## The Earth's Water

Water is one of the most essential elements for all forms of life on Earth. All plants and animals, including humans, need water to survive. Water is found almost everywhere on Earth. Almost $71 \%$ of Earth's surface is covered with water. Water is found in the form of groundwater, soil moisture, snow, ice, and surface waters. Groundwater is water stored in underground aquifers. Surface water is visible and is stored in oceans, streams, rivers, lakes, and manmade reservoirs. A large portion of water is locked in the form of ice in glaciers and polar ice caps. Water is also present in the atmosphere in the form of water vapor. Due to its abundance of water, Earth is known as "the blue planet."


## The Water Cycle

Earth has almost the same amount of water as it had millions of years ago. The water we drink today is the same water the dinosaurs drank. Water on Earth keeps moving through its various states-solid, liquid, and vapor. This continual movement of water on, above, and below the surface of Earth is known as the water cycle or hydrologic cycle. The water cycle helps Earth recycle water naturally, with help from the sun's heat. Though the water cycle is a continuous process, it has no starting or ending point. It is made up of several processes:

- Evaporation: Heat and energy from the sun warm the water of oceans, lakes, and rivers. The warm water changes from liquid into a gas called water vapor. Since water vapor is lighter
than dry air, it rises into the atmosphere This process is known as evaporation.
- Condensation: In the atmosphere, water vapor comes into contact with cooler air and changes into liquid. Water vapor takes the form of little water droplets in the air and forms clouds. This is called condensation.
- Precipitation: When a lot of water vapor condenses into droplets, the clouds become so heavy that air cannot hold them anymore. As a result, the droplets fal from the sky. This is called precipitation. Precipitation occurs on Earth in the form of rain, hail, snow, or sleet.
- Collection: When water falls back to Earth, it may fall on oceans, lakes, or rivers, or it may fall back onto land. On land, water seeps into the ground and becomes groundwater.


## Oceans

Oceans are large bodies of water that cover about $71 \%$ of Earth's surface. Oceans contain about $97 \%$ of Earth's total water. The five oceans on Earth are the Pacific, Atlantic, Indian, Arctic, and Southern Oceans. The oceans are made up of smaller water bodies known as seas, bays, and gulfs.


## Glaciers

Glaciers are thick layers of compacted snow and ice that flow like slow-moving rivers. The snow in glaciers accumulates over many years. Some glaciers in the Canadian Arctic icecaps are around 100,000 years old. They are the largest storage of fresh water on Earth. Around $69 \%$ of the world's total fresh water is in the form of glaciers and ice caps. Scientists worry that if these glaciers and ice caps start melting, sea levels could rise by as much as 210 feet. About $10 \%-11 \%$ of the world's total landmass is covered in glacial ice. Glacial ice is found all over the world except in Australia. Most glaciers are located in Greenland and Antarctica. Glaciers can range in size from as small as a football field to hundreds of miles long.

## Rivers

Rivers are natural waterways flowing on the Earth's surface. Rivers carry water over land from a higher altitude to a lower altitude. When rain falls on the ground, it either seeps in or flows downhill into rivers and lakes. Rivers eventually drain their water into the

## Aquifer

Aquifers are underground water storage areas. Aquifers store water between layers of rocks, sand, and gravel Aquifer water is cleaner in comparison to surface water and is also free from bacteria. Rocks and soil filter out pollutants. The water in aquifers can be pumped out by digging wells into the ground. Aquifer water is a source of fresh water that can be used for household and agricultural purposes.


Lakes and Reservoirs
Lakes are water bodies surrounded by land. Lakes form when water flows to a place that is enclosed by higher land on all sides. Most lakes are a source of fresh water, but some lakes are even saltier than the ocean. Reservoirs are manmade lakes where water is stored for future use. They form when dams are built on rivers.


## Usable Water

Usable water means water that we use daily for many purposes. We use water for drinking, washing, bathing, cooking, and watering plants and food crops. Earth has plenty of water, but not all the water on Earth is usable. About $97 \%$ of Earth's water is stored in the oceans. Ocean water is salty and therefore unusable. This means that only $3 \%$ of the water on Earth is fresh water, which is usable water. Most of this fresh water, however, is locked in glaciers and ice caps, which makes it unusable. Only $1 \%$ of the water remains usable for humans. This usable water can be found in groundwater, lakes, and rivers. Americans use a large amount of water every day. An average American family of four uses about 400 gallons of water a day.

