**Water resources**

**Water resources**are [natural resources](https://en.wikipedia.org/wiki/Natural_resource) of [water](https://en.wikipedia.org/wiki/Water) that are potentially useful for humans,[[1]](https://en.wikipedia.org/wiki/Water_resources#cite_note-1) for example as a source of drinking [water supply](https://en.wikipedia.org/wiki/Water_supply) or [irrigation](https://en.wikipedia.org/wiki/Irrigation) water. 97% of the water on the Earth is [salt water](https://en.wikipedia.org/wiki/Saline_water) and only three percent is [fresh water](https://en.wikipedia.org/wiki/Fresh_water); slightly over two thirds of this is frozen in [glaciers](https://en.wikipedia.org/wiki/Glacier) and [polar](https://en.wikipedia.org/wiki/Polar_climate) [ice caps](https://en.wikipedia.org/wiki/Ice_cap).[[2]](https://en.wikipedia.org/wiki/Water_resources#cite_note-USGS_dist-2) The remaining unfrozen freshwater is found mainly as groundwater, with only a small fraction present above ground or in the air.[[3]](https://en.wikipedia.org/wiki/Water_resources#cite_note-3) Natural sources of [fresh water](https://en.wikipedia.org/wiki/Fresh_water) include [surface water](https://en.wikipedia.org/wiki/Surface_water), under river flow, [groundwater](https://en.wikipedia.org/wiki/Groundwater) and [frozen water](https://en.wikipedia.org/wiki/Frozen_water). Artificial sources of fresh water can include treated wastewater ([wastewater reuse](https://en.wikipedia.org/wiki/Reclaimed_water)) and [desalinated seawater](https://en.wikipedia.org/wiki/Desalination). Human uses of water resources include [agricultural](https://en.wikipedia.org/wiki/Agricultural), [industrial](https://en.wikipedia.org/wiki/Industrial_sector), [household](https://en.wikipedia.org/wiki/Household), [recreational](https://en.wikipedia.org/wiki/Recreational) and [environmental](https://en.wikipedia.org/wiki/Natural_environment) activities.

Water resources are under threat from [water scarcity](https://en.wikipedia.org/wiki/Water_scarcity), [water pollution](https://en.wikipedia.org/wiki/Water_pollution), [water conflict](https://en.wikipedia.org/wiki/Water_conflict) and [climate change](https://en.wikipedia.org/wiki/Climate_change). Fresh water is a [renewable resource](https://en.wikipedia.org/wiki/Renewable_resource), yet the world's supply of [groundwater](https://en.wikipedia.org/wiki/Groundwater) is steadily decreasing, with depletion occurring most prominently in Asia, South America and North America, although it is still unclear how much natural renewal [balances](https://en.wikipedia.org/wiki/Water_balance) this usage, and whether [ecosystems](https://en.wikipedia.org/wiki/Ecosystem) are threatened.[[4]](https://en.wikipedia.org/wiki/Water_resources#cite_note-4) The framework for allocating water resources to water users (where such a framework exists) is known as [water rights](https://en.wikipedia.org/wiki/Water_rights).

**Surface water**

*Main article:*[*Surface water*](https://en.wikipedia.org/wiki/Surface_water)

[](https://en.wikipedia.org/wiki/File:Parinacota.jpg)

[Lake Chungará](https://en.wikipedia.org/wiki/Lake_Chungar%C3%A1) and [Parinacota](https://en.wikipedia.org/wiki/Parinacota_Volcano" \o "Parinacota Volcano) volcano in northern Chile

Surface water is water in a river, [lake](https://en.wikipedia.org/wiki/Lake) or fresh water [wetland](https://en.wikipedia.org/wiki/Wetland). Surface water is naturally replenished by [precipitation](https://en.wikipedia.org/wiki/Precipitation_(meteorology)) and naturally lost through discharge to the [oceans](https://en.wikipedia.org/wiki/Oceans), [evaporation](https://en.wikipedia.org/wiki/Evaporation), [evapotranspiration](https://en.wikipedia.org/wiki/Evapotranspiration) and [groundwater recharge](https://en.wikipedia.org/wiki/Groundwater_recharge). The only natural input to any surface water system is precipitation within its [watershed](https://en.wikipedia.org/wiki/Drainage_basin). The total quantity of water in that system at any given time is also dependent on many other factors. These factors include storage capacity in lakes, wetlands and artificial [reservoirs](https://en.wikipedia.org/wiki/Reservoir_(water)), the permeability of the [soil](https://en.wikipedia.org/wiki/Soil) beneath these storage bodies, the [runoff](https://en.wikipedia.org/wiki/Surface_runoff) characteristics of the land in the watershed, the timing of the precipitation and local evaporation rates. All of these factors also affect the proportions of water loss.

