Water

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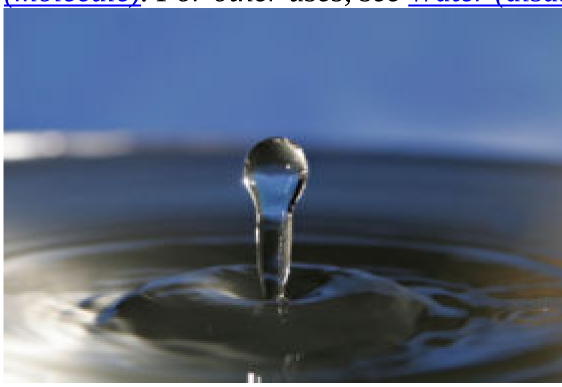
This article is about the chemical substance. For a discussion of its properties, see water (molecule). For other uses, see Water (disambiguation).



Impact from a water drop causes an upward "rebound" jet surrounded by circular capillary waves.

Water is a common chemical substance, that is essential to all known forms of life. [1] In typical usage **water** refers only to its liquid form or state, but the substance also has the solid state, **ice**, and gaseous state, **water vapor**. About 1,460 teratonnes (Tt) of water (1,610 teratons) covers 71% of Earth's surface, with 1.6% of water below ground in aquifers and 0.001% in the air as vapor, clouds, and precipitation. [2] Saltwater oceans hold 97% of surface water, glaciers and polar ice caps 2.4%; and other land surface water such as rivers and lakes 0.025%. Water in these forms moves perpetually through the *water cycle* of evaporation and transpiration, precipitation, and runoff usually reaching the sea. Winds carry water vapor over land at the same rate as runoff into the sea, about 36 Tt per year. Over land, evaporation and transpiration contribute another 71 Tt per year to the precipitation of 107 Tt per year over land. Some water is trapped for periods in ice caps, glaciers, aquifers, or lakes for varying periods, sometimes providing fresh water for life on land. Clean, fresh water is essential to human and other land-based life. In many parts of the world, it is in short supply. Many very important chemical substances, such as salts, sugars, acids, alkalis, some gases (especially oxygen) and many organic molecules dissolve in water. Outside of our planet, a significant quantity (1/3 to 1/2 of the planet) is thought to exist underground on the planet Mars, on the moons Europa and Enceladus, and on the exoplanet known as HD 209458 b. [3]

Water covers 71% the Earth's surface, the oceans contain 97.2% of Earth's water. The Antarctic ice sheet, which contains 90% of all fresh water on Earth, is visible at the bottom. Condensed atmospheric water can be seen as clouds, contributing to the earth's albedo.

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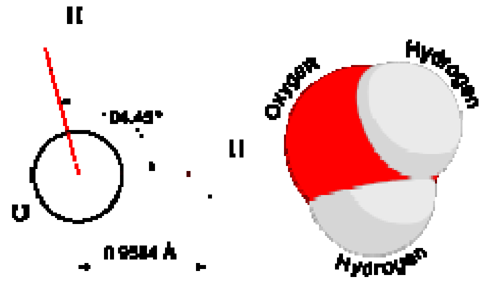
[edit] Chemical and physical properties

Main article: Water (molecule)

Water	



Water is a natural and renewable energy source.
It is also the base of human life, considering people are 2/3 water.

Information and properties	
Systematic name	water
Alternative names	aqua, dihydrogen monoxide, hydrogen hydroxide
Molecular formula	H_2O
Molar mass	18.0153 g/mol
Density and phase	0.998 g/cm³ (liquid at 20 °C) 0.92 g/cm³ (solid)
Melting point	0 °C (273.15 K) (32 ºF)
Boiling point	100 °C (373.15 K) (212 ºF)
Specific heat capacity	4.184 J/(g•K) (liquid at 20 °C)
Supplementary data page	
Disclaimer and references	

Water is the chemical substance with chemical formula H_2O: one molecule of water has two hydrogen atoms covalently bonded to a single oxygen atom. Water is a tasteless, odourless liquid at ambient temperature and pressure, and appears colourless, although it has its own intrinsic very light blue hue. Ice also appears colorless, and water vapor is essentially invisible as a gas. [4] Water is primarily a liquid under standard conditions, which is not predicted from its relationship to other analogous hydrides of the oxygen family in the periodic table which are gases, such as hydrogen sulfide. Also the elements surrounding oxygen in the periodic table, nitrogen, fluorine, phosphorus, sulfur and chlorine, all combine with hydrogen to produce gases under standard conditions. The reason that oxygen hydride (water) forms a liquid is that it is more electronegative than all of these elements (other than fluorine). Oxygen attracts electrons much more strongly than hydrogen, resulting in a net positive charge on the hydrogen atoms, and a net negative charge on the oxygen atom. The presence of a charge on each of these atoms gives each water molecule a net dipole moment. Electrical attraction between water molecules due to this dipole pulls individual molecules closer together, making it more difficult to separate the molecules and therefore raising the boiling point. This attraction is known as hydrogen bonding. Water can be described as a polar liquid that dissociates disproportionately into the hydronium ion ($H_3O^+_{(aq)}$) and an associated hydroxide ion ($OH^-_{(aq)}$). Water is in dynamic equilibrium between the liquid, gas and solid states at standard temperature and pressure, and is the only pure substance found naturally on Earth to be so.

[edit] Cohesion and adhesion

Water has a partial negative charge (σ-) near the oxygen atom due the unshared pairs of electrons, and partial positive charges (σ+) near the hydrogen atoms. In water, this happens because the oxygen atom is more electronegative than the hydrogen atoms — that is, it has a stronger "pulling power" on the molecule's electrons, drawing them closer (along with their negative charge) and making the area around the oxygen atom more negative than the area around both of the hydrogen atoms.

[edit] Adhesion

Dew drops adhering to a spider web

Water sticks to itself (cohesion) because it is polar. Water also has high adhesion properties because of its polar nature. On extremely clean/smooth glass the water may form a thin film because the molecular forces between glass and water molecules (adhesive forces) are stronger than the cohesive forces. In biological cells and organelles, water is in contact with membrane and protein surfaces that are hydrophilic; that is, surfaces that have a strong attraction to water. Irving Langmuir observed a strong repulsive force between hydrophilic surfaces. To dehydrate hydrophilic surfaces — to remove the strongly held layers of water of hydration — requires doing substantial work against these forces, called hydration forces. These forces are very large but decrease rapidly over a nanometer or less. Their importance in biology has been extensively studied by V. Adrian Parsegian of the National Institute of Health.[5] They are particularly important when cells are dehydrated by exposure to dry atmospheres or to extracellular freezing.'

