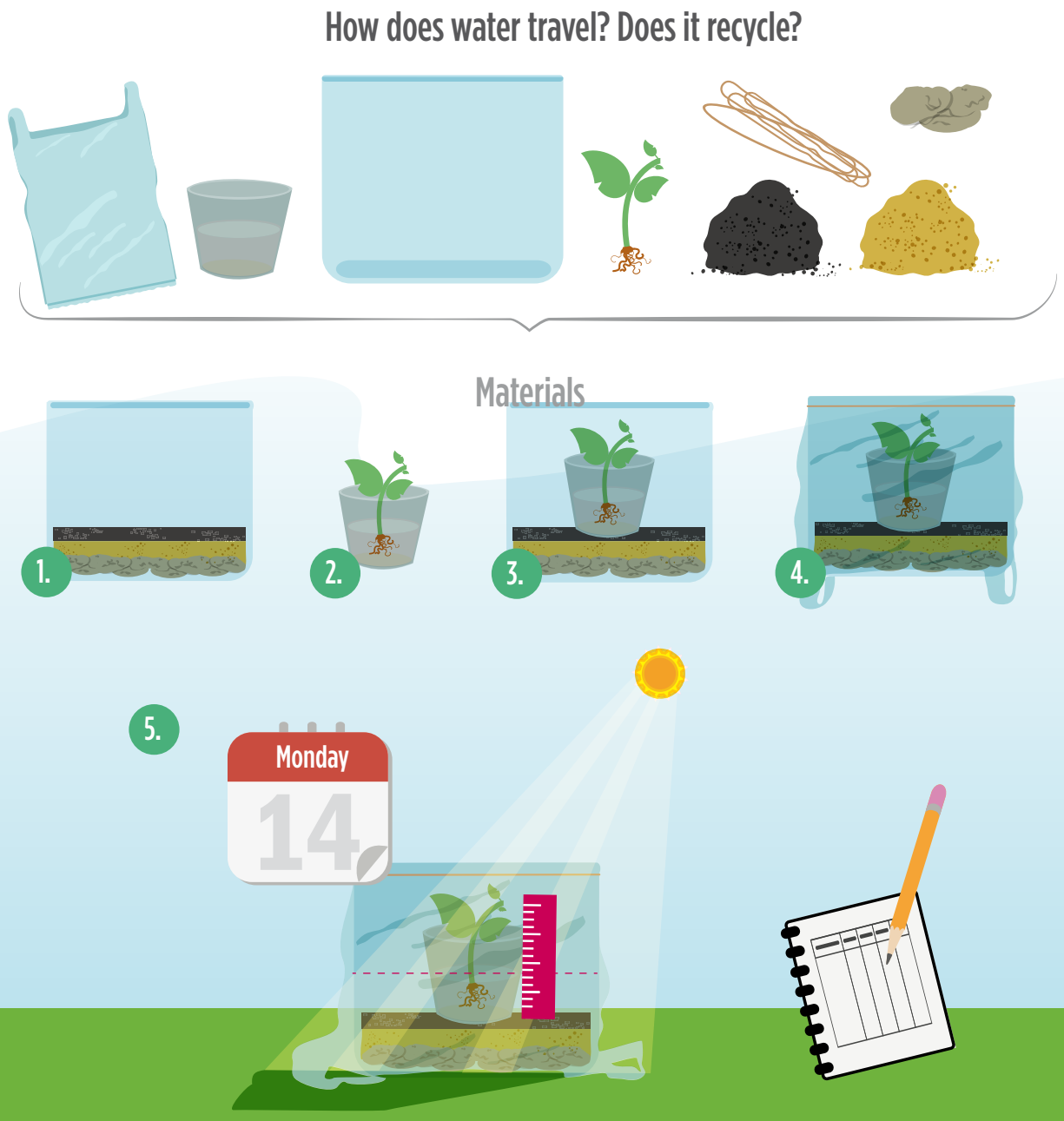
» Perform the experiment yourself before performing it with the class.

» Organize groups and ask students to bring the materials needed for the experiment; each group should have a set of materials.

» Print the follow-up table for each group.

» Find a place to do the experiment that is available for a week to allow students to complete their follow-up.

Figure 23. How does water travel? Does it recycle?



Step by step

» In the large, transparent bowl, students should place a layer of small stones, followed by a layer of sand and, on the surface, a layer of soil (figure 23).

» Tell students to place the plant and the small container of water inside the large bowl, and mark the initial water level in the small container.

» Have students cover the large bowl with the plastic bag and secure it with a rubber band so no air can enter.

» Each group should label its container.

» Let the bowls sit in the sun for one week. Make initial observations: How much water is in the small container? (Measure with a ruler.) What is the general appearance of the plant? What does the plastic look like? Are the soil, sand, and stones wet or dry?

» Ask students to check their bowl daily for one week and record any changes (compared with the first day) in the following table:

Table of observations

Day	Description of observations	Drawing of observations
1		
2		
3		
4		
5		
6		
7		

» At the end of the week, ask students the following questions:
  - What changes did they see during the week?
  - What do they think caused these changes?
  - Has the water level changed in the small container? Why?
» Explain the experiment using the notes in box 3.
» Ask: Is water recycled? How? And why?

Formative assessment

Before proceeding to the next topic, students should be able to:

» Identify 8–10 places where water is found naturally.
» Understand the liquid, solid, and gaseous states of water and identify where in nature each state occurs.
» Explain the water cycle: evaporation, transpiration, condensation, precipitation, and infiltration.

Box 3. The water cycle

This experiment represents the water cycle as it travels from the soil (and other sources) through living organisms and the places where they live into the atmosphere and back to the ground.

The small container represents water's sources. As the temperature increases, evaporation occurs (thanks to the heat trapped by the plastic that covers the container, which is similar to the greenhouse effect that occurs on Earth), leaving less water in the container.

At the same time, transpiration occurs as the plant releases oxygen molecules, which become part of the water vapor inside the plastic.

The water droplets in the container represent condensation. As more and more water evaporates inside the container and oxygen is released through transpiration, the water vapor adheres to the plastic and changes state, forming droplets.

Water drops on the plastic fall onto the plant, representing precipitation, which returns the water to the plant and to the soil at the bottom of the container.

The sand and stones get wet due to infiltration, which occurs when water enters the ground through the Earth's surface.

Class activity 3: Online game to test students' knowledge—Rise Up Water

Step by step

Invite your students to play the video game "Rise Up Water," which you can find at www.idb.org/riseup.

Integration with other subjects

» **Science:** Research an aquatic ecosystem and its role in the water cycle.

» **Language:** Write an essay describing the life of a water droplet.

» **Mathematics:** Take an empty plastic bottle, cut off its top, and draw a line 10 centimeters from the bottom. Place it outdoors and measure the amount of rain water collected in the bottle per day over five days. Record the data gathered in a table and graph it at the end of five days.

» **Social Studies:**

- Research how indigenous peoples use water in their daily lives and discuss its significance to them.
- Have students list the problems that occur at school and at home when the *water is turned off* for whatever reason. Ask them to imagine what would happen if this situation were prolonged or permanent, and discuss, write about, or draw their conclusions.
- Discuss: What conflicts may arise if some communities had water and others did not? If they were leaders, what would they do to prevent these conflicts from turning violent?

Remember

» Our body is mostly water (75 percent), and we lose water constantly through our sweat (transpiration) and urine. It is very important to drink water and eat fruit to replace this lost water.

» Water has three states: liquid, solid, and gaseous. Its state depends on the speed at which its molecules are moving.

» The water cycle is endless: Water molecules pass through the oceans, clouds, glaciers, soil, plants, animals, serving specific purposes in each and changing states in the process.

Tips for the teacher

Explore with your students the path water takes as it travels from where it is "born" to the place where we get it. If possible, go out and follow the actual path; otherwise, have students use their imaginations and the information they have learned.

Suggested reading and viewing

» www.pmm.nasa.gov
Search for the clue words "Water cycle." You'll find lots of information; useful videos, articles, and pictures.

» www.usgs.gov
Search for the water cycle diagram for kids.

2 Basic lesson plan 2: Getting to know water's spirit

General objective

» Learn about natural phenomena related to water and the weather.

» Understand that human actions can alter the quality of water and its cycles.

Class activity 1: Water makes its presence known

Objective	Time	Place
Identify natural phenomena that change the flow of water.	1 hour	Classroom

Materials

» Handout consisting of eight images in pairs as follows (figures 24 and 25):

- A river and an overflowing river because of rising water
- A savanna or field with houses on a rainy day and in a strong storm, with trees fallen on the houses
- Green crops and dry soil with no vegetation
- Houses on an eroded mountain and a landslide on the eroded mountain

Preparation

Print out figures 24 and 25 or collect your own set of pictures. Give students an introduction to the natural phenomena associated with the role of water in the ecosystem, using the background material for this unit.