Humans often increase storage capacity by constructing reservoirs and decrease it by draining wetlands. Humans often increase runoff quantities and velocities by paving areas and channelizing the stream flow.

Natural surface water can be augmented by importing surface water from another watershed through a [canal](https://en.wikipedia.org/wiki/Canal) or [pipeline](https://en.wikipedia.org/wiki/Pipeline_transport).

[Brazil](https://en.wikipedia.org/wiki/Brazil) is estimated to have the largest supply of fresh water in the world, followed by [Russia](https://en.wikipedia.org/wiki/Russia) and [Canada](https://en.wikipedia.org/wiki/Canada).[[5]](https://en.wikipedia.org/wiki/Water_resources#cite_note-5)

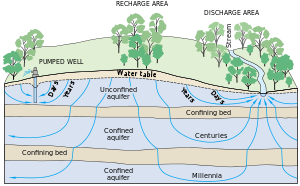
* [](https://en.wikipedia.org/wiki/File:Sinclair_Wetlands.jpg)

*Panorama of a natural wetland (*[*Sinclair Wetlands*](https://en.wikipedia.org/wiki/Sinclair_Wetlands)*, New Zealand)*

**Water from glaciers**

[Glacier](https://en.wikipedia.org/wiki/Glacier) runoff is considered to be surface water. The Himalayas, which are often called "The Roof of the World", contain some of the most extensive and rough high altitude areas on Earth as well as the greatest area of glaciers and permafrost outside of the poles. Ten of Asia's largest rivers flow from there, and more than a billion people's livelihoods depend on them. To complicate matters, temperatures there are rising more rapidly than the global average. In Nepal, the temperature has risen by 0.6 degrees Celsius over the last decade, whereas globally, the Earth has warmed approximately 0.7 degrees Celsius over the last hundred years.[[6]](https://en.wikipedia.org/wiki/Water_resources#cite_note-6)

**Groundwater**

[](https://en.wikipedia.org/wiki/File:Groundwater_flow.svg)

Relative groundwater travel times in the subsurface

*This section is an excerpt from*[*Groundwater*](https://en.wikipedia.org/wiki/Groundwater)*.*[[edit](https://en.wikipedia.org/w/index.php?title=Groundwater&action=edit)]

[Groundwater](https://en.wikipedia.org/wiki/Groundwater) is the [water](https://en.wikipedia.org/wiki/Water) present beneath [Earth](https://en.wikipedia.org/wiki/Earth)'s surface in rock and [soil pore spaces](https://en.wikipedia.org/wiki/Pore_space_in_soil) and in the [fractures](https://en.wikipedia.org/wiki/Fracture) of [rock formations](https://en.wikipedia.org/wiki/Stratum). About 30 percent of all readily available freshwater in the world is groundwater.[[7]](https://en.wikipedia.org/wiki/Water_resources#cite_note-7) A unit of rock or an unconsolidated deposit is called an [aquifer](https://en.wikipedia.org/wiki/Aquifer) when it can yield a usable quantity of water. The depth at which [soil](https://en.wikipedia.org/wiki/Soil) pore spaces or fractures and voids in rock become completely saturated with water is called the [water table](https://en.wikipedia.org/wiki/Water_table). Groundwater is [recharged](https://en.wikipedia.org/wiki/Groundwater_recharge) from the surface; it may discharge from the surface naturally at [springs](https://en.wikipedia.org/wiki/Spring_(hydrosphere)) and [seeps](https://en.wikipedia.org/wiki/Seep_(hydrology)), and can form [oases](https://en.wikipedia.org/wiki/Oasis) or [wetlands](https://en.wikipedia.org/wiki/Wetland). Groundwater is also often withdrawn for [agricultural](https://en.wikipedia.org/wiki/Agriculture), [municipal](https://en.wikipedia.org/wiki/City), and [industrial](https://en.wikipedia.org/wiki/Industrial_sector) use by constructing and operating extraction [wells](https://en.wikipedia.org/wiki/Water_well). The study of the distribution and movement of groundwater is [hydrogeology](https://en.wikipedia.org/wiki/Hydrogeology), also called groundwater [hydrology](https://en.wikipedia.org/wiki/Hydrology).