[edit] Surface tension

Main article: Surface tension

This daisy is under the water level, which has risen gently and smoothly. Surface tension prevents the water from submerging the flower.

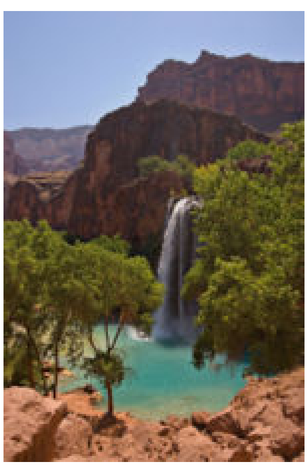
Water has a high surface tension caused by the strong cohesion between water molecules. This can be seen when small quantities of water are put onto a non-soluble surface such as polythene; the water stays together as drops. Just as significantly, air trapped in surface disturbances forms bubbles, which sometimes last long enough to transfer gas molecules to the water. Another surface tension effect is capillary waves which are the surface ripples that form from around the impact of drops on water surfaces, and some times occur with strong subsurface currents flow to the water surface. The apparent elasticity caused by surface tension drives the waves.

[edit] Capillary action

Main article: Capillary action

Capillary action refers to the process of water moving up a narrow tube against the force of gravity. It occurs because water adheres to the sides of the tube, and then surface tension tends to straighten the surface making the surface rise, and more water is pulled up through cohesion. The process is repeated as the water flows up the tube until there is enough water that gravity can counteract the adhesive force.

[edit] Solvation



High concentrations of dissolved lime make the water of Havasu Falls appear turquoise.

Water is a very strong solvent, referred to as the *the universal solvent*, dissolving many types of substances. The substances that will mix well and dissolve in water (e.g. salts) are known as "hydrophilic" (water-loving) substances, and those that do not mix well with water (e.g. fats and oils), are known as "hydrophobic" (water-fearing) substances. The ability of a substance to dissolve in water is determined by whether or not the substance can match or better the strong attractive forces that water molecules generate between other water molecules. If a substance has properties that do not allow it to overcome the strong intermolecular forces between water molecules, the molecules are "pushed out" from amongst the water and do not dissolve.

[edit] Electrical conductivity

Pure water has a *low* electrical conductivity, but this increases significantly upon solvation of a small amount of ionic material water such as hydrogen chloride. Thus the risks of electrocution are much greater in water with the usual impurities not found in pure water. Any electrical properties observable in water are from the ions of mineral salts and carbon dioxide dissolved in it. Water does self-ionize where two water molecules become one hydroxide anion and one hydronium cation, but not enough to carry enough electric current to do any work or harm for most operations. In pure water, sensitive equipment can detect a very slight electrical conductivity of 0.055 µS/cm at 25°C. Water can also be electrolyzed into oxygen and hydrogen gases but in the absence of dissolved ions this is a very slow process since very little current is conducted.

[edit] Deuterated compounds of water

Hydrogen has 3 isotopes, the first being the most common, or having 1 proton and 0 neutrons. More than 95% of water consists of this regular water. There is a second isotope having 1 proton and 1 neutron, called deuterium (short form "D"). This D_2O is also known as heavy water and it used in nuclear reactors for storing nuclear wastes. The third isotope has 1 proton and 2 neutrons, called tritium. Tritium is radioactive, and therefore T_2O does not exist in nature as creation of the rare molecule would result in almost instantaneous decomposition. D_2O is stable; however, it is different from H_2O in that D_2O is heavier and denser (it can block alpha and beta rays). D_2O occurs naturally in water in very low concentrations; however consumption of pure isolated D_2O may affect biochemical processes. Ingestion of large amounts impairs kidney function and central nervous system operation.

[edit] Water, ice, and vapor

[edit] Heat capacity and heat of vaporization

Main article: heat of vaporization

Water has the second highest specific heat capacity of any known chemical compound, after ammonia, as well as a high heat of vaporization (40.65 kJ mol^{-1}), both of which are a result of the extensive hydrogen bonding between its molecules. These two unusual properties allow water to moderate Earth's climate by buffering large fluctuations in temperature.

[edit] Freezing point

A simple but environmentally important and unusual property of water is that its usual solid form, ice, floats on its liquid form. This solid state is not as dense as liquid water because of the geometry of the hydrogen bonds which are formed only at lower temperatures. For almost all other substances the solid form has a greater density than the liquid form. Fresh water at standard atmospheric pressure is most dense at 3.98 °C, and will sink by convection as it cools to that temperature, and if it becomes colder it will rise instead. This reversal will cause deep water to remain warmer than shallower freezing water, so that ice in a body of water will form first at the surface and progress downward, while the majority of the water underneath will hold a constant 4 °C. This effectively insulates a lake floor from the cold. The water will freeze at 0°C (32°F, 273 K), however, it can be supercooled in a fluid state down to its crystal homogeneous nucleation at almost 231 K (−42 °C).[1] Ice also has a number of more exotic phases not commonly seen (go to the full article on Ice).

[edit] Triple point

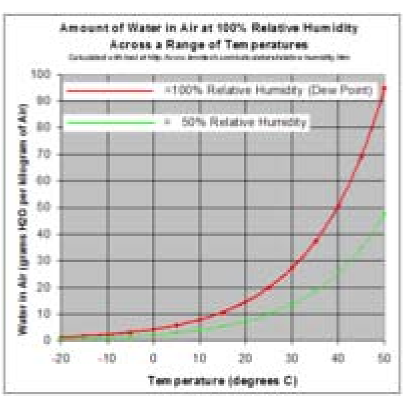
Main article: Triple point

The triple point of water (the single combination of pressure and temperature at which pure liquid water, ice, and water vapor can coexist in a stable equilibrium) is used to define the kelvin, the SI unit of thermodynamic temperature. As a consequence, water's triple point temperature is an exact value rather than a measured quantity : 273.16 kelvins (0.01 °C) and a pressure of 611.73 pascals (0.0060373 atm). This is approximately the combination that exists with 100% relative humidity at sea level and the freezing point of water.

[edit] Miscibility and condensation

Main article: Humidity

Water is miscible with many liquids, for example ethanol in all proportions, forming a single homogeneous liquid. On the other hand water and most oils are *immiscible* usually forming layers according to increasing density from the top.