## Ways We Use Water

- For agriculture
- In homes
- By industry
- To generate thermoelectric power
- For mining
- To water livestock
- In hotels and restaurants


What makes water unusable?

- Hazardous waste
- Improperly disposed of toxic products
- Improperly disposed of wastes
- Use of chemical pesticides and fertilizers
- Water contaminated with motor oil, grease, and paint



## Virtual Water: Embedded Usable Water

Water is used to produce food and other goods. The largest percentage of usable water is used by agriculture and industry. The water that is embedded in our food and manufactured products is called "virtual water." For example, about 265 gallons of water is needed to produce two pounds of wheat. So the virtual water of this two pounds of wheat is 265 gallons. Virtual water is also present in dairy products, soups, beverages, and liquid medicines. Every day, humans consume and use lots of virtual water. The content of virtual water varies according to products. For instance, to produce two pounds of meat requires about 5 to 10 times as much water as to produce two pounds of bread, rice or vegetables. In the United States, the average person consumes more than 175 cubic feet of virtual water per day from a meat-based diet.

## Did you know?

About 280 cubic miles of water evaporates into the atmosphere every day

## Facts You Should Know

- About one gallon of water is used to make a quarter pound of hamburger.
- About 39,090 gallons of water is required to manufacture a new car, including its tires.
- A birch tree evaporates nearly 70 gallons of water per day.
- One inch of rainfall gives about 27,000 gallons of water per acre of land.
- About 1,500 gallons of water is needed to make just one barrel of beer.



## Potable Water

Water that is safe and suitable for human consumption is known as potable water. Potable water does not contain salt and is also known as drinking water. Potable water is free from contaminants and other impurities that can cause diseases. Potable water is actually treated water. Water from streams, rivers, springs, and lakes is treated to remove impurities and make it potable. Potable water is not equally distributed throughout the world. Most of Earth's fresh water is located in North America. Each year, more than 671,000 cubic feet of water is available per person in North America. In contrast, just over 166,000 cubic feet of water is available annually for a person in Asia.

Where does potable water come from?
Potable water comes from two sources: groundwater and surface water. Groundwater is found underground in watersheds, springs, and aquifers. Surface water includes lakes, streams, and rivers. Both these water sources are dependent on rain, snowfall, and other forms of precipitation. Rain and snowfall recharge groundwater sources as well as surface water sources. About 74\% of the fresh water used in the United States comes from surface water. The other $26 \%$ comes from groundwater sources. Groundwater is an important source of potable water in the arid regions. The western states of the United States get their potable water mainly from groundwater reserves.


Who is responsible for potable water quality?
Governments are responsible for providing safe potable water. Water can contain around 80 contaminants that can cause health hazards. The responsibilities of governments include:

- Checking for contaminants in water
- Testing the water system
- Distribution and supply of potable water
- Recording consumer complaints
- Taking necessary action against these complaints



## Water Contaminants

Contaminants are impurities that pollute water. They are harmful for humans as well as for plants and animals. Contaminated water can cause serious diseases. At any given time, about $50 \%$ of the world's hospital beds are occupied by patients suffering from waterborne diseases. About 3,900 children die every day due to lack of potable water. Contaminants can be natural or manmade. Natural contaminants can come from soil erosion or rocks. Manmade contaminants include chemicals and toxic materials from industrial agricultural, or household sources. Some common water contaminants:

- Antifreeze and coolants
- Batteries, new and used
- Cleaning solvents
- Disinfectants
- Explosives
- Food processing wastes
- Glues, adhesives, and resins
- Greases
- Printing and photocopying chemicals
- Laboratory chemicals
- Metal finishing solutions
- Oils (petroleum based)
- Paints, primers, thinners, dyes, stains
- Photo development chemicals
- Tanning (leather) industry chemical


## What you can do?

- Always be informed about the source of your drinking water.
- Always be informed about the surroundings of your drinking water source.
- Always be informed about the contaminants that pollute drinking water sources.
- Participate actively in your community water conservation activities
- Always be observant about chemical spills and leakage, and report these activities.
- Reuse oil, paints, etc. wherever possible.
- Use and dispose of chemicals properly.