Step by step

» Put images of various ecosystems (i.e., river, savanna, mountain, and crops) in one column, and images of natural phenomena in the other.

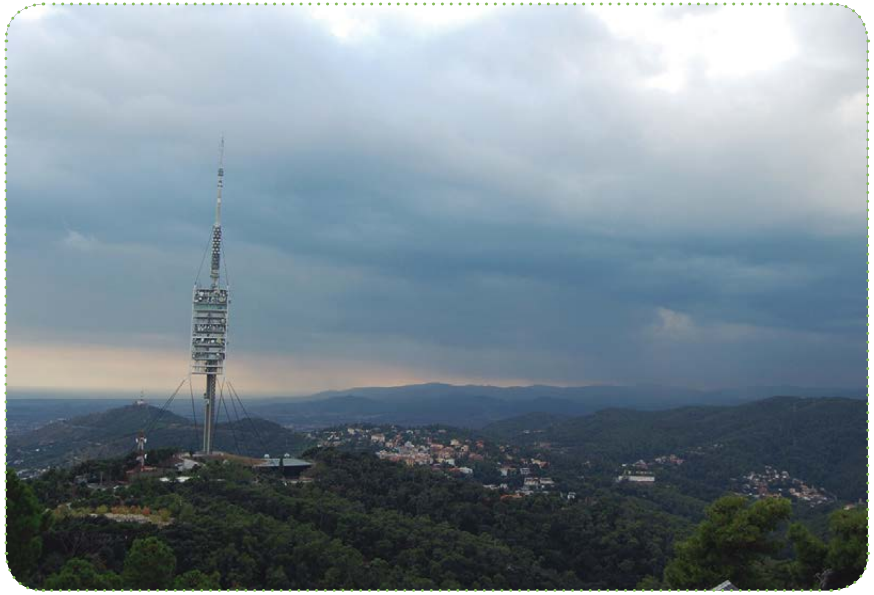
» Ask students to match each ecosystem with a natural phenomenon that occurs there. Each ecosystem should have just one match. Help the students as needed.

» Once they have finished matching the images, ask them:

- What causes a river to rise?
- What causes erosion in an urban mountain area?
- How does climate affect the water cycle?
- How does it affect you if it rains for days and days? How about if it doesn't rain for a long time?
- How about if it's colder than usual?

» Discuss their responses and reflect on the spirit of water and how much more natural phenomena affect us when we build houses on river banks, mountain slopes, or too close to the shore; or when we grow crops in areas that once had plenty of water, but now are dry.

Figure 24. Picture cards 1–4 for activity "Water makes its presence known"



Source: River, ZackClark; Flooded town, U.S. Army Corps of Engineers; rainy landscape, alegri / 4freephotos.com; toppled tree, shutterstock.com.

Figure 25. Picture cards 5–8 for activity "Water makes its presence known"

Source: Green field, shutterstock.com; eroded ground, by alegri / 4freephotos.com; dwellings on eroded hill, Shutterstock.com; subsidence of eroded hill, EPA/Brendan McDermid.

Class activity 2:
Comic strip—Water counts!

Time	Place
1 hour	Classroom

Materials

» Videos: “Ready to Dance the Global Water Dance?” and “Rise Up for Water,” both available from www.idb.org/riseup; projector or DVD player; recycled cardboard; colored pencils

Step by step

» After watching the videos, ask students:
  • What is the main theme?
  • How important is water for humanity?

» Tell students to create a cartoon or comic strip about ways to improve our relationship with water.

» Discuss their answers and students’ comic strips. Talk about human activities that cause climate change and how we can make life better by using natural resources responsibly and making a lifelong habit of caring for the environment.

Formative assessment

Before proceeding to the next topic, verify that:

» Students recognize that climate plays a role in the water cycle.

» Students can differentiate between natural changes in the water cycle and those caused by humans.

Integration with other subjects

» **Science:** Research the effects of climate change on aquatic ecosystems in the region.

» **Language:** Get students talking about the importance of water in their community (uses, changes, ecosystems involved, proposals, and solutions).

» **Mathematics:** Create two tables:
  • Table 1. List the months of the year and describe the normal weather for each month.
  • Table 2. Look at newspaper weather reports from last year and describe the actual weather in each month.

» Compare the tables and note any differences between the expected and actual weather.

» **Social Studies:** Research the effects of weather on the community.

» **Civics:** Discuss ways to prevent weather-related disasters.

Remember

» The Earth is the only planet in our **solar system** with extensive amounts of liquid water. Although we think Mars once had water on its surface (and it may have liquid water deep below its surface), we know that our oceans, rivers, and rain are the unique mainstay of life on Earth.

» Floods, tropical storms, landslides, droughts, and so on are part of nature, as are the sun and the rain. These phenomena affect the entire planet; but in areas with poorly planned housing and inadequate safety measures, emergency plans, and early warning systems, they can turn into natural disasters.

Tips for the teacher

Encourage students to celebrate life by celebrating water. Just as we all celebrate our own birthdays, the United Nations Conference on Environment and Development declared a day to celebrate water: March 22.

Lesson Plans at the

Intermediate Level

1 Intermediate lesson plan 1: When water causes trouble

General objectives

» See how water pollution affects living organisms.
» Identify water-related adaptations of living things.
» Understand that human activity affects water's availability as a vital resource.

Class activity 1: Seed survival—Can a seed sprout in any kind of water?

Objective	Time	Place
Compare the development of seeds in different types of water.	30 minutes (monitored over one week)	Outdoors

Materials

» Cups, water, seeds, waste (used oil, cement, food scraps, toothpaste, powdered soap)

Preparation

» Perform the experiment yourself first.
» Organize groups of students and ask them to bring the needed materials.

Step by step

» Ask: Can a seed survive in any type of water? Why? Discuss their answers.
» Ask: What would happen if we put some seeds in dirty water and others in clean water? Would they develop equally? Use their answers to form a hypothesis.
» Organize students into groups and ensure that each has a glass of water, one waste product from the list (see materials), and seeds.
» Ask them to mix water with one waste product (oil, toothpaste, soap, etc.) and put it in the cup.
» Finally, put one seed inside a cup on a cotton swab moistened with the water mixture, and another seed inside a second cup on a cotton swab moistened with clean water.
» Use the accompanying table to record the seed's growth and the status of the water in the cups over the next week:
» After a week, ask students to compare their results with those of their peers and review their hypothesis based on the results of the experiment.
» Talk about how they get rid of liquid or aqueous waste at home. For example, where do they dispose of used cooking oil? What sorts of home refuse go down the drain? Why is important to think about how we dispose of waste?

Tip for the teacher

Talk about water's importance and how living things use it for nutrition, respiration, excretion, and so on. Discuss how some animals and plants can adapt to changes caused by human activity, whereas others cannot. That's why we must consider the right of all living things to have clean water and uphold our responsibilities with regard to this resource.

Table of observations

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Water and oil							
Water and cement							
Water and soap							
Water and toothpaste							
Water and food scraps							
Clean water							

Class activity 2: "Hey, plant! Don't drink that water!"

Objective	Time	Place
Observe how substances in the water affect plants.	1 hour (monitored over three days)	Outdoors

Materials

» 2 glasses, water, white flowers with long stems (25 cms or 10 inches), red and blue ink, sharp knife, adhesive tape, and marker

Preparation

» Do the experiment yourself in advance.

» Look for a place to do the experiment that is available for three days.

» Organize work groups and ask each group to bring in a set of materials.

» Before starting, have each group carefully cut the stem in half, length-wise, from the bottom to the 10 cm point.

