xylem watermark

THE GREAT BOOK OF WATER

INDIA

Denise Pouleurs

Yatin Tayalia, Rajul Mehrotra, Arnab Chakraborty, Chaya Ravishankar and Mahesh Kothiyal

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Encounter with water

I will never forget that summer. I was happy! Anytime I could, I joined letters and put together words from the signs on the streets, the ads on newspapers and my storybook. I had learned to read, and it was the beginning of vacation!

After a whole day of traveling, with my sister and my parents in my uncle's car, we arrived at a small town. We travelled the main street until the end, where we found a lake beach.

The afternoon sun created thousands of little stars over the rippling surface. It was the first time, I saw that much water in the same place. It was the first time I saw a lake!

Years went by, and I never forgot that afternoon breeze, and the sun reflected on that immensity.

That place became my favourite in the world. Anytime I can, I go back to visit it. And every time I go back, I learn something new: the importance of the lake for the forests living nearby, the rivers that flow into it and from the lake, how everything moves around it, how everything is interconnected.

Years went by, and I kept studying - a lot. The visits to that lake inspired me, to learn more about water and how to preserve it. I felt that, I wanted to keep visiting that place for a long time, and that future generations could see it too.

Today I am an engineer.
Along with several colleagues, we prepared this book so that every boy and girl, can learn about the importance of water; the way the water cycle connects to our territory, the climate, and the ecosystems.
Review why it is necessary, to know the properties of water, and how they help in the occurrence of wonderful phenomena in nature. Learn the course of water through the cities, and above all, how we, the people, can become aware and help protect this valuable resource.

We hope that you like *The Great Book of Water,* as much as us and enjoy reading it and learning.

Denise Pouleurs

Chapter 1

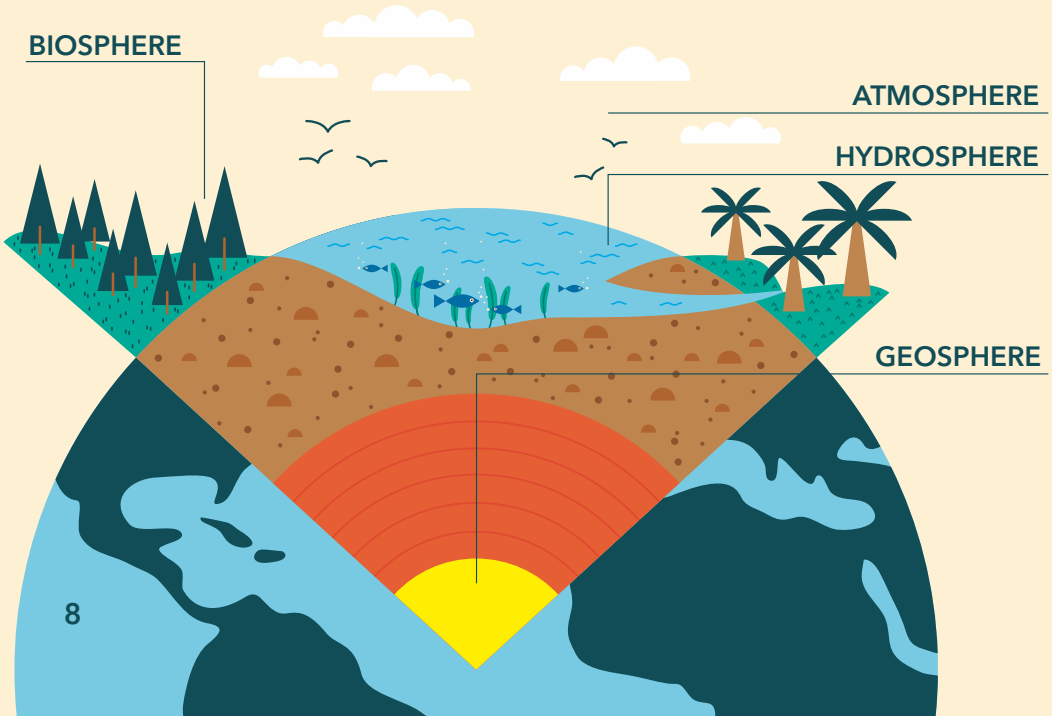
Planet Earth, planet water

We only have one planet Earth. Everything that happens on it, is interconnected. Everything circulates, connects, and transforms as a part of a cycle, where each element is related to what happened and what will happen, starting from a drop of water.

We invite you to learn how our planet is formed, and where and how you can find water.

Layers of the Earth

The Earth is shaped as a sphere or ball, and it is composed of several layers of different materials, that interconnect and create a system. Identify the layers and what is in them.



ATMOSPHERE (AIR)
It is the gas layer that surrounds the Earth. It protects it from outer space, especially the harmful rays of the sun, and catches the heat that comes off the surface of the planet, helping regulate the temperature. Here you can find the oxygen, that we need to live.

GEOSPHERE (ROCKS AND MINERALS)
It encompasses the solid part of the Earth (land and rocks), and it is the one that provides support to the other layers. It extends from the surface to the center of the planet, and it has three levels: crust, mantle, and the core.

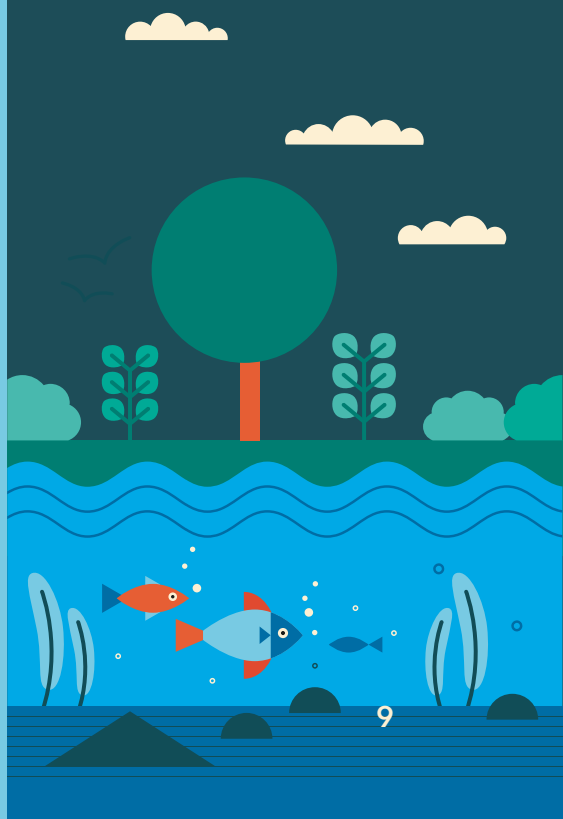
HYDROSPHERE (WATER)
It is all the water that exists on Earth, in its many forms, states, colors, and flavors. Here you can find the oceans, seas, rivers, lakes, groundwater currents, glaciers, and the water present in the atmosphere.

BIOSPHERE (LIVING BEINGS)
This layer includes living beings and the different ecosystems, where they inhabit and interact, such as forests, rainforests, deserts, savannahs, tundra, etc. The biosphere also encompasses other layers, like the depths of the oceans or the closest part to the atmosphere, where fish and birds live.

✳ UNDERSTAND THE WORDS

A SYSTEM, IS A MIXTURE OF SEVERAL ELEMENTS OR COMPONENTS INTERCONNECTED. EACH ONE PERFORMS A TASK, THAT LINKS AND COMPLEMENTS THE OTHER COMPONENTS, SO THEY CANNOT WORK SEPARATELY.

AN ECOSYSTEM, IS A SYSTEM FORMED IN A GEOGRAPHIC AREA CONSISTING OF ALL THE NATURAL ELEMENTS FOUND THERE; INCLUDED THE LIVING ORGANISMS AND THE PHYSICAL ENVIRONMENT. THESE ELEMENTS ARE CONNECTED IN HARMONY.



A liquid treasure

The water formed in the hydrosphere, can be freshwater or saltwater.

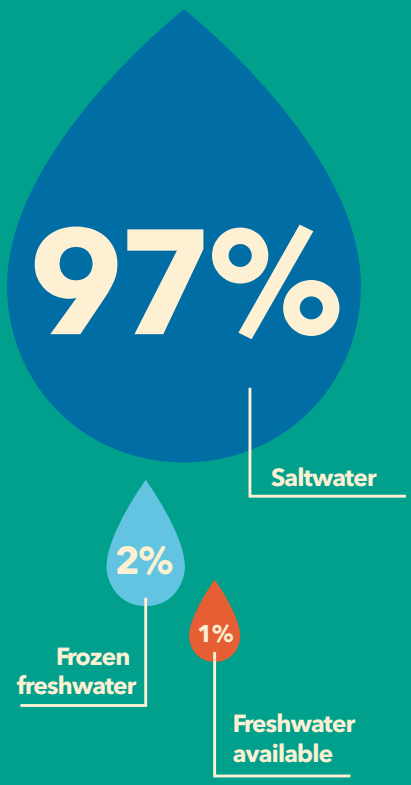
Saltwater contains an excess of dissolved minerals, which gives it a salty flavor. That is the water you can find in oceans and seas.

Most living beings (except for the ones that live at sea), do not drink saltwater but freshwater. That is the water, that gives life to plants, animals, and human beings.

The problem is that, even if there is a lot of water on Earth, most of it is saltwater. Just a small part of it is freshwater and, besides, a great amount is frozen in the poles or high mountains.

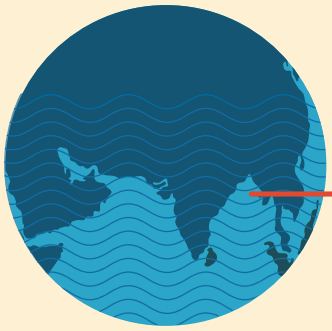
This means that the water available in the form of rivers, lakes, ponds, and groundwater is even smaller, and amounts to only 1% of the total water on the planet! In other words, for every hundred drops of water, only one of them is available through freshwater sources.

With this 1%, all the necessary activities for life on this planet take place. It seems too little, right? Well, it is. And that is one of the main reasons, why we should protect this liquid treasure.



WHY IS SEAWATER SALTY?

BECAUSE OF THE RIVERS THAT FLOW INTO THE SEAS AND OCEANS. IN ITS CURRENTS, RIVERS CARRY MINERALS FROM THE EROSION OF ROCKS. OUT OF THESE MINERALS, THE MOST COMMON IS SODIUM CHLORIDE, ALSO KNOWN AS SALT. FOR MILLIONS OF YEARS RIVERS HAVE TAKEN SALT FROM THE SURFACE OF THE EARTH TOWARD THE OCEANS.



70%

PLANET EARTH

IS WATER-COVERED

97% Saltwater

3% Freshwater

TOTAL FRESHWATER IN THE WORLD

2%

GLACIERS, SNOW OR ICE

1%

ARE SURFACE WATERS AND GROUNDWATERS

LESS THAN 1%

WATER AVAILABLE FOR HUMAN CONSUMPTION AND FOR THE ECOSYSTEMS

ITS EXTRACTION PER USE IS...

69%

AGRICULTURAL SECTOR

19%

INDUSTRIAL SECTOR

12%

MUNICIPAL SECTOR

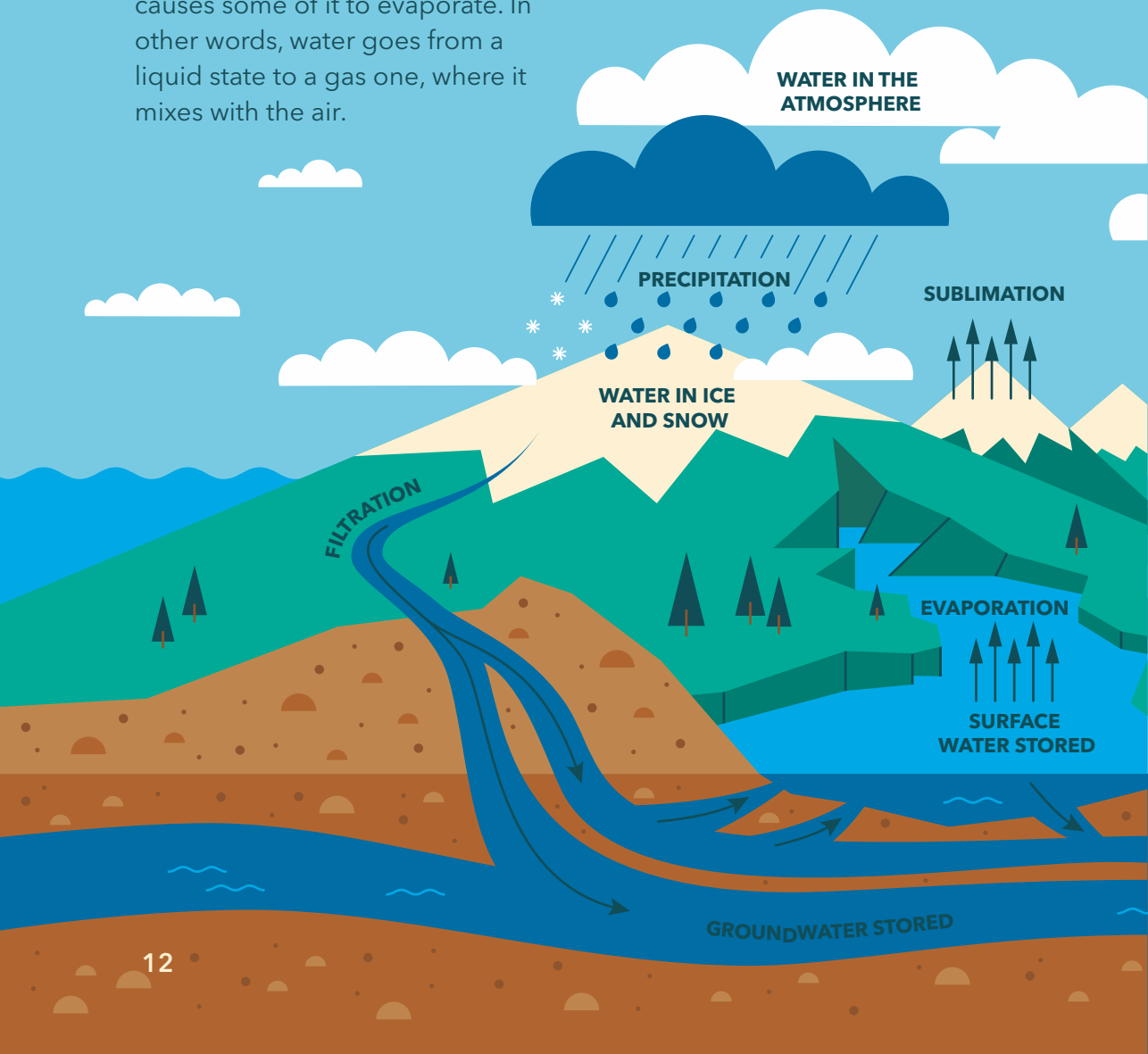
Taken from Agua.org.mx, Fund for the Communication and Water Education (https://agua.org.mx/en-el-planeta/)

The water cycle

Water is neither created nor destroyed, but transformed. The one we have today is the same one that dinosaurs drank from, and has traveled over and over through the layers of the Earth. This is what we call - "the water cycle".

The rays of the sun heat the water of oceans, rivers, and lakes, which causes some of it to evaporate. In other words, water goes from a liquid state to a gas one, where it mixes with the air.

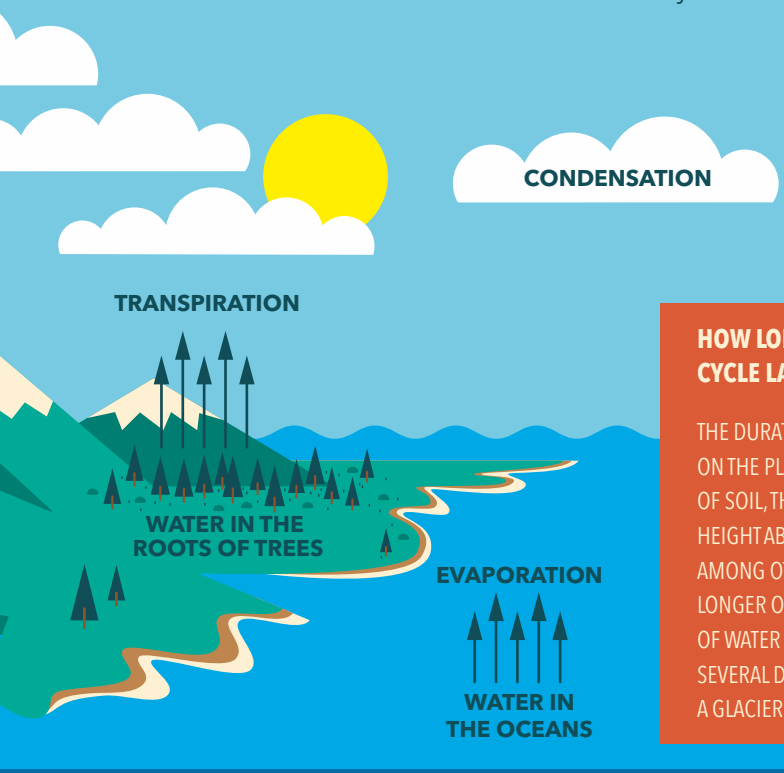
When water evaporates, it turns into steam. In this state, it rises to the atmosphere until it reaches cool air currents. Then, that steam is condensed, and water goes back to its liquid state as drops produced by clouds.