## World Water Day

Potable water is becoming scarce in many parts of the world. About 1.1 billion people around the world do not have access to enough safe, clean potable water. To highlight the importance of conserving water, the United Nations has declared March 22 as "World


## Did you know?

At any particular moment, the atmosphere contains about 3,100 cubic miles of water, mainly in the form of water vapor. This water could make a one-inch covering of water around our entire planet.

## Precious Water: Water Management

| arge parts of Earth are covered in water. But most of Earth's water is saline, or salty, and thus unfit for human consumption. Only about $1 \%$ of all water is available for our use. This makes water a precious commodity. Therefore, it is essential for water to be managed properly. Water management aims to limit the amount of water usage so that fresh water can be conserved. Water management also helps to determine the location and available amounts of fresh water and to estimate the requirements of various water users.

## World Water Forum

The World Water Forum is a worldwide initiative for better water management. This forum, sponsored by the World Water Council, aims to create global awareness about water and to find solutions to achieve water security. The first World Water Forum was held in 1997 in Marrakech, Morocco. Since then, every third year the World Water Council organizes the World Water Forum in collaboration with the world's countries. So far, four meetings of the World Water Forum
have been held in different parts of the world. The fifth will be held in Istanbul, Turkey, in March of 2009
The main purposes of the forum:

- To highlight the importance of water
- To create awareness about water issues
- To formulate concrete proposals
- To generate government intervention where needed $\rightarrow$



## Water Management Policy

The world's population is rising steadily, which will create further water shortages in many places. The scarcity of water is already a concern in many areas. To manage water better, governments have formulated many policies to conserve water. These policies, known as water management policies, aim to:

- Find new areas where usable water is available
- Find areas with scarce water
- Supply water to water-scarce areas
- Ensure proper use of available water
- Make people aware of water wastage
- Save money by saving water
- Save electricity by saving water
- Find solutions for growing water needs
- Maintain quality of surface water and groundwater
- Protect water from getting contaminated


## Water Recycling

Water recycling is a process of reusing water. Wastewater comes from many household and industrial sources, and most types of wastewater can be recycled Some wastewater can be recycled directly. Other types of wastewater can be recycled by water treatment plants. Treated wastewater is nonpotable water and is used to irrigate fields, flush toilets, and in industries and landscape irrigation.



## Water Management Techniques

Water management techniques broadly cover three areas: reducing water loss or saving water, increasing awareness among people, and reusing wastewater. Some of these techniques:

- Harvest rainwater
- Apply xeriscaping (land use planning) to reduce water wastage
- Install new and efficient sanitary equipment
- Use measuring equipment to determine water usage
- Reuse water used for sterilizing equipment
- Store and reuse the condensate water released by air conditioners
- Reuse water used for cooling machines in industry


## Benefits of Water Management

- Saves precious water
- Preserves water quality
- Saves wildlife
- Reduces possibility of floods
- Improves living conditions for aquatic animals


## Did you know?

If all the water on Earth were poured onto the United States, it would form a 90 - mile-deep layer of water


## Water Shortage: Population Growth

OOctober 12, 1999, there were 6 billion people living on Earth. Each year, 80 million more people are added to the world's population. The ever-increasing population means an increased demand for fresh water. About $60 \%$ of the world's population lives in Asia, but the fresh water available there is only about $30 \%$ of world supplies. To meet this shortage, Asia needs an extra 84 billion cubic yards of water each year. This is equal to the entire annual flow of the Rhine River in Europe.

## Factors Affecting Water Shortage

- Population growth • Water demand
- Food production
,
- Rising temperatures - Immigration
- Climate change - Poverty
- Water quality
- Urbanization



## Immigration and Water Supply

Immigration is migrating from one's native land and settling in a new country. Humans migrate to other places according to their comfort and needs. Immigration increases the population of a country, which creates water shortages. It is estimated that 1 million people migrate every year to the United States. By 2050, this figure will go up to about 10 million. Scientists predict that about 2 billion people could face water shortages by 2050 .


## Did you know?

By 2025, about 48 countries, or $35 \%$ of the global population, will face water shortage.