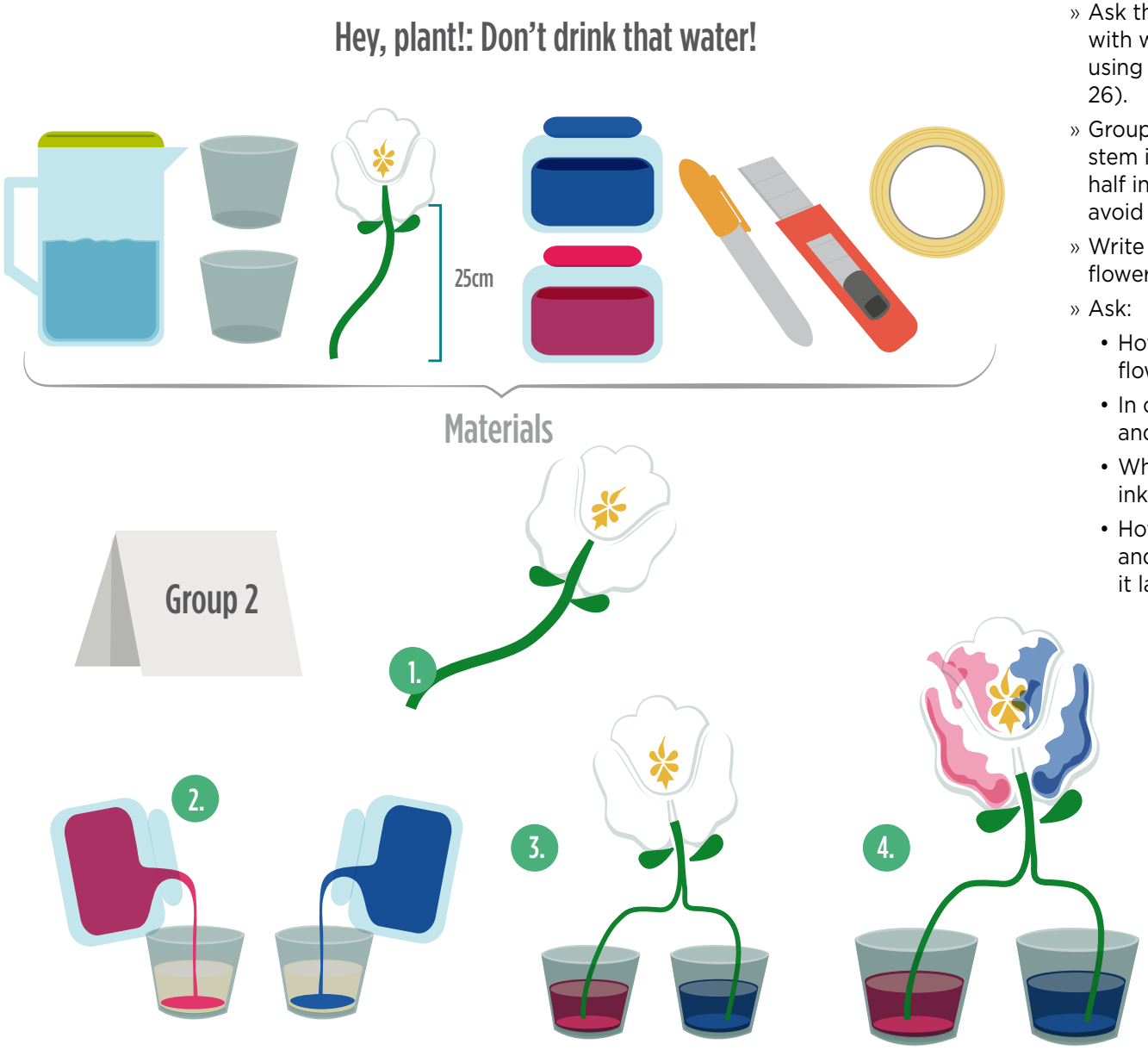
Step by step

» Ask and discuss: Can substances in the water affect plants?

» Ask: What could substances absorbed via water do to plants? Use students' ideas to form a hypothesis.

» Have students form their groups and ensure that each has a set of materials.

Figure 26. Hey, plant! Don't drink that water!



» Ask them to fill their glasses halfway with water and add a few drops of ink, using a different color for each (figure 26).

» Groups should insert half of the cut stem into the blue glass and the other half into the red glass, taking care to avoid damaging the flower.

» Write down what happens to the flower petals over the next three days.

» Ask:

- How far did the ink go up the flower?
- In our region, what might the blue and red ink represent?
- What would happen if, instead of ink, the flower drank oil residue?
- How would that affect the plant and the living thing that consumes it later?

Formative assessment

Before proceeding to the next topic, ensure that:

- » Students can identify substances that pollute the water
- » Students understand how living things adapt to aquatic ecosystems

Integration with other subjects

- » **Science:** Research how pollutants in the water affect aquatic ecosystems.
- » **Language:** Write about how wetland plants adapt to wastewater pollutants.
- » **Social Studies:** Create a declaration of rights for the water and propose ways to protect it.

Tips for the teacher

Discuss good water practices with students and encourage them to enjoy this resource responsibly. Ask them to share what they've learned at home; or invite parents to workshops on the community's environmental responsibility.

2 Intermediate lesson plan 2: Invisible water

General objectives

» Understand the role and effect of atmospheric gases and pollution in the water cycle.

» Assess the importance of water as a resource and reflect on its use.

» Promote conservation and efficient water use.

Class activity 1: Experiment—Cloud factory

Objective	Time	Place
Understand how a cloud forms and becomes contaminated.	40 minutes	Classroom

Materials

» Warm water, box of matches, plastic liter bottle with cap

Tip for the teacher

Clouds consist of many small water droplets. They form when warm, moist air in the atmosphere rises. It cools as it rises, allowing the water vapor to condense on small particles and form water droplets.

Preparation

» Give students an overview of the topic before doing the experiment.

» Make it clear to students that they may light the matches only when instructed to do so for the experiment; matches are not toys.

Step by step

» Ask: Can humans make clouds? How?

» Help your students formulate a hypothesis to answer this research question.

» Organize students into groups of three (figure 27).

» Ask them to put some water in the bottle to moisten it; then pour it out and cap the bottle.

» Ask one student to squeeze the middle of the bottle tightly.

» Students should observe what happens to the bottle when the pressure is released.

» Ask them to remove the cap and squeeze the bottle again, gently this time. They should take notes on what happens to the neck of the bottle.

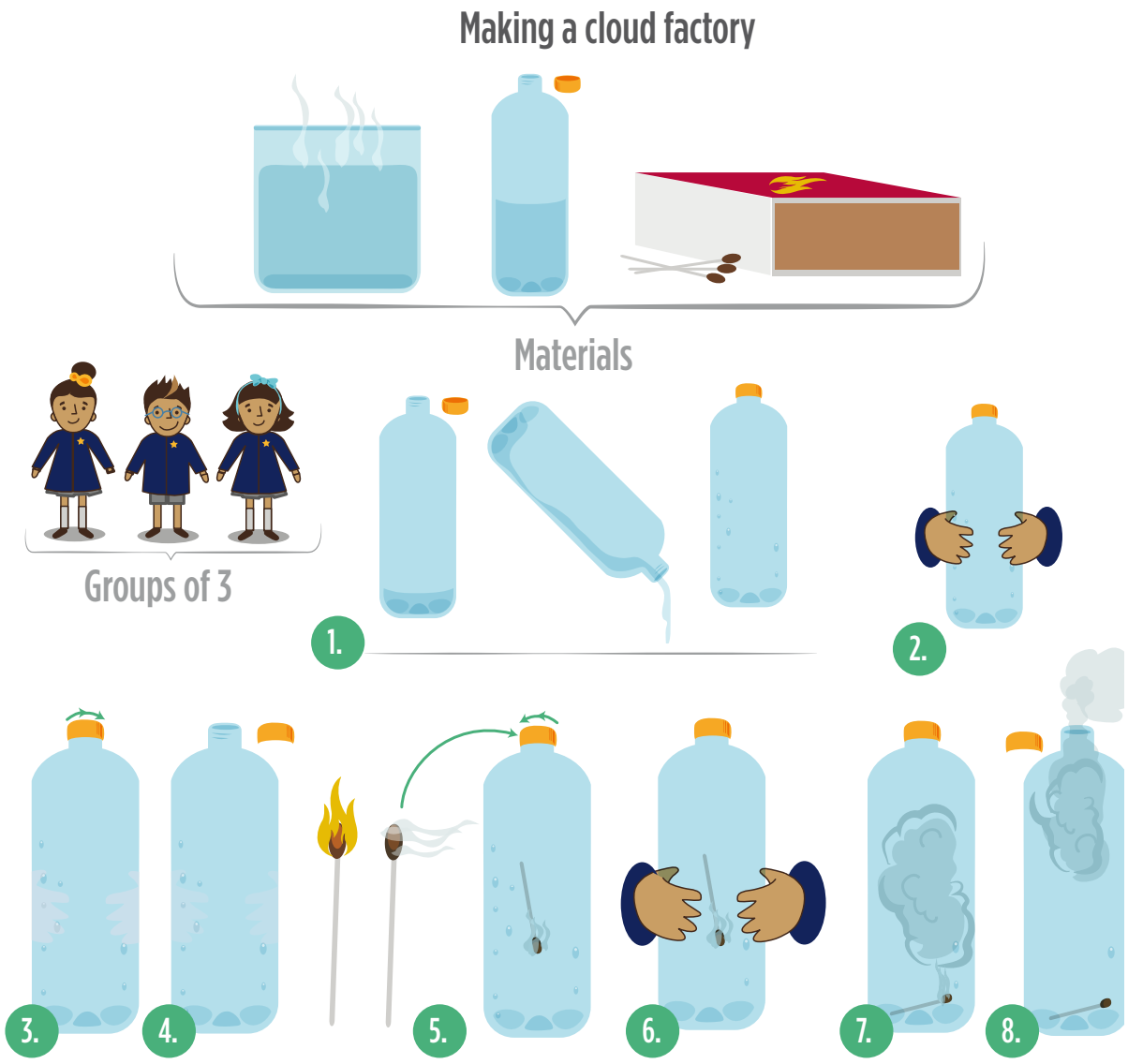
» Have them light a match, quickly put it out, insert it into the bottle, and cap it. Again, ask them to press on the center of the bottle and note what they see.

