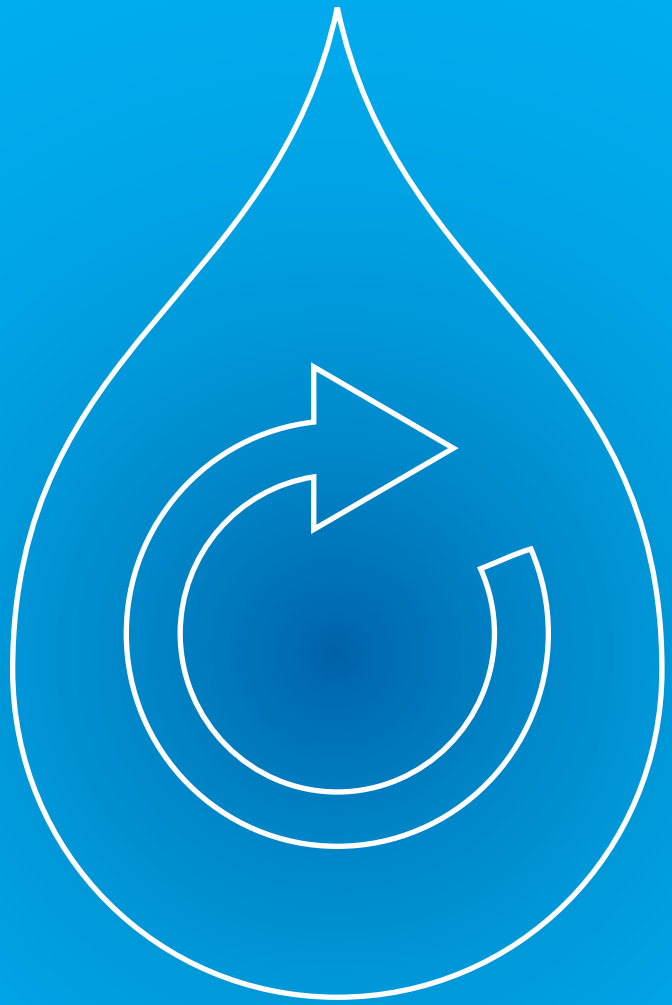
An Taisce
*The National Trust for Ireland*

# Green-Schools Programme

Information for secondary schools

# Water



UISCE ÉIREANN : IRISH WATER

# Welcome

**This booklet is designed to be an interactive resource that teachers and students can use to explore important issues relating to water. The accompanying lesson plans will engage students in a practical way and walk you through the various topics.**

### Green-Schools

Green-Schools, known internationally as Eco-Schools, is a whole school, long-term, action based programme and award scheme operated in Ireland by An Taisce. Schools who successfully implement the 7 steps of the programme are awarded a Green Flag. The themes of the programme are: Litter and Waste, Energy, Water, Travel, Biodiversity and Global Citizenship. Green-Schools is a programme of FEE (The Foundation for Environmental Education).

### Irish Water

Irish Water is Ireland's new national water utility that is responsible for providing and developing water services throughout Ireland. Irish Water is delighted to be working with Green-Schools on this very worthwhile initiative, helping to educate young people in schools throughout Ireland about water conservation. Together we can improve and secure this precious resource that will be vital to the social and economic life of this nation far into the future.

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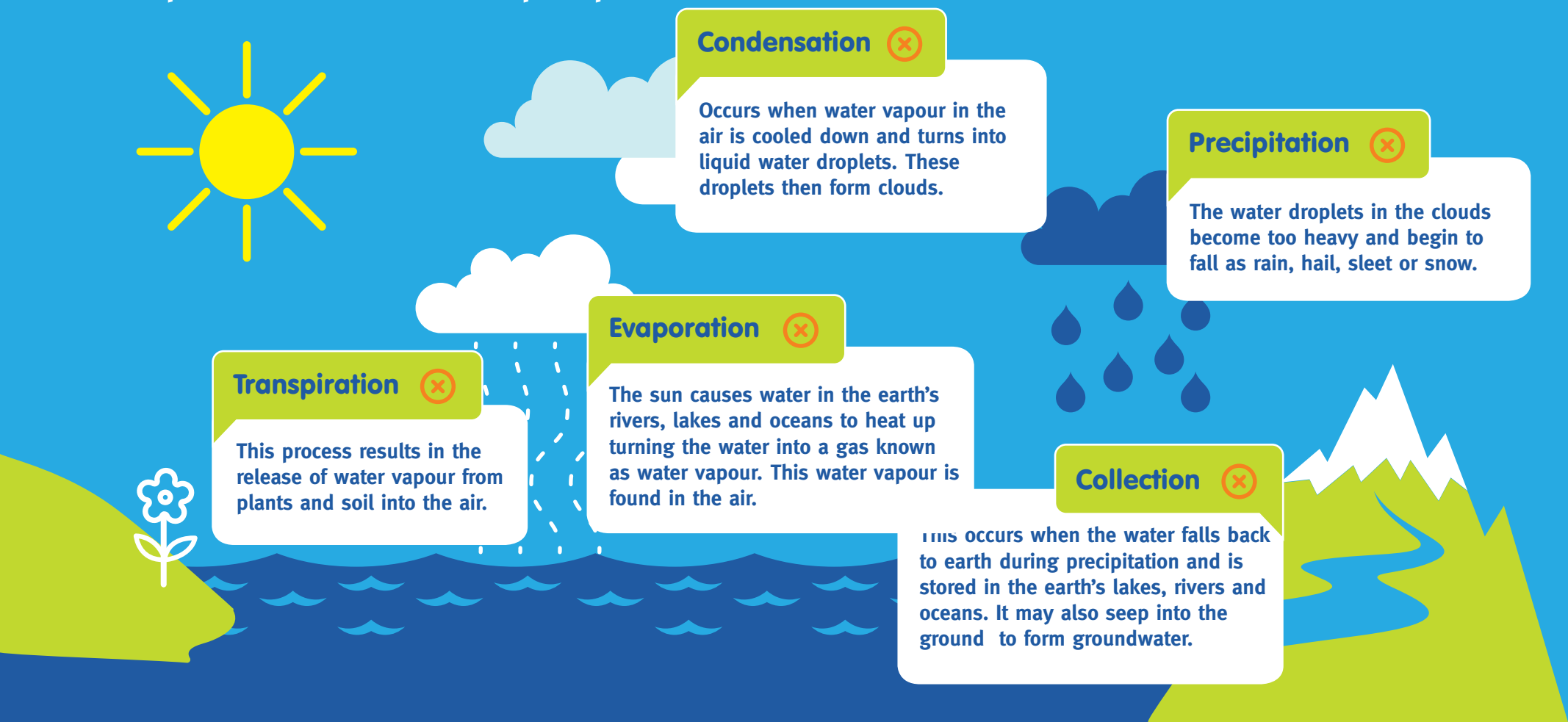
Hover over this symbol to reveal a text box. To hide it, click outside the text box.