These clouds travel from one place to another, helped by air currents and the wind. When clouds have enough water, droplets start to gather, growing and getting heavier. Then, the Earth's gravity attracts them, and it starts to rain. If it is too cold up there, the water freezes and falls as snow.

The water that falls on the surface of the Earth, finds its way until it reaches a river or seeps into the soil looking for a place to stay. This is how subterranean rivers and aquifers are formed. While on the land surface, water is used by plants, forests, and living beings.

In the end, all that water will flow into the ocean, where it will evaporate again to start a new cycle.



HOW LONG DOES THE WATER CYCLE LAST?

THE DURATION OF THE WATER CYCLE DEPENDS ON THE PLACE. DEPENDING ON THE TYPE OF SOIL, THE LOCATION ON THE PLANET, THE HEIGHT ABOVE SEA LEVEL, AND THE CLIMATE, AMONG OTHER FACTORS, THE CYCLE CAN BE LONGER OR SHORTER. FOR EXAMPLE, A DROP OF WATER MAY BE IN THE ATMOSPHERE FOR SEVERAL DAYS, IN A LAKE FOR DECADES, AND IN A GLACIER FOR THOUSANDS OF YEARS.

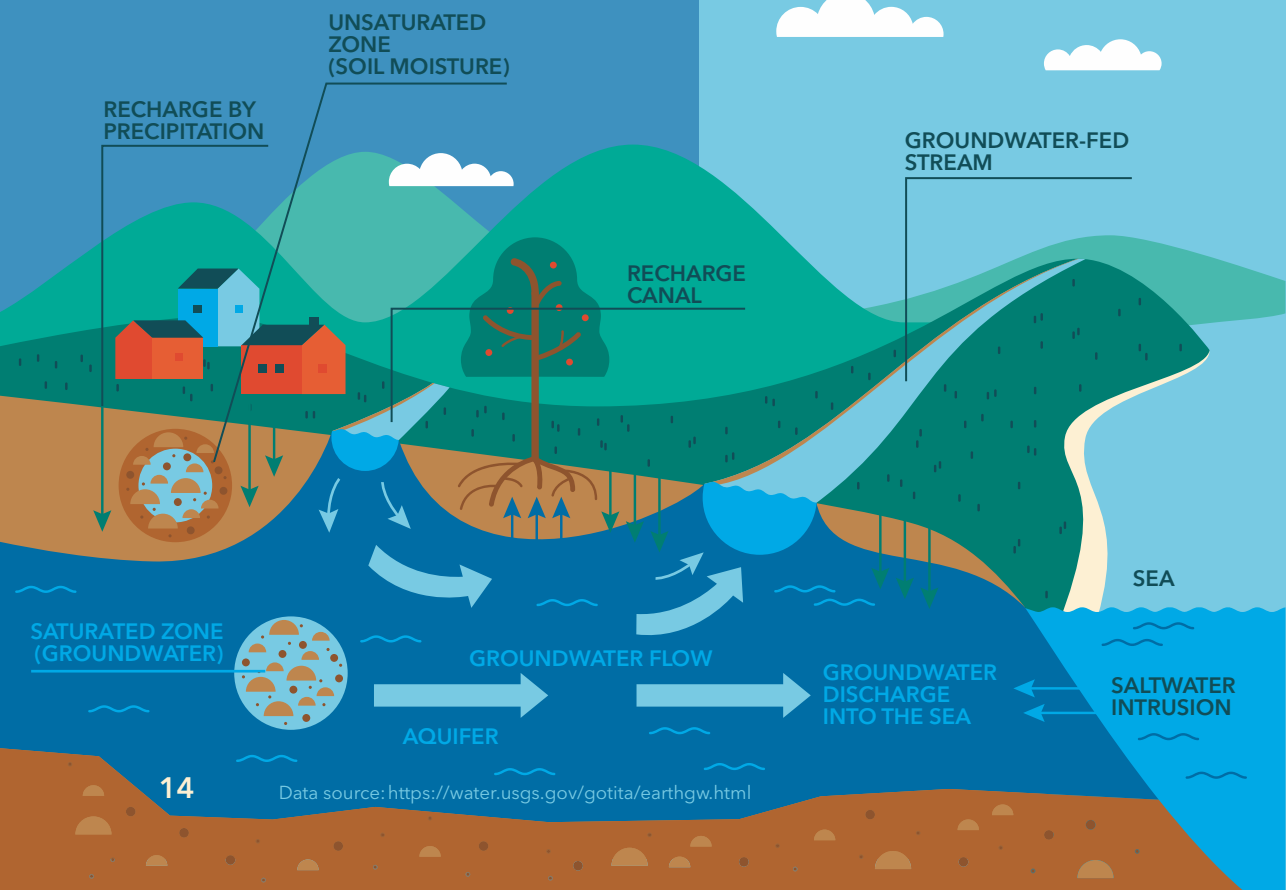
✳ UNDERSTAND THE WORDS

WHAT IS AN AQUIFER?

AN AQUIFER CONSISTS OF GROUNDWATER ACCUMULATED UNDERNEATH OUR FEET, BETWEEN IMPERMEABLE UNDERGROUND LAYERS (THROUGH WHICH WATER CANNOT PASS) AND PERMEABLE ONES.

THE CAPACITY TO ACCUMULATE WATER DEPENDS ON HOW POROUS THE SOIL IS, THAT IS, THE SPACE BETWEEN THE GRAINS THAT FORM IT. WATER FLOWS THROUGH THESE TINY SPACES AND FILLS THEM. WHEN THIS HAPPENS, WE SAY THAT THE SOIL IS SATURATED WITH WATER.

AQUIFERS ARE VERY IMPORTANT, BECAUSE THANKS TO THEM WE CAN OBTAIN WATER FOR HUMAN CONSUMPTION, AND CARRY OUT SEVERAL PRODUCTIVE ACTIVITIES, SUCH AS AGRICULTURE AND INDUSTRY



Data source: https://water.usgs.gov/gotita/earthgw.html

Based on physical characteristics, India has been divided into 14 Principal Aquifer Systems and 42 significant aquifers. One of India's major aquifer systems encompasses 31 percent of the country and is available in Uttar Pradesh, Bihar, West Bengal, Assam, Odisha, and Rajasthan.

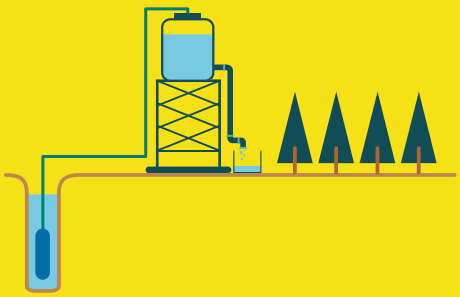
HOW IS WATER EXTRACTED FROM AQUIFERS?

THE WATER FROM AQUIFERS, CAN BE USED TO IRRIGATE CROPS AND PRODUCE DRINKING WATER, AMONG OTHER ACTIONS FOR THE BENEFIT OF A POPULATION. BUT HOW DO WE EXTRACT IT, FROM THE SUBSOIL TO THE SURFACE? USING A PUMP!

A PUMP IS A MACHINE, THAT MOVES WATER FROM ONE PLACE TO ANOTHER, GENERALLY UPWARD, WHERE IT DOES NOT FLOW NATURALLY DUE TO THE ACTION OF GRAVITY.

PUMPS NEED SOME TYPE OF ENERGY TO BE ABLE TO FUNCTION, WHICH IS SUPPLIED BY AN ELECTRIC GRID OR GENERATOR.

IN THEIR INTERIOR, PUMPS HAVE SEVERAL PROPELLERS (CALLED IMPELLERS), THAT ROTATE VERY FAST TO DELIVER ENERGY IN THE FORM OF SPEED TO THE WATER WE WANT TO PUMP. IT IS LIKE THESE IMPELLERS WERE PUSHING THE WATER, SO IT CAN RISE AND GET TO THE SURFACE OF THE EARTH.



When water is at great depth, below the surface of the earth, you must use a well pump. Well pumps allow us to extract water over 200 meters (650 ft) deep below the surface of the earth.

Ecosystems and watersheds

Just like human beings live in houses and neighborhoods, living beings live in ecosystems and watersheds.

- An ecosystem is a group of living beings, that share the same habitat. These beings interact with each other and their environment (soil, water, light, air), which is also a part of the ecosystem.

- A watershed is like a big neighborhood. It is an area or region, where all the rainwater that falls infiltrates (because the soil absorbs it) or runs off the land surface, forming small rivers. All this water feeds the main river. Often, the height of the mountains divides the watersheds, depending on the side that water runs off. On one side a river will be born, on the other a different river.

A watershed is like a store of freshwater, where you can find different natural ecosystems, just like towns and cities.

It is very important to maintain the balance on a watershed, and between the ecosystems in it. Human activities such as agriculture and industry, and the growth of cities are elements, that can modify this natural balance. That is why, they must be carried out with great care.

LEARN AND THINK

DO YOU KNOW HOW MUCH IT RAINS WHERE YOU LIVE?

It does not rain the same everywhere. For example, look at how much it rains in the following average annual rainfall in Indian cities:

Mumbai	2168
Kolkata	1800
New Delhi	790
Chennai	1541
Bengaluru	905
Hyderabad	803
Vadodara	868

← WATER PRECIPITATION IS MEASURED IN MILLIMETERS (MM).

1 MM OF WATER EQUATES TO 1 LITER OF RAIN ON A SQUARE METER. IN OTHER WORDS, IF YOU POUR 1 LITER OF WATER IN 1 SQUARE METER, THE HEIGHT OF WATER IN THAT SQUARE METER WILL BE 1 MM.

Data source: Climate-Data.org
(https://www.currentresults.com/Weather/India/average-yearly-precipitation.php)

- Do you know how much it rains where you live?
- Which are the driest months?
- Does it rain the same every year?

HOW IS THE ECOSYSTEM WHERE YOU LIVE?

- Do you know the name of the closest river to your city?
- What are the main features of your ecosystem? Think about the type of vegetation, the climate, type of fauna, among other elements of the nature that form it.

Chapter 2

The water molecule, and its amazing properties

All things and living beings, even us, are made of millions of atoms, which are particles that cannot be divided. It is the smallest component of something.

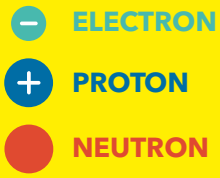
The atoms of several elements join to form molecules, with which new substances or materials are created, like water! When molecules get together, they create more complex structures, like a rock, a rose, a cat, or a human being, among many others.

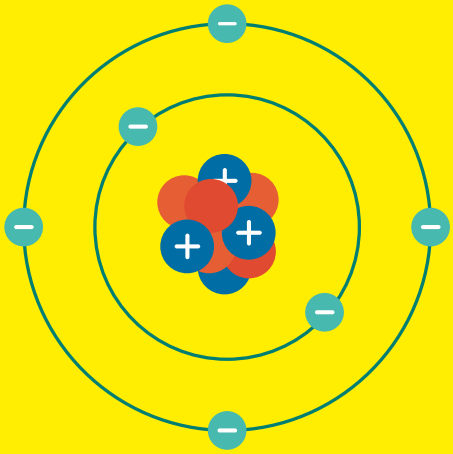
Let's start with the atom

Think of an atom as a miniature solar system, composed of a nucleus of grouped protons and neutrons, with electrons revolving around it, just like the planets around the Sun.

- Protons have a positive charge (+).
- Electrons have a negative charge (-).
- Neutrons have no charge.

An atom is balanced, when it has the same number of protons and electrons, so its charge compensates.





A very special molecule

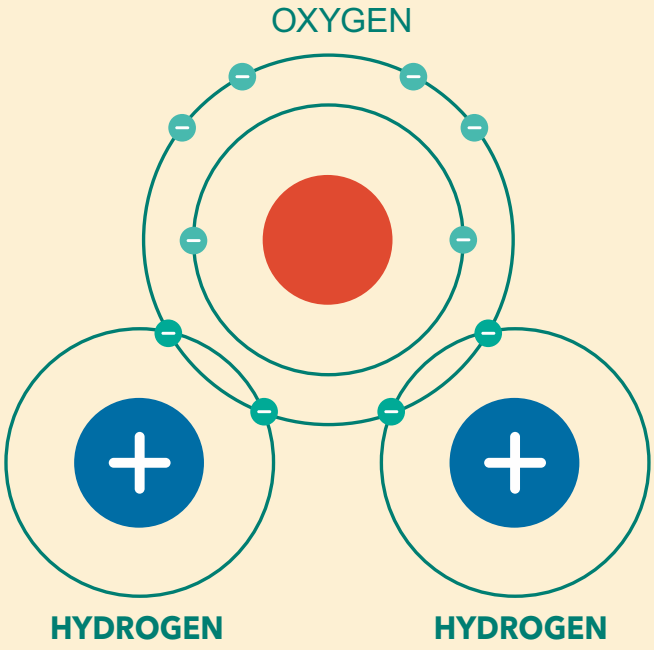
A water molecule is formed, by an oxygen atom and two hydrogen atoms.

When a molecule is formed, the atoms share some electrons. In the case of water, the molecule has the oxygen atom at its center and two hydrogen atoms at the sides, each with its orbit of electrons surrounding them.

Oxygen has 8 electrons, from which it shares one with each hydrogen. In turn, each hydrogen shares one electron with oxygen. As consequence:

- The **atom of oxygen** keeps 6 electrons that it does not share, concentrating this way an area of **negative charge** around itself.
- The **atoms of hydrogen**, by leaving their electrons on the side of oxygen, are left with a **positive charge**.

That is why we say that water is a polar molecule. On the side or pole of oxygen, it has a negative charge, and on the hydrogen side, it has a positive charge.



Hydrogen bonds

How does a water molecule connect with another? Precisely because of the force of attraction: an oxygen atom (negative) attracts a hydrogen atom (positive) but from another molecule, acting as a magnet. Then a hydrogen bond is formed.

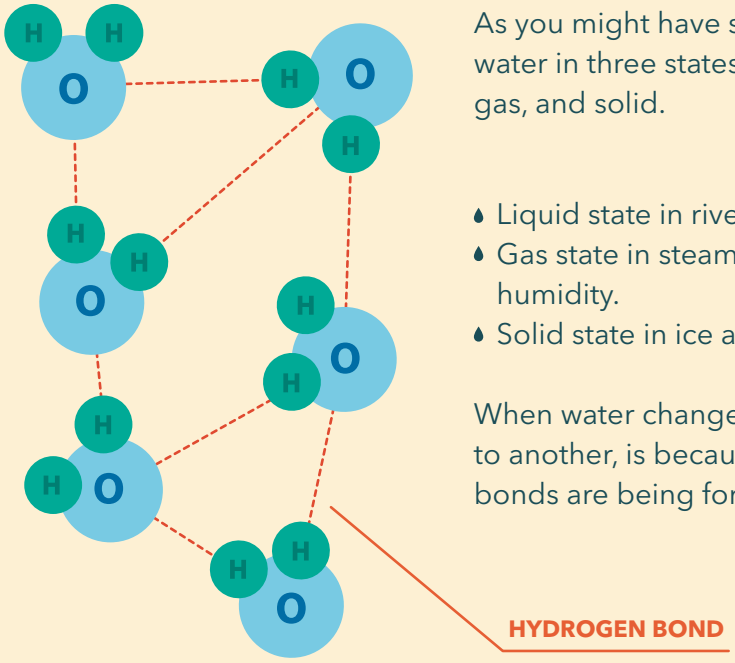
This way, each water molecule is connected to the others through hydrogen bonds.

These bonds are what make water so special, and with incredible properties that allow many phenomena in nature, the human body, and industrial processes.

WHY DOES ICE FLOAT ON WATER?