» Again, have them remove the lid, press down slightly on the bottle, and note what they see, answering the following questions in their notebook:

- How did the clouds form?
- What was the first cloud made of?
- What was the second cloud made of?
- What happens when clouds are contaminated with particles?
- How does this affect the water cycle?

» Discuss the experiment as a class, drawing on the information in box 4.

Figure 27. A cloud factory



Box 4. Cloud formation

As pressure builds inside the bottle, the temperature rises. By uncapping the bottle, the pressure drops and returns to its original state. As its temperature drops, small droplets of water vapor condense on the smoke particles.

The match's role in the experiment: Burning petroleum products such as diesel and gas produces sulfur dioxide, which rises into the atmosphere. When it rains, sulfur dioxide comes into contact with water, forming sulfurous acid and acidifying the rain. In this experiment, the sulfur (S) on the match head produces sulfur dioxide (SO_2) when lit. When that gas comes into contact with the water in the bottle, sulfurous acid (H_2SO_3) is formed.

Remember

Clouds are important because they contain water that moves around the world through the water cycle. Acid rain is made when water droplets condense on contaminated particles in the atmosphere, such as those produced by industries and automobiles. Acid rain is any precipitation containing high concentrations of sulfuric and nitric acids, including snow, fog, and dry particles that alight on the ground.

Class activity 2: Game—Running out of water

Objective	Time	Place
Promote conservation and efficient water use	40 minutes	Outdoors

Materials

» Four buckets or large containers, plastic lids from soda or juice bottles, small plastic cup

Preparation

Collect bottle tops from juice or soda bottles in advance and select an outdoor location to play the game.

Step by step

» Put two empty buckets two meters apart at one end of an open space. At the other end, place two lid-filled buckets, also two meters apart. There should be six meters between the empty and full buckets.

» Organize students into two groups of 10; each group should stand behind one of the empty buckets (figure 28).

» Tell students that the lids in the buckets represent our greatest treasure—the last of the planet's water. Tell them there is enough drinking water for 6 billion people, but since it is distributed unevenly and much is wasted or polluted, it is important to conserve it.

» The objective of the game is for each group member to carry as many lids as possible from the full bucket to the empty bucket on the other side of the field.

» The buckets cannot be lifted or moved. Students cannot use any containers other than their cup to carry the lids.

» The game ends when one of the groups has transported all of the lids from one bucket to the other.

» Afterward, discuss what happened during the game:

- Did the number of lids increase, decrease, or stay the same?
- How did you feel knowing these lids represented the last water on the planet?
- What strategies did you use to transport the lids?
- What happened to the water (lids) that didn't stay in the bucket?

» Discuss how water is used at home, at school, and in the community. Emphasize that we should not waste water.

» Variant: Divide the class into two groups. Take students outside to an open area, such as a patio. Place a bucket filled with lids in the middle of the space. Give each group a small cup.

» A representative of each group should fill the cup with lids and give the filled cup to the teacher. The first group to arrive gets to answer a question. In case of a tie, the group with the most lids in their container gets to respond first. Groups that spill any lids lose a turn. The goal is for students to answer the questions correctly and to show they can conserve (avoid spilling) "water."

Questions

» Name five examples of air pollutants.

» By what process does water vapor turn into rain?

» Contaminated clouds make what type of rain?

» Name five examples of inappropriate water use.

» Name five examples of appropriate water use.

Formative assessment

Before proceeding to the next topic, ensure that:

» Students understand the process of cloud formation

» Students can identify some pollutants in the atmosphere

» Students understand how acid rain is formed

» Students understand how to use water wisely

» Students understand the importance of conserving water.

Integration with other subjects

» **Science:** Research the effects of acid rain on living things

» **Civics:** Create a poster on responsible water use practices

» **Mathematics**: Discuss the information about "virtual water" in the introduction to the unit so that students understand how much water it takes to produce our food. Ask them to calculate the amount of water it takes to prepare food for one day at home, including breakfast, lunch, and dinner.

Remember

» Atmospheric gases in the clouds change the chemical composition of water droplets.

» Acid rain affects the environment when polluted water soaks into the soil and is absorbed by vegetation. This contaminates the food chain and threatens biodiversity.

» It is estimated that 20 percent of the projected global water shortage is due to climate change. The water shortage is part natural phenomenon, part due to human activities.

» Give students the facts about how much water it takes to make various products.

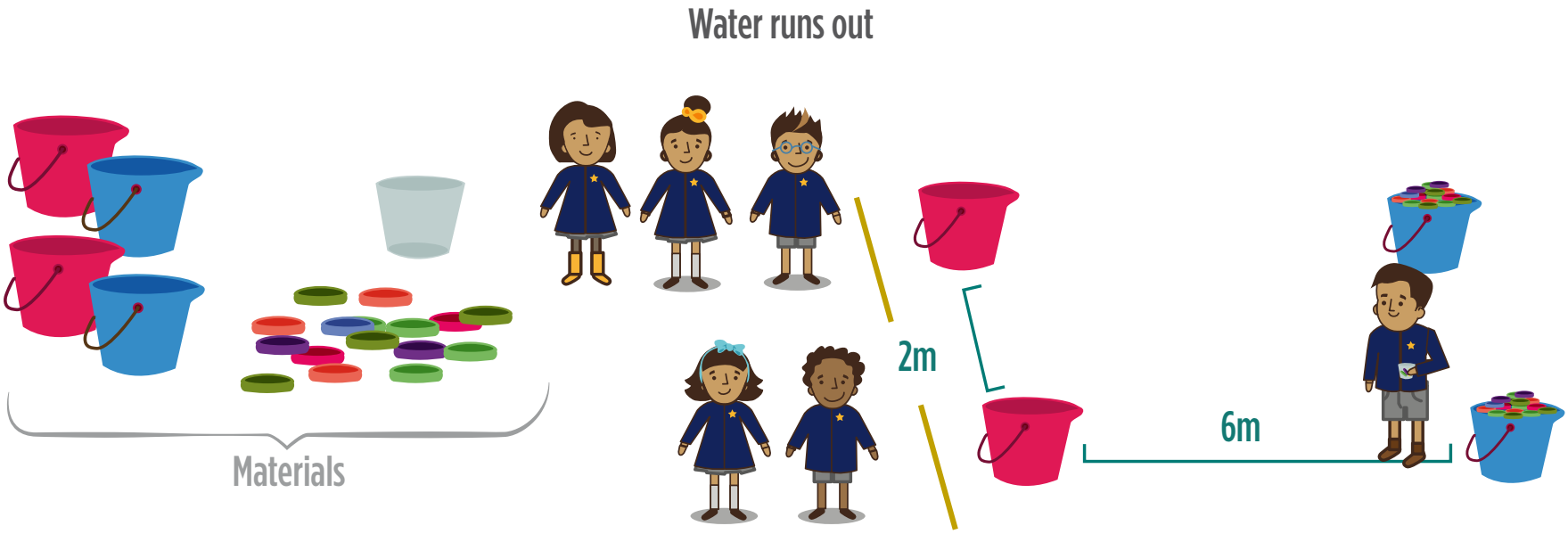
Tips for the teacher

Have students make a table to track monthly water consumption at home. Ask them to look at their water bills and record monthly consumption (in cubic meters) in a table. Consumption should decrease as they implement strategies for good water use at home.

Suggested reading and viewing

» www.epa.gov
The U.S. Environmental Protection Agency has an acid rain website for students. Search for "acid rain student site (grades 4–6)."

