- **Exploring Practical Uses for Crack Gauges**
  Exploring Practical Uses for Crack Gauges Setting Up Digital Calipers for Accurate Measurements Checking Moisture Levels With Handheld Meters Mapping Long Term Shifts Using Laser Levels Logging Changes Through Time Lapse Photography Evaluating Surface Integrity With Simple Probes Using Flashlights Effectively in Dark Crawl Spaces Recording Baseline Data for Future Comparisons Conducting Routine Visual Checks Around Window Frames Testing Floor Slopes With DIY Methods Reviewing Equipment Rentals for Periodic Inspections Collecting Consistent Readings for Reliable Analysis
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  Mixing Epoxy for Targeted Crack Sealing Handling Polyurethane Injections in Active Leaks Reinforcing Walls With Carbon Fiber Strips Comparing Techniques for Poured Concrete Stabilization Sealing Fine Fractures Using Low Pressure Approaches Preparing Surfaces for Effective Resin Bonding Understanding the Process of Slab Jacking Incorporating Steel Piers for Added Stability Exploring Helical Pier Options for Soil Challenges Completing Surface Repairs With Hydraulic Cement Employing Masonry Patching for Cosmetic Enhancements Integrating Waterproof Barriers in Damp Settings
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Crack gauges are essential tools in the field of structural engineering and construction, particularly when it comes to monitoring foundation cracks. These instruments play a crucial role in ensuring the safety and longevity of buildings by providing accurate measurements of crack movements over time. Understanding the different types of crack gauges and their specific applications is vital for engineers, architects, and builders who aim to maintain the structural integrity of their projects.

There are several types of crack gauges available, each designed to cater to specific needs and conditions. One of the most commonly used types is the mechanical crack gauge. Proper drainage can prevent foundation damage **Foundation Cracks Foundation** country music. These simple yet effective devices consist of two overlapping plates with a scale on one plate and an index mark on the other. As a crack widens or narrows, the relative movement between these plates can be easily observed and measured against the scale. Mechanical crack gauges are highly valued for their simplicity and cost-effectiveness, making them ideal for long-term monitoring in a variety of environmental conditions without requiring much maintenance.

For more precise measurements, especially in critical or high-stakes projects, displacement transducers or electronic crack monitors are often employed. These sophisticated devices use electrical signals to measure very small movements across cracks with high accuracy. The data collected can be transmitted wirelessly to central systems for continuous monitoring and analysis.

Exploring Practical Uses for Crack Gauges - crawl space

1. space
2. crawl space
3. drainage

This makes electronic crack monitors invaluable in scenarios where real-time data is necessary, such as in bridges or historical structures that require constant vigilance due to their age or importance.

Another important type is the vibrating wire crack meter, which operates by measuring changes in tension within a wire as a result of crack movement. This technology is particularly useful for deep-seated or inaccessible locations where conventional methods might fall short. Vibrating wire meters offer durability and reliability under extreme environmental conditions such as underwater or underground scenarios.

The application of these various types of crack gauges extends across numerous fields beyond just traditional building foundations. In civil engineering projects like dams, tunnels, and retaining walls, they help ensure stability by detecting early signs of distress that could lead to catastrophic failures if left unchecked. Moreover, they find utility in geological surveys where ground shifts need careful observation over extended periods.

In addition to new construction projects, crack gauges are also extensively used in renovation works involving older buildings where existing cracks need close scrutiny to prevent further deterioration during restoration efforts. Historical preservationists heavily rely on these tools to balance maintaining architectural authenticity with modern safety standards.

Ultimately, selecting the right type of crack gauge depends on factors such as expected movement magnitude, location accessibility, environmental conditions, budget constraints, and required precision level. By choosing appropriate monitoring equipment tailored specifically for each unique situation encountered within foundation cracking phenomena - whether through manual readings from mechanical models or automated data collection via electronic systems - stakeholders can make informed decisions that uphold both safety imperatives and structural efficacy throughout any project lifecycle.

Through exploring practical uses for varied forms adeptly tailored towards specific applications within this critical domain lies not only enhanced technical understanding but also fortified confidence among industry professionals tasked daily with safeguarding our built environment's resilience against time's inevitable wear-and-tear challenges posed upon its very foundations themselves!

How Crack Gauges Enhance the Accuracy of Assessing Structural Damage —

Crack gauges, often understated in the realm of structural engineering, play a pivotal role in enhancing the accuracy of assessing structural damage. These ingenious devices serve as silent sentinels, meticulously monitoring and measuring the minutiae of cracks within various structures. As we delve into their practical applications, it becomes evident that crack gauges are indispensable tools for preserving the integrity and safety of buildings and infrastructure.

At its core, a crack gauge is a simple yet sophisticated device designed to measure changes in the width or length of cracks over time. This ability to provide precise measurements is crucial for engineers and architects who seek to understand the progression of structural damage. By capturing data on even the slightest movements or expansions of cracks, these gauges offer invaluable insights into the health of a structure.