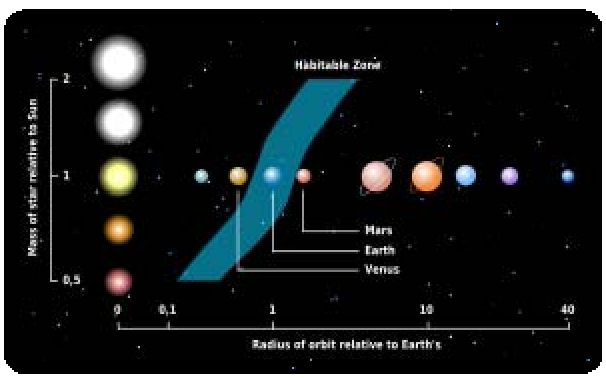


Red line shows saturation

As a gas, water vapor is completely miscible with air. On the other hand the maximum water vapor pressure that is thermodynamically stable with the liquid (or solid) at a given temperature is relatively low compared with total atmospheric pressure. For example, if the vapor *partial pressure*[6] is 2% of atmospheric pressure and the air is cooled from 25 deg C, starting at about 22 C water will start to condense, defining the dew point, and creating fog or dew. The reverse process accounts for the fog *burning off* in the morning. If one raises the humidity at room temperature, say by running a hot shower or a bath, and the temperature stays about the same, the vapor soon reaches the pressure for phase change, and condenses out as steam. A gas in this context is referred to as *saturated* or 100% relative humidity, when the vapor pressure of water in the air is at the equilibrium with vapor pressure due to (liquid) water; water (or ice, if cool enough) will fail to lose mass through evaporation when exposed to saturated air. Because the amount water vapor in air is small, *relative humidity*, the ratio of the partial pressure due to the water vapor to the saturated partial vapor pressure, is much more useful. Water vapor pressure above 100% relative humidity is called *super-saturated* and can occur if air is rapidly cooled, say by rising suddenly in an updraft. [7]

[edit] Water on Earth

[edit] Origin and planetary effects



The Solar System along center row range of possible habitable zones of varying size stars.

Much of the universe's water may be produced as a byproduct of star formation. When stars are born, their birth is accompanied by a strong outward wind of gas and dust. When this outflow of material eventually impacts the surrounding gas, the shock waves that are created compress and heat the gas. The water we observe is quickly produced in this warm dense gas. [8]

[edit] Solar distance and Earth gravity

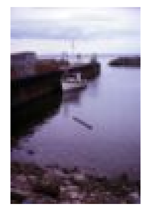
The existence of liquid water, to lesser extent its gaseous and solid forms, on Earth is vital to the existence of life on Earth. The Earth is located in the habitable zone of the solar system,if it were slightly closer to or further from the Sun (about 5%, or 8 million kilometers or so), the conditions which allow the three forms to be present simultaneously would be far less likely to exist. [9]

Earth's mass allows gravity to hold an atmosphere. Water vapor and carbon dioxide in the atmosphere provide a greenhouse effect which helps maintain a relatively steady surface temperature. If Earth were smaller, a thinner atmosphere would cause temperature extremes preventing the accumulation of water except in polar ice caps (as on Mars).

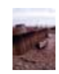
It has been proposed that life itself may maintain the conditions that have allowed its continued existence. The surface temperature of Earth has been relatively constant through geologic time despite varying levels of incoming solar radiation (insolation), indicating that a dynamic process governs Earth's temperature via a combination of greenhouse gases and surface or atmospheric albedo. This proposal is known as the *Gaia hypothesis*.

[edit] Tides

Main article: Tide



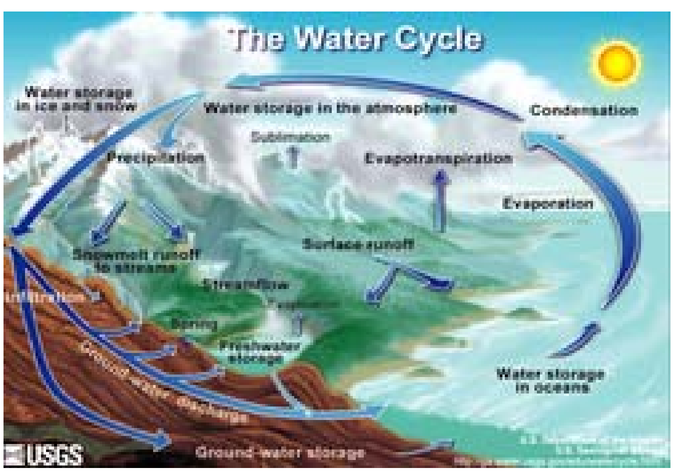
High tide



Low tide

Tides are the cyclic rising and falling of Earth's ocean surface caused by the tidal forces of the Moon and the Sun acting on the oceans. Tides cause changes in the depth of the marine and estuarine water bodies and produce oscillating currents known as tidal streams. The changing tide produced at a given location is the result of the changing positions of the Moon and Sun relative to the Earth coupled with the effects of Earth rotation and the local bathymetry. Sea level measured by coastal may also be strongly affected by wind. The strip of seashore that is submerged at high tide and exposed at low tide, the intertidal zone, is an important ecological product of ocean tides.

[edit] Water cycle



The movement of water around, over, and through the Earth is called the **water cycle**.

The biosphere can be roughly devided into oceans, land, and atmosphere.

Water moves perpetually through each of these regions in the *water cycle* consisting of following transfer processes:

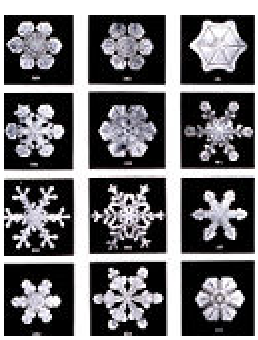
- evaporation from oceans and other water bodies into the air and transpiration from land plants and animals into air.
- precipitation, from water vapor condensing from the air and falling to earth or ocean.
- runoff from the land usually reaching the sea.

Most water vapor over the oceans returns to the oceans, but winds carry water vapor over land at the same rate as runoff into the sea, about 36 Tt per year. Over land, evaporation and transpiration contribute another 71 Tt per year. Precipitaion, at a rate of 107 Tt per year over land, has several forms: most commonly rain, snow, and hail, with some contribution from fog and dew. Condensed water in the air may also refract sunlight to produce rainbows.

Water runoff often collects over watersheds flowing into rivers. Some of this is diverted to irrigation for agriculture. Rivers and seas offered opportunity for travel and commerce. Through erosion, runoff shapes the environment creating river valleys and deltas which provide rich soil and level ground for the establishment of population centers.

[edit] Fresh water storage

Some runoff water is trapped for periods, for example in lakes. At high altitude, during winter, and in the far north and south, snow collects in ice caps, snow pack and glaciers. Water also infiltrates the ground and goes into aquifers. This groundwater later flows back to the surface in springs, or more spectacularly in hot springs and geysers. Groundwater is also extracted artificially in wells. This water storage is important, since clean, fresh water is essential to human and other land-based life. In many parts of the world, it is in short supply.



Snowflakes by Wilson Bentley, 1902

[edit] Forms of water

For more details on this topic, see Category: Forms of water.