# Contents

# 1. The Water Cycle

The earth's water is always moving on, above, and below the surface of the earth. For example, a river flowing into an ocean. The amount of water on earth has remained more or less the same over time and it is continuously going through various processes that can change it into a liquid, gas or solid. These processes are known as evaporation, transpiration, condensation, precipitation, and collection.



## Condensation

Occurs when water vapour in the air is cooled down and turns into liquid water droplets. These droplets then form clouds.

## Precipitation

The water droplets in the clouds become too heavy and begin to fall as rain, hail, sleet or snow.

## Evaporation

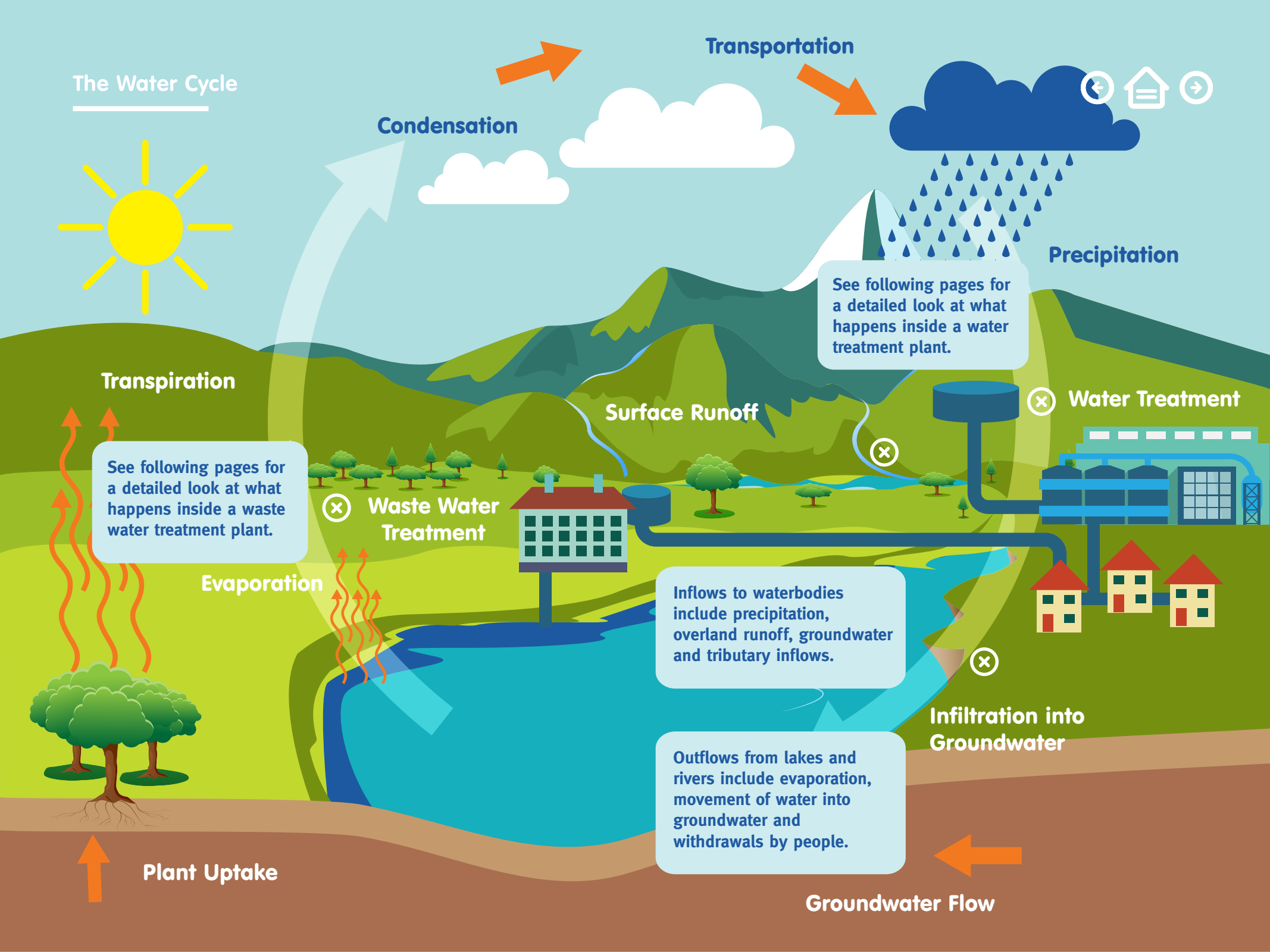
The sun causes water in the earth's rivers, lakes and oceans to heat up turning the water into a gas known as water vapour. This water vapour is found in the air.