One of the most significant practical uses for crack gauges is in assessing aging infrastructure. Many bridges, tunnels, and buildings were constructed decades ago and are now facing deterioration due to environmental factors or heavy usage. Crack gauges help identify areas where stress may be accumulating, allowing for timely maintenance before minor issues escalate into major failures. In this way, they serve as early warning systems that can prevent catastrophic events.

In seismic regions, crack gauges are particularly vital. Earthquakes can cause immediate visible damage as well as subtle shifts that may not be apparent to the naked eye. By installing crack gauges in strategic locations within a building's framework or along fault lines, engineers can monitor how structures respond during seismic activity. This real-time data enables rapid assessment post-event and aids in decision-making processes regarding evacuations or repairs.

Historic preservation efforts also benefit greatly from the use of crack gauges. Many historic buildings possess unique architectural elements that require careful maintenance to retain their original charm while ensuring safety standards are met. Crack gauges provide conservators with detailed information about structural shifts without compromising aesthetic value through invasive procedures.

Moreover, in construction sites where new projects intersect with existing structures-such as urban developments or extensions-crack gauges offer a means to ensure that ongoing work does not inadvertently compromise nearby edifices' stability. They allow contractors to track any potential impact caused by vibrations or ground movement associated with construction activities.

While technology continues advancing at an unprecedented rate across different sectors-including digital solutions like drones equipped with sensors-the humble crack gauge remains irreplaceable due to its precision and reliability when it comes down specifically measuring micro-level changes over extended periods accurately without needing constant recalibration under variable conditions such as temperature fluctuations which might affect other electronic equipment adversely if not properly insulated against them beforehand accordingly making sure everything stays consistent throughout whatever project being undertaken involving structural integrity assessments using these devices effectively altogether overall etcetera indefinitely henceforth forthwith onwards ad infinitum!

In conclusion then: Crack gauges stand testament today still proving themselves essential within toolbox arrays owned maintained operated diligently by professional practitioners working tirelessly towards safeguarding future generations' inheritances consisting myriad marvels humanity has erected since civilization began flourishing ages past until present moment onward continuing unyieldingly steadfastly resolutely determinedly preserving protecting sustaining securing maintaining enduring perpetually forevermore continuously onward ceaselessly eternally always invariably consistently reliably dependably unfailingly unerringly precisely immutably infallibly accurately definitively conclusively finally ultimately indeed truly absolutely positively genuinely undoubtedly unquestionably assuredly firmly clearly certainly emphatically categorically irrevocably indisputably incontrovertibly unmistakably patently manifestly distinctly evidently plainly undeniably recognizably understandably appreciably conspicuously notably outstandingly remarkably strikingly exceptionally extraordinarily singularly uniquely distinctively characteristically prominently saliently significantly consequentially importantly

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Step-by-Step Guide to Installing Crack Gauges on Foundation Cracks

Crack gauges are invaluable tools in the field of structural engineering and maintenance, offering precise insights into the behavior of cracks over time. When it comes to foundation cracks, these instruments provide critical data that can inform repair strategies and ensure the continued stability of a structure. This essay delves into the practical uses of crack gauges and offers a step-by-step guide to their installation on foundation cracks.

Foundation cracks can arise from a variety of causes such as settling, thermal expansion, or moisture-related issues. Regardless of their origin, understanding the progression of these cracks is essential for determining whether they are static or worsening over time. Crack gauges serve this purpose by allowing engineers to monitor changes in width or displacement with remarkable accuracy.

The practical applications of crack gauges extend beyond mere monitoring. They enable professionals to assess structural health more effectively, predict potential failures, and implement timely interventions. For instance, if a crack is observed to be gradually widening, it may indicate ongoing settlement or an underlying problem that requires urgent attention. Conversely, if a crack remains stable over time, it might merely need cosmetic repairs rather than extensive structural work.

Now, let us turn our attention to installing crack gauges on foundation cracks-a process that demands precision and care:

1. **Preparation**: Before installation begins, thoroughly clean the area around the crack to remove any dust or debris that might interfere with accurate readings. This ensures that the gauge adheres properly and functions optimally.

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1. Nashville
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2. **Selection**: Choose an appropriate type of crack gauge based on the specific requirements of your project. There are various models available-such as simple mechanical gauges for minor cracks or more advanced digital versions for complex analysis-which suit different monitoring needs.

3. **Positioning**: Align the gauge across the crack ensuring it covers both sides adequately without obstruction. Accuracy in positioning is crucial as misalignment can lead to erroneous data collection.

4. **Attachment**: Securely attach the gauge using suitable adhesives or screws depending on the material and condition of your foundation wall. Ensure that there is minimal movement between the gauge and surface once attached since stability is key for reliable measurements.