Water takes many different forms on Earth: water vapor and clouds in the sky; seawater and rarely icebergs in the ocean; glaciers and rivers in the mountains; and aquifers in the ground.

Water can dissolve many different substances imparting upon it different tastes and odours. In fact, humans and other animals have developed senses to be able to evaluate the drink-ability of water: animals generally dislike the taste of salty sea water and the putrid swamps and favor the purer water of a mountain spring or aquifer. The taste advertised in spring water or mineral water derives from the minerals dissolved, while pure H_2O is tasteless. As such, purity in spring and mineral water refers to purity from toxins, pollutants, and microbes.

[edit] Effects on life

A captive lion drinking water

From a biological standpoint, water has many distinct properties that are critical for the proliferation of life that set it apart from other substances. It carries out this role by allowing organic compounds to react in ways that ultimately allow replication. All known forms of life depend on water. Water is vital both as a solvent in which many of the body's solutes dissolve and as an essential part of many metabolic processes within the body. Metabolism is the sum total of anabolism and catabolism. In anabolism, water is removed from molecules (through energy requiring enzymatic chemical reactions) in order to grow larger molecules (e.g. starches, triglycerides and proteins for storage of fuels and information). In catabolism, water is used to break bonds in order to generate smaller molecules (e.g. glucose, fatty acids and amino acids to be used for fuels for energy use or other purposes). Water is thus essential and central to these metabolic processes.

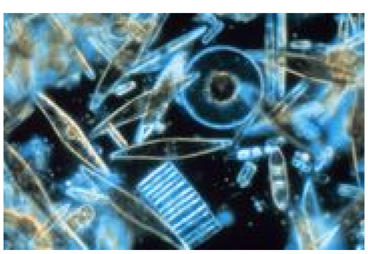
Water is also central to photosynthesis and respiration. Photosynthetic cells use the sun's energy to split off water's hydrogen from oxygen. Hydrogen is combined with CO_2 (absorbed from air or water) to form glucose and release oxygen. All living cells use such fuels and oxidize the hydrogen and carbon to capture the sun's energy and reform water and CO_2 in the process (cellular respiration).

Water is also central to acid-base neutrality and enzyme function. An acid, a hydrogen ion (H^+, that is, a proton) donor, can be neutralized by a base, a proton acceptor such as hydroxide ion (OH^-) to form water. Water is considered to be neutral, with a pH (the negative log of the hydrogen ion concentration) of 7. Acids have pH values less than 7 while bases have values greater than 7. Stomach acid (HCl) is useful to digestion. However, its corrosive effect on the esophagus during reflux can temporarily be neutralized by ingestion of a base such as aluminum hydroxide to produce the neutral molecules water and the salt aluminum chloride. Human biochemistry that involves enzymes usually performs optimally around a biologically neutral pH of 7.4.

[edit] Aquatic life forms

Some of the biodiversity of a coral reef

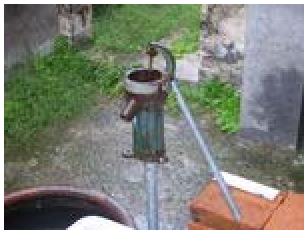
Earth's waters are filled with life. Nearly all fish live exclusively in water, and there are many types of marine mammals, such as dolphins and whales that also live in the water. Some kinds of animals, such as amphibians, spend portions of their lives in water and portions on land. Plants such as kelp and algae grow in the water and are the basis for some underwater ecosystems. Plankton is generally the foundation of the ocean food chain.



Some marine diatoms - a key phytoplankton group

Different water creatures have found different solutions to obtaining oxygen in the water. Fish have gills instead of lungs, though some species of fish, such as the lungfish, have both. Marine mammals, such as dolphins, whales, otters, and seals need to surface periodically to breathe air.

[edit] Effects on human civilization



A manual water pump in China

Civilization has historically flourished around rivers and major waterways; Mesopotamia, the so-called cradle of civilization, was situated between the major rivers Tigris and Euphrates; the ancient society of the Egyptians depended entirely upon the Nile. Large metropolises like Rotterdam, London, Montreal, Paris, New York City, Shanghai, Tokyo, and Chicago owe their success in part to their easy accessibility via water and the resultant expansion of trade. Islands with safe water ports, like Singapore and Hong Kong, have flourished for the same reason. In places such as North Africa and the Middle East, where water is more scarce, access to clean drinking water was and is a major factor in human development.

[edit] Health and pollution

Water fit for human consumption is called drinking water or "potable water". Water that is not fit for drinking but is not harmful for humans when used for food preparation is called safe water.

This natural resource is becoming scarcer in certain places, and its availability is a major social and economic concern. Currently, about 1 billion people around the world routinely drink unhealthy water. Most countries accepted the goal of halving by 2015 the number of people worldwide who do not have access to safe water and sanitation during the 2003 G8 Evian summit.[10] Even if this difficult goal is met, it will still leave more than an estimated half a billion people without access to safe drinking water supplies and over 1 billion without access to adequate sanitation facilities. Poor water quality and bad sanitation are deadly; some 5 million deaths a year are caused by polluted drinking water.

In the developing world, 90% of all wastewater still goes untreated into local rivers and streams. Some 50 countries, with roughly a third of the world's population, also suffer from medium or high water stress, and 17 of these extract more water annually than is recharged through their natural water cycles[citation needed]. The strain affects surface freshwater bodies like rivers and lakes, but it also degrades groundwater resources.

[edit] Human uses

Water under pressure from a sprinkler

[edit] For drinking

Main article: Drinking water

About 70% of the fat free mass of the human body is made of water. To function properly, the body requires between one and seven liters of water per day to avoid dehydration; the precise amount depends on the level of activity, temperature, humidity, and other factors. Most of this is ingested through foods or beverages other than drinking straight water. It is not clear how much water intake is needed by healthy people, though most experts agree that 8-10 glasses of water (approximately 2 liters) daily is the minimum to maintain proper hydration.[11] For those who do not have kidney problems, it is rather difficult to drink too much water, but (especially in warm humid weather and while exercising) it is dangerous to drink too little. People can drink far more water than necessary while exercising, however, putting them at risk of water intoxication, which can be fatal. The "fact" that a person should consume eight glasses of water per day cannot be traced back to a scientific source.[12] There are other myths such as the effect of water on weight loss and constipation that have been dispelled.[13]

A shower

Original recommendation for water intake in 1945 by the Food and Nutrition Board of the National Research Council read: "An ordinary standard for diverse persons is 1 milliliter for each calorie of food. Most of this quantity is contained in prepared foods."[14] The latest dietary reference intake report by the United States National

Research Council in general recommended (including food sources): 2.7 liters of water total for women and 3.7 liters for men.[15] Also noted is that normally, about 20 percent of water intake comes from food, while the rest comes from drinking water and beverages (caffeinated included). Water is excreted from the body in multiple forms; through urine and feces, through sweating, and by exhalation of water vapor in the breath. With physical exertion and heat exposure, water loss will increase and daily fluid needs may increase as well.