EVEN THOUGH WATER AND ICE ARE PART OF THE SAME SUBSTANCE, IF YOU ADD ICE TO A GLASS OF WATER, YOU WILL SEE THAT IT FLOATS. THIS HAPPENS BECAUSE ICE IS LESS DENSE, SINCE THE DISTANCE BETWEEN ITS MOLECULES IS BIGGER THAN, THE DISTANCE OF THE WATER MOLECULES IN A LIQUID STATE.

BEING LESS DENSE OR CRAMPED, ICE IS ALSO LESS HEAVY, THAT IS WHY IT FLOATS!



As you might have seen, we can find water in three states in nature: liquid, gas, and solid.

- Liquid state in rivers, lakes, and seas.
- Gas state in steam, clouds, and air humidity.
- Solid state in ice and snow.

When water changes from one state to another, is because hydrogen bonds are being formed or broken.

Heat capacity of water

Hydrogen bonds are so strong that, it takes a lot of power to separate the molecules, which is why water can store a great amount of energy in the form of heat. That means it has, a high **heat capacity**.

If you have been to the beach, you surely have noticed that the sand is very hot, and that water is a lot cooler at noon or afternoon. But at night is the other way around: the sand is colder and the water warmer. This happens because water has a bigger heat capacity than sand, which is why it takes it longer to cool down. So, at night, water keeps the heat that accumulated during the day.

Due to its heat capacity, water is an **excellent temperature regulator**, both in our bodies and nature.

For example, when we have a fever, we sweat because our body is lowering the temperature through the elimination of sweat, and that makes us thirsty.

That way, by drinking more water, we help the body regulate its temperature.

And what about nature? Something similar happens. For example, in arid climates like deserts, the temperature difference between day and night is much bigger than in climates with water because it helps regulate the changes.

On the other hand, forests are always cooler than open fields because of tree transpiration. The water they evaporate captures the heat of the air, which reduces high temperatures, and that way, forests stay cool.

WHAT DOES IT MEAN THAT TREES TRANSPIRE?

TREES AND PLANTS ABSORB WATER THROUGH THEIR ROOTS, AND THEN ELIMINATE IT THROUGH THEIR LEAVES. THIS IS CALLED TRANSPIRATION.

THIS WATER, WHICH HELPS REGULATE THE TEMPERATURE OF THE FORESTS, ALSO TAKES PART IN THE WATER CYCLE BECAUSE WHEN IT EVAPORATES, IT GOES BACK TO THE ATMOSPHERE AND TRANSFORMS INTO CLOUDS.

Two forces that move water

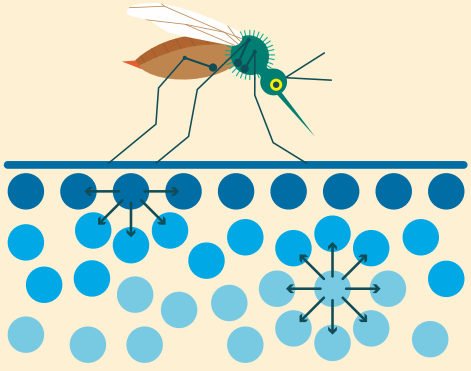
From the water molecule and hydrogen bonds that bind different molecules, scientists have discovered other interesting characteristics of water:

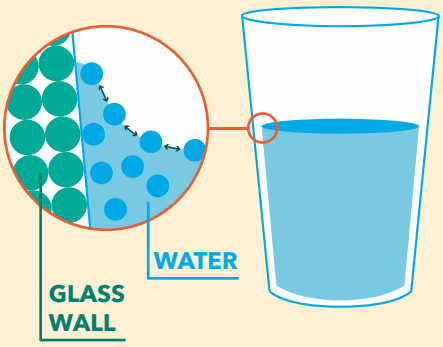
- **Surface tension:** since hydrogen bonds are so tough, water has high cohesive strength, which results in surface tension. It forms spherical droplets in the water that do not break easily, as if there was an invisible net on which an insect could walk without sinking, to give an example.

✳ UNDERSTAND THE WORDS

COHESIVE STRENGTH IS THE ATTRACTION BETWEEN PARTICLES, THAT ARE NEXT TO EACH OTHER IN THE SAME BODY. IN OTHER WORDS, IT IS THE STRENGTH THAT BINDS PARTICLES TOGETHER.

ADHESIVE STRENGTH IS THE ATTRACTION BETWEEN TWO DIFFERENT MOLECULES. FOR EXAMPLE, IT IS THE STRENGTH THAT ATTRACTS WATER TO THE SURFACE OF A CONTAINER.





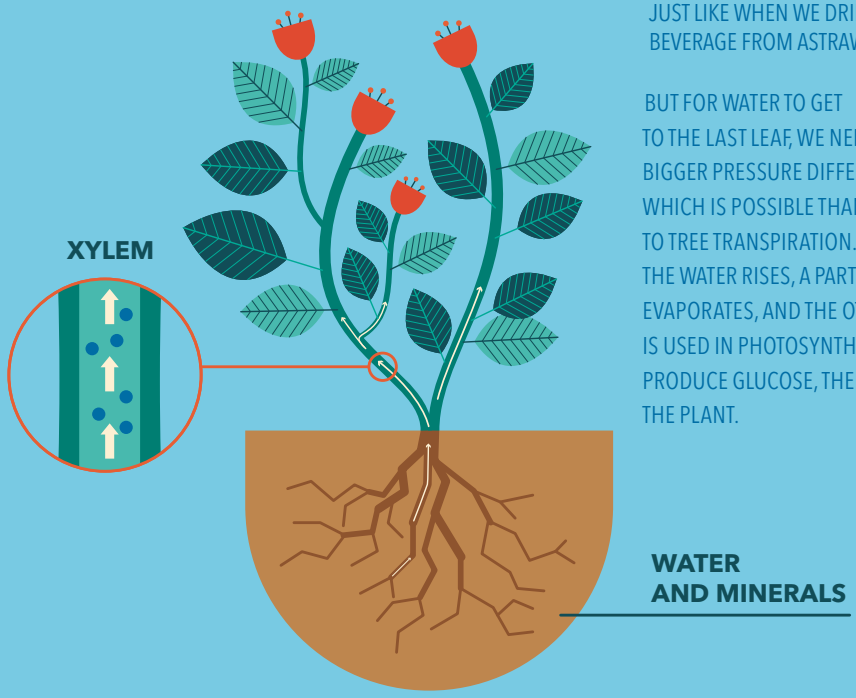
- **Capillarity:** is the water's ability to rise against the force of gravity. This happens when water joins another type of molecule, that attracts it by its positive or negative charge. When the adhesive strength is bigger than the cohesive one, water can rise through very thin glass tubes called capillaries. If we look inside the capillary tube with a big magnifier, we will see that the water surface is not flat but concave (having an outline or surface that curves inwards like the interior of a circle or sphere) ; it is like water was climbing.

HOW DOES WATER GET TO THE TREE TOPS?

TRUNKS AND STEMS ARE MADE OF HUNDREDS OF TINY CAPILLARY TUBES CALLED XYLEM, THROUGH WHICH WATER CAN RISE. THANKS TO A PRESSURE DIFFERENCE, WATER CAN TRAVEL FROM THE ROOTS TO THE LAST LEAF ON THE TREE TOP.

SINCE THERE IS MORE WATER IN THE GROUND THAN IN THE PLANT, A PRESSURE DIFFERENCE OCCURS. WATER PASSES THROUGH THE WALLS OF THE ROOTS, AND THEN IT STARTS TO RISE DUE TO CAPILLARITY (the tendency of a liquid in a capillary tube or absorbent material to rise or fall as a result of surface tension) , JUST LIKE WHEN WE DRINK A BEVERAGE FROM A STRAW.

BUT FOR WATER TO GET TO THE LAST LEAF, WE NEED A BIGGER PRESSURE DIFFERENCE, WHICH IS POSSIBLE THANKS TO TREE TRANSPIRATION. AS THE WATER RISES, A PART OF IT EVAPORATES, AND THE OTHER IS USED IN PHOTOSYNTHESIS TO PRODUCE GLUCOSE, THE FOOD OF THE PLANT.



A world in the water

Another great water feature is that, it can contain a large amount of other dissolved substances. It is like a big vehicle that transports many things: nutrients, mineral salts, foods, microorganisms. But as it carries these, it can also transport dangerous substances for the human body or nature: contaminants, toxic substances, diseases.

This occurs due to its condition as a polar molecule, which attracts other molecules and reacts to a lot of substances to form or disintegrate others.

You may not believe this, but you can find dissolved gases in water, like oxygen, the same we need to breathe. We can have aquatic life like algae, fish, mollusks, and microorganisms that are not visible to the naked eye because there is oxygen in the water.

As you can see, water has properties that allow many different reactions, processes, and phenomena in nature and our human body.

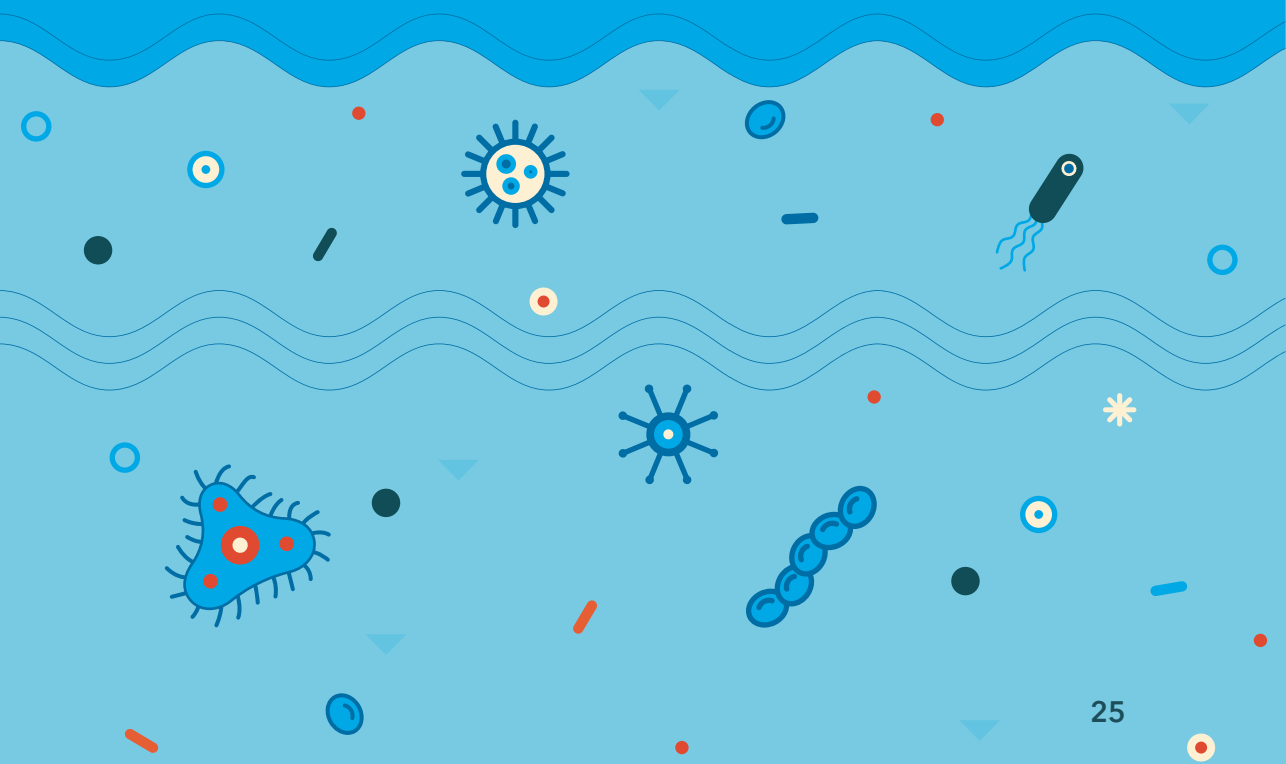
LEARN AND THINK

HOW MUCH DOES TEMPERATURE VARY IN YOUR CITY?

Palodhi, Rajasthan - Palodhi in Rajasthan is hottest place in India with maximum recorded temperature of 51 degree Celsius. India recorded its highest ever temperature of 51 degrees Celsius in town of Phalodi of Rajasthan.

Dras, Jammu and Kashmir - Dras valley of Kashmir is the coldest inhabited place in India, often called The Gateway to Ladakh. Dras is the part of the Kargil tehsil and during the height of winter temperature goes down as low as – 23 degrees Celsius.

- How does temperature relate to water availability in your region?
- What is the highest temperature it reaches? In what season?
- What is the lowest?



Chapter 3

Urban water cycle

Have you ever wondered, where does the water you consume come from? And where do the waters used and discharged go to, like the ones used in sanitation?

All this water has a route from when it is taken from nature, until it returns to it with a quality that does not damage living organisms.

Learn about the urban water cycle, and discover all the knowledge and work that make it possible.

Potable water

Potable water is the one that we can drink, because it is clean and healthy. The word *potable* comes from the verb *potare* in Latin, that means to *drink*

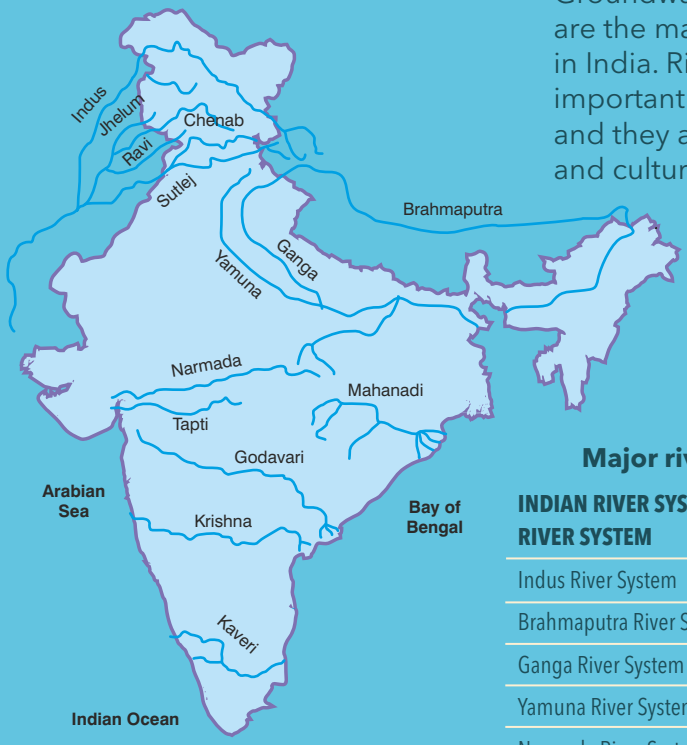
This type of water has no smell, flavor or color. Besides, it needs to be free of any substances that can harm our health, like some minerals, chemical compounds, and pathogenic microorganisms (that cause diseases) like bacteria and viruses.

If you live in the city, water gets to your house through a network of underground pipes and comes out from a faucet so your family can cook, do the laundry, take showers, and go to the bathroom. But before that, it traveled a long way.

Water Source:

The origin of the water we consume is in nature. It may come from: Glaciers in high peaks, Lakes and ponds, Aquifers (groundwater) and Rivers.

All of these are water sources. After the water is taken, it goes through a purification process that will leave it fit for human consumption.
Groundwater and surface water are the main source of fresh water in India. Rivers are the most important source of surface water, and they are vital to the growth and culture of the region.



Major river systems in India:

INDIAN RIVER SYSTEMS – RIVER SYSTEM	TOTAL LENGTH	LENGTH IN INDIA
Indus River System	3180 km	1114 km
Brahmaputra River System	2900 km	916 km
Ganga River System	2510 km	2510 km
Yamuna River System	1376 km	1376 km
Narmada River System	1312 km	1312 km
Tapi River System	724 km	724 km
Godavari River System	1465 km	1465 km
Krishna River System	1400 km	1400 km
Cauvery River System	805 km	805 km
Mahanadi River System	851 km	851 km

CAN YOU GET DRINKING WATER FROM THE SEA?

YES, YOU CAN! SALTWATER CAN ALSO BE A SOURCE OF DRINKING WATER. ESPECIALLY FOR SOME PLACES WHERE DRINKING WATER IS NOT AVAILABLE FOR THE POPULATION, IT IS NECESSARY TO USE WATER FROM THE OCEANS.

WE USE A SPECIAL TREATMENT CALLED **DESALINATION**, WHICH ALLOWS US TO REMOVE SALTS AND TURN SEAWATER INTO DRINKING WATER.