Typically, groundwater is thought of as water flowing through shallow aquifers, but, in the technical sense, it can also contain [soil moisture](https://en.wikipedia.org/wiki/Soil_moisture), [permafrost](https://en.wikipedia.org/wiki/Permafrost) (frozen soil), immobile water in very low permeability [bedrock](https://en.wikipedia.org/wiki/Bedrock), and deep [geothermal](https://en.wikipedia.org/wiki/Geothermal_(geology)) or [oil formation](https://en.wikipedia.org/wiki/Petroleum_geology) water. Groundwater is hypothesized to provide [lubrication](https://en.wikipedia.org/wiki/Lubrication) that can possibly influence the movement of [faults](https://en.wikipedia.org/wiki/Fault_(geology)). It is likely that much of [Earth](https://en.wikipedia.org/wiki/Earth)'s subsurface contains some water, which may be mixed with other fluids in some instances.

**Under river flow**

Throughout the course of a river, the total volume of water transported downstream will often be a combination of the visible free water flow together with a substantial contribution flowing through rocks and sediments that underlie the river and its floodplain called the [hyporheic zone](https://en.wikipedia.org/wiki/Hyporheic_zone). For many rivers in large valleys, this unseen component of flow may greatly exceed the visible flow. The hyporheic zone often forms a dynamic interface between surface water and groundwater from aquifers, exchanging flow between rivers and aquifers that may be fully charged or depleted. This is especially significant in [karst](https://en.wikipedia.org/wiki/Karst) areas where pot-holes and underground rivers are common.

Artificial sources of usable water

Artificial sources of fresh water can include [treated wastewater](https://en.wikipedia.org/wiki/Wastewater_treatment) ([reclaimed water](https://en.wikipedia.org/wiki/Reclaimed_water)) and [desalinated seawater](https://en.wikipedia.org/wiki/Desalination). However, economic and environmental side effects of these technologies must also be taken into consideration.[[8]](https://en.wikipedia.org/wiki/Water_resources#cite_note-8)

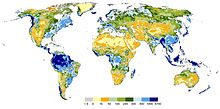
**Wastewater reuse**

*This section is an excerpt from*[*Reclaimed water*](https://en.wikipedia.org/wiki/Reclaimed_water)*.*[[edit](https://en.wikipedia.org/w/index.php?title=Reclaimed_water&action=edit)]

[Water reclamation](https://en.wikipedia.org/wiki/Reclaimed_water) (also called wastewater reuse, water reuse or water recycling) is the process of converting [municipal wastewater](https://en.wikipedia.org/wiki/Sewage) (sewage) or [industrial wastewater](https://en.wikipedia.org/wiki/Industrial_wastewater_treatment) into water that can be [reused](https://en.wikipedia.org/wiki/Reuse) for a variety of purposes. Types of reuse include: urban reuse, agricultural reuse (irrigation), environmental reuse, industrial reuse, planned potable reuse, de facto wastewater reuse (unplanned potable reuse). For example, reuse may include [irrigation](https://en.wikipedia.org/wiki/Irrigation) of gardens and agricultural fields or replenishing [surface water](https://en.wikipedia.org/wiki/Surface_water) and [groundwater](https://en.wikipedia.org/wiki/Groundwater) (i.e., [groundwater recharge](https://en.wikipedia.org/wiki/Groundwater_recharge)). Reused water may also be directed toward fulfilling certain needs in residences (e.g. [toilet flushing](https://en.wikipedia.org/wiki/Flush_toilet)), businesses, and industry, and could even be treated to reach [drinking water](https://en.wikipedia.org/wiki/Drinking_water) standards. The injection of reclaimed water into the water supply distribution system is known as direct potable reuse, however, drinking reclaimed water is not a typical practice.[[9]](https://en.wikipedia.org/wiki/Water_resources#cite_note-9) Treated municipal wastewater reuse for irrigation is a long-established practice, especially in [arid](https://en.wikipedia.org/wiki/Arid) countries. Reusing wastewater as part of sustainable [water management](https://en.wikipedia.org/wiki/Water_management) allows water to remain as an alternative water source for human activities. This can reduce [scarcity](https://en.wikipedia.org/wiki/Water_scarcity) and alleviate pressures on groundwater and other natural water bodies.[[10]](https://en.wikipedia.org/wiki/Water_resources#cite_note-Reclaimed_water_Andersson-10)