## Urbanization

Urbanization is the migration of people from villages to towns and cities. People migrate to urban areas in search of new opportunities. Urbanization leads to a greater concentration of people in cities. The United Nations has predicted that 19 out of the 25 big cities in the developing world will become overpopulated by 2025. This will create severe scarcity of water in these cities. The United Nations made serious attempts to curb this crisis through an initiative called Millennium Development Goals. One of its important objectives is to reduce the amount of population without safe drinking water and sanitation by $50 \%$ by 2015 .

## Climate Change

Climate change is the variation in a region's climate due to global warming. Earth is getting warmer, which causes melting of glaciers, increased droughts in some areas, and increased precipitation in others. All these factors greatly affect water availability. Studies have shown that about three billion people will suffer from water shortage in the near future.


## Population Growth in Asia

The population of India, China, and Pakistan wil increase by about a billion people by 2050. By 2050 India is projected to add 519 million people, China 211 million, and Pakistan nearly 200 million.

## Water Shortage: Drought

Drought is a natural phenomenon. It is usually a long period of dry weather, which causes a serious shortage of water. Drought occurs due to lack of rainfall, which causes adverse effects on the plants, animals, and human beings of a particular region. During droughts, there is very little moisture in the air. This causes breathlessness, dryness, and thirst. Drought may last a few months, or it may occur for several years. Drought threatens food production, hinders economic development, and damages ecosystems.

## Deadly Droughts

The effects of drought can be even more severe than other natural calamities. The 1988 U.S. drought caused a loss of about $\$ 40$ billion, which exceeded the loss caused by Hurricane Andrew in 1992, the Mississippi River floods of 1993, and the San Francisco earthquake in 1989. The 1984-85 droughts in the horn of Africa led to a famine that killed about 750,000 people.

## Causes of Drought

- Irregular pattern of rainfall or snow over different areas
- Changing pattern of rainfall or snow in an area over a period of years
- Water supplies are not sufficient to meet the requirements
- Changing pattern of blowing winds
- Change of ocean currents



## Adverse Effects of Drought

- Soil erosion
- Loss of vegetation
- Infestations of destructive insects and other pests
- Survival of rare animals and plants endangered
- Wildfires
- Dust storms
- Loss of crops and livestock
- Migration of humans, animals, and birds
- Problem of public health and safety
- Loss of swampland, rivers, and lakes



## Three Types of Drought

1. Meteorological drought occurs due to low rainfall.
2. Hydrological drought occurs due to shrinking water levels.
3. Agricultural drought occurs due to less moisture in air and soil.

## Meteorological Drought

Meteorological drought occurs when rainfall decreases over a period of time. Diminished rainfall leads to a reduction in soil moisture, and this affects vegetation. The definition of what constitutes a drought varies greatly by region, because some regions normally get much less rain than others. For example, the average annual rainfall in the U.S. Southwest is much less than that in the Northwest.

## Hydrological Drought

Hydrological drought is the result of decreased rainfall and its effects on water levels. As rainfall decreases, the water levels in rivers, reservoirs, lakes, and aquifers also decreases proportionately. Usually hydrological droughts occur after meteorological droughts. They affect ecosystems, hydroelectrical power production, and water usage of commercial, recreational, industrial, and urban facilities.


Agricultural Drought
Agricultural drought is the result of decreased rainfall and its effects on crops. Dry air and reduced moisture in soil affect crops drastically As the water levels in rivers, reservoirs, lakes, and aquifers decreases, this affects irrigational facilities. Apart from low rainfall, water wastage is also an important reason for agricultural droughts. Usually these occur after meteorological and hydrological droughts.

## Some Major Droughts of the World

- Drought of Sahel

The prolonged drought of Sahel in the early 1980s and 1990s is considered one of the most destructive droughts ever. Sahel is a semi-arid region of the Sahara Desert in Africa. This drought affected around 150 million people in 20 countries and caused 100,000 to 250,000 deaths.
The 1876 Drought of China
The most destructive drought in China occurred between 1876 and 1879. Wetlands, lakes, and rivers turned dry and affected crops and livestock. Lack of food spread in nine provinces in an area covering 390,000 square miles. An estimated death toll of nine million people was recorded.

## Did you know?

Nine of the world's countries possess $60 \%$ of Earth's available fresh water supply. They are Brazil, Russia China, Canada, Indonesia, the United States, India, Colombia, and the Democratic Republic of Congo.