From the water source to your home

The water path from nature until you drink it, is long and complex. The professionals and operators that make this, possible are full of knowledge and dedication. In addition, there are laws and health standards that drinking water should meet. Let's learn about the stages:

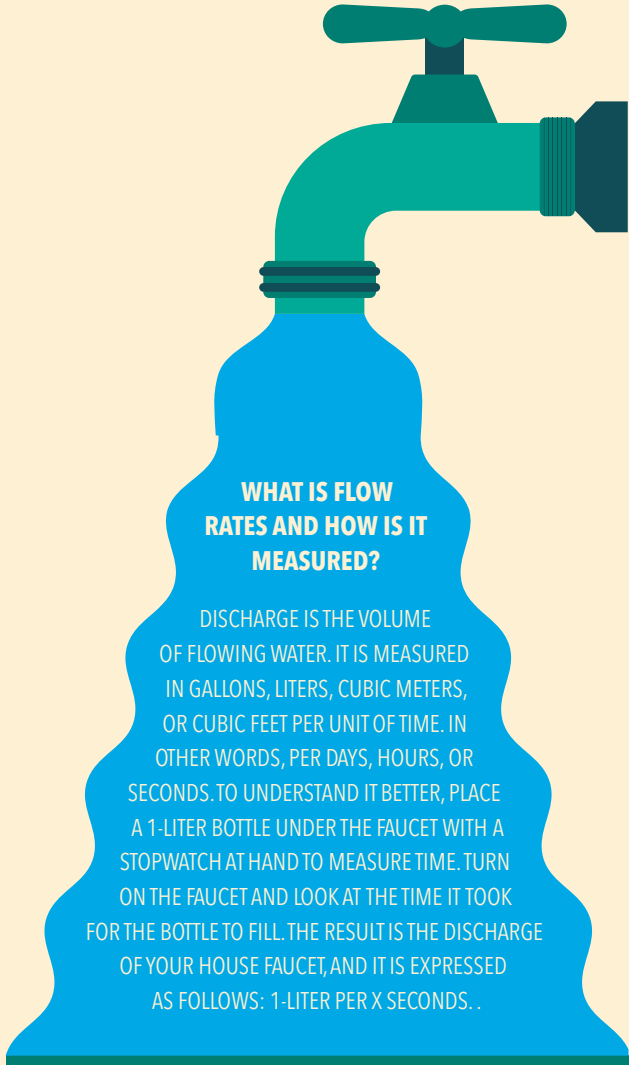
RAW WATER INTAKE

It is the first step of the urban water cycle: taking water from nature to a drinking water treatment plant.

To move water, we need to use pumps like the ones you learned about in chapter 1.

When carrying out this process, there must be monitoring stations in place to evaluate water quality and aspects such as turbidity, conductivity, temperature, and pH, among many others. With this information, we can know whether water can be treated to be turned into drinking water.

It is also very important to control the discharge of water being extracted from nature.



WHAT IS FLOW RATES AND HOW IS IT MEASURED?

DISCHARGE IS THE VOLUME OF FLOWING WATER. IT IS MEASURED IN GALLONS, LITERS, CUBIC METERS, OR CUBIC FEET PER UNIT OF TIME. IN OTHER WORDS, PER DAYS, HOURS, OR SECONDS. TO UNDERSTAND IT BETTER, PLACE A 1-LITER BOTTLE UNDER THE FAUCET WITH A STOPWATCH AT HAND TO MEASURE TIME. TURN ON THE FAUCET AND LOOK AT THE TIME IT TOOK FOR THE BOTTLE TO FILL. THE RESULT IS THE DISCHARGE OF YOUR HOUSE FAUCET, AND IT IS EXPRESSED AS FOLLOWS: 1-LITER PER X SECONDS. .

✳ UNDERSTAND THE WORDS

TURBIDITY IS RELATED TO WATER TRANSPARENCY. WHEN THERE ARE PARTICLES SUSPENDED THAT DO NOT LET LIGHT PASS THROUGH, WE SAY IT IS TURBID.

CONDUCTIVITY IS THE WATER CAPACITY OF CONDUCT ELECTRICITY, WHICH IS A SIGN OF THE TYPE OF SUBSTANCES DISSOLVED IN IT.

PH IS A MEASUREMENT THAT DETERMINES WHETHER WATER IS TOO SOUR (LIKE LEMON JUICE), IN OTHER WORDS WHETHER IT IS ACIDIC OR ALKALINE.

pH ranges from 0 to 14, with 7 being neutral. pHs less than 7 are acidic while pHs greater than 7 are alkaline (basic).

POTABLE WATER TREATMENT PLANT

When water gets to the treatment plant, it passes through several processes to clean and purify it.

Pretreatment

Big solids, such as sticks, stones, and sand, are eliminated. First, water passes through the bar screens in which these materials get stuck, and then it goes into grit chambers, in which sand settles out to the bottom due to its weight.

Coagulation-flocculation

In this process, smaller solids are eliminated. For this purpose, chemical compounds (called coagulants and flocculants) are added, which cause the solids to stick together, become bigger and heavier, and then drop because of their weight.

Sedimentation

Water sits in a big tank for the time required, so that the aggregation of solids (flocs) settles out to the bottom.

Filtration

Water passes through sand and anthracite (a very hard coal) filters, that help eliminate the smallest solids that were not removed during the previous step.

Disinfection

Chemical agents, such as chlorine or ozone, or ultraviolet light are used to eliminate pathogenic microorganisms, that may cause diseases to humans.

During this process, it must be ensured that water quality levels are according to regulation, so that sensors are put in place to measure pH and temperature, among other factors. Just like when your mom or your dad checks your temperature to see if you are sick, a water treatment plant must also control some parameters, to see if things are going well or not.

Storage and distribution

When it is ready, potable water is stored in big tanks. While there, a bit more chlorine is added to ensure that microorganisms do not grow back in the distribution pipes.

The distribution network is composed of kilometers of pipes that run under cities, streets, buildings and houses and act like arteries that carry water to every corner of a country.

These networks, invisible to our eyes, are very important and must be protected from damage and filtration, so that water quality and distribution is not affected. The older the city, the older is its distribution network; some networks are over 100 years old!

On an average, cities lose 30% -50% of the water in distribution network due to flaws in the network. To avoid this, companies in charge of producing and delivering potable water, must constantly keep an eye on the pipes' condition with electrical sensors that detect

pressure differences.
These instruments allow them to evaluate, whether there is leak in the water network.

If there are areas of a city that are unconnected to the distribution network, tank trucks are sent. After families get water from these trucks, they store it in their tanks.

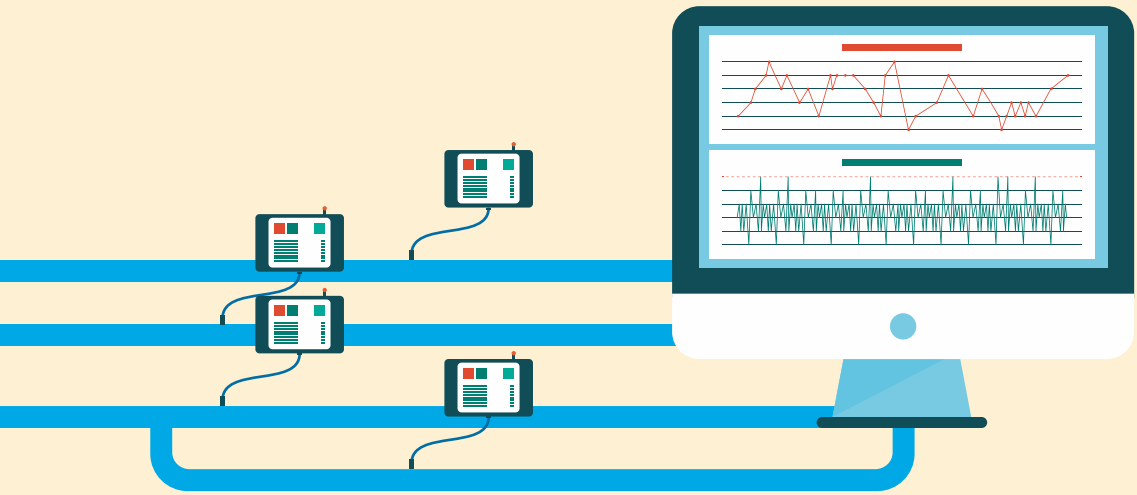
That is how clean, crystal potable water gets to your house.

WHO WORKS IN WATER TREATMENT?

TO PRODUCE WATER AND ENSURE ITS QUALITY, WE NEED A BIG TEAM OF TECHNICIANS AND MECHANICAL, ELECTRICAL, AND CHEMICAL ENGINEERS.

EACH TECHNICIAN HAS A SPECIFIC ROLE: ENSURE WATER QUALITY, HANDLE MECHANICAL EQUIPMENT, CONTROL ENGINES, AND CHECK THE CONNECTIONS. ALL OF THEM WORK AS A TEAM.

YOU COULD ALSO BECOME A WATER PROFESSIONAL. IT DOES NOT MATTER WHAT SUBJECT YOU LIKE AT SCHOOL, BECAUSE EVERYTHING IS CONNECTED!

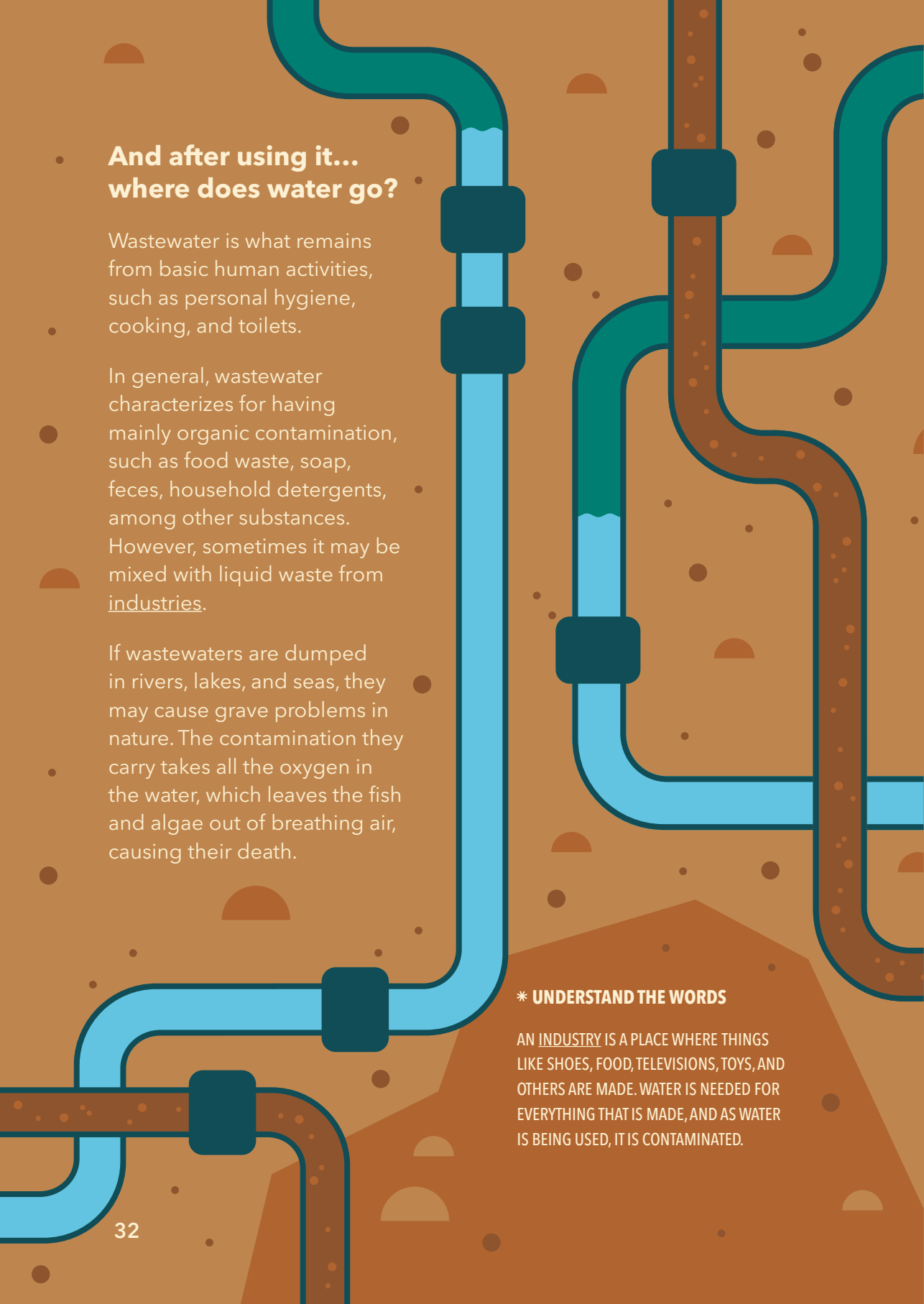


And after using it... where does water go?

Wastewater is what remains from basic human activities, such as personal hygiene, cooking, and toilets.

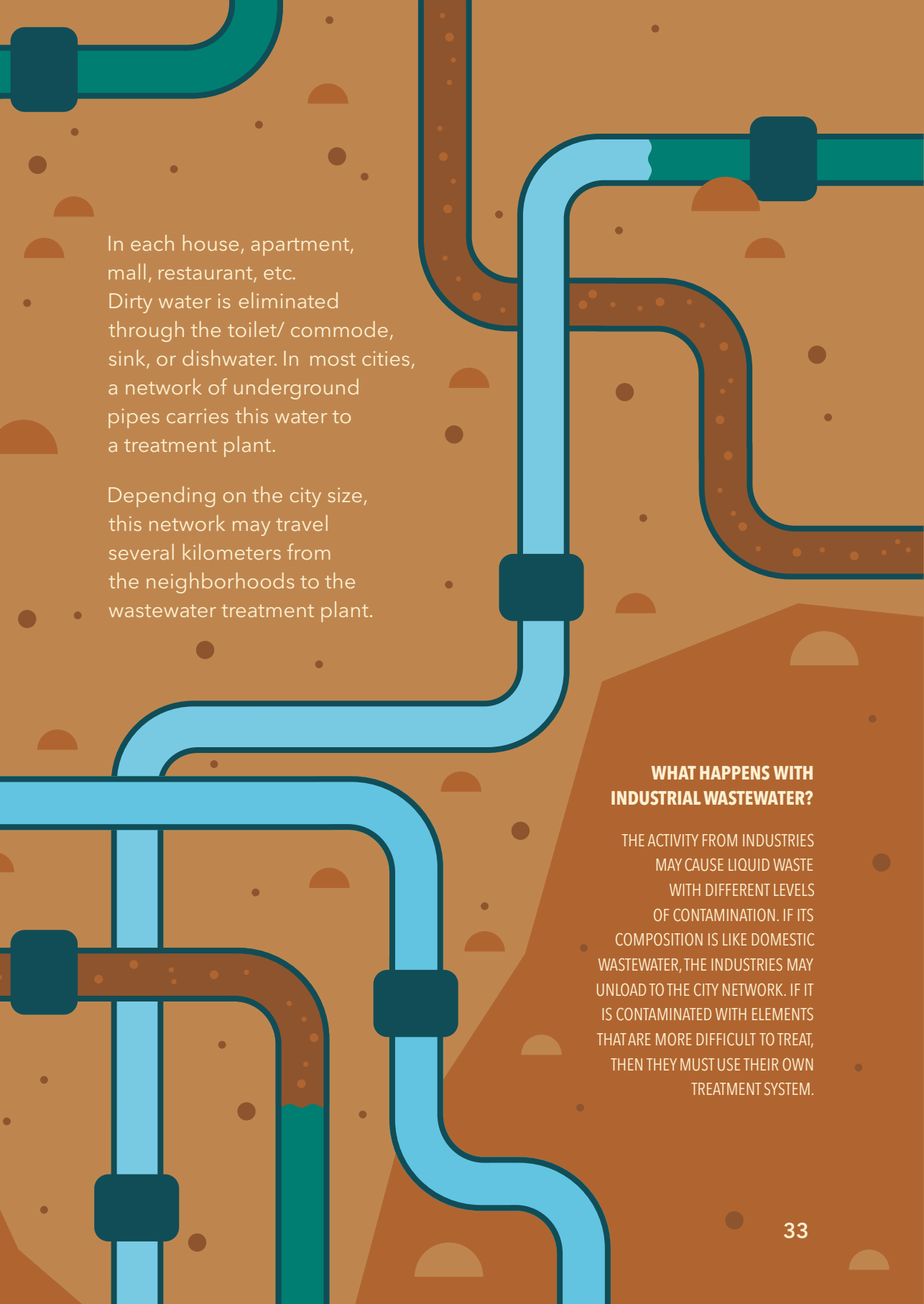
In general, wastewater characterizes for having mainly organic contamination, such as food waste, soap, feces, household detergents, among other substances. However, sometimes it may be mixed with liquid waste from industries.

If wastewaters are dumped in rivers, lakes, and seas, they may cause grave problems in nature. The contamination they carry takes all the oxygen in the water, which leaves the fish and algae out of breathing air, causing their death.