## Transpiration

This process results in the release of water vapour from plants and soil into the air.

## Collection

This occurs when the water falls back to earth during precipitation and is stored in the earth's lakes, rivers and oceans. It may also seep into the ground to form groundwater.


The Water Cycle
Transportation
Condensation
Precipitation
See following pages for a detailed look at what happens inside a water treatment plant.
Water Treatment
Transpiration
Surface Runoff
See following pages for a detailed look at what happens inside a waste water treatment plant.
Waste Water Treatment
Evaporation
Inflows to waterbodies include precipitation, overland runoff, groundwater and tributary inflows.
Infiltration into Groundwater
Outflows from lakes and rivers include evaporation, movement of water into groundwater and withdrawals by people.
Plant Uptake
Groundwater Flow

# Water Treatment

## When a drop of water enters a river it can end up in a treatment plant where it undergoes many different processes:

The water passes through coarse and fine screens which filter debr

Sampling and testing are carried out to check water quality. Some of the things that are looked at are: colour, odour, taste, conductivity, turbidity, fluoride, pH levels, and if bacteria are present.

The pH of a solution is a measure of the concentration of hydrogen ions in the solution. Thus, it is a measure of the acidity or basicity of the solution. Ideally tap water should have a pH range of six to eight. Lime is added if the water is too acidic (pH less than 6) and dilute sulphuric acid or carbon dioxide can be added if the water is too basic (pH above 7). This is important because if water is too acidic it could corrode the water pipes leading to toxic metal compounds entering the water and if it's too basic it could lead to limescale build-up.

Fluoridation is the controlled addition of fluoride to water in order to reduce tooth decay. The chemical used to fluoridate water in Ireland is called hydrofluosilicic acid ($H_2SiF_6$).

Small fine particles in the water undergo coagulation (the process of forming semisolid lumps in a liquid) to create particles of greater size called flocs
ıce the name). An agent called aluminium
hate is added to make this happen. Sometimes
electrolyte's are added to speed up the
gulation process and to help coagulation by
enting the filters from becoming clogged with
ll particles.

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### 3. Flocculation / Sedimentation

The water is then passed through large sand filters which clear the water of any remaining solids. The sand filters are made up of beds of sand 1 metre thick, with fine sand on top and coarse sand on the bottom. All this sand is on top of gravel and a bed of large stones.

A process called back washing is employed to clean the filters when they get clogged. This is done by pumping water and air up through the filters.

### 4. Filtration

arrying micro-organisms, which are too
he eye to see, are killed by chlorine which
during the disinfection stage. A common
chlorination involves the addition of sodium
ite (NaOCl) to water. It reacts with water to
chlorous acid (HOCl) which is a very effective
nt. $NaOCl + H_2O \rightarrow HOCl + NaOH$