Figure 28. Materials for the game of "Running Out of Water"



Lesson Plans at the Advanced Level

1 Advanced lesson plan 1: Water—A continuous cycle

General objective

Understand that the climate, fresh water, and socioeconomic and biophysical systems are interconnected, and that human activity affects the water cycle.

Class activity 1: Natural water purification

Objective	Time	Place
Explain the natural process of water purification.	30 minutes	Classroom

Materials

» Printed or projected illustration of the water cycle and natural purification (figure 10), computer and projector, sheets of recycled paper cut to 30 x 10 cm

Preparation

Read the background material in advance.

Step by step

» Display a picture of the planet's water cycle and natural filtration process.

» Discuss how, for millions of years, nature has renewed water through soil filtration, oxygenation in waterfalls and rapids, evaporation, and precipitation.

» Give a sheet of cut paper to each student.

» Ask: Do human activities affect the natural water cycle and purification process?

» Ask students to write down a human activity that affects the water cycle and its natural recycling.

» Separate students' papers into groups: Put activities related to water overexploitation in the first group, pollution in the second group, and changing the land in the third group. Gather responses that do not fit into these categories in another pile.

» Share what the students wrote by group. Read the papers in the first group and ask: What do these activities have in common? Do the same for each group.

» Explain that three main types of human activities affect the water cycle and natural purification process: water overexploitation, pollution, and changing the land.

Class activity 2: Experiment—Purification of water for reuse

Objective	Time	Place
Filter water for reuse.	2 hours	Laboratory, garden, or schoolyard

Materials

» Clean cotton balls, clean fine sand, clean gravel, small stones, large stones, plastic bottles (such as soft drink bottles), swampy water, knives or scalpels, scratchpads or notebooks, pencils

Preparation

» Select students to bring the materials.

» Reserve space to carry out the experiment.

» Try the experiment yourself beforehand.

Step by step

» Divide the class into teams of 4 to 5 students.

» Tell students that they will build a natural water filter.

» Distribute the materials to each group and ask them to follow the step-by-step instructions to construct a filter. Warn them to be careful when cutting the bottles.

» Build the device along with each group:

- Cut off the top of the bottle.
- Turn the top over, plug the tip with a clean cotton ball and insert the inverted top into the bottom half of the bottle (figure 29).

» Emphasize that water can be recycled multiple times, using the astronaut example as a case in point.

» Ask: What if we reused our bath water after filtering it? Maybe to clean the floor or wash the car? Ask students to list as many ways as they can to reuse water in their daily lives.

» In the inverted top, put a layer of each in the following order: fine sand, clean gravel, small stones, and large stones.

» Pour dirty water (with suspended solids: sand, plastic, etc.) into the funnel and wait until the water makes it all the way through the filter. Record any changes in the water in a notebook.

» Ask students to consider and research the following question: What happens to water in the natural purification process under ideal conditions?

» Encourage conversation by saying: Did you know that astronauts drink water recovered from their urine after it is treated?

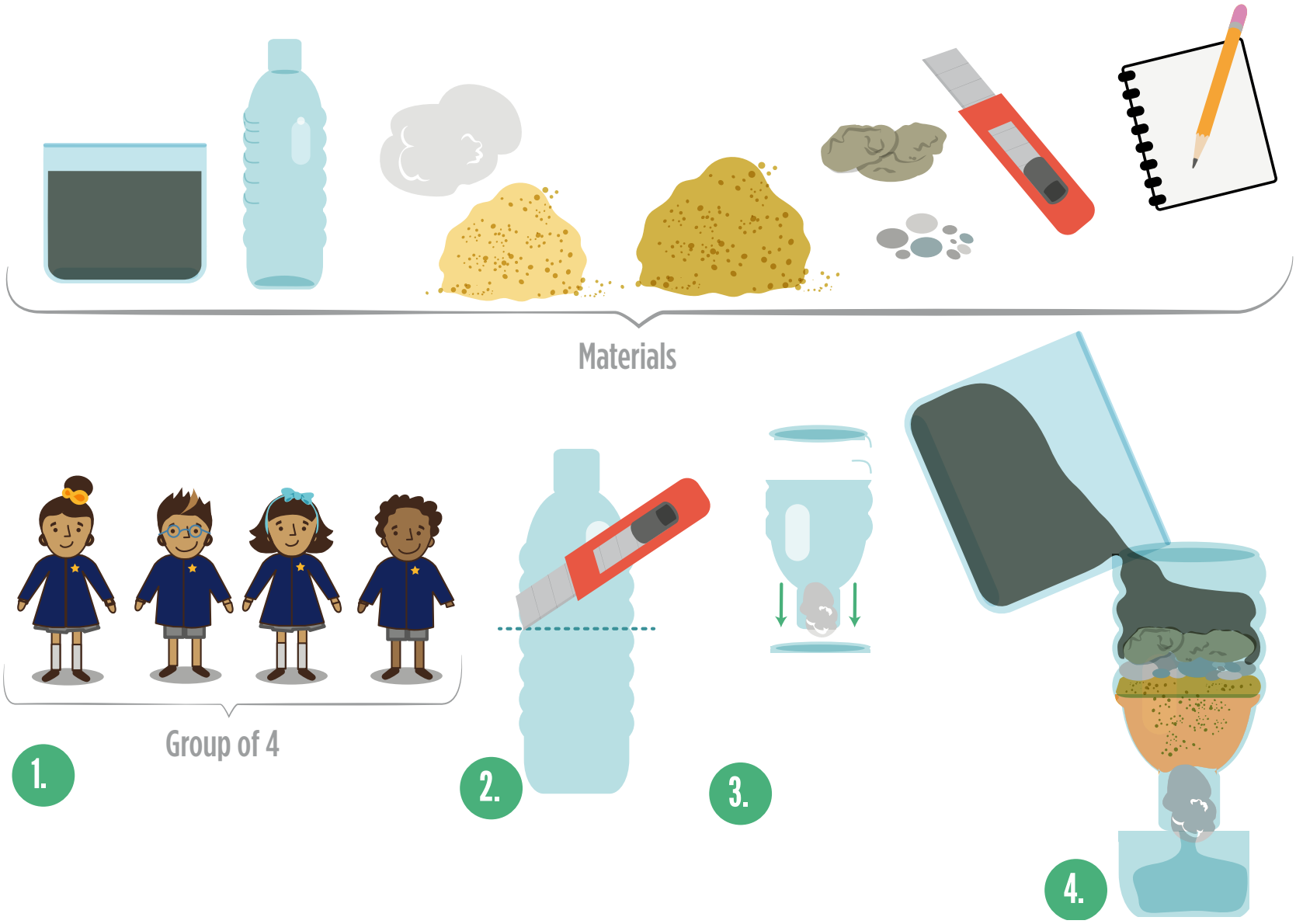
» Pick the best ideas and share them with the class.

» Encourage students to use what they learned in the experiment and discussion at home.

Tip for the teacher

Make sure students don't drink the filtered water because it may not have been completely purified.

Figure 29. Purification of water for reuse



Class activity 3: How changes in the water cycle affect human health

Objective	Time	Place
Better understand the importance of water for human health.	4 hours	Library or computer classroom

Materials

» Access to Internet or research books

Preparation

» Read the background material for this activity.

Step by step

» Ask: Have you ever had an illness related to water consumption or contact?

» Encourage students to hypothesize about the possible causes of water-related diseases. Talk about their experiences or those of people they know. Talk about pollution, shortages, and vectors that transmit disease. Tell students that those three factors are the main causes of water-related illnesses.

» Divide students into at least five groups to research water-related diseases. They can decide which disease to research, but no two groups should research the same disease.

» They should find out the following information about the disease: its common name, cause(s), how it is transmitted, disease symptoms, and prevention measures.

» Ask each group to prepare a skit based on their research to demonstrate a disease, its possible causes, symptoms, and preventive measures. Possible scenarios may be a community, a hospital, a school, and a health center—or wherever they believe they can best represent the situation.

Formative assessment

After this lesson, students should understand:

» That there is a shortage of drinking water in the world, despite the existence of vast quantities of water

» Natural water purification

» That some changes in water quality are due to human activity

» Artificial water purification

» The relationship between water quality and some diseases.

If students do not yet grasp these concepts, review the background material for this unit and encourage students to look online for news related to floods, droughts, gastrointestinal diseases caused by pollution, and extinction of species due to changes in the water.

Remember

» Climate change causes 20 percent of the water shortages on Earth; the remaining 80 percent is caused by population growth and development.