There are several technologies used to treat wastewater for reuse. A combination of these technologies can meet strict treatment standards and make sure that the processed water is hygienically safe, meaning free from [pathogens](https://en.wikipedia.org/wiki/Pathogen). The following are some of the typical technologies: [Ozonation](https://en.wikipedia.org/wiki/Ozonation), [ultrafiltration](https://en.wikipedia.org/wiki/Ultrafiltration), [aerobic treatment](https://en.wikipedia.org/wiki/Aerobic_treatment_system) ([membrane bioreactor](https://en.wikipedia.org/wiki/Membrane_bioreactor)), [forward osmosis](https://en.wikipedia.org/wiki/Forward_osmosis), [reverse osmosis](https://en.wikipedia.org/wiki/Reverse_osmosis), [advanced oxidation](https://en.wikipedia.org/wiki/Advanced_oxidation_process).[[11]](https://en.wikipedia.org/wiki/Water_resources#cite_note-Reclaimed_water_PotableReuseMembraneReview-11) Some water demanding activities do not require high grade water. In this case, wastewater can be reused with little or no treatment.

Water uses

[](https://en.wikipedia.org/wiki/File:Total_Renewable_Freshwater_Resources_in_mm_per_year_By_WaterGAP_Average_1961-1990.jpg)

Total renewable freshwater resources of the world, in mm/yr ( 1 mm is equivalent to 1 l of water per m²) (long-term average for the years 1961-1990). Resolution is 0.5° longitude x 0.5° latitude (equivalent to 55 km x 55 km at the equator). Computed by the global freshwater model [WaterGAP](https://en.wikipedia.org/wiki/WaterGAP" \o "WaterGAP).

The total quantity of water available at any given time is an important consideration. Some human water users have an intermittent need for water. For example, many [farms](https://en.wikipedia.org/wiki/Farm) require large quantities of water in the spring, and no water at all in the winter. To supply such a farm with water, a surface water system may require a large storage capacity to collect water throughout the year and release it in a short period of time. Other users have a continuous need for water, such as a [power plant](https://en.wikipedia.org/wiki/Power_plant) that requires water for cooling. To supply such a power plant with water, a surface water system only needs enough storage capacity to fill in when average stream flow is below the power plant's need. Nevertheless, over the long term the average rate of precipitation within a watershed is the upper bound for average consumption of natural surface water from that watershed.

**Agriculture and other irrigation**

*Main article:*[*Irrigation*](https://en.wikipedia.org/wiki/Irrigation)

It is estimated that 70% of worldwide water is used for [irrigation](https://en.wikipedia.org/wiki/Irrigation), with 15–35% of irrigation withdrawals being unsustainable.[[19]](https://en.wikipedia.org/wiki/Water_resources#cite_note-WBCSD_Water_Facts_&_Trends-19) It takes around 2,000 – 3,000 litres of water to produce enough food to satisfy one person's daily dietary need.[[20]](https://en.wikipedia.org/wiki/Water_resources#cite_note-20) This is a considerable amount, when compared to that required for drinking, which is between two and five litres. To produce food for the now over 7 billion people who inhabit the planet today requires the water that would fill a canal ten metres deep, 100 metres wide and 2100 kilometres long.