Humans require water that does not contain too many impurities. Common impurities include metal salts and/or harmful bacteria, such as *Vibrio*. Some solutes are acceptable and even desirable for taste enhancement and to provide needed electrolytes. The single largest freshwater resource suitable for drinking is the Lake Baikal in Siberia, which has a very low salt and calcium content and is very clean.

[edit] As a solvent

Dissolving (or suspending) is used to wash everyday items such as the human body, clothes, floors, cars, food, and pets. Sometimes water is not enough, and many chemicals can be added in order to improve the solvating power of water. These chemicals include saliva, soap, shampoo, alcohol, vinegar and various surfactants; these are all examples of emulsifying agents. When water will not do (to remove a non-water-soluble substance such as paint), other solvents are used, such as ethanol (in meths) or acetone (in nail varnish remover).

[edit] As a thermal transfer agent

Boiling, steaming, and simmering are popular cooking methods that often require immersing food in water or its gaseous state, steam. Water is also used in industrial contexts as a coolant, and in almost all power-stations as a coolant and to drive steam turbines to generate electricity. In the nuclear industry, water can also be used as a neutron moderator.

[edit] Recreation

Humans use water for many recreational purposes, as well as for exercising and for sports. Some of these include swimming, waterskiing, boating, fishing, and diving. In addition, some sports, like ice hockey and ice skating, are played on ice.

Some boats in a harbor in Miami Beach, Florida

Lakesides and beaches are popular places for people to go to relax and enjoy recreation. Many find the sound of flowing water to be calming, too. Some keep fish and other life in water tanks or ponds for show, fun, and companionship. People may also use water for play fighting such as with snowballs, water guns or water balloons.

[edit] Industrial applications

Pressurized water is used in water blasting and water jet cutters. Also, very high pressure water guns are used for precise cutting. It works very well, is relatively safe, and is not harmful to the environment.

This section is a stub. You can help by expanding it.

[edit] Food Processing

Water plays many critical roles within the field of food science. It is important for a food scientist to understand the roles that water plays within food processing to ensure the success of their products.

Solutes such as salts and sugars found in water affect the physical properties of water. The boiling and freezing points of water is affected by solutes. One mole of sucrose (sugar) raises the boiling point of water by 0.52 °C, and one mole of salt raises the boiling point by 1.04 degrees while lowering the freezing point of water in a similar way.[16] Solutes in water also affect water activity which affects many chemical reactions and the growth of microbes in food.[17] Water activity can be described as a ratio of the vapor pressure of water in a solution to the vapor pressure of pure water.[16] Solutes in water lower water activity. This is important to know because most bacterial growth ceases at low levels of water activity.[17] Not only does microbial growth affect the safety of food but also the preservation and shelf life of food.

Water hardness is also a critical factor in food processing. It can dramatically affect the quality of a product as well as playing a role in sanitation. Water hardness is classified based on the amounts of removable calcium carbonate salt it contains per gallon. Water hardness is measured in grains; 0.064 g calcium carbonate is equivalent to one grain of hardness.[16] Water is classified as soft if it contains 1 to 4 grains, medium if it contains 5 to 10 grains and hard if it contains 11 to 20 grains.[16] The hardness of water may be altered or treated by using a chemical ion exchange system. The hardness of water also affects its pH balance which plays a critical role in food processing. For example, hard water prevents successful production of clear beverages. Water hardness also affects sanitation; with increasing hardness, there is a loss of effectiveness for its use as a sanitizer.[16]

[edit] Power Generation

Hydroelectricity is electricity obtained from hydropower. Hydroelectric power comes from water driving a water turbine connected to a generator. Hydroelectricity is a low-cost, non-polluting, renewable energy source.

[edit] Politics

See also: Water resources and Category:Water and politics

People waiting in line to gather water during the Siege of Sarajevo

Because of overpopulation, mass consumption, misuse, and water pollution, the availability of drinking water per capita is inadequate and shrinking as of the year 2006. For this reason, water is a strategic resource in the globe and an important element in many political conflicts. Some have predicted that clean water will become the "next oil"[citation needed], making Canada, with this resource in abundance, possibly the richest country in the world. There is a long history of conflict over water, including efforts to gain access to water, the use of water in wars started for other reasons, and tensions over shortages and control.[18] UNESCO's World Water Development Report (WWDR, 2003) from its World Water Assessment Program indicates that, in the next 20 years, the quantity of water available to everyone is predicted to decrease by 30%. 40% of the world's inhabitants currently have insufficient fresh water for minimal hygiene. More than 2.2 million people died in 2000 from diseases related to the consumption of contaminated water or drought. In 2004, the UK charity WaterAid reported that a child dies every 15 seconds from easily preventable water-related diseases; often this means lack of sewage disposal; see toilet. Fresh water — now more precious than ever in our history for its extensive use in agriculture, high-tech manufacturing, and energy production — is increasingly receiving attention as a resource requiring better management and sustainable use.

[edit] OECD countries

Hopetoun Falls near Otway National Park, Victoria, Australia

With nearly 2,000 cubic metres (70,000 ft^3) of water per person and per year, the United States leads the world in water consumption per capita. In the Organization for Economic Co-operation and Development (OECD) countries, the U.S. is first for water consumption, then Canada with 1,600 cubic meters (56,000 ft^3) of water per person per year, which is about twice the amount of water used by the average person from France, three times as much as the average German, and almost eight times as much as the average Dane. Since 1980, overall water use in Canada has increased by 25.7%. This is five times higher than the overall OECD increase of 4.5%. In contrast, nine OECD nations were able to decrease their overall water use since 1980 (Sweden, the Netherlands, the United States, the United Kingdom, the Czech Republic, Luxembourg, Poland, Finland and Denmark).[19][20]

[edit] United States

Ninety-five percent of the United States' fresh water is underground. One crucial source is a huge underground reservoir, the 1,300-kilometer (800 mi) Ogallala aquifer which stretches from Texas to South Dakota and waters one fifth of U.S. irrigated land. Formed over millions of years, the Ogallala aquifer has since been cut off from its original natural sources. It is being depleted at a rate of 12 billion cubic meters (420 billion ft^3) per year, amounting to a total depletion to date of a volume equal to the annual flow of 18 Colorado Rivers. Some estimates say it will dry up in as little as 25 years. Many farmers in the Texas High Plains, which rely particularly on the underground source, are now turning away from irrigated agriculture as they become aware of the hazards of overpumping.[21]