» Climate change affects the water cycle directly as well as the quantity and quality of water resources available to meet human and environmental demands.

» Intense rainfall can cause flooding, loss of life, and damage to infrastructure.

» When river water levels get too low, there may not be enough water for wildlife, drinking, hydroelectric power production, cooling of thermal plants, and navigation.

» Global warming increases water temperatures, contributing to the loss of biodiversity.

» Changes in the soil, pollution, and overexploitation of water resources all change the water cycle and lower water quality.

» There are many water-related diseases. Some are transmitted through polluted water, others are borne by water-dwelling vectors, and still others appear during water shortages.

Integration with other subjects

» **Social Studies:** Ask students to research water availability and quality in their town and reflect on differences among neighborhoods or towns in their area.

» **Economics or Geography:** Ask students to research the availability of water in the world and write an essay on the influence of water availability on the economy of a given country. Have them map out water availability on the continents or by region, department, state, or province in their country.

» **Arts:** Encourage your students to use recycled items to construct models illustrating the water cycle and natural purification process.

Suggested reading and viewing

» www.iadb.org
Sections of the IDB website devoted to the Regional Policy Dialogue (DRP) on Water and Climate Change in the Americas explain the impact of climate change on the continent's water resources, present some agreements on water, and describe public policies on water resource management.

» www.who.int
The website of the World Health Organization has sections on water, sanitation, and health that offer detailed descriptions of water-borne diseases and their causes, symptoms, diagnoses, and so on, as well as information on drinking water levels around the world.

» www.worldmapper.org
The world as you've never seen it before! Find the volume on water resources, groundwater recharge, and rainfall. The map on water resources shows water availability for the different countries around the world. The maps on groundwater recharge and rainfall distribution reveal the unequal distribution of water available for consumption.

2 Advanced lesson plan 2: Addressing water challenges in Latin America and the Caribbean

General objectives

» Identify water-related issues that expose Latin America and the Caribbean to vulnerable situations.

» Understand how public policies can protect water resources and improve their management.

Class activity 1: Climate change and water

Objective	Time	Place
Understand the impact of climate change on the planet and its relationship with water.	1.5 hours	Classroom

Materials

» Table on effects of climate change on water (table 1 in introduction to unit)

» Tape, glue, cardboard, colored markers

» News articles or reports on recent weather events. These do not necessarily have to be about disasters; they can also describe changes that affect certain ecosystems.

Preparation

» Review the table on climate change and its effects on water (table 1) as well as the suggested reading material.

» Look for news about recent events related to water and climate change so you can discuss important examples in class.

» Review the video "Are You Averse to Risk" that you can find at www.idb.org/riseup

» Ask the class to bring in news articles or reports about recent water-related weather events. These can be about disasters or changes that affect certain ecosystems.

Step by step

» Divide students into groups of no more than five or six.

» Ask each group to choose two important facts from the news reports they brought and use the table on effects of climate change in water (table 1) to analyze them. Ask:

- What weather event may have triggered the problem you chose?
- What were the natural, social, economic, and cultural impacts?
- What can be done to lessen those impacts and better adapt to environmental change?

» After the discussion, share the material in box 5.

» Invite each group to find connections between the problems they listed and the recommended solutions; if necessary, add a "general solutions" column to the table using cardboard. Hang the finished table on a classroom wall as a reminder.

Box 5 Measures to improve water management

The Intergovernmental Panel on Climate Change, the World Bank, and the IDB suggest ways to improve water management in Latin America:

- Collect and store rainwater for agricultural and forest production
- Protect water sources through water decontamination and wastewater treatment
- Recycle and reuse water by developing artificial water purification mechanisms
- Use large reservoirs to expand water collection
- Protect groundwater; expand rainwater collection and storage capacities
- Use solar distillation for desalination
- Engage in reforestation
- Better manage storm water and build of underground replenishment areas

Class activity 2: Water problems around the world

Objective	Time	Place
Understand the past, present and future of water around the world.	30 minutes	Classroom

Materials

- Figures 31–33, computer and projector, copies of the text in box 6

Preparation

- Read the last section of the introduction to this unit (under the heading "Working together to slow climate change and its effects on our water").
- Carefully review the three graphics prepared for this activity (figures 31–33).
- If needed, research the impact of climate change around the world to supplement the information in the graphics.
- Watch the video "Are You Averse to Risk?" You can find it at www.idb.org/riseup.

Step by step

- Project figure 31. Ask students to look at it carefully. Repeat with figures 32 and 33.
- Ask: What do these graphics have in common?
- Ask: What is the present status and future of water in Latin America and the Caribbean?
- Briefly introduce the term "adaptation" and have students read the text in box 6.
- Encourage students to reflect on ancestral environmental practices and the examples of peoples from Nazca and other regions in the face of our need today to adapt to climate change and to find solutions to environmental problems. Consider Machu Picchu, whose inhabitants built a stone city that withstood earthquakes and heavy rainfall by managing water intelligently through carefully engineered drainage systems.

Box 6. How Pre-Columbian civilizations adapted to the highlands

Pre-Columbian indigenous peoples had few resources available in and around their settlements. Even today in the Latin American highlands, one of the most serious constraints to development is uneven distribution of water. This is due to extreme atmospheric processes, rapid water runoff, and changing soil conditions.

Melting glaciers were, and remain, a reliable source of water during the dry season. However, this water is only available in certain areas. As a result, pre-Columbian communities developed various ways to adapt to their environment.

They adapted ways to solve several hydraulic problems and to predict seasonal climate variations and rainy periods. For example, they captured rainwater for cultivation, developed filtration and storage methods, and built surface and underground canals for irrigation, as well as devices to measure stored water volumes. They were also able to connect the Pacific and Atlantic basins in La Cumbre and Cajamarca (Peru).

The Incas developed ways to predict seasonal rainy periods and climate variations such as El Niño, for scheduling planting and food harvests. They also improved the riverbeds of the Urubamba River, among others, and built hanging bridges as well as bridges on pillars that were erected in riverbanks.

They used running water from geothermal sources for leisure and spiritual renewal; Inca sites such as the "Bath of the Inca" and the ruins of a musical garden in Tampumacchay (near Cusco) still exist today. Priests of the Chavin culture used the flow of running water through perforated pipes in their temples to produce sounds like the roar of a jaguar (representing the spirit of the physical world).

Water was also used to cut blocks of stone for construction. In Ollantaytambo (between Cusco and Machu Picchu), stones were cut into regular geometric shapes by streams of water artfully arranged in the cracks and frozen overnight at the sub-zero temperatures of the Altiplano. Indigenous people pioneering efforts to adapt to local conditions and define sustainable development paths allowed them to thrive in harsh environments.

Today it is becoming increasing important to review and update such adaptation measures, given current weather and climate conditions, the increasing greenhouse effect, and the melting glaciers.