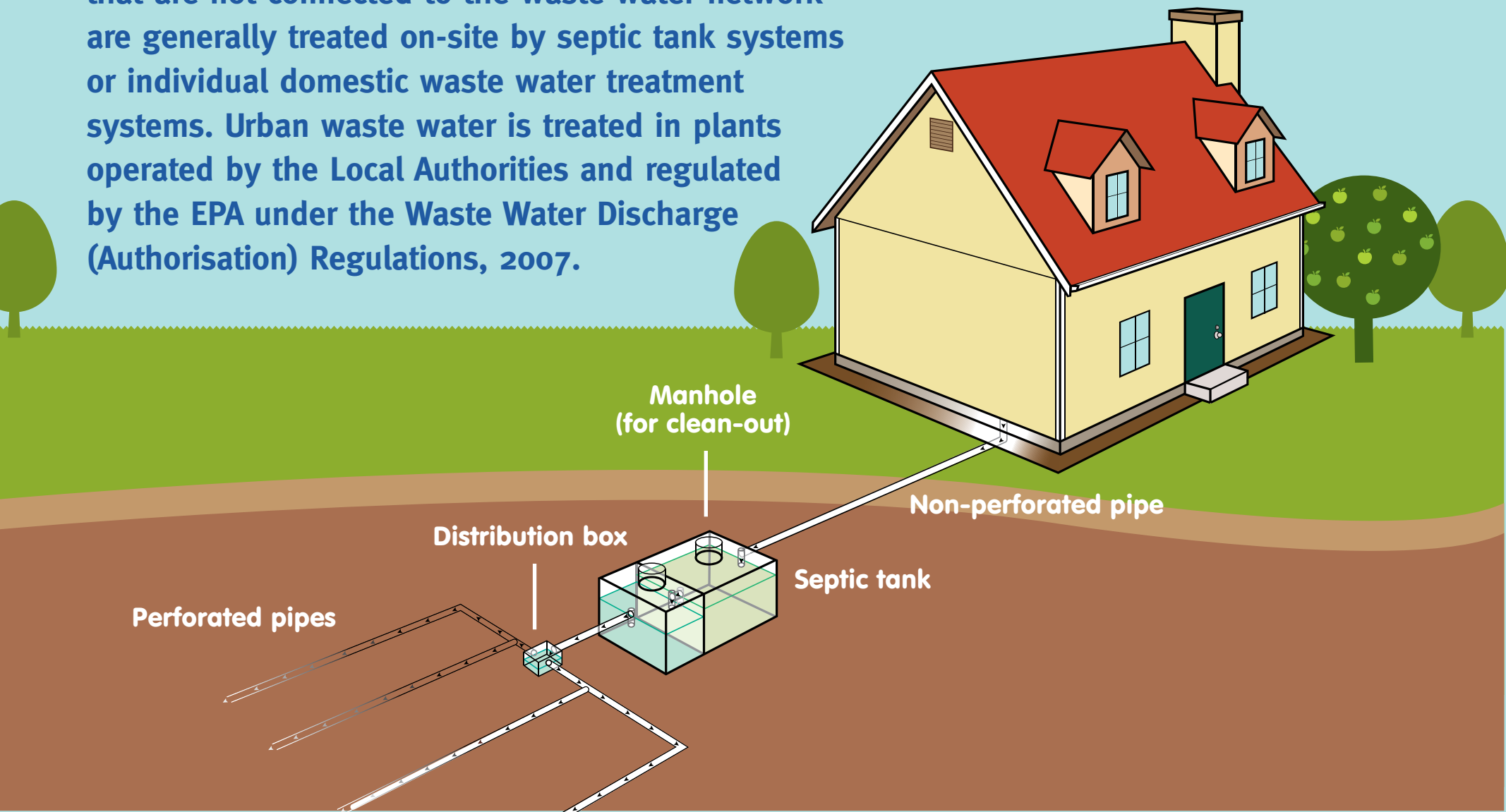
### 6. Samplir and Testin

The treated water is stored and then distributed. The water travels through miles of pipe, taking a few days to reach a tap.

### 7. Storage and Distribution

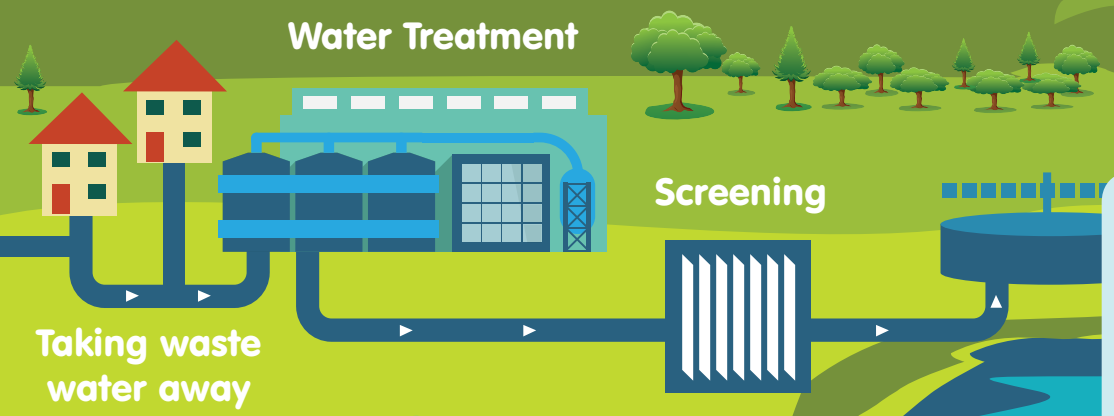
## Waste water treatment

Waste water from single houses in the countryside that are not connected to the waste water network are generally treated on-site by septic tank systems or individual domestic waste water treatment systems. Urban waste water is treated in plants operated by the Local Authorities and regulated by the EPA under the Waste Water Discharge (Authorisation) Regulations, 2007.



**Sewage is the term used to describe waste water which is produced by domestic, industrial and commercial sources and discharged into the waste water network (i.e. sewers). Sewage is generally treated in a series of stages called preliminary, primary, secondary and tertiary treatment and these stages involve physical, chemical and biological processes.**

1. Preliminary
2. Primary
3. Secondary
4. Tertiary




Preliminary treatment is the removal of coarse solids and other large materials often found in raw waste water. The removal of these materials is necessary to enhance the operation and maintenance of subsequent treatment units. The sewage is initially pushed through mechanically raked screens to remove large solids, oily scums and floating debris and then passed through long concrete grit channels to remove sand or gravel particles.

Secondary treatment is the further treatment of the effluent from primary treatment to remove the residual organic material and suspended solids. The material is treated using biological processes such as suspended growth and attached growth.