## Water Wasters

Deople waste water both indoors and out. Wasting water resources harms the Earth. Water is the most important resource, required for most things we do. We waste water everyday while cleaning, cooking, and drinking. Water wastage also results in rising costs for other things, such as electricity. By saving water, we can also save money. Installing efficient taps and flush systems goes a long way in saving money and water. Leakage can cause water wastage. Check for leaks both inside and outside the house and repair them immediately.

## Water Wasters

- Showers (2-5 gallons per minute)
- Bathroom Sinks (2-5 gallons per minute)
- Toilet (2-5 gallons per flush)
- Dishwasher ( 25 gallons per load)
- Kitchen Sink (2-5 gallons per minute)
- Washing Machine (30 gallons per load)


## Water Wasted In One Month From Leaks

| Source | Gallons Wasted Per Month |
| :--- | :--- |
| A slow steady drip | $(100$ drops per minute) 350 <br> gallons |
| A fast drip | about 600 gallons |
| A small stream | $2,000-2,700$ gallons |
| A large stream | 4,600 gallons |

## Water Use Statistics

Indoor water use in the typical single family home is 69.3 gallons in the United States.

| Use | Gallons per <br> Capita | Percentage of <br> Total Daily Use |
| :--- | :--- | :--- |
| Showers | 11.6 | $16.8 \%$ |
| Clothes Washers | 15.0 | $21.7 \%$ |
| Dishwashers | 1.0 | $1.4 \%$ |
| Toilets | 18.5 | $26.7 \%$ |
| Baths | 1.2 | $1.7 \%$ |
| Leaks | 9.5 | $13.7 \%$ |
| Faucets | 10.9 | $15.7 \%$ |
| Other Domestic Uses | 1.6 | $2.3 \%$ |

Installing efficient water systems and regularly checking of leaks can reduce the daily household water use by about 35 percent to about 45.2 gallons every day.

| Use | Gallons <br> per Capita | Percentage of <br> Total Daily Use |
| :--- | :--- | :--- |
| Showers | 8.8 | $19.5 \%$ |
| Clothes Washers | 10.0 | $22.1 \%$ |
| Dishwashers | 0.7 | $1.5 \%$ |
| Toilets | 8.2 | $18.0 \%$ |
| Baths | 1.2 | $2.7 \%$ |
| Leaks | 4.0 | $8.8 \%$ |
| Faucets | 10.8 | $23.9 \%$ |
| Other Domestic Uses | 1.6 | $3.5 \%$ |




## Did you know?

Since 1960, use of water for irrigation has increased by more than 60\%.

## Water-Soving Etiquette

Saving water is essential for the survival of humans on Earth. People need water for various purposes, from drinking to cleaning. In the United States, the total amount of water used by households is about 408 billion gallons a day. Americans usually use most of the water for flushing toilets and bathing, followed by laundry, cleaning dishes, cooking, and drinking.


## Did you know?

An average person unknowingly wastes about 30 gallons of water per day.

## Conserving Water When Washing Vehicles

- Wash the vehicle on grass instead of on pavement or sidewalks.
- Give the vehicle a sponge bath.
- Use soapy water to wash the vehicle.
- Use a bucket of soapy water for washing the vehicle instead of running water.
- Clean your vehicle with a hose that has an automatic shutoff nozzle.


## Recycle Water

Most of the water used in homes can be recycled. Toilet water cannot be used again, but other wastewater can be. Wastewater that can be reused can be collected from different sources. The main sources of wastewater collection in a home:

- Washing machine
- Bathroom sink
- Bathtub
- Dishwasher
- Shower
- Utility sink




## Water-Saving Ideas

- Install faucet aerators.
- Take shorter showers.
- Choose plants that require less water.
- Use low-flow showerheads.
- Recycle water.
- Do not run water unnecessarily.
- Do not run tap while scrubbing dishes and pots.
- Use brooms instead of hose for cleaning sidewalks and driveways.
- Install new toilets that use less water per flush
- Use a shutoff nozzle on tap.
- Reuse wastewater to irrigate plants.
- Store drinking water in the refrigerator
- Avoid running water to defrost frozen foods such as vegetables and fruits.
- Start a compost pile instead of putting food scraps in the garbage disposal.
- Install an instant water heater.
- Water the lawns and gardens early in the morning
- Plant native and drought-resistant grasses, shrubs, trees, and plants.
- Do not buy toys, such as squirt guns, that require water.