*** UNDERSTAND THE WORDS**

AN INDUSTRY IS A PLACE WHERE THINGS LIKE SHOES, FOOD, TELEVISIONS, TOYS, AND OTHERS ARE MADE. WATER IS NEEDED FOR EVERYTHING THAT IS MADE, AND AS WATER IS BEING USED, IT IS CONTAMINATED.



In each house, apartment, mall, restaurant, etc. Dirty water is eliminated through the toilet/ commode, sink, or dishwater. In most cities, a network of underground pipes carries this water to a treatment plant.

Depending on the city size, this network may travel several kilometers from the neighborhoods to the wastewater treatment plant.

WHAT HAPPENS WITH INDUSTRIAL WASTEWATER?

THE ACTIVITY FROM INDUSTRIES MAY CAUSE LIQUID WASTE WITH DIFFERENT LEVELS OF CONTAMINATION. IF ITS COMPOSITION IS LIKE DOMESTIC WASTEWATER, THE INDUSTRIES MAY UNLOAD TO THE CITY NETWORK. IF IT IS CONTAMINATED WITH ELEMENTS THAT ARE MORE DIFFICULT TO TREAT, THEN THEY MUST USE THEIR OWN TREATMENT SYSTEM.

Wastewater treatment plant: a big strainer

1. PUMPING STATION
Water enters the treatment plant through a **pumping station**. Upon arrival, it falls to a basin, where it is pushed through pumps to the next step. At this point, the flow rate that enters the plant is measured.

2. PRETREATMENT
The treatment starts by removing the biggest solids that have come through the pipes with the water, objects that we can easily identify, such as bits of plastic, paper, fabric, and wood. For this, big bar screens act as a colander (a perforated bowl used to strain off liquid from food after washing or cooking), letting water through but stopping the solids. After that, these items are raked by mechanical combs, put in containers, and sent off to a landfill.

The next step consists of removing sand and grease. Since sand is composed of heavy particles, water is pumped through a wider canal than the pipes. This way, the water slows down, and the sand particles have enough time to settle out, or in other words, they sink to the bottom of the tank.

Air is injected from the bottom of the tank to remove grease and oils, creating air bubbles that catch grease and oil molecules. Since these are lighter than water, they form a film on the surface, ready to be cleaned by special sweepers that remove them from water, and take them to a collector.

✳ UNDERSTAND THE WORDS

A LANDFILL IS A PLACE THAT RECEIVES, COMPRESSES, AND DISPOSES OF THE SOLID WASTE GENERATED IN A CITY. IS. THE CONTENTS OF THE GARBAGE TRUCK ARE EMPTIED THERE.

3. BIOLOGICAL TREATMENT

After removing solids, sand, and grease, the next step is a biological treatment or an activated sludge. The name is because water has taken a brown color, like sludge, and because there are millions of active microorganisms in the basin: our friends, bacteria. They are the ones that digest all organic matter present in the water.

Bacteria need oxygen to break down organic matter, which they receive through big machines called blowers. Blowers take the air from the atmosphere and inject it into the bottom of the tank. The result is that bacteria eat, grow and multiply, producing more bacteria. They also generate CO_2, (carbon dioxide) which is released into the atmosphere.

Since there are excess bacteria in the basin, a part is removed so there is an even concentration, and the ones left keep working.

The mixture of water and activated sludge goes to the next basin, where it sits so in time the clarified water will rise to the top, and the sludge will settle out to the bottom.

4. DISINFECTION

The last step of the treatment is disinfecting clarified water.
On it, pathogenic microorganisms (the ones that cause diseases) are removed. In some cases, water needs to be filtrated to eliminate the smallest solids before is suitable to be returned to the environment.

✳ UNDERSTAND THE WORDS

SLUDGE IS SEMI SOLID MASS THAT IS PRECIPITATED AND PRODUCED BY WATER AND SEWAGE TREATMENT PROCESSES.

AFTER ALL THESE TREATMENTS, WATER IS READY TO BE RETURNED TO THE ENVIRONMENT WITHOUT CAUSING ANY HARM.

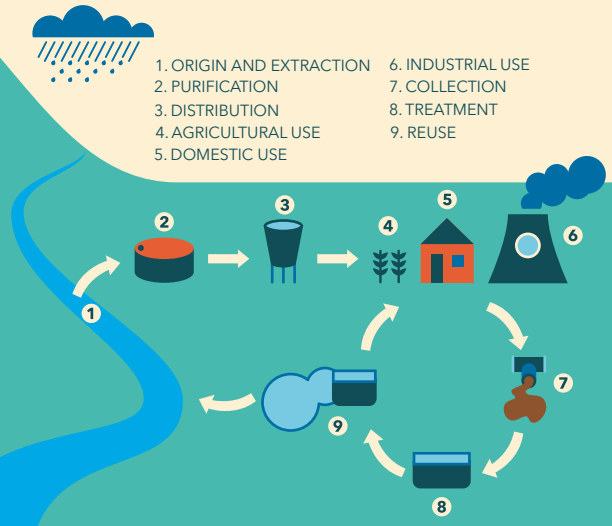
This is the urban water cycle

So far, we have gone through the urban water cycle, or when humans take water from nature, use it, and then return it safely and responsibly.

CAN WE REUSE WATER THAT HAS BEEN TREATED?

OF COURSE, WE CAN. DEPENDING ON THE WATER QUALITY AT THE END OF THE TREATMENT, IT CAN BE REUSED TO IRRIGATE SOME CROPS, DO THE LAUNDRY, CLEAN, AMONG OTHER ACTIVITIES. REUSING WATER HELPS US LOWER THE CONSUMPTION OF WATER TAKEN FROM NATURE.

In a watershed, you can find as many urban water cycles as cities exist in it. The most important thing is to protect the natural cycle and avoid excess extraction from the watershed, since it affects cities, ecosystems, flora, and fauna.



LEARN AND THINK

WHAT IS WASTEWATER? WHAT IS IT LIKE?

To understand what wastewater is, carry out this experiment:

MATERIALS

- 1 plastic bottle of one liter or more
- 2 spoonsfuls of oil
- 1 spoonful of shampoo
- 1 piece of soap
- 3 spoonsfuls of vinegar
- Bits of bread
- 1 handful of sand
- Some potato peels and other vegetables in small pieces.

STEPS

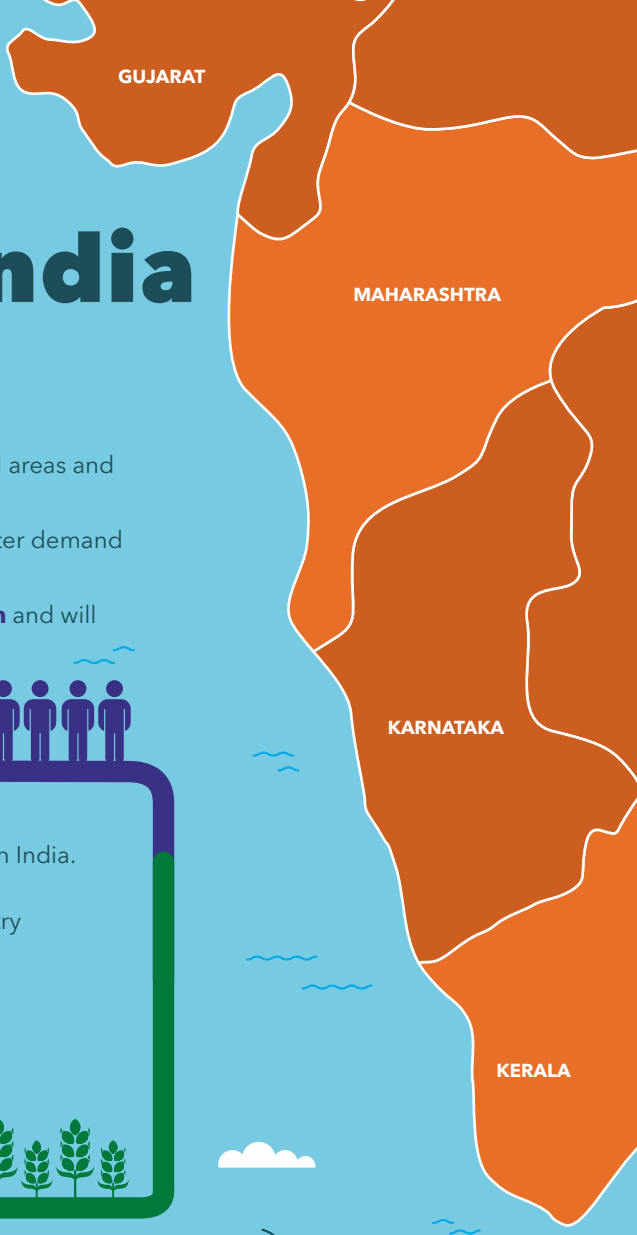
1. Take the water bottle and fill it halfway up.
2. Add the oil, shampoo, soap, and vinegar to the bottle. Put the lid on and shake it a bit, so it gets mixed.
3. Add the bits of bread and peels of potatoes or other vegetables you have gathered.
4. Add the sand, cover it, and shake it again.
5. Watch the bottle and describe: what color is the water now?
6. Let it sit for some days and watch if there is some change

What you have made is a sample of wastewater.

Can you think of a way to separate and remove the contaminants from the water, so it can go back to being transparent? Propose a way of doing it, by applying what you learnt in this chapter.

Chapter 4

Water in India

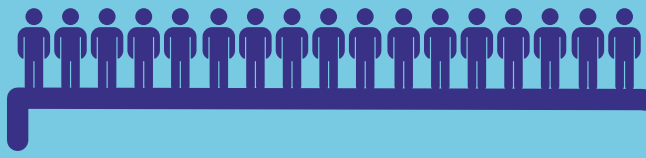


Overview

1.33 Billion people live in India, **70%** in rural areas and **30%** urban

With **4378** cities/towns and **6.64** villages water demand is around **813 BCM**.

By **2050**, population will grow to **1.62 Billion** and will demand **1447 BCM** of water



Agriculture is the largest consumer of water in India. It accounts for approximately **85% of** of annual freshwater withdrawals in the country

Micro Irrigation Potential - **69 Mha**

Current Micro Irrigation Coverage - **7.7 Mha**

Water Crisis in India

600 Million Indians face high to extreme water stress

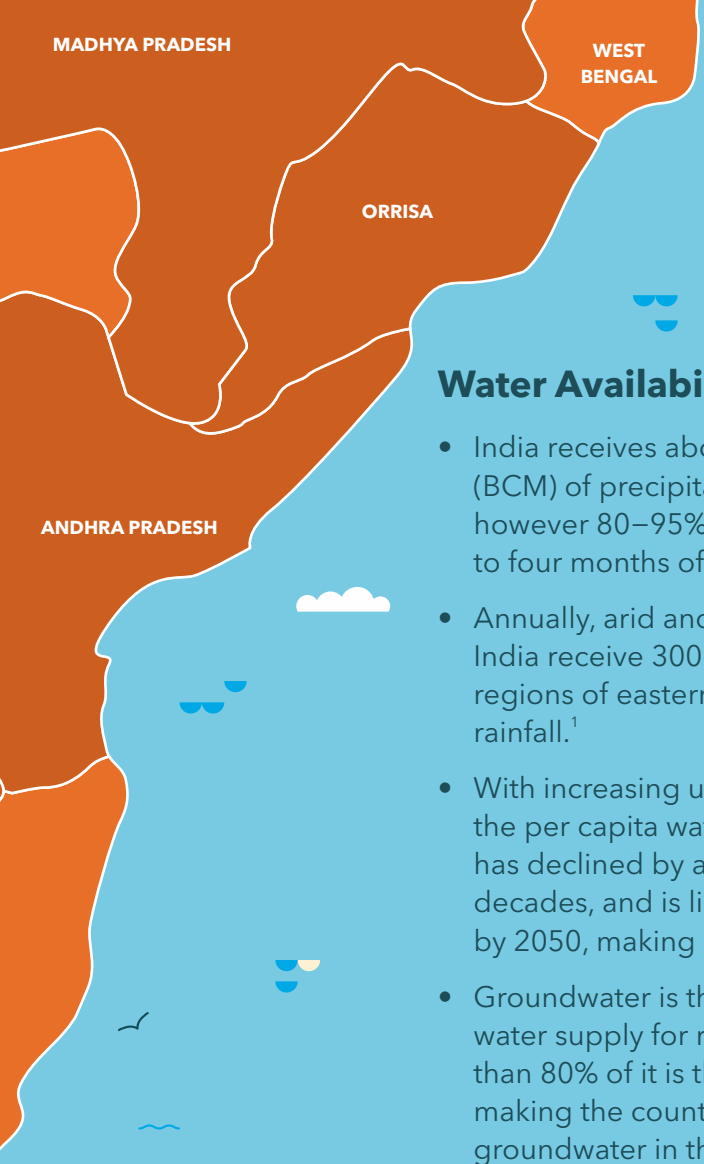
54% of India faces high to **extremely high** water stress

2 Lakh people die every year due to inadequate access to safe water

84% of rural homes do not have access to piped water

India ranks **second from bottom** in global water quality index

BCM is Billion cubic metre, 1 billion cubic metre is equal to 10^8 cubic metre.
Mha is Mega hectare (ha x 10^6)



Water Availability

- India receives about 4000 billion cubic metre (BCM) of precipitation / drizzle in a year, but / however 80–95% of this is received during three to four months of the monsoon season.[1]
- Annually, arid and semi-arid regions of Western India receive 300–500 mm rainfall, while humid regions of eastern India receive about 3000 mm rainfall.[1]
- With increasing urbanization and water demand, the per capita water availability in the country has declined by almost 20% in the last two decades, and is likely to decline by another 20% by 2050, making India a water-scarce country.[2]
- Groundwater is the main source of domestic water supply for rural and urban India, as more than 80% of it is the supply sourced through it, making the country the largest user of groundwater in the world.[3]

✳ UNDERSTAND THE WORDS

MICRO IRRIGATION IS A MODERN IRRIGATION TECHNIQUE THAT IRRIGATE THE SURFACE OR SUBSURFACE OF THE GROUND USING DRIPPERS, SPRINKLERS, FOGGERS, AND OTHER EMITTERS. MICRO-IRRIGATION CAN INCREASE YIELDS WHILE LOWERING WATER, FERTILISER, AND LABOUR COSTS. IT REDUCES WATER LOSS DUE TO CONVEYANCE, RUN-OFF, DEEP PERCOLATION, AND EVAPORATION BY DELIVERING WATER DIRECTLY TO THE ROOT ZONE.

Data source:
1 Based on data from CWC, 2013. Water and Related Statistics. Central Water Commission, India.
2 Based on data from https://pib.gov.in/
3 Details available at https://www.worldbank.org/en/news/press-release/2020/02/17/

Water Consumption

- The agriculture sector is considered to be the largest freshwater user in the country, accounting for almost 85% of total water usage. This is mainly on account of the cultivation of water intensive crops such as rice, wheat, sugarcane and cotton and very low irrigation efficiency.
- For 2030, it has been projected that the country's water demand would be twice the available supply.[4] This would lead to severe scarcity and affect millions of people along with industrial operations and economic activities.
- Water required for cooking food per day constitutes 6–8% of the total water demand in urban India. This water requirement includes water for cooking and washing utensils. The water demand in food consumption by the end users is expected to increase by 1.5 times for urban India by 2031.[5]
- Over 40 billion cubic metres of water is utilized by industries in India that is 6% of the total water availability.
- Of the total electricity production in the country, 83% is based on the utilization of water. Also, production of almost one-third of the total coal-based electricity, 24% of nuclear electricity and 22.5% of petroleum refining capacity is dependent on melted water from snow and ice in the Himalayas.[6]

Data source:

4 Details available at http://social.niti.gov.in/uploads/sample/water_index_report2.pdf

5 Shresth Tayal and Swati Singh. 2016. Sustainable Urban Development : Necessity of Integrating Water -Energy - Food Dimensions in Developmental Policies. Details available at http://www.teriin.org/policybrief/.

6 Shresth Tayal. 2019. Climate Change Impacts on Himalayan Glaciers and Implications on Energy Security of India. New Delhi : The Energy and Resources Institute

A lot of water!

India has just 4% of the world's fresh water – but 16% of the global population.

The Ganga-Brahmaputra-Meghna system is the largest river system in India

India is rated as 'high risk' in the Climate Change Vulnerability Index, with major Indian cities anticipated to have a larger number of continuous dry days with less rainfall in the near future.

Over 58% of ground water recharge is through monsoon rainfall and 32% of the recharge is through the other sources like seepage from canal, tank pond etc.