Break down of material through suspended growth is carried out in an activated sludge unit. The effluent is first treated in an aeration tank where oxygen is fed into a tank to support growth of suspended micro-organisms that decompose the organic matter. The liquid then flows into a settling tank where material settles as sludge on the bottom of the tank. The treatment of effluent through attached growth is carried out using trickling filters. This is where waste is aerobically oxidised by organisms which grow on the surface of the filter as a slime. The filter is usually a large concrete tank loosely packed with stones to allow for a good circulation of air.

# 2. Water Conservation

Only **2.5%** of the earth's water is **fresh water** and of that **less than 1% is accessible for human use**

Nearly 70% of fresh water is frozen in the icecaps of Antarctica and Greenland; most of the remainder is present as soil moisture, or lies in deep underground aquifers as groundwater not accessible for human use.

Approximately 1% of the world's fresh water is accessible for direct human use. This is the water found in lakes, rivers, reservoirs and those underground sources that are easily accessible.

97.5% of all water on earth is salt water.

Over 70% of our earth's surface is covered by water.

# ‘Water Conservation’ means protecting and managing this limited fresh water supply and protecting the aquatic environment.

The reason for this is to make sure we have enough clean water for current and future generations. Water is an extremely important resource; it influences weather, it shapes the landscape and it supports all life.

## How is water used?

Humans use water in many ways, for example, we use it in our everyday lives for drinking, washing, cleaning, cooking **(off-stream use)** and for leisure activities **(in-stream use)**.

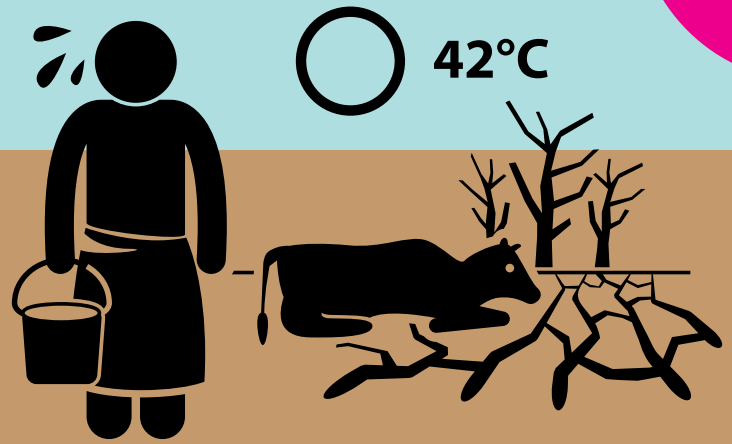
**Off-stream use is when water is removed from its source by pumping and diversion.**

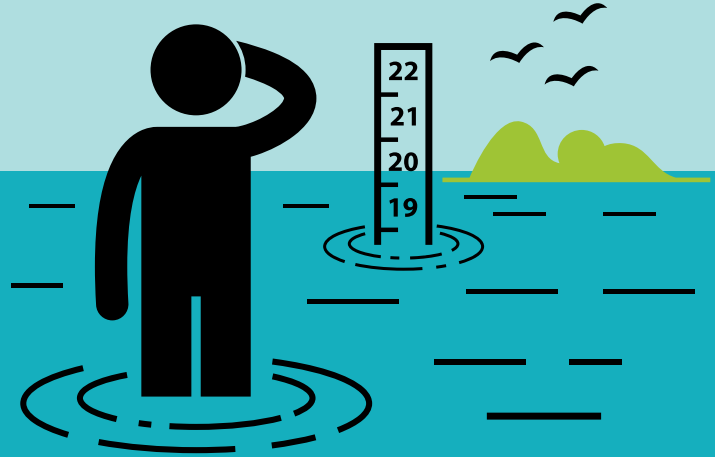
**In-stream use is when water is used at the source e.g. lakes and rivers.**

There are huge pressures on our water resources as it is used in almost every part of daily life and, as the earth's population grows, so too will the demand. Climate change is another major issue that affects our water resources.



Can you think of other examples?