[edit] Mexico

See also: Water supply and sanitation in Mexico

In Mexico City, an estimated 40% of the city's water is lost through leaky pipes built at the turn of the 20th century. Many people advise that it is not safe to drink.[22]

[edit] Middle East

The Middle East region has only 1% of the world's available fresh water, which is shared among 5% of the world's population. Thus, in this region, water is an important strategic resource. By 2025, it is predicted that the countries of the Arabian peninsula will be using more than double the amount of water naturally available to them.[23] According to a report by the Arab League, two-thirds of Arab countries have less than 1,000 cubic meters (35,000 ft^3) of water per person per year available, which is considered the limit.[24]

Jordan, for example, has little water, and dams in other countries have reduced its available water over the years. The 1994 Israel-Jordan Treaty of Peace stated that Israel would give 50 million cubic meters of water (1.7 billion ft^3) per year to Jordan, which it refused to do in 1999 before backtracking. The 1994 treaty stated that the two countries would cooperate in order to allow Jordan better access to water resources, notably through dams on the Yarmouk River.[25] Confronted by this lack of water, Jordan is preparing new techniques to use non-conventional water resources, such as second-hand use of irrigation water and desalinization techniques, which are very costly and are not yet used. A desalinization project will soon be started in Hisban, south of Amman. The Disi groundwater project, in the south of Jordan, will cost at least $250 million to bring out water. Along with the Unity Dam on the Yarmouk River, it is one of Jordan's largest strategic projects. Born in 1987, the "Unity Dam" would involve both Jordan and Syria. This "Unity Dam" still has not been implemented because of Israel's opposition, Jordan and Syrian conflictive relations and refusal of world investors. However, Jordan's reconciliation with Syria following the death of King Hussein represents the removal of one of the project's greatest obstacles.[26]

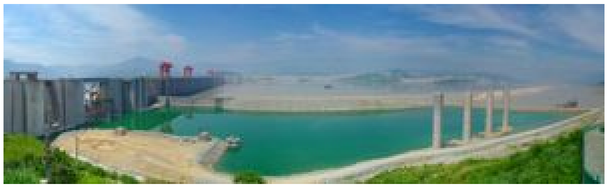
The Jordan River

Both Israel and Jordan rely on the Jordan River, but Israel controls it, as well as 90% of the water resources in the region. Water is also an important issue in the conflict with the Palestinians - indeed, according to former Israeli prime minister Ariel Sharon quoted by Abel Darwish in the BBC, it was one of the causes of the 1967 Six-Day War. In practice the access to water has been a casus belli for Israel. The Israeli army prohibits Palestinians from pumping water, and settlers use much more advanced pumping equipment. Palestinians complain of a lack of access to water in the region.[27] Israelis in the West Bank use four times as much water as their Palestinian neighbors.[28] According to the World Bank, 90% of the West Bank's water is used by Israelis.[26] Article 40 of the appendix B of the September 28, 1995 Oslo accords stated that "Israel recognizes Palestinians' rights on water in the West Bank".

The Golan Heights provide 770 million cubic meters (27 billion ft^3) of water per year to Israel, which represents a third of its annual consumption. The Golan's water goes to the Sea of Galilee — Israel's largest reserve — which is then redistributed throughout the country by the National Water Carrier. The Golan, which Israel annexed, represents a strategic territory for Israel because of its water resources.[26]. However, the level on the Sea of Galilee has dropped over the years, sparking fears that Israel's main water reservoir will become salinated. On its northern border, Israel threatened military action in 2002 when Lebanon opened a new pumping station taking water from a river feeding the Jordan. To help ease the crisis, Israel has agreed to buy water from Turkey and is investigating the construction of desalination plants.[29]

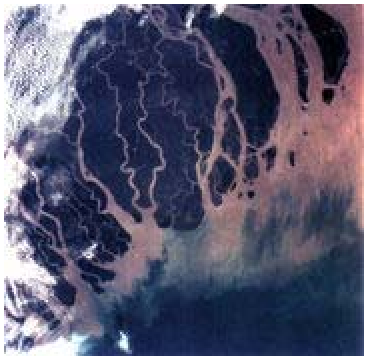
Iraq and Syria watched with apprehension the construction of the Atatürk Dam in Turkey and a projected system of 22 dams on the Tigris and Euphrates rivers.[30] According to the BBC, the list of 'water-scarce' countries in the region grew steadily from three in 1955 to eight in 1990 with another seven expected to be added within 20 years, including three Nile nations (the Nile is shared by nine countries).

[edit] Asia



Three Gorges Dam, receiving, upstream side, 26 July 2004

In Asia, Vietnam and Cambodia are concerned by China's and Laos' attempts to control the flux of water. China is also preparing the Three Gorges Dam project on the Yangtze River, which would become the world's largest dam, causing many social and environmental problems. It also has a project to divert water from the Yangtze to the dwindling Yellow River, which feeds China's most important farming region.



Ganges river delta, Bangladesh and India

The Ganges is disputed between India and Bangladesh. The water reserves are being quickly depleted and polluted, while the glacier feeding the sacred Hindu river is retreating hundreds of feet each year because of global warming[citation needed] and deforestation in the Himalayas, which is causing subsoil streams flowing into the Ganges river to dry up. Downstream, India controls the flow to Bangladesh with the Farakka Barrage, 10 kilometers (6 mi) on the Indian side of the border. Until the late 1990s, India used the barrage to divert the river to Calcutta to keep the city's port from drying up during the dry season. This denied Bangladeshi farmers water and silt, and it left the Sundarban wetlands and mangrove forests at the river's delta seriously threatened. The two countries have now signed an agreement to share the water more equally. Water quality, however, remains a problem, with high levels of arsenic and untreated sewage in the river water.[31]

[edit] South America

The Guaraní Aquifer, located between the Mercosur countries of Argentina, Brazil, Bolivia and Paraguay, with a volume of about 40,000 km³, is an important source of fresh potable water for all four countries.