India has faced 649 disasters from 1915 to 2015 out of which 302 were caused by flood with an average of 3 floods per year.

✳ UNDERSTAND THE WORDS

CLIMATE CHANGE IS A PHENOMENON RELATED TO GLOBAL WARMING OBSERVED BY SCIENTISTS. AS A RESULT OF INDUSTRIAL AND HUMAN ACTIVITIES, A LARGE AMOUNT OF CO_2 HAS ACCUMULATED IN THE ATMOSPHERE. THIS CAUSES AN INCREASE IN GLOBAL TEMPERATURE AND, IN TURN, A DRASTIC CHANGE IN THE CLIMATE OF SOME REGIONS, WHICH THEN SUFFER FROM HEAVY RAINS AND FLOODS OR SEVERE DROUGHTS.

CLIMATIC CHANGE VULNERABILITY INDEX ASSESSES HUMAN POPULATIONS' SENSITIVITY TO EXTREME CLIMATE EVENTS AND CLIMATE CHANGE OVER THE NEXT 30 YEARS.

Data source : https://impakter.com/water-scarcity-how-climate-crisis-is-unfolding-in-india/

Water-borne Diseases and Contamination

- India ranks 120 among 122 countries in the water quality index, and 133 out of 180 nations for its water availability.[7] It has been estimated that around 40 million litres of wastewater enters Indian rivers and other water bodies every day, and only a small part of it gets treated properly[8]. In the country, 70% of the water is considered to be contaminated /unfit for consumption.
- Water-borne diseases are quite common in India and they have a significant economic burden, which has been estimated to be around USD 600 million per year.[9] Drought and flood-prone areas are more vulnerable to these diseases and almost 33% of the country has been affected in the last few years. Fluoride and arsenic contamination has affected 1.96 million dwellings in the country.

Water and Disasters

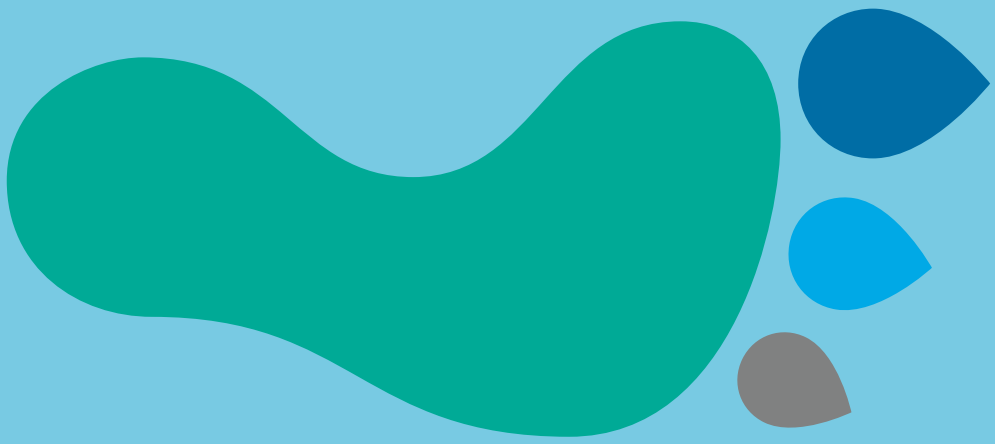
- India is one of the most disaster-prone countries in the world, with hydrological (water-related) disasters being amongst the most frequent and having high mortality and damage costs. Out of 10 natural disasters, 9 are water-related.[10]
- According to International Disasters Database, the country had 278 floods from 1980 to 2017, affecting more than 750 million people and causing about USD 58.7 billion in losses. [10, 11]
- The average global sea levels are projected to rise at a rate of 2 to 3 mm per year over the coming 100 years. Rising seas threaten millions of people who live in densely populated coastal areas and low-lying islands of the country with 7500 km long coastline stretching through nine states.
- The Intergovernmental Panel on Climate Change (IPCC) projects an increase in both the mean and the extreme precipitation in the Indian summer monsoon. By 2100, extreme rainfall events are very likely in three major river basins, viz. Krishna, Godavari and the Ganga.
- On an average, 80–100 districts received deficient rainfall and were declared drought affected in India every year, including the best monsoon years since 2000.[11]

Data source:
7 Details available at https://www.forbesindia.com/blog/economy-policy/
8 Details available at https://www.weforum.org/agenda/2019/10/
9 Details available at https://www.unicef.org/india/what-we-do/clean-drinking-water
10 Details available at https://www.unep.org/news-and-stories/story/
11 J P Mishra and Shresth Tayal. 2018. Drought Proofing India: Key Learnings from Bundelkhand Drought Mitigation Package. Details available at http://www.teriin.org/policybrief/

Water footprint

Have you ever wondered, how much water you use to do everything you need to do during the day? For example, when you take a shower, brush your teeth, flush the toilet, water your plants, and in the foods you consume.

Also, the things we use and eat every day need a lot of water to be produced. A glass of milk, a notebook, your clothes, everything, absolutely everything, needs water in its production chain.



This is what we call water footprint, the total volume of water used from the production until the consumption of a product, in addition to the water needed to treat the pollutants that it produced.

Water footprint consists of three water sources:

Blue water → it comes from natural sources such as rivers, lakes, aquifers, and surface water extracted from a basin.

Green water → it comes from the rain stored temporarily on the surface of the earth.

Grey water → is the one needed to clean the water polluted in the process.

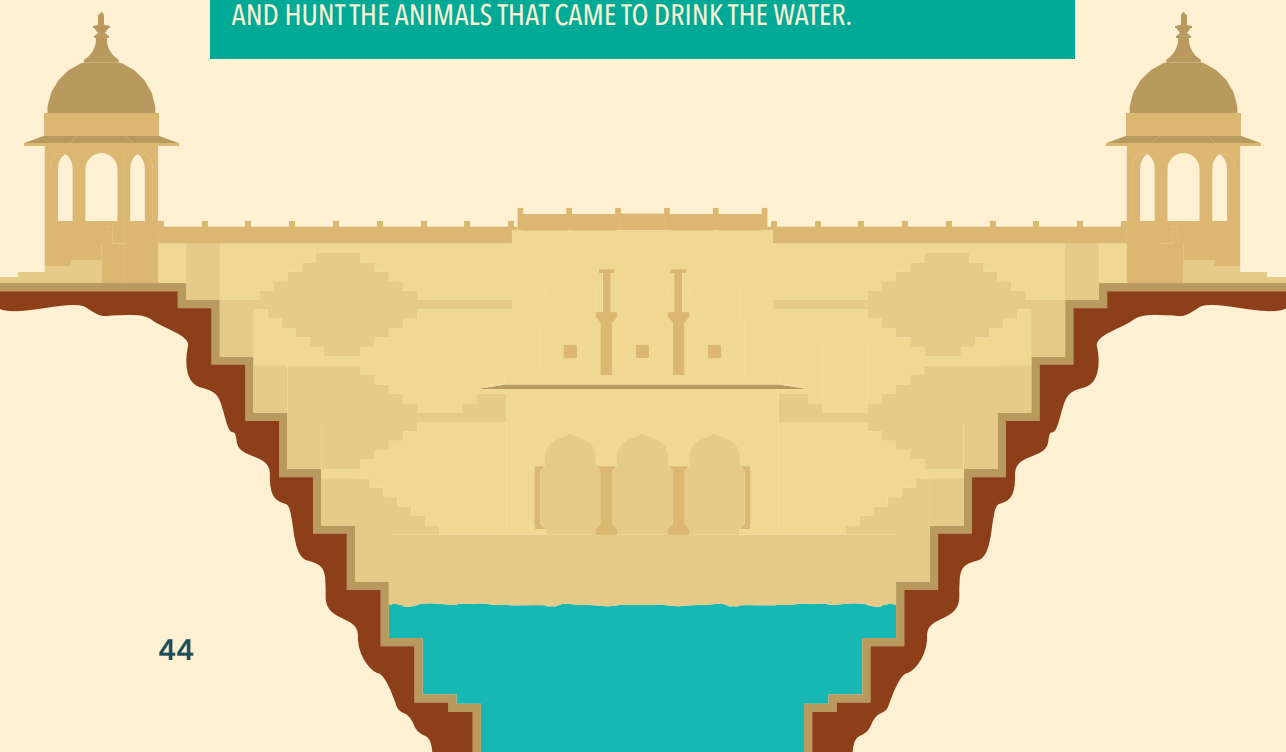
Conservation of Water in Ancient India

Floods and drought have been a common occurrence in India. It could explain why each region of the country has its own distinct water collection methods that reflect the area's physical and cultural characteristics. All of these solutions are based on the idea of collecting rain whenever and wherever it falls.

Archaeological evidence suggests that water conservation is deeply engrained in ancient Indian knowledge. The towns of the Indus Valley Civilization featured outstanding water collecting and drainage systems.

WHY ANCIENT CIVILIZATION DEVELOPED AROUND THE RIVERS?

ANCIENT CIVILIZATIONS WERE DEVELOPED AROUND THE RIVERS BECAUSE THEY SUPPLIED A CONSISTENT SOURCE OF DRINKING WATER AND MADE THE AREA PRODUCTIVE FOR RAISING CROPS. GOODS AND PEOPLE COULD BE READILY MOVED, AND THE INHABITANTS OF THESE CIVILIZATIONS COULD FISH AND HUNT THE ANIMALS THAT CAME TO DRINK THE WATER.



The Indus Valley Civilisation, also known as the Harappan Civilisation, was a Bronze Age civilisation that flourished mostly in the Indian subcontinent's northeast region, particularly around the Indus River. The civilization's cities are 4700 years old and were found in the 1920s in the Indian subcontinent.

Dholavira is an excellent example of water engineering since it is built on a hill between two storm water canals. Chanakya's Arthashashtra describes irrigation utilising water harvesting methods. Near Allahabad, Sringaverapura featured a complex water harvesting system that utilised the natural slope of the ground to store the flood water rom river Ganga. King Karikala of Chola constructed the Grand Anicut or Kallanai across the Cauvery River to redirect water for agriculture (it is still operational), while King Bhoja of Bhopal constructed India's largest manmade lake.

✳ UNDERSTAND THE WORDS

ANICUT IS A DAM MADE IN A STREAM FOR REGULATING AND MANAGING WATER SUPPLY FOR DRINKING, AGRICULTURE, IRRIGATION, AND OTHER HOUSEHOLD PURPOSES.

Indians proceeded to create shelters to capture, contain, and store monsoon rainfall for future dry seasons, drawing on centuries of experience. Traditional procedures are still in use and effective, even though they are less popular nowadays. Here's a quick rundown of India's unique water saving techniques, as well as the villages that have been using them for decades before the climate change discussion ever began.

1. Jhalara

Jhalaras are stepwells that are typically rectangular in shape and contain tiered steps on three or four sides. The subsurface seepage from an upstream reservoir or lake is collected in these stepwells. Jhalaras were constructed to maintain a steady supply of water for religious rites, royal events, and communal consumption. The city of Jodhpur has eight jhalaras, the oldest being the Mahamandir jhalara that dates back to 1660 AD.

Data source: https://www.thebetterindia.com/61757/traditional-water-conservation-systems-india/

2. Talab /Bandhi

Talabs are reservoirs that store water for household consumption and drinking purposes. They may be natural, such as the pokhariyan ponds at Tikamgarh in the Bundelkhand region or manmade, such as the lakes of Udaipur. A reservoir with an area less than five bighas is called a talai, a medium sized lake is called a bandhi and bigger lakes are called sagar or samand.

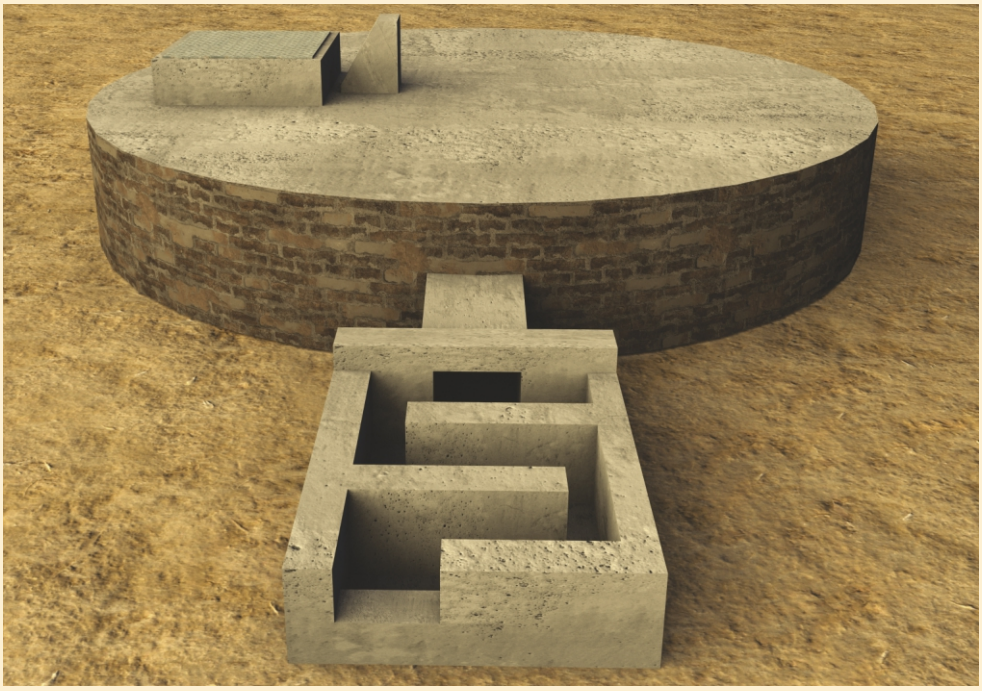
Data source: https://www.thebetterindia.com/61757/traditional-water-conservation-systems-india/

3. Bawari

Bawaris are unique stepwells that were once a part of the ancient networks of water storage in the cities of Rajasthan. The region's little rainfall would be redirected to man-made tanks via canals constructed on the steep fringes of towns. The water would then seep into the earth, increasing the water table and replenishing a complex network of aquifers. To minimize water loss through evaporation, a series of layered steps were built around the reservoirs to narrow and deepen the wells.

Data source: https://www.thebetterindia.com/61757/traditional-water-conservation-systems-india/

4. Tankan



Taanka is a traditional rainwater harvesting technique that originated in Rajasthan's Thar desert. Rainwater from rooftops, courtyards, or intentionally created catchments pours into a Taanka, a cylindrical paved subterranean pit. The water kept in a fully filled taanka may last during the whole dry season and is sufficient for a family of 5-6 people.

Data source: https://www.thebetterindia.com/61757/traditional-water-conservation-systems-india/

LEARN AND THINK

DOES EVERYONE HAVE ACCESS TO WATER IN YOUR CITY?

India has some serious water issues. Millions of people in our country do not have access to safe drinking water. Sixty percent of India's districts have critical levels of groundwater.

- Do you know if everyone has access to water in your city? Ask an adult. If they do not know, ask them to help you look for information on the internet.
- What solutions can you think of so every person can have access to water?
- How could we help solve water scarcity? Think about something you could do and something authorities should do.

Chapter 5

Sustainability, the great challenge

Sustainabili–what? What a long word!
Sus-tain-a-bi-li-ty!

This must be a collective concern. It means to use resources responsibly, without exhausting them nor exceeding their capacity for renovation, so future generations can keep counting on them.

Do you think it is possible? What could we do to accomplish it?

Goals for a sustainable world

Many people in this world, as well as groups and associations they form, are concerned about sustainability and the future of the planet.

One of the most important groups that currently exist, and that works for the good of all countries is the United Nations (UN). This organization has established 17 Goals of sustainable development. Review them on the next page and pay attention to what they are targeting.

*** UNDERSTAND THE WORDS**

SUSTAINABILITY AND SUSTAINABLE ARE SYNONYMS. BOTH WORDS REFER TO THE IDEA OF MAINTAINING SOMETHING, OF PRESERVING IT. THAT IS WHY YOU WILL FIND THAT, IN SOME PLACES, WE USE THE TERM SUSTAINABILITY AND IN OTHERS SUSTAINABLE. BOTH EXPRESSIONS ARE VALID TO REFER TO THE NECESSITY TO PRESERVE NATURAL RESOURCES FOR A LONG TIME WITHOUT EXHAUSTING THEM NOR HARMING THE ENVIRONMENT.