## Drought

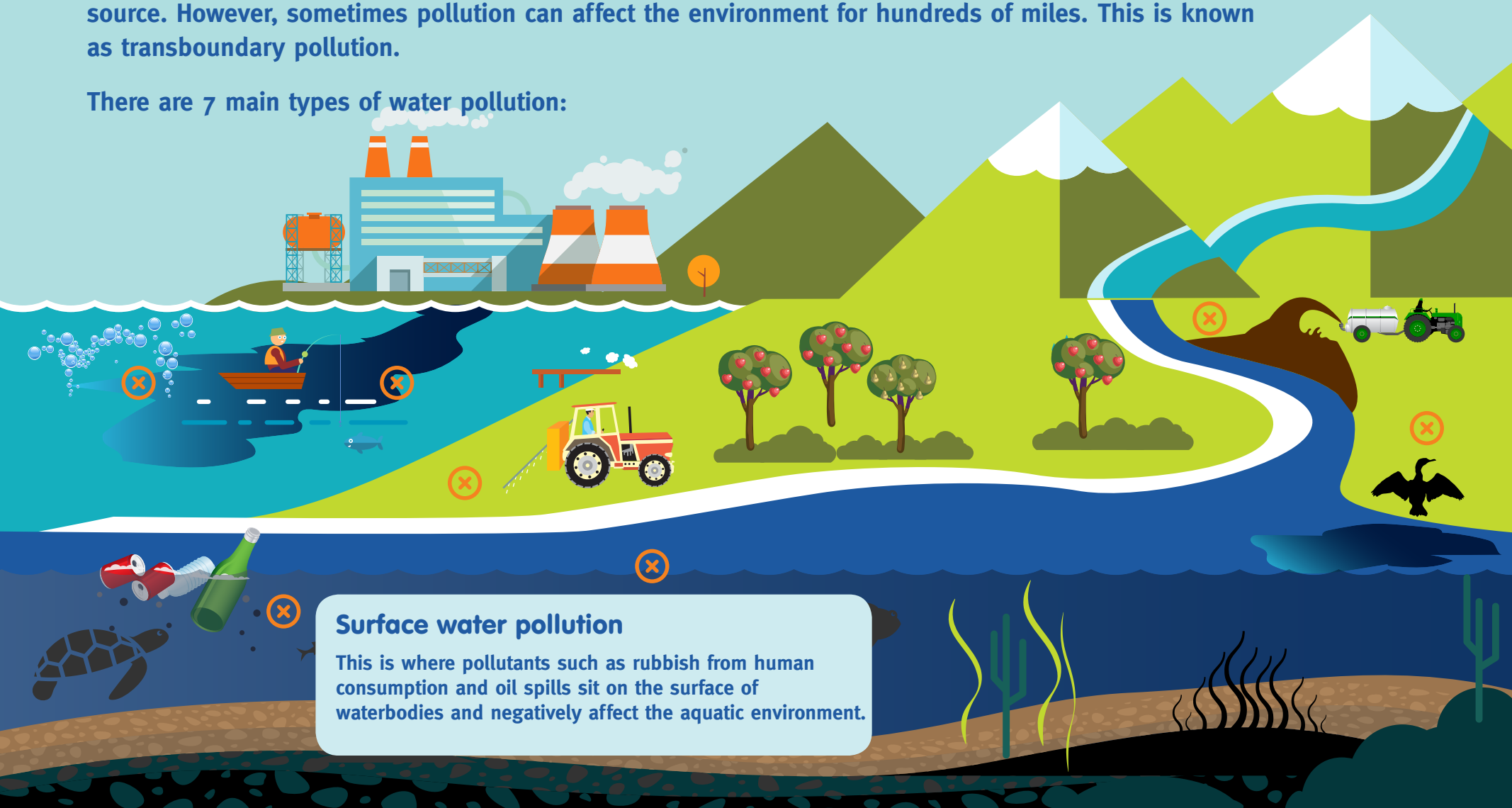
As the earth gets warmer some areas may experience increased rates of evaporation (see Section 1 on the Water Cycle) which may lead to these areas drying out causing droughts.

## Flooding

The excess evaporation may then be transferred to other areas as rainfall resulting in flooding (See Section 3 on Climate Change).

Pollution due to human activities is also a major threat to our water resources. Water pollution is the contamination of waterbodies e.g. rivers, lakes, groundwater and oceans by untreated substances, chemicals and particles. Pollution can be point source (pollution from one source) or nonpoint source (pollution from many sources) and predominantly affects the immediate area surrounding the pollution source. However, sometimes pollution can affect the environment for hundreds of miles. This is known as transboundary pollution.

There are 7 main types of water pollution:



## Surface water pollution

This is where pollutants such as rubbish from human consumption and oil spills sit on the surface of waterbodies and negatively affect the aquatic environment.

## Water Conservation

**As water is used by everybody on the earth it is important that everyone plays a part in conserving it, from individuals to homeowners to schools, businesses, industries and national governments.**

**Some of the things you can do to protect our water:**

# 3. Climate Change

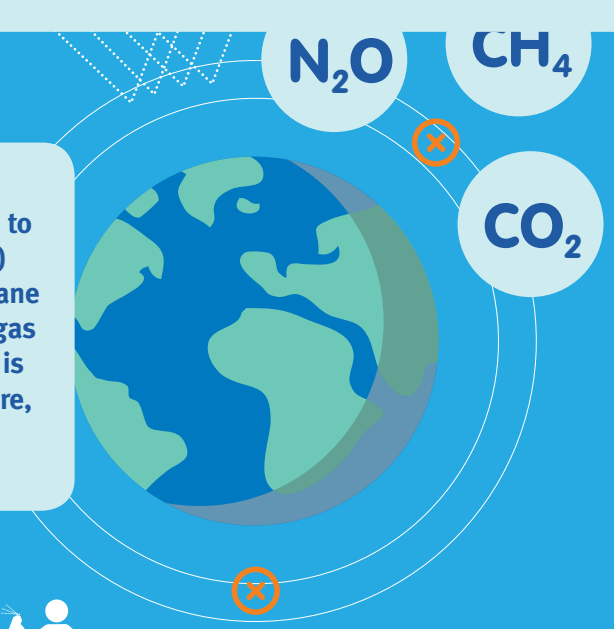
**Climate change is now widely acknowledged as the biggest challenge facing our global environment and human species today. It can be defined as a change in global and regional weather patterns over time.**

Weather describes the atmospheric conditions such as temperature, precipitation and wind in a particular place over a short period of time. Climate, on the other hand, refers to the average weather conditions in a certain place over many years. Global climate refers to the average climate around the world.