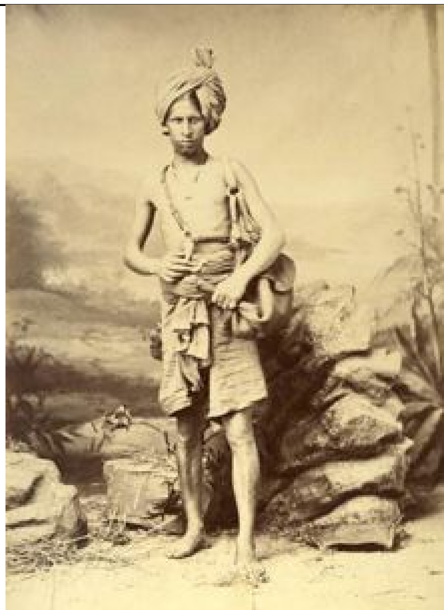
[edit] Privatization

Privatization of water companies has been contested on several occasions because of bad quality of the water, increasing prices, and ethical concerns. In Bolivia for example, the proposed privatization of water companies by the IMF were met by popular protests in Cochabamba in 2000, which ousted Bechtel, an American engineering firm based in San Francisco. SUEZ has started retreating from South America because of similar protests in Buenos Aires, Santa Fe, and Córdoba, Argentina. Consumers took to the streets to protest water rate hikes of as much as 500% mandated by SUEZ. In South and Central America, SUEZ has water concessions in Argentina, Bolivia, Brazil and Mexico. "Bolivian officials fault SUEZ for not connecting enough households to water lines as mandated by its contract and for charging as much as $455 a connection, or about three times the average monthly salary of an office clerk", according to the *Mercury News*.[32]

South Africa also made moves to privatize water, provoking an outbreak of cholera killing 200.[33]

In 1997, World Bank consultants assisted the Philippine government in the privatization of the city of Manila's Metropolitan Waterworks and Sewerage Systems (MWSS). By 2003, water prices increase registered at 81% in the east zone of Philippine and 36% in the west region. As services became more expensive and inefficient under privatization, there was reduced access to water for poor households. In October 2003, the Freedom from Debt Coalition reported that the diminished access to clean water resulted in an outbreak of cholera and other gastro-intestinal diseases.[34]

[edit] Regulation



A water-carrier in India, circa ~1882. In many places where running water is not available, water has to be transported by people.

Drinking water is often collected at springs, extracted from artificial borings in the ground, or wells. Building more wells in adequate places is thus a possible way to produce more water, assuming the aquifers can supply an adequate flow. Other water sources are rainwater and river or lake water. This surface water, however, must be purified for human consumption. This may involve removal of undissolved substances, dissolved substances and harmful microbes. Popular methods are filtering with sand which only removes undissolved material, while chlorination and boiling kill harmful microbes. Distillation does all three functions. More advanced techniques exist, such as reverse osmosis. Desalination of abundant ocean or seawater is a more expensive solution used in coastal arid climates.

The distribution of drinking water is done through municipal water systems or as bottled water. Governments in many countries have programs to distribute water to the needy at no charge. Others argue that the market mechanism and free enterprise are best to manage this rare resource and to finance the boring of wells or the construction of dams and reservoirs.

Reducing waste by using drinking water only for human consumption is another option. In some cities such as Hong Kong, sea water is extensively used for flushing toilets citywide in order to conserve fresh water resources. Polluting water may be the biggest single misuse of water; to the extent that a pollutant limits other uses of the water, it becomes a waste of the resource, regardless of benefits to the polluter. Like other types of pollution, this does not enter standard accounting of market costs, being conceived as externalities for which the market cannot account. Thus other people pay the price of water pollution, while the private firms' profits are not redistributed to the local population victim of this pollution. Pharmaceuticals consumed by humans often end up in the waterways and can have detrimental effects on aquatic life if they bioaccumulate and if they are not biodegradable.

[edit] Religion, philosophy, and literature

A Hindu ablution as practiced in Tamil Nadu

Water is considered a purifier in most religions. Major faiths that incorporate ritual washing (ablution) include Hinduism, Christianity, Islam, Judaism, and Shinto. Water baptism is a central sacrament of Christianity; it is also a part of the practice of other religions, including Judaism (*mikvah*) and Sikhism (*Amrit Sanskar*). In addition, a ritual bath in pure water is performed for the dead in many religions including Judaism and Islam. In Islam, the five daily prayers can be done in most cases after completing washing certain parts of the body using clean water (*wudu*). In Shinto, water is used in almost all rituals to cleanse a person or an area (e.g., in the ritual of *misogi*). Water is mentioned in the Bible 442 times in the New International Version and 363 times in the King James Version: 2 Peter 3:5(b) states, "The earth was formed out of water and by water" (NIV).

Some faiths use water especially prepared for religious purposes (holy water in some Christian denominations, *Amrit* in Sikhism and Hinduism). Many religions also consider particular sources or bodies of water to be sacred or at least auspicious; examples include Lourdes in Roman Catholicism, the Zamzam Well in Islam and the River Ganges (among many others) in Hinduism.

Water is often believed to have spiritual powers. In Celtic mythology, Sulis is the local goddess of thermal springs; in Hinduism, the Ganges is also personified as a goddess, while Saraswati have been referred to as goddess in Vedas. Also water is one of the "panch-tatva"s (basic 5 elements, others including fire, earth, space, air). Alternatively, gods can be patrons of particular springs, rivers, or lakes: for example in Greek and Roman mythology, Peneus was a river god, one of the three thousand Oceanids. In Islam, not only does water give life, but every life is itself made of water: "We made from water every living thing".[35]

The Greek philosopher Empedocles held that water is one of the four classical elements along with fire, earth and air, and was regarded as the ylem, or basic substance of the universe. Water was considered cold and moist. In the theory of the four bodily humors, water was associated with phlegm. Water was also one of the five elements in traditional Chinese philosophy, along with earth, fire, wood, and metal.

Water also plays an important role in literature as a symbol of purification. Examples include the critical importance of a river in *As I Lay Dying* by William Faulkner and the drowning of Ophelia in *Hamlet*.

[edit] See also

- Atmospheric water generator
- Bioswale
- Carbonation
- Color of water
- Dehydration (hypohydration) vs. hyperhydration
- Desalination
- Dihydrogen monoxide hoax
- Distilled water
- Drinking water
- Drought
- Ecohydrology
- Evapotranspiration
- Flood
- Fresh water
- Heavy water
- Hydrological transport model
- Hydrography
- Hydrology
- Hydropower
- Hydrosphere
- Ice
- Irrigation
- Mineral water
- Origin of water on Earth
- Precipitation (meteorology)
- Rain
- Safe water
- Sea water
- Spring water
- Steam
- Tide
- United Nations Convention to Combat Desertification (UNCCD).
- Wastewater
- WaterAid (international non-profit organisation).
- Water crisis
- Water (molecule) - Water (data page)
- Water cycle
- Water fuel cell
- Water industry
- Water intoxication
- Water ionizer
- Water memory
- Water park
- Water purification
- Water quality
- Water resources
- Water right
- Water sport (recreation)
- Water tank
- Water torture
- World Ocean Day
- World Water Day

Water Portal

[edit] References

[edit] Cited references

1. ^ http://pubs.acs.org/cgi-bin/abstract.cgi/bichaw/1997/36/i43/abs/bi971323j.html
2. ^ Water Vapor in the Climate System, Special Report, [AGU], December 1995 (linked 4/2007). Vital Water UNEP.
3. ^ Water Found in Extrasolar Planet's Atmosphere - Space.com