An assessment of water management in agriculture sector was conducted in 2007 by the [International Water Management Institute](https://en.wikipedia.org/wiki/International_Water_Management_Institute) in [Sri Lanka](https://en.wikipedia.org/wiki/Sri_Lanka) to see if the world had sufficient water to provide food for its growing population.[[21]](https://en.wikipedia.org/wiki/Water_resources#cite_note-21) It assessed the current availability of water for agriculture on a global scale and mapped out locations suffering from water scarcity. It found that a fifth of the world's people, more than 1.2 billion, live in areas of [physical water scarcity](https://en.wikipedia.org/wiki/Physical_water_scarcity), where there is not enough water to meet all demands. A further 1.6 billion people live in areas experiencing [economic water scarcity](https://en.wikipedia.org/wiki/Economic_water_scarcity), where the lack of investment in water or insufficient human capacity make it impossible for authorities to satisfy the demand for water. The report found that it would be possible to produce the food required in future, but that continuation of today's food production and environmental trends would lead to crises in many parts of the world. To avoid a global water crisis, farmers will have to strive to increase productivity to meet growing demands for food, while industry and cities find ways to use water more efficiently.[[22]](https://en.wikipedia.org/wiki/Water_resources#cite_note-22)[[23]](https://en.wikipedia.org/wiki/Water_resources#cite_note-23)

In some areas of the world, irrigation is necessary to grow any crop at all, in other areas it permits more profitable crops to be grown or enhances crop yield. Various irrigation methods involve different trade-offs between crop yield, water consumption and capital cost of equipment and structures. Irrigation methods such as [furrow](https://en.wikipedia.org/wiki/Furrow_irrigation) and overhead [sprinkler](https://en.wikipedia.org/wiki/Irrigation_sprinkler) irrigation are usually less expensive but are also typically less efficient, because much of the water evaporates, runs off or drains below the root zone. Other irrigation methods considered to be more efficient include [drip or trickle irrigation](https://en.wikipedia.org/wiki/Drip_irrigation), [surge irrigation](https://en.wikipedia.org/wiki/Surface_irrigation#Surge_irrigation), and some types of sprinkler systems where the sprinklers are operated near ground level. These types of systems, while more expensive, usually offer greater potential to minimize runoff, drainage and evaporation. Any system that is improperly managed can be wasteful, all methods have the potential for high efficiencies under suitable conditions, appropriate irrigation timing and management. Some issues that are often insufficiently considered are salinization of groundwater and contaminant accumulation leading to water quality declines.

As global populations grow, and as demand for food increases, there are efforts under way to learn how to produce more food with [less water](https://en.wikipedia.org/wiki/Water_supply), through improvements in irrigation[[24]](https://en.wikipedia.org/wiki/Water_resources#cite_note-24) methods[[25]](https://en.wikipedia.org/wiki/Water_resources#cite_note-25) and [technologies](https://en.wikipedia.org/wiki/Technologies), agricultural [water management](https://en.wikipedia.org/wiki/Water_management), crop types, and water monitoring. [Aquaculture](https://en.wikipedia.org/wiki/Aquaculture) is a small but growing agricultural use of water. Freshwater commercial fisheries may also be considered as agricultural uses of water, but have generally been assigned a lower priority than irrigation (see [Aral Sea](https://en.wikipedia.org/wiki/Aral_Sea) and [Pyramid Lake](https://en.wikipedia.org/wiki/Pyramid_Lake_(Nevada))).

Changing landscape for the use of agriculture has a great effect on the flow of fresh water. Changes in landscape by the removal of trees and [soils](https://en.wikipedia.org/wiki/Soil) changes the flow of fresh water in the local environment and also affects the cycle of fresh water. As a result, more fresh water is stored in the soil which benefits the agriculture. However, since agriculture is the human activity that consumes the most fresh water,[[26]](https://en.wikipedia.org/wiki/Water_resources#cite_note-Gordon-26) this can put a severe strain on local freshwater resources resulting in the destruction of local [ecosystems](https://en.wikipedia.org/wiki/Ecosystem).

In [Australia](https://en.wikipedia.org/wiki/Australia), over-abstraction of fresh water for intensive [irrigation](https://en.wikipedia.org/wiki/Irrigation) activities has caused 33% of the land area to be at risk of [salination](https://en.wikipedia.org/wiki/Soil_salinity).