## Cause

The earth's climate has been changing consistently and very slowly over its 4.5 billion-year history. The changes were due to natural processes such as plate tectonics, volcanic activity, and interactions between land, oceans and the atmosphere, as well as variations in sunlight. However, the most recent changes in climate have been as a result of human activity.

There are two other heat trapping gases that contribute to climate change: methane ($CH_4$) and nitrous oxide ($N_2O$). Methane is the second most prevalent gas that causes climate change. It is released by industry, agriculture, and waste management activities.




More than 100 years ago, people around the world started burning large amounts of coal, oil, and natural gas to power their homes, factories, and vehicles. Today, most of the world relies on these fossil fuels for their energy needs. Burning fossil fuels releases carbon dioxide ($CO_2$), a heat-trapping gas, into the atmosphere, which is the main reason why the climate is changing.

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Heat-trapping gases are also called greenhouse gases. They exist naturally in the atmosphere, where they help keep the earth warm enough for plants and animals to live but people are adding extra greenhouse gases to the atmosphere. This is resulting in increased global temperatures (global warming) and widespread adverse environmental impacts.

## Habitat loss

As the earth gets warmer, plants and animals that need to live in cold places, like on mountaintops or in the Arctic, might not have a suitable place to live and coastal wildlife may find their habitat underwater as sea levels rise.

## Loss of pola

Glaciers around
threatening alpine and Arctic ecosystems.

## Extreme weather conditions

There has been more intense precipitation and extreme heat which has led to more frequent flooding, heatwaves, wildfires and drought. As the top layer of the ocean gets warmer, hurricanes and other tropical storms which get their energy from the warm ocean water will become more frequent.

## Thawing Permafrost

Glaciers around the world are shrinking rapidly, contributing to rising sea levels and threatening alpine and Arctic ecosystems. Permafrost underlies about 20 percent of the land in the Northern hemisphere and is widespread within the Arctic Ocean's vast continental shelves and in parts of Antarctica. Most of the world's permafrost has been frozen for millennia and can be up to 5,000 feet thick.

Melting permafrost can cause the land above it to sink or change shape which can damage buildings, roads, airports, water and waste water pipes, and it can affect ecosystems. Also, when permafrost melts it releases carbon that was stored inside it.

animals
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source of

## Sea level rise

Sea levels have increased by between 12 and 22cm and are projected to rise by a further 40cm this century.

## Students from all over the world are taking action to slow down the impacts of climate change. When you add together all the actions taken by students from every corner of the globe it makes a big positive difference to our planet.

Saving water saves energy, which in turn reduces greenhouse gas emissions. It takes a lot of energy to treat the water you use every day to make it safe to drink and to deliver it to your house. It takes even more energy to turn it into hot water.


## What you can do:

### Calculate your usage

Calculate your water usage to see how much you use.

### Water audit

Conduct a manual water audit to find out the ways you use water.

### Look for and fix leaks

You can look for drips and leaks in taps, toilets and radiators. You can put food colouring in the toilet cistern, give it some time and see if it shows up in the bowl. If it appears in the bowl without flushing, you have a leak!

Fix any leaks you find, as a dripping tap can waste over 4 litres of water per day.

### Be water wise

Turn the water off while brushing your teeth, try taking shorter showers, use dual flush toilets correctly, turn off urinals at night and on weekends, use watering cans instead of sprinklers for the garden and a bucket of water instead of a hose to clean your car.

### Go low–flow

Install water–efficient appliances and plumbing fixtures like dual flush toilets, hippo bags and low-flow showerheads. Every time you flush the toilet you use 6 litres of water, but with a dual flush or a hippo bag, a flush can be 3 litres!

# The Green-Schools Programme

You can make a difference by getting involved in the Green-Schools programme in your school.

With 7 steps to follow there is an action for everyone!

For further information go to:
**www.greenschoolsireland.org**

7 step programme


1 Green-Schools Committee

2 Environmental Review

3 Action Plan

4 Monitoring and Evaluation

5 Curriculum Work


6 Informing and Involving

Green-Schools
An Taisce

7 Green Code

# 4. Water People

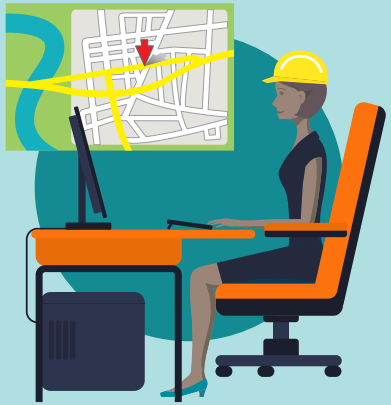
**A lot of people are involved in water processes. The general areas of employment include engineering; organisational services; communications, policy and education; laboratory and science; operations, maintenance, trades, and environmental.**

Can you guess what I am doing?

## 1. Engineering

### Engineering

Civil Engineers design and engineer dams, reservoirs, aqueducts, pumping stations, pipelines, waste water treatment plants, and other parts of the water supply and water delivery system.



## 2. Organisational Services

### Geographic Information Systems Specialist

A GIS (Geographic Information Systems) Specialist uses computers to analyse geographic information and to display the data in maps, graphs, and tables. The water sector needs GIS specialists to provide detailed maps of the locations affected by the water supply and delivery system.

## 3. Communications, Policy & Education

### Green-Schools Officer

A Green-Schools Officer helps to educate people about the various ways they can conserve and protect water, as well as the processes involved in the water cycle and getting water to taps. They develop educational materials, visit schools and carry out workshops.