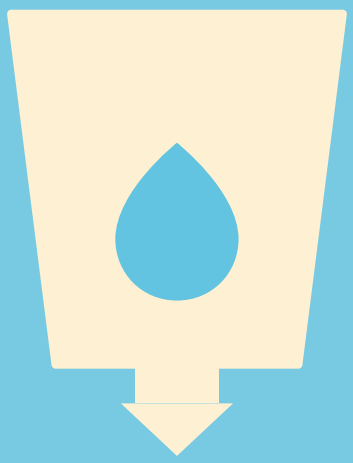
These objectives or goals are a commitment to work for a development, where everyone has the possibilities of living well; growing up, and contribute with their work but, at the same time, protecting the environment.

Countries, companies, and people must unite and cooperate to make this a better world for every one of its inmates/people in other words, ourselves.

Sustainable Development Goals

Data source: https://www.un.org/sustainabledevelopment/es/objetivos-de-desarrollo-sostenible/

DID YOU SEE GOAL NUMBER 6?



"Clean water and sanitation." It means ensuring water availability, its sustainable management and sanitation for everyone.

- Sustainability for water means using the right amount, without wasting it and return it to nature free of contamination.
- Water sanitation means that people can safely access it, and that wastewater must be treated, before returning it to the environment or reusing it.

We have learnt that we need water every day and for all our activities. We cannot live without water. The great challenge is ensuring that, this resource is available in enough quantity and quality for every human being, today and in the future.

Quantity and quality

Two current problems related to water are shortage and contamination. That means that we do not always have enough availability of this resource, to satisfy the needs of a region or, if we do, then it is not safe. Why does this happen?

Why is there not enough water in regions where it used to be before?
The main reasons are:

- **Climate change.** As you learned in the last chapter, two consequences of this phenomenon are a decrease in rainfall (which causes droughts) or, the other way around, an increase in precipitation (which causes floods).
- **The excessive usage of water available in watersheds.** An example of this is, when there is not enough groundwater or river water for the population, after using it for watering species that need too much water.
- **Deforestation of watersheds.** It is the severe reduction of plants and native trees in a place. Because of this, when it rains, the vegetation does not retain water, the underground layers cannot absorb it, and it runs off the surface dragging part of the soil into the rivers.

✳ UNDERSTAND THE WORDS

NATIVE TREES AND PLANTS ARE THE ONES THAT GROW IN THEIR REGION OF ORIGIN, AND THEREFORE ARE INDIGENOUS TO THE AREA'S ECOSYSTEM. ON THE OTHER HAND, A NON-NATIVE TREE WAS BROUGHT FROM ANOTHER AREA, WHICH MEANS THAT SOMEONE INTRODUCED ITS CULTIVATION IN THAT REGION. FOR EXAMPLE, BANYAN, ARJUN, JAMUN, NEEM ARE NATIVE TO INDIA, BUT EUCALYPTUS, RAIN TREE, KANCHAN AND KAJU TREES ARE NON-NATIVE TO INDIA

WHY IS THE QUALITY OF WATER NOT ALWAYS SAFE?

- It often occurs from natural causes, such as catastrophic events or soil characteristics. For example, when a volcano erupts, it deposits large amounts of ashes and minerals that reach the water and contaminate it. It may also happen with heavy rains on eroded soil, dragging debris, and muddying the rivers. In other cases, there are natural mineral deposits in groundwater that, in high concentrations, are harmful to our health.
- Water quality is also affected by human action, mainly by domestic, agricultural, and industrial activities that cause food waste, feces, and urine, pathogenic microorganisms, detergents, chemical substances, agricultural fertilizers, and pesticides, among others.

When things like these happen, the characteristics of water change and it is dangerous to reuse it. Then it is no longer safe to drink it, irrigate crops or practice water activities in that place.

WHO IS AFFECTED BY WATER CONTAMINATION?

IT NOT ONLY AFFECTS HUMANS, BUT CAN ALSO DAMAGE THE FLORA AND FAUNA OF A PLACE. FOR EXAMPLE, IF THE CONTAMINATION REACHES RIVERS AND LAKES, IT REDUCES THE OXYGEN IN THE WATER, WHICH CAUSES THE DISAPPEARANCE OF NATURAL VEGETATION, AND THE DEATH OF FISH AND OTHER AQUATIC ANIMALS. AND IF AN OIL TANKER SPILLS OIL IN THE OCEAN, THIS DENSE BLACK LIQUID ADHERES TO BIRDS' FEATHERS, MAMMAL'S FUR, AND FISH'S SCALES, CAUSING THEIR DEATH.

HOW CAN WE HELP REDUCE WATER CONTAMINATION?

1. Consuming responsibly, choosing less-polluting products, generating less waste, and recycling what we cannot avoid.
2. Demanding that industries reduce hazardous materials in their operations and control their waste production.
3. Keeping sewage in good condition, not throwing objects or trash down the toilet or maintenance hole covers.
4. Reducing pesticides and other chemical products in agriculture, because they may filter through the ground and contaminate groundwater.

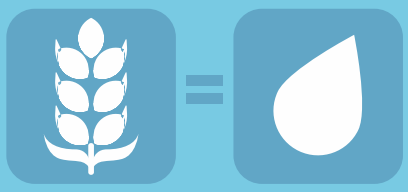
Can you think of other measures to help preserve the quality of our water?

What is virtual water?

Virtual water refers to the water included in the production of everything we eat, buy and wear. The amount of water that it takes to create a product is its water footprint. For example, take your morning cup of coffee, of about 125 ml of actual water. The water used to produce the ground coffee, from irrigating coffee plants and processing the beans, is more than 1,000 times that amount, at 132 litres or nearly seven 20-litre buckets full[12].

From farm to table in India [13]

One kg of wheat requires an average 1,654 litres of water



1 kg wheat **1,654 litres***

One kg of rice requires an average 2,800 litres of water

1 kg rice **2,800 litres***

*can vary depending on geography and climate

The water footprint of a rice-eating family of four that consumes 1kg of rice per day.

1 x 30^{days} x 2,800^{ltrs} = 84,000^{ltrs} of virtual water

+ 5 ^{lpcd} x 4 ^{people} x 30^{days} = 600^{ltrs} of virtual water

Based on the cooking standard as per government of India (5 lpcd per person per day)

So, just for rice, a family of 4 consumes approximately 84,600 ltrs of virtual water in a month.

In 2014-15, India exported 37.2 lakh tonnes of basmati[10]. To export this rice, the country used around 10 trillion litres of water, meaning India virtually exported 10 trillion litres of water.

Data source:
12 Water Footprint Network. Available at: https://waterfootprint.org/en/water-footprint/
13 https://www.prsindia.org/administrator/uploads/general/
14 https://www.livemint.com/ - India is the biggest virtual exporter of water

FOOD AND BEVERAGES

1 APPLE
70 LITRES

VS

1 GLASS OF APPLE JUICE
190 LITRES

1 OF POTATOES
900 LITRES

VS

1 BAG OF CHIPS
185 LITRES

1 OF BARLEY
1300 LITRES

1 SLICE OF BREAD
40 LITRES

1 OF CORN
900 LITRES

1 LITER OF MILK
1000 LITRES

1 OF CHEESE
5000 LITRES

1 EGG
200 LITRES

1 OF CHICKEN
3900 LITRES

1 KILO OF RICE
3400 LITRES

1 KILO OF CANE SUGAR
1500 LITRES

1 KILO OF COCONUT
2500 LITRES

1 CUP OF COFFEE
140 LITRES

1 CUP OF TEA
35 LITRES

CLOTHES AND OTHERS

1 COTTON SHIRT
2700 LITRES

1 KILO OF LEATHER
16.600 LITRES

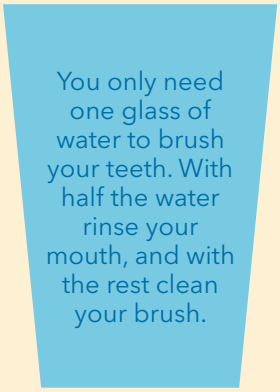
1 LEGAL SIZE SHEET
10 LITRES

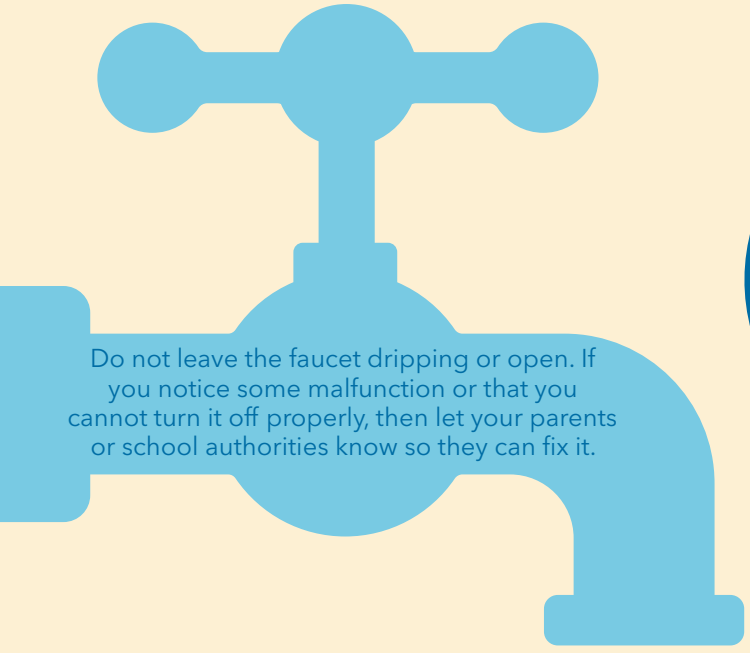
Data source: Taken from Soy responsable, soy mejor, student handbook from SISS, Superintendency of Sanitary Systems (http://www.siss.gob.cl/586/articles-16787_recurso_1.pdf)

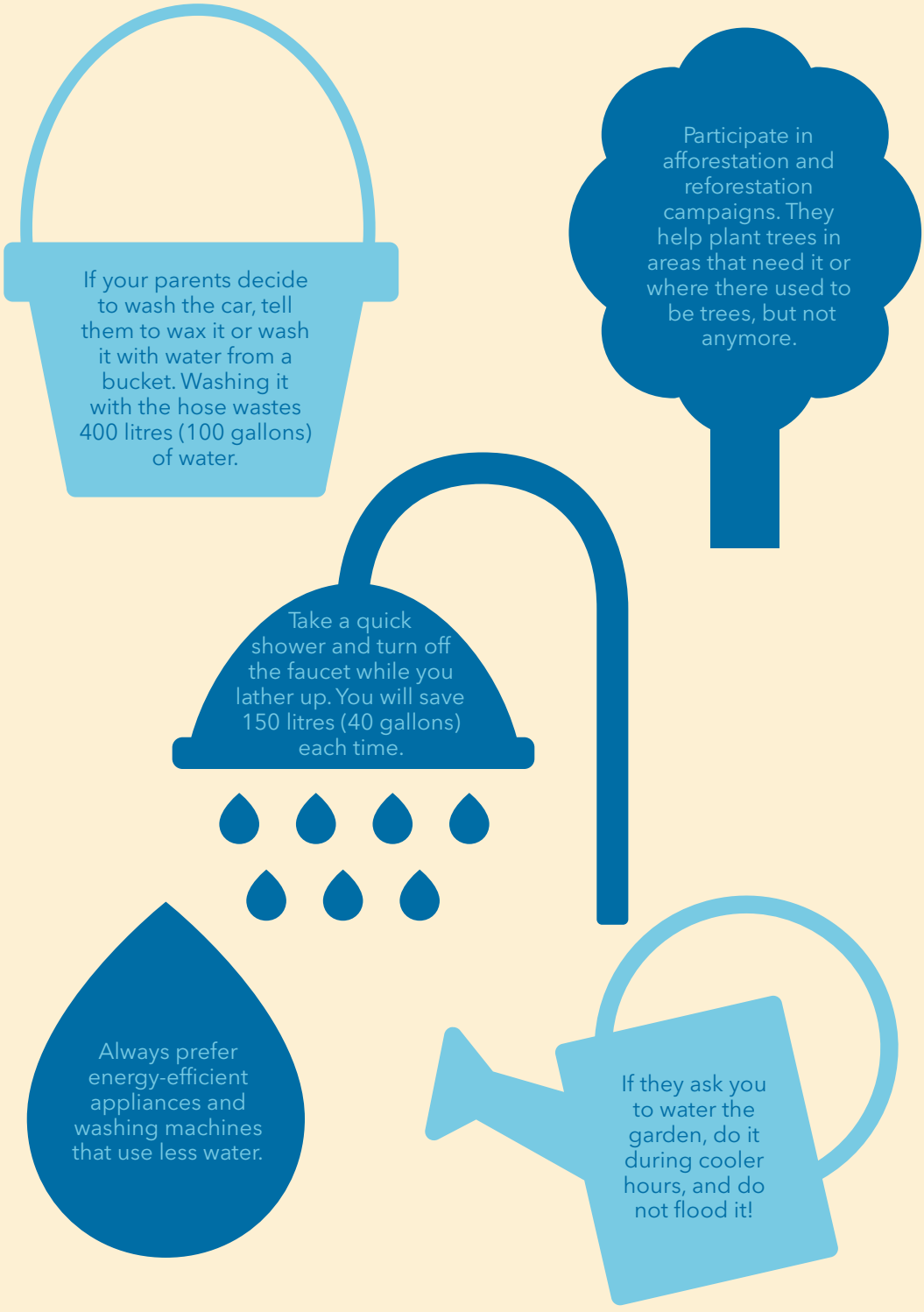
How can I help, if I am just a child?

We can all help to preserve water. The first thing is having responsible habits and consuming only the water and things we need. For example, try not to waste food or school material, so you do not need to buy more.

Read the suggestions and think about which ones you could follow on your own, and which ones you could talk about with the adults you live or study.







Data source: Virtual Center of Information about Water, 2017
(https://agua.org.mx/sustentabilidad/#huella-hidrica)

LEARN AND THINK

DO YOU KNOW HOW MUCH WATER YOUR FAMILY USES IN YOUR HOUSE?
Since we wake up in the morning until we go to bed, we do not notice the number of times we use water and how much we consume. Check the following information:

Activity	Estimated liters
Washing your hands	2 to 18 litres
Brushing your teeth	2 to 12 litres
Filling up the tub	200 to 300 litres
Taking a shower	80 to 120 litres
Using the washing machine	60 to 90 litres
Using the dishwasher	18 to 30 litres
Doing the dishes	15 to 30 litres
Flushing the toilet (new model)	5 to 7 litres
Flushing the toilet (old model)	13 to 22 litres
Cooking and drinking	10 litres a day
Mopping the floor	10 litres a day
Washing the car	400 litres
Water 100 m^2 (1000 ft^2) of lawn	1000 litres

Data source: Taken from Soy responsable, soy mejor, student handbook from SISS, Superintendency of Sanitary Systems (http://www.siss.gob.cl/586/articles-16787_recurso_1.pdf)

If we are not careful enough, we can waste much more water. For example:

A running faucet wastes 5 to 10 litres (1 – 2 gal) per minute.	A leaky faucet or tap wastes 30 litres (8 gal) per day.	A faucet or tap that is constantly dripping wastes 700 litres (185 gal) per day.

How much water do you consume and save in your house? To calculate, learn to read the water meter and record the data. Follow these steps:

1. Locate the water meter and read it every day at the same time for a week.
2. Record the information for seven days in a table like the one below.

Day	Meter reading		Consumption in m^3
	TODAY	YESTERDAY	
0	101000		
1	101600	101000	600
2	102390	101600	790
3	102990	102390	600
4	103780	102990	790
5	104566	103780	786
6	105003	104566	437
7	105495	105003	492
	Weekly total		**4495**

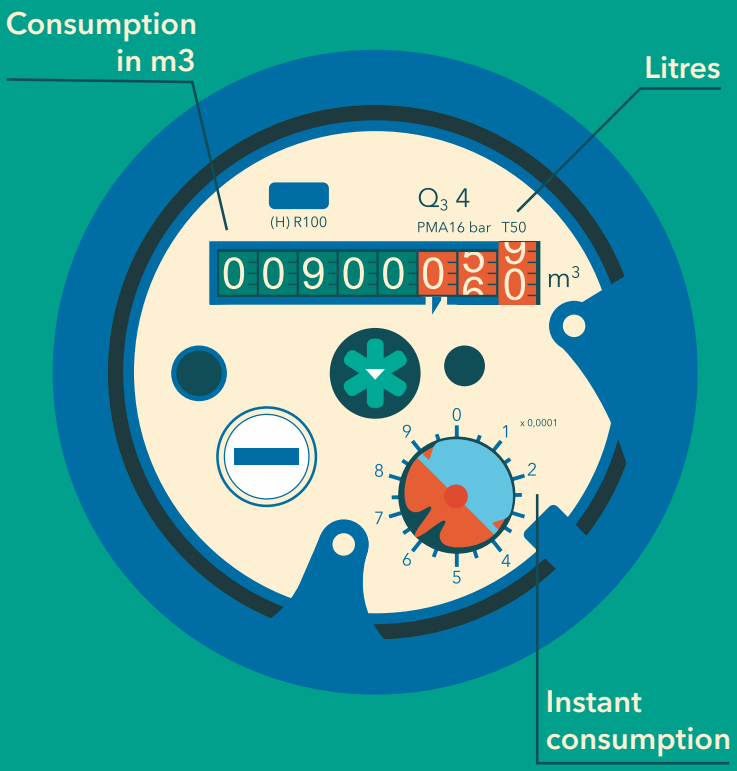
← YOU MUST SUBTRACT YESTERDAY'S READING TO TODAY'S READING TO GET THE CONSUMPTION OF THE LAST 24 HOURS.