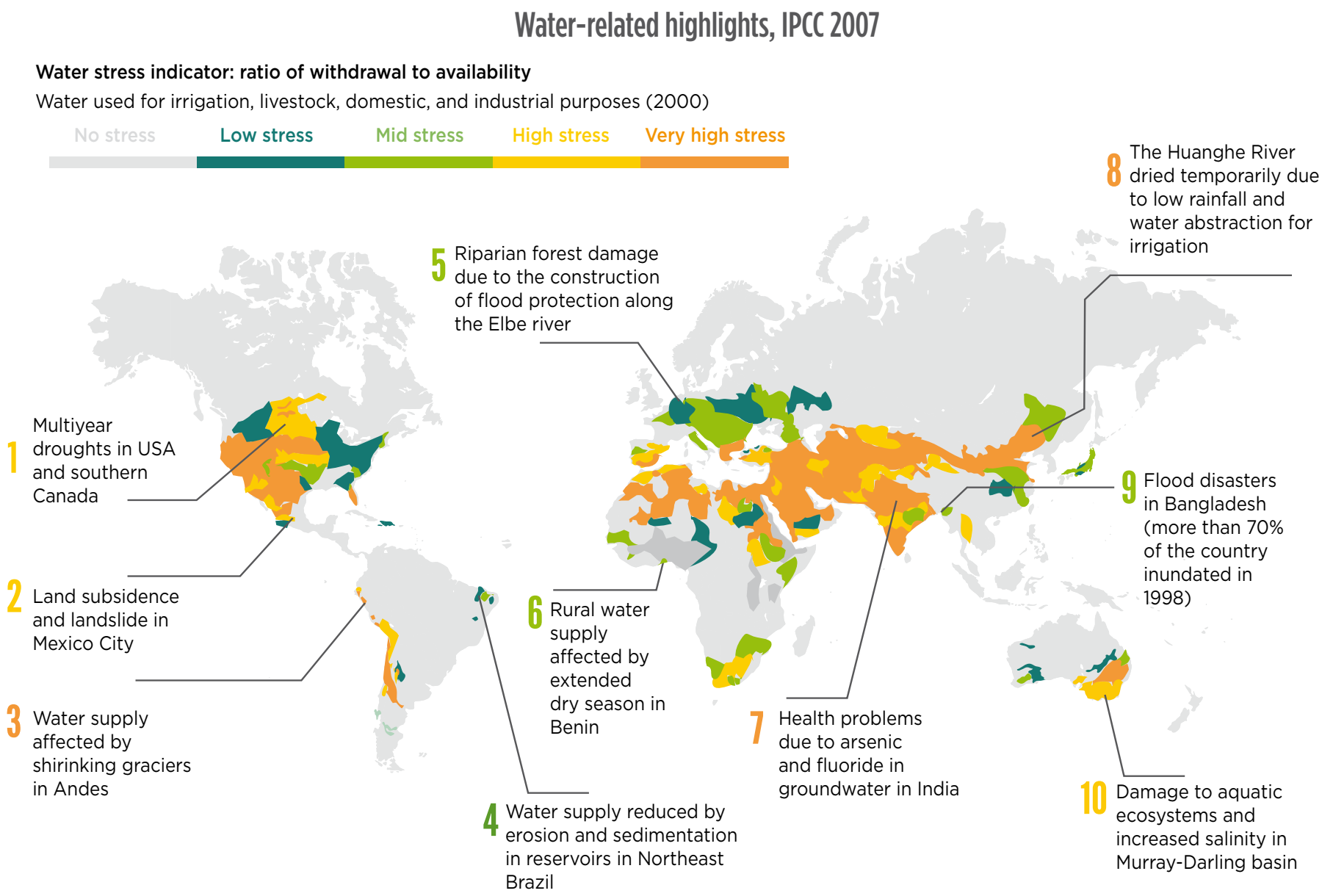
Source: www.hidraulicainca.com

Nazca

Southern coast of Peru:

Water cultivation system for underground aqueducts and supplying the water table

Figure 31. Water-related highlights (IPCC 2007)



Source: www.ipcc.ch.

Figure 32. Selected extreme events and their impacts on Latin America and the Caribbean from 2004 to 2015

Heavy rains

Colombia — September 2005

70 dead

86 injured

6 missing

140,000 victims of flooding

Venezuela — February 2005

Heavy rainfall mainly along the coast and in the Andean mountains, severe flooding and heavy landslides.

Losses of US $52 million

70 dead

175,000 injured

51 dead

76 missing

Tsunami in Chile — 2010

181 dead

25 missing

17,000 houses affected

3,000 damaged boats

Colombia — 2011—2011

Flooding left:

3,219,000 victims

1,374 dead

Losses of US $6,062 million

Brazil — January 2011

Landslides and flash floods in Brazil claimed the lives of: 900 people and thousands of homes destroyed

Rio de Janeiro, Brazil — 2011

Flooding left:

900 dead

35,000 homeless

Salgar, Colombia

May 2015

49 dead

Chile — 2015

51 dead

59 missing

The number of storms between 2000 and 2009 multiplied by 12 relative to those that occurred between 1970 and 1979.

In the same period cuadruplicaeon floods. The number of people affected by extreme temperatures, forest fires, droughts, storms and floods grew from:

5 millon in the 70s > more than **40 millon** over the past decade

Droughts

Argentina

2004—2005

Losses estimated at **US $360** million

120,000 livestock losses

10,000 livestock losses

Similar cases in Bolivia and Paraguay (2004 and 2005).

Brazil

Amazonia

Severe drought affected the southwestern area

Probably associated with the warming of the sea surface in the tropical North Atlantic

Rio Grande do Sul

Reduced production

soybeans **65%**

corn **56%**

South America

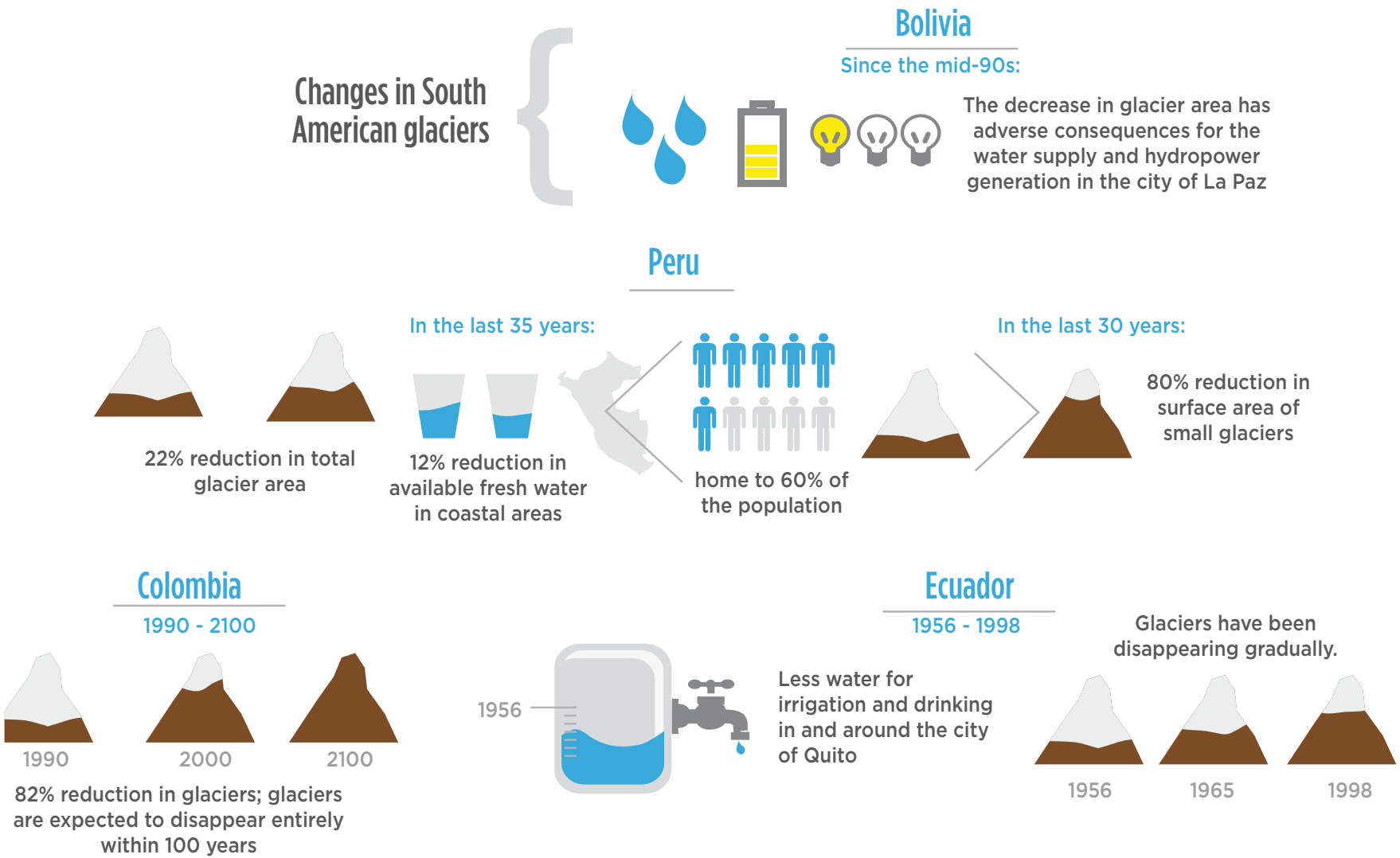
Between 1980 and 2010 reported

68,250 dead

as a result of natural disasters.

Source: www.ipcc.ch, www.cepal.org

Figure 33. Trends in South American glaciers



Class activity 3: The region's water problem is also my problem

Objectives	Time	Place
Encourage students to learn about the water conditions in their region and to propose solutions to local problems.	3 hours	Classroom

Materials

» Data on water supply, glacier trends, and related phenomena in your region, available through water resources management organizations, watershed committees, and specialists. Visit their websites (if available) or offices to obtain this data.

Preparation

Research and encourage students to research the following aspects of their region:

» How has the population grown over the last 50 years?

» What main activities drive the local economy?

» How does this economy influence water resources?

» Are there many arid or semi-arid areas? What actions are being taken to remedy water shortages and prevent further problems for the population?

» Are deforestation and overuse of land harming local waterways?