## 4. Laboratory & Water Science

### Hydrologist

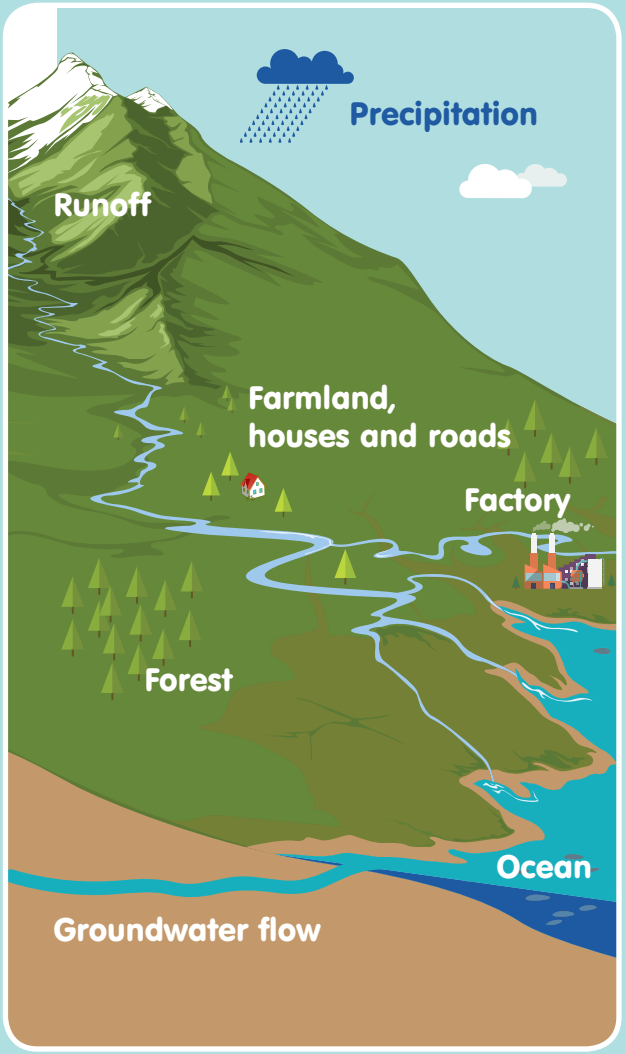
Hydrology is the study of how water moves through the water cycle on earth. Hydrologists specialise in underground and surface water supplies. They look at the movement of water in the atmosphere (precipitation, evaporation), surface water (rivers and lakes) and groundwater. They also map and measure the flow of water in the watershed. They try to predict if floods and droughts will happen in the future and how severe they will be.

### Microbiologist

Microbiologists study the life of organisms that are too small to see without a microscope. Some of these microscopic organisms can cause serious or deadly diseases in people. Keeping these organisms out of the water supply is a major concern. Microbiologists use microscopes, chemical tests, and other diagnostic techniques to check the water for dangerous micro-organisms.

### What is a Watershed?

A watershed is an area of land where all of the water that is under it, or drains off of it, collects into the same place (e.g. a river).



## 5. Operations, Maintenance, Trades

### Reservoir Manager

A Reservoir Manager must monitor and control pollution and erosion in the land surrounding the reservoir (including wild animals and birds that can pollute the water), oversee water quality sampling, and keep the environment safe, for the public and employees, in and around the reservoir.

### Plumber

A Plumber is a tradesperson who specialises in installing, repairing and maintaining plumbing systems used for drinking water, sewage and drainage. Some of the work a plumber undertakes involves testing pipes for leaks using air and water pressure gauges and reading drawings to determine the layout of water supply, waste, and venting systems.

## 6. Environmental

### Environmental Engineer

An Environmental Engineer tries to protect a natural ecosystem from damage caused by human-made projects. For example, the ecosystem of a stream may be damaged by bulldozers while building a pipeline, and an environmental engineer would be there to limit damage to the natural ecosystem.

### A Reservoir

Reservoirs are human-made lakes for storing water that will be treated for drinking. A reservoir is a very complex system. Its water is affected by everything that goes on in the surrounding area (watershed) such as industries, roads, farms, golf courses, flocks of birds, wildlife and farm animals, recreational fishing and boating, etc. Temperature, rainfall, and water usage also affect the health of a reservoir.

### An Ecosystem

An ecosystem is a community of plants and animals that depend on each other to live.

# 5. Lesson Plans

## Summary of Lesson Plans

Lesson plans on all sections of the water resource can be found on the Green-Schools website: www.greenschoolsireland.org/resources/water.215.html

Our animated videos on the Green-Schools 7 Steps in Action and Our Water from Cloud to Glass can also be found on the above link


### Lesson Plan 1: The Water Cycle

Learn about the water cycle through discussion, drawing and carrying out condensation and evaporation experiments.

### Lesson Plan 2: Water Conservation

Learn, through discussion and observation, about the importance of water, the many different ways we use it, how it can be wasted and the measures we can take to save it.

### Lesson Plan 3: Climate Change

Learn about climate change, the causes, its impact on our environment and what you can do to help stop it, through discussion, experimentation and investigation.

### Lesson Plan 4: Water People

Learn about those who are involved in providing our water and observe, discuss and investigate where water comes from and its movement.