## Saving Water in the Kitchen

The kitchen is a place in a home used for cooking and preparing food. Kitchens contain cooking devices, washing equipment, and a sink for cleaning utensils, fruits, and vegetables. Large amounts of water are used in the average kitchen, amounting to about $15 \%$ of household water.

## Saving Water While Cooking

- Use less water for cooking.
- Always cover pans or pots while cooking.
- Use leftover cooking water for soups or sauces.

Defrost frozen vegetables and fruits in the refrigerator Don't wash them under a running tap.

## Saving Water While Washing Dishes

- Run the dishwasher only when it is fully loaded.
- When washing dishes by hand, fill the sink or a bowl instead of using running water.
- Soak pans or bowls instead of scrubbing them under running water.



## Good Water-Conserving Habits

- Install flow-controlled aerators on taps.
- Insulate hot-water pipes.
- Do not use the sink for garbage disposal. Use the garbage can.
- Try to wash dishes by hand instead of using a dishwasher.
- Always turn taps off tightly.
- Install fit spray taps
- Reuse clean household water, such as water used to boil vegetables or eggs.


## Dos and Don'ts

- Check for leaks and repair them.
- Wash vegetables and fruits in a filled sink
or basin rather than under a running tap.
- Keep the lid over a pan while boiling vegetables.
- Never leave a running tap while cleaning vegetables or fruits.
- Minimize the number of cooking utensils and dishes used



## Saving Water in the Garden

Agarden is a piece of land where flowers, fruits, vegetables, and other plants are grown On average, $50 \%$ to $70 \%$ of home water is used outdoors for watering lawns and gardens Saving water in the garden saves money by reducing water bills. It could also help in maintaining a healthy garden.

Why is it important to save water in the garden? Saving water in the garden will save about 750 to 1,500 galloons of water every month. Watering plants early in the morning prevents the growth of fungus. It also helps in preventing water loss by reducing evaporation. Using a layer of mulch around plants helps in reducing evaporation, which could save hundreds of gallons of water every year. Saving water in the garden helps reduce water bills.

## Good Water-Conservation Habits

- Install a drip irrigation system.
- Use homemade compost for your plants.
- Group plants according to their watering needs.
- Water the garden only when needed.
- Install a water-recycling system in your garden.


## Dos and Don'ts

- Water the roots and soil rather than spraying water in the leaves and stems.
- Regularly check garden taps and pipes for leaks, and repair them immediately
- Do not water the garden during windy days, as the wind will blow the water to where it is not required.
- Choose plants that are native to your local climate.
- Use a water-efficient nozzle for your hose that ranges from high to low spray.
- Do not overwater the garden.
- Install a tap timer for watering the plants.
- Choose drought-resistant plants for your garden.
- Use a watering can rather than a hose.


## Use Graywater in the Garden

Graywater is water that has been used in the home. This water includes wastewater from sinks, showers, laundry, and kitchen. Graywater does not include water from toilets. It often contains soaps, detergents, and fats. Graywater can be used in gardens during droughts or when there is a shortage of water. Dish, shower sink, and laundry water accounts for about $50 \%$ to $60 \%$ of wastewater that can be reused Graywater can be used in the garden in the following ways:

- Add graywater directly to the soil instead of using a sprinkler.
- Do not use graywater for seedlings or young plants.
- Use graywater on larger areas, and also spray fresh water, which helps in preventing an increase of sodium salts.
- Water only the hardier plants with graywater.
- Use graywater only when it is cool.
- Do not apply graywater directly to foliage use on roots and surrounding soil.
- Nonedible plants can be watered with graywater from baths and showers.


## Drought-Resistant Plants

Drought-resistant plants can be planted in your garden to save water. Some common drought-resistant plants:

- Eucalyptus
- Juniper
- Pines
- Lavende
- Poppy
- Marigolds
- Tulip


Crops That Require Little Water

- Turnips
- Parsnips
- Beets
- Onions
- Carrots
- Rhubarb
- Asparagus


Benefits of Saving Water in the Garden

- Saves money by reducing water bills
- Reduces maintenance time
- Protects the environment
- Healthy and beautiful garden
- Water can be reused and recycled


## Did you know?

Watering the garden with a sprinkler wastes a lot of water. A sprinkler running for two hours can use about 500 gallons of water.