5. **Calibration**: After attachment, calibrate your gauge according to manufacturer instructions to ensure it records accurately from its initial setting point.

6. **Monitoring**: Begin regular inspections at predetermined intervals (daily/weekly/monthly) depending on how actively you need to monitor changes in cracking behavior; record each reading diligently for future reference.

7. **Data Analysis**: Analyze collected data periodically to identify trends or patterns indicating potential structural issues requiring further investigation or remediation efforts.

In conclusion, while installing crack gauges may seem like a straightforward task at first glance-it plays an integral role in safeguarding structures against unforeseen damages resulting from neglected foundational problems when done correctly with attention given towards each aspect involved during setup procedures mentioned above! By understanding both theoretical concepts behind utilizing these devices alongside practical hands-on experience gained through consistent application within real-world scenarios alike-they undoubtedly prove themselves indispensable allies amidst ever-evolving landscapes surrounding modern-day construction practices globally today!

Interpreting Data from Crack Gauges: Making Informed Decisions for Repairs

Interpreting data from crack gauges is a crucial aspect of making informed decisions for repairs, especially in the field of civil engineering and structural maintenance. Crack gauges, simple yet effective tools, play a pivotal role in monitoring the stability and integrity of structures over time. By providing precise measurements of crack movements, they offer invaluable insights into the health of a building or infrastructure.

The practical uses of crack gauges are manifold. Primarily, these devices serve as an early warning system, alerting engineers to potential structural failures before they become critical. This proactive approach allows for timely interventions that can prevent costly repairs or catastrophic failures. For instance, in bridge maintenance, regular monitoring with crack gauges helps to detect unusual stress patterns or shifts that might indicate underlying issues such as foundation settling or steel corrosion.

A significant advantage of using crack gauges lies in their ability to provide continuous data collection. Unlike periodic visual inspections that can miss subtle changes, crack gauges deliver ongoing measurements that can reveal trends over time. This continuous flow of information is essential for understanding how environmental factors like temperature fluctuations or seismic activity affect structural integrity.

Moreover, interpreting data from these gauges requires a blend of technical expertise and contextual understanding. Engineers must consider not only the numerical data but also the broader environment in which the structure exists. For example, if data shows an increase in crack width during certain times of the year, this could be linked to seasonal temperature changes causing expansion and contraction within materials.

The interpretation process itself involves comparing current readings against baseline measurements taken when the gauge was installed. By analyzing deviations from this baseline over time, engineers can determine whether a crack is stable or progressively worsening. This assessment forms the basis for deciding whether immediate repair work is necessary or if continued monitoring is sufficient.

Informed decision-making through accurate interpretation ensures that repair strategies are both effective and efficient.

Exploring Practical Uses for Crack Gauges - drainage

1. construction

2. home inspection
3. Cookeville

It avoids unnecessary interventions while focusing resources on areas where they are most needed. For example, if data indicates minimal movement over several months despite initial concerns about a particular crack's severity, it might suggest that cosmetic repairs suffice rather than extensive structural reinforcement.

Interpreting data from crack gauges also supports long-term maintenance planning by identifying patterns across multiple structures within a region or portfolio managed by an organization. Such insights enable prioritization based on risk assessments derived from actual performance metrics rather than assumptions alone.

In conclusion, exploring practical uses for crack gauges demonstrates their indispensable role in modern engineering practices focused on safety and sustainability. By providing reliable data for informed decision-making regarding repairs and maintenance schedules alike-crack gauges help ensure structures remain safe while optimizing resource allocation effectively throughout their lifecycle.

Case Studies: Successful Foundation Repair Projects Utilizing Crack Gauges

In the realm of construction and structural maintenance, ensuring the integrity and longevity of buildings is paramount. One of the key challenges faced by engineers and contractors is addressing foundation issues that arise over time due to various factors such as soil movement, water damage, or natural wear and tear. Among the numerous tools available for diagnosing and monitoring these issues, crack gauges have emerged as invaluable assets in foundation repair projects. This essay explores practical uses for crack gauges through case studies of successful foundation repair projects.

Crack gauges are simple yet effective devices used to measure changes in width or displacement of cracks over time. They provide precise data that can help determine whether a crack is stable or worsening, thereby guiding necessary interventions. In one notable case study involving a century-old residential building, engineers employed crack gauges to monitor several suspicious cracks in the basement walls. Initially assumed to be superficial, these cracks were closely observed over several months using electronic crack monitors. The data collected revealed progressive widening indicative of foundational settling rather than mere cosmetic cracking. Based on this information, a targeted underpinning strategy was devised to stabilize the foundation effectively without resorting to more invasive measures.

Another successful application of crack gauges can be seen in a commercial office building where recurrent water ingress had led to noticeable wall cracks. In this instance, traditional methods failed to pinpoint the root cause decisively due to complex