4. ^ Why is water blue?
5. ^ Physical Forces Organizing Biomolecules (PDF)
6. ^ The pressure due to water vapor in the air is called the **partial pressure**(Dalton's law) and it is directly proportional to concentration of water molecules in air (Boyle's law).
7. ^ *Adiabatic cooling* resulting from the ideal gas law.
8. ^ Gary Melnick, Harvard-Smithsonian Center for Astrophysics and David Neufeld, Johns Hopkins University quoted in: "Discover of Water Vapor Near Orion Nebula Suggests Possible Origin of H20 in Solar System [sic]", *The Harvard University Gazette*, April 23, 1998. "Space Cloud Holds Enough Water to Fill Earth's Oceans 1 Million Times", *Headlines@Hopkins, JHU*, April 9, 1998. "Water, Water Everywhere: Radio telescope finds water is common in universe", *The Harvard University Gazette*, February 25, 1999. . (linked 4/2007)
9. ^ J. C. I. Dooge. "Integrated Management of Water Resources". in E. Ehlers, T. Krafft. (eds.) *Understanding the Earth System: compartments, processes, and interactions. Springer, **2001**, p. 116. More references are at the end of the article "Habitable Zone" at The Encyclopedia of Astrobiology, Astronomy and Spaceflight.*
10. ^ G8 "Action plan" decided upon at the 2003 Evian summit
11. ^ Healthy Water Living. Retrieved on February 1, 2007.
12. ^ "Drink at least eight glasses of water a day." Really? Is there scientific evidence for "8 × 8"? by Heinz Valdin, Department of Physiology, Dartmouth Medical School, Lebanon, New Hampshire
13. ^ Drinking Water - How Much?, Factsmart.org web site and references within
14. ^ Food and Nutrition Board, National Academy of Sciences. Recommended Dietary Allowances, revised 1945. National Research Council, Reprint and Circular Series, No. 122, 1945 (Aug), p. 3-18.
15. ^ Dietary Reference Intakes: Water, Potassium, Sodium, Chloride, and Sulfate, Food and Nutrition Board
16. ^ *a b c d e* Vaclacik and Christian, 2003
17. ^ *a b* DeMan, 1999
18. ^ A Chronology of Water-Related Conflicts
19. ^ Water consumption indicator in the OECD countries
20. ^ "Golf 'is water hazard'", *BBC News*, March 17, 2003.
21. ^ "Ogallala aquifer - Water hot spots", *BBC News*, ?.
22. ^ "Mexico City - Water hot spots", *BBC News*, ?.
23. ^ "Water shortages 'foster terrorism'", *BBC News*, March 18, 2003.
24. ^ "Major aspects of scarce water resources management with reference to the Arab countries", Arab League report published for the International Conference on water gestion and water politics in arid zones, in Amman, Jordan, December 1-3, 1999. Quoted by French journalist Christian Chesnot in "Drought in the Middle East", *Monde diplomatique*, February 2000. - French original version freely available here.
25. ^ See 1994 Israel-Jordan Treaty of Peace, annex II, article II, first paragraph
26. ^ *a b c* See Christian Chesnot in "Drought in the Middle East", *Le Monde diplomatique*, February 2000. - French original version freely available here.

27. ^ "Analysis: Middle East water wars, by Abel Darwish", *BBC News*, May 30, 2003.
28. ^ "Israel - water hot spots", *BBC News*, ?.
29. ^ "Israel - water hot spots", *BBC News*, ?.
30. ^ "Turkey - water hot spots", *BBC News*, ?.
31. ^ "Ganges river - water hot spots", *BBC News*, ?.
32. ^ "Bolivia's water wars coming to end under Morales", *Mercury News*, February 26, 2006.
33. ^ "Water privatisation: ask the experts", *BBC News*, December 10, 2004.
34. ^ "Rights Education Empowers People in the Philippines", *Aurora Parong*, 1995.
35. ^ Sura of Al-Anbiya 21:30

- John M. DeMan (1999). *Principles of Food Chemistry 3rd Edition*.
- Vickie A. Vaclavik and Elizabeth W. Christian (2003). *Essentials of Food Science 2nd Edition*.

[edit] General references

- OA Jones, JN Lester and N Voulvoulis, Pharmaceuticals: a threat to drinking water? *TRENDS in Biotechnology* 23(4): 163, 2005
- Franks, F (Ed), Water, A comprehensive treatise, Plenum Press, New York, 1972-1982
- Property of Water and Water Steam w Thermodynamic Surface
- PH Gleick and associates, The World's Water: The Biennial Report on Freshwater Resources. Island Press, Washington, D.C. (published every two years, beginning in 1998.)
- Marks, William E., The Holy Order of Water: Healing Earth's Waters and Ourselves. Bell Pond Books (a div. of Steiner Books), Great Barrington, MA, November 2001 [ISBN 0-88010-483-X]
- Debenedetti, P. G., and Stanley, H. E.; "Supercooled and Glassy Water", *Physics Today* **56** (6), p. 40–46 (2003). Downloadable PDF (1.9 MB)

[edit] Water as a natural resource

- Gleick, Peter H.. *The World's Water: The Biennial Report on Freshwater Resources*. Washington: Island Press. (November 10, 2006)| ISBN-13: 9781597261050]
- Postel, Sandra (1997, second edition). *Last Oasis: Facing Water Scarcity*. New York: Norton Press.
- Anderson (1991). *Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment*.
- Marq de Villiers (2003, revised edition). *Water: The Fate of Our Most Precious Resource*.
- Diane Raines Ward (2002). *Water Wars: Drought, Flood, Folly and the Politics of Thirst*.

- Miriam R. Lowi (1995). *Water and Power: The Politics of a Scarce Resource in the Jordan River Basin*. (Cambridge Middle East Library)
- Worster, Donald (1992). *Rivers of Empire: Water, Aridity, and the Growth of the American West*.
- Reisner, Marc (1993). *Cadillac Desert: The American West and Its Disappearing Water*.
- Maude Barlow, Tony Clarke (2003). *Blue Gold: The Fight to Stop the Corporate Theft of the World's Water*.
- Vandana Shiva (2002). *Water Wars: Privatization, Pollution, and Profit*. ISBN 0-7453-1837-1.
- Anita Roddick, et al (2004). *Troubled Water: Saints, Sinners, Truth And Lies About The Global Water Crisis*.
- William E. Marks (2001). *The Holy Order of Water: Healing Earths Waters and Ourselves*.

[edit] External links

- Water UK, Water for Health: Ask About: Adults : Water requirements in adults
- Water for kids
- Answers to several questions of curious youngsters related to water