» Over the last 50 years, has there been a water-related disaster in your region?

» Are there problems with water supply?

» Are there problems with wastewater collection and treatment?

» Which municipal, state, and federal programs are responsible for these issues?

Step by step

» Ask students what struck them the most (positively or negatively) about the research they did for class and note their comments so that, following their presentations, you can create a balance sheet listing their region's advantages and difficulties with respect to water availability and quality.

» Based on your notes, list the advantages and difficulties on the board.

» Ask students to read the lists and use them to analyze the region's water status.

» Discuss the students' findings about local or state problems and potential solutions, and determine whether their proposals are appropriate and adequate to address the problems.

» Divide students into groups of three or four and have them do a project addressing needs or problems they identified that are not currently included in state or local programs. Their report should include the following information: general objective, specific objectives, introduction or statement of water status (using and complementing their research), methodology, economic resources, execution time, human resource requirements, and expected results.

» Ask groups to present their proposals.

Tip for the teacher

Send the best proposals to the local authorities so they will be taken into account for future decisions. Invite government officials involved in water management to talk to students and listen to their presentations. If possible, ask the officials to comment on the methodology and viability of students' projects, given local circumstances.

Class activity 4: Natural resource campaign

Objectives	Time	Place
» Empower students, the school community, and the community at large to take charge of local natural resources. » Design a communications/action campaign to conserve or restore a natural resource (water or forest).	Two months	Classroom, school, neighborhood, town, or municipality

Materials

» Copies of a project management guide and materials identified during the project planning stages

Preparation

» Ask if any students have relatives who work in communications, advertising, or marketing. Ask them to invite these relatives to class to help plan a local natural resource campaign. Consider asking a local nongovernmental organization for assistance.

» Plan the meeting with your students. Tell them that they will organize a campaign for the school community, the neighborhood, or the city (if small) to protect local environmental resources, via reforestation, creating green areas, or cleaning up watersheds.

» Read with your students the material on environmental services fees in the introduction to this unit and research the project in Costa Rica.

» Find a biologist, either a school teacher or someone outside the school, to support the class during the project.

Step by step

Keep in mind that this project will be carried out over several months, depending on the work schedule created by students.

» Ask: What basic natural resource problems do we have in our area?

» What are the advantages of environmental service payments? Discuss this concept in depth.

» Based on the discussion, select an easily accessible area in the community to develop a reforestation or watershed restoration project. Having a biologist involved would be helpful.

» Ask students to research the physical characteristics of the selected area: Who owns it? From whom should they request permission to do the project? What native species live there? What other information do they need to do the project?

» Use Costa Rica's project on payments for environmental services as a model to get students thinking about what they'll need for their own project. (Who was involved? What steps were followed?) Use Costa Rica's experience to ask local entrepreneurs, schools, and residents to contribute. Sell the benefits of the project to potential supporters.

» Create a strategic planning flowchart for the project (figure 34 provides an example). The more complex and detailed the flowchart, the more helpful it will be for the project. Remember that you will need funding for the project, and ask students to propose ways to get it. Some cities have entities that will contribute trees for reforestation in exchange for physical labor. Find out if such an entity exists in your area, and research other funding options.

» After project logistics have been clearly defined, invite students' relatives with experience in communication campaigns to a meeting and have the students share what they want to do and ask for advice. If possible, also invite a biologist or environmental manager to the meeting, as well as members of nongovernmental organizations that work on environmental issues and citizen participation.

Keep in mind that the campaign must begin with the school, and that members of the school community will need to promote the project in the school's sphere of influence.

Figure 34. Example of a strategic planning flowchart

Tip for the teacher

Divide the school community into groups and assign them very specific tasks. The success or failure of the project depends on this. Enlist the help of a group of student leaders or teachers to follow up and help resolve any problems.

Class activity 5: To take care of our water, be aware!

Objectives	Time	Place
Empower students, the school community, and the community at large to conserve water.	Three months: 4 class hours to program calculators; the rest of the time for follow-up	Classroom, school, home

Materials

» Computer

Preparation

» Meet with your school's computer teacher and ask him or her to undertake a joint project to create a calculator to measure water use in the school community.

» Tell him or her that students will learn how to program a calculator to measure changes in water use over time and capture visible statistics. It should use a point system, with results displayed via tables, graphs, or icons.

» Review a few online water consumption calculators with the computer teacher.

» Make a list of activities and behavioral changes that may improve water management in the school community and in students' homes.

Step by step

» Gather your students in the computer room and ask: We've learned about water's role in the climate change. What can we do to improve water use in our daily lives?

» Make a list of specific activities, such as: turn off the faucet when lathering, don't use a hose to wash the car, save and reuse water at home, reuse water from the shower in toilets, and so on. Share as many ideas as possible.

» Add your own ideas to the list.

» Invite the computer teacher to tell your students about the project. Tell them they will divide into groups to develop three calculators: one for the school, one for each student, and one for their families.

» Divide your students into three groups. Based on the list they made in steps 2 and 3 and together with the computer teacher, help them program calculators to measure water use over time. The calculators should have a point system, graphs, and diagrams to encourage students, families, and the school as a whole to conserve water. Make these calculators as fun as possible; use images and animations.

» Ask students to use their individual calculators to measure their own water use for two months.

» Have them share the calculator with their families and challenge them to improve water use at home and lower their water bill.

» Share the schoolwide calculator with teachers and administrative staff and work together to implement it. Share the results with students weekly.

» Ask students to bring in their individual and family statistics each week to share with the class. Keep track of these statistics on posters.

Tip for the teacher

It's easiest to have two posters—one for families and another for students—to facilitate comparisons. Some studies indicate that direct comparisons encourage people to work harder to achieve their goals.

Formative assessment

Upon completing this unit, students should understand:

» The direct relationship between climate change and water availability

» That Latin America and the Caribbean are vulnerable owing to the water crisis caused by climate change

» That increased rainfall, melting glaciers, and droughts are causing climate events and disasters in the region

» The many available ways to improve water management in the region: rainwater storage, protecting water sources, water decontamination and wastewater treatment, reforestation, water reuse and recycling practices, artificial water purification mechanisms, using large reservoirs to collect water, groundwater protection, expanding rainwater collection and storage capacities, using solar distillation for desalination, storm water management, and underground replenishment areas

» That environmental services payments are an interesting tool for natural resource management.

Integration with other subjects

Linking your topic with the concept of sustainable development will create synergies with subjects such as economics and environmental and social development in the region.

» **Geography**: Have students point out water resources and forests on the map.

» **Biology**: Encourage students to research local native plants. Which species are no longer found today due to climate change?

» **Social and Cultural Studies**: Have students research local water agreements involving entrepreneurs, the government, and the community.

» **Design, Art, or Drawing**: Have students design a city showing water usage and management plans and facilities.

Remember

» Latin American tropical forests in the eastern Amazon are predicted to become savanna by the middle of this century.

» It is likely that many species will become extinct. In drier areas, arable land is expected to transform into salt flats or steppes. Access to fresh water will decrease.

» We already see rising atmospheric temperatures, rising water surface temperatures, rising sea levels, changing precipitation patterns and evapotranspiration, and more intense and frequent disasters.

» Environmental services are benefits we derive from the operation of ecosystems, such as soil formation, climate regulation, oxygen production, food, water resources, and forest protection.

Suggested reading and viewing

» www.whymap.org
The Worldwide Hydrogeological Mapping and Assessment has produced maps of water availability around the world and water management development reports.

» www.ipcc.ch
Climate Change and Water. IPCC Technical Paper VI, 2008.

» www.worldbank.org
The World Bank's website offers resources on climate change and its influence on the waters of Latin America.

» www.iadb.org
The Water and Sanitation Initiative of the Inter-American Development Bank includes projects on climate change and water.

» www.ipcc.ch
The website of the IPCC tells us how climate change will affect the balance of water demand and water availability.

» www.youtube.com
Machu Picchu: The lost city of the Incas — Modern Marvels, History Channel. Documents the Inca civilization's feats of architectural and hydraulic engineering.

» www.aguasdesevilla.com
Example of an individual water consumption calculator.

» www.unep.org
The website of the United Nations Environment Programme offers resources on adaptation to climate change and mitigation of its effects on the world's water resources, including coastal waters.


Rise Up
Against Climate Change

2016

Water to Treasure

Lesson Plans for Children and Youth

Emma Näslund-Hadley, María Clara Ramos, Juan Paredes, Ángela Bolivar, and Gustavo Wilches-Chaux

Rise Up Against Climate Change!

A school-centered educational initiative of the Inter-American Development Bank