**Water scarcity**

*This section is an excerpt from*[*Water scarcity*](https://en.wikipedia.org/wiki/Water_scarcity)*.*[[edit](https://en.wikipedia.org/w/index.php?title=Water_scarcity&action=edit)]

[Water scarcity](https://en.wikipedia.org/wiki/Water_scarcity) (closely related to water stress or water crisis) is the lack of [fresh water](https://en.wikipedia.org/wiki/Fresh_water) resources to meet the standard water demand. There are two types of water scarcity: physical or economic water scarcity. Physical water scarcity is where there is not enough water to meet all demands, including that needed for [ecosystems](https://en.wikipedia.org/wiki/Ecosystem) to function effectively. [Arid areas](https://en.wikipedia.org/wiki/Desert_climate) for example Central and [West Asia](https://en.wikipedia.org/wiki/West_Asia), and North Africa often suffer from physical water scarcity.[[35]](https://en.wikipedia.org/wiki/Water_resources#cite_note-Water_scarcity_:0-35) On the other hand, economic water scarcity is caused by a lack of investment in infrastructure or technology to draw water from rivers, aquifers, or other water sources, or insufficient human capacity to satisfy the demand for water.[[36]](https://en.wikipedia.org/wiki/Water_resources#cite_note-36) Much of [Sub-Saharan Africa](https://en.wikipedia.org/wiki/Sub-Saharan_Africa) has economic water scarcity.[[37]](https://en.wikipedia.org/wiki/Water_resources#cite_note-Water_scarcity_:68-37): 11

**Water pollution**

[](https://en.wikipedia.org/wiki/File:Water_pollution.jpg)

Polluted water

*This section is an excerpt from*[*Water pollution*](https://en.wikipedia.org/wiki/Water_pollution)*.*[[edit](https://en.wikipedia.org/w/index.php?title=Water_pollution&action=edit)]

[Water pollution](https://en.wikipedia.org/wiki/Water_pollution) (or aquatic pollution) is the contamination of [water bodies](https://en.wikipedia.org/wiki/Body_of_water), usually as a result of human activities, so that it negatively affects its uses.[[38]](https://en.wikipedia.org/wiki/Water_resources#cite_note-Water_pollution_Von_Sperling-38): 6 Water bodies include [lakes](https://en.wikipedia.org/wiki/Lake), [rivers](https://en.wikipedia.org/wiki/River), [oceans](https://en.wikipedia.org/wiki/Ocean), [aquifers](https://en.wikipedia.org/wiki/Aquifer), [reservoirs](https://en.wikipedia.org/wiki/Reservoir) and [groundwater](https://en.wikipedia.org/wiki/Groundwater). Water [pollution](https://en.wikipedia.org/wiki/Pollution) results when [contaminants](https://en.wikipedia.org/wiki/Contaminant) are introduced into these water bodies. It can be attributed to one of four sources: [sewage](https://en.wikipedia.org/wiki/Sewage) discharges, industrial activities, agricultural activities, and urban runoff including [stormwater](https://en.wikipedia.org/wiki/Stormwater).[[39]](https://en.wikipedia.org/wiki/Water_resources#cite_note-Water_pollution_Eckenfelder-39) It can be grouped into [surface water](https://en.wikipedia.org/wiki/Surface_water) pollution (either [fresh water](https://en.wikipedia.org/wiki/Fresh_water) pollution or [marine pollution](https://en.wikipedia.org/wiki/Marine_pollution)) or [groundwater pollution](https://en.wikipedia.org/wiki/Groundwater_pollution). For example, releasing inadequately treated [wastewater](https://en.wikipedia.org/wiki/Wastewater) into natural waters can lead to [degradation](https://en.wikipedia.org/wiki/Environmental_degradation) of these [aquatic ecosystems](https://en.wikipedia.org/wiki/Aquatic_ecosystems). Water pollution can also lead to [water-borne diseases](https://en.wikipedia.org/wiki/Waterborne_diseases) in people using polluted water for drinking, bathing, washing or [irrigation](https://en.wikipedia.org/wiki/Irrigation).[[40]](https://en.wikipedia.org/wiki/Water_resources#cite_note-40) Water pollution reduces the ability of the body of water to provide the [ecosystem services](https://en.wikipedia.org/wiki/Ecosystem_service) (such as [drinking water](https://en.wikipedia.org/wiki/Drinking_water)) that it would otherwise provide.