REPEAT THIS STEP EVERY DAY FOR A WEEK.

YOU MUST TAKE THE READING EVERY DAY AT THE SAME TIME TO MAKE SURE IT CORRESPONDS TO A WHOLE DAY!

3. Divide the weekly total by the number of days, to get the average consumption of water in your house. Write the result down in your notebook.
4. Estimate how many people live in your house, and divide the average by the number of people. That is the average daily consumption per person.

- According to the results, how many litres of water per person are consumed daily in your house?
- What actions could you take as a family to lower your water consumption? Share with them the examples on the last page and talk about them.
- Once everyone has committed to save water, begin a new week of reading, and calculate again how much water is consumed in your house. Did you manage to reduce it?

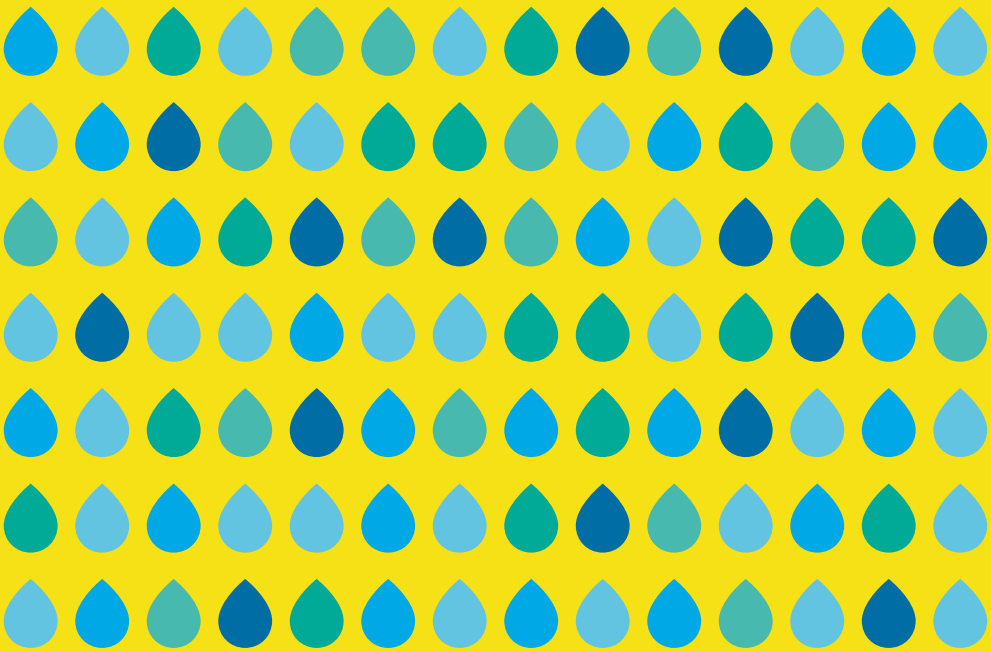


WHAT IS MY WATER FOOTPRINT?

- Write down what you usually eat during the day, look for the water footprint of each food item and add the results.

Meal	Content	Water footprint
Breakfast	1 glass of milk and 1 scrambled egg sandwich.	40 + 200 + 200 litres
Lunch	Dal with Rice	
Afternoon snack	Curd	
Dinner	Roti and Paneer Curry	
	TOTAL	

- With the information on the previous pages, can you calculate the water footprint of the clothes you are wearing today?
- What could you do to reduce your water footprint?



Let's save water!

We have reached the end of this book, but the beginning of a new story, the one you will be able to tell the boys and girls of future generations.

It can only be possible, if you start practicing what you have learned on these pages, and continue studying and understanding the problems that water faces nowadays.

We say goodbye, wishing you the best…

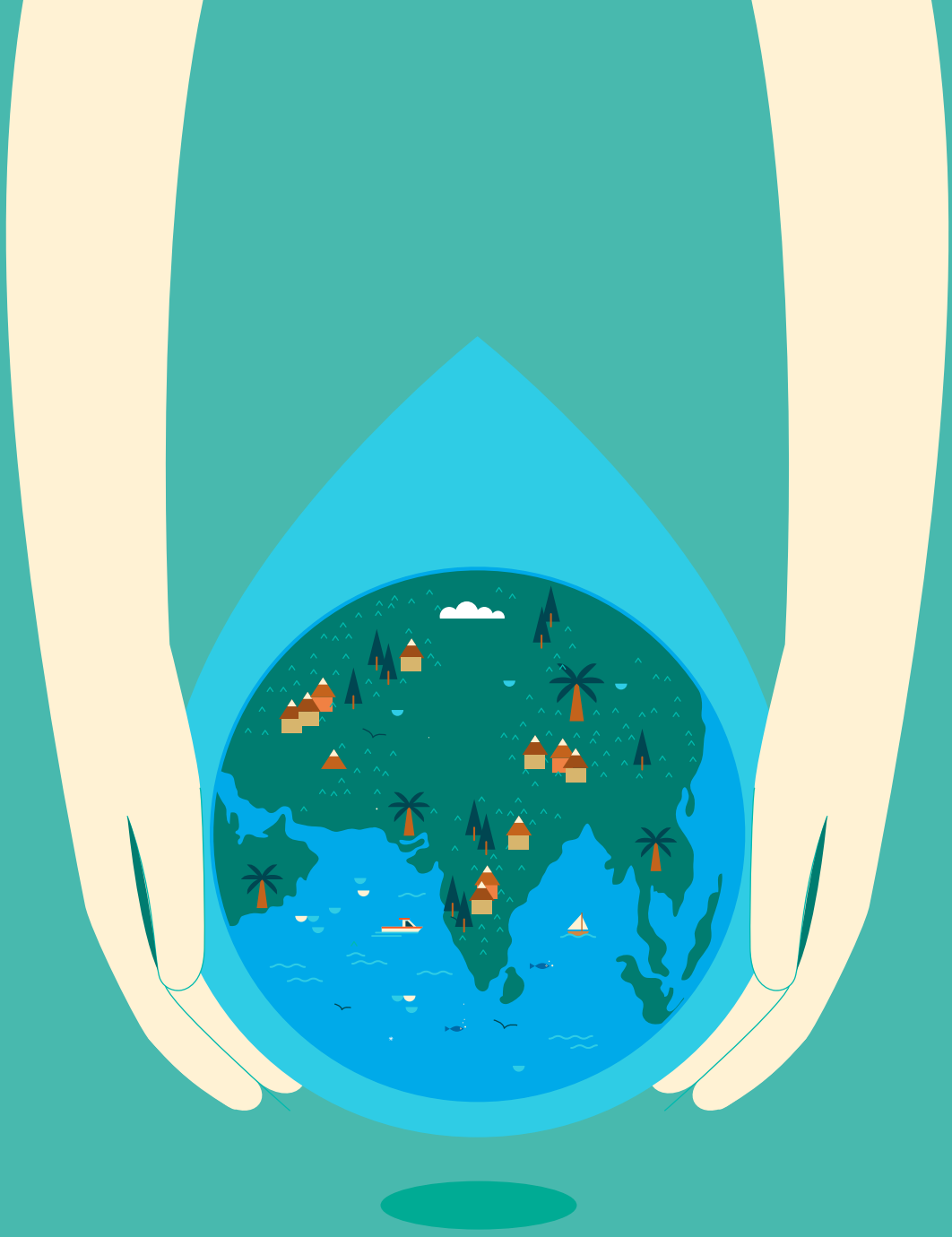
… that the word sustainability accompanies your daily actions.

… that you commit to small measures that may bring big positive changes to our planet.

… that people of the future may get to see the glaciers of the world, the Amazon Forest, and the amazing Sunderbans and the majestic Himalayas.

… that everyone, today and tomorrow, can drink a glass of crystalline freshwater and look at the thousands of little stars over the rippling surface of a lake at sunset.

The future of water and our planet is a task that includes everyone – each one of us!



Xylem (XYL) is a leading global water technology company that provides end to end solutions for water and infrastructure challenges. To know more visit www.xylem.com

If you have any questions, please feel free to write to us at xylem.india@xylem.com.

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Denise Pouleurs is Market Manager for Water Utilities in Latin America. She is an Environmental Engineer and Global MBA and MSc in Business Administration. She is extremely passionate about fighting water challenges and has a strong background in drinking water and wastewater treatment. She specializes in the fields of consulting, engineering and construction, project management as well as in business development. Her purpose is not only to help solve water but also to inspire young generations to take care of water challenges across Latin America and the World.

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THE GREAT BOOK OF WATER, INDIA

Denise Pouleurs

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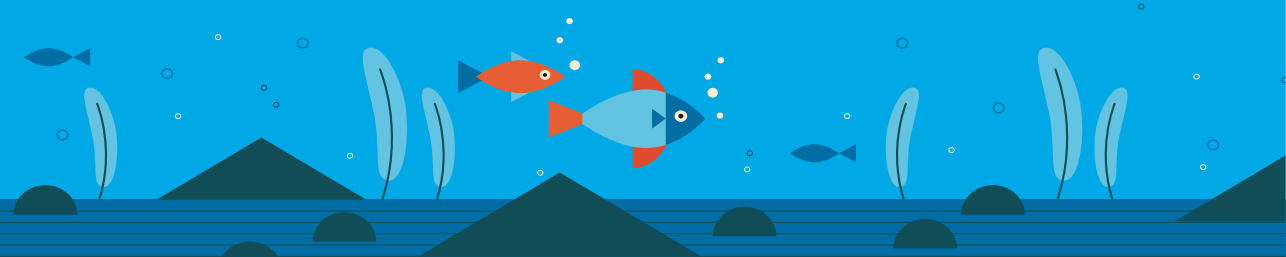
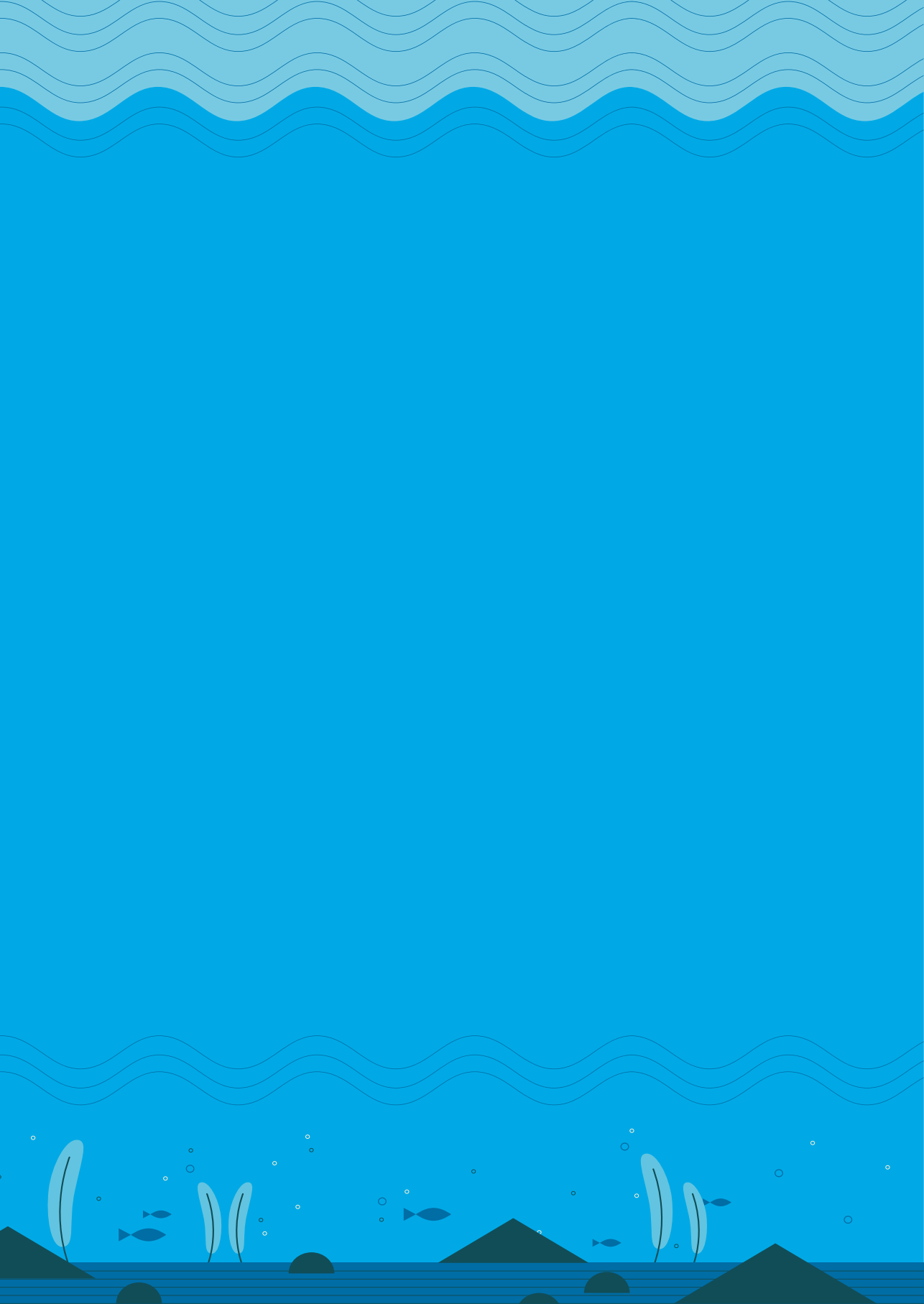
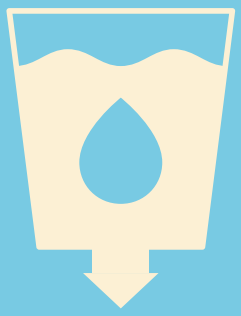
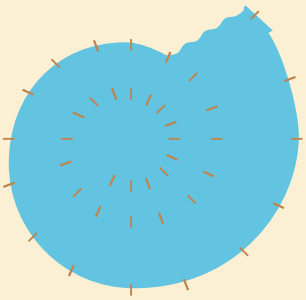
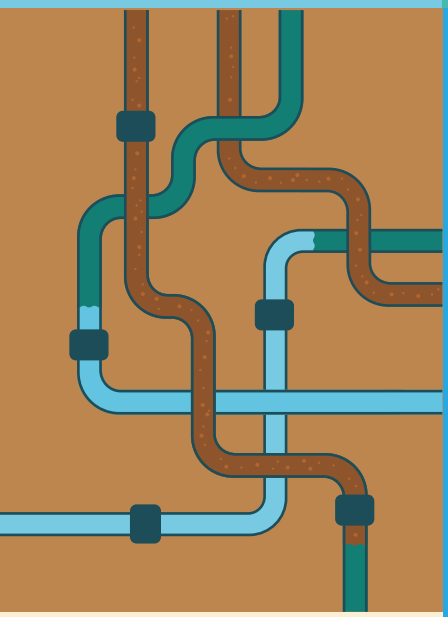
Xylem Inc., through its Watermark program, is committed to the preservation of this valuable resource, water. We want this book to contribute to the Indian region and children and young people, so they learn from these words and take action because every drop counts!







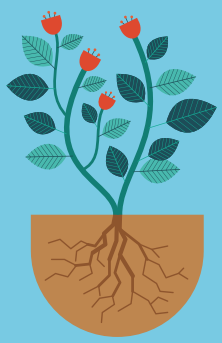


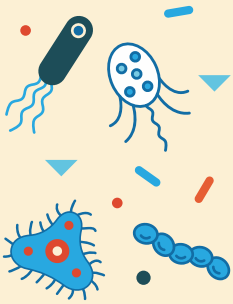


Water is so prevalent in our lives that we don't see it, it becomes transparent. But the truth is that, today more than ever, we need to preserve this valuable resource in a sustainable way.

Xylem Inc., through its **Watermark** program, invites you to read this book and discover many things about this vital element that today is being threatened, from its properties as a molecule to how it is distributed to our houses.

We want this book to contribute to India region, so children and young people learn from these words and take action… because every drop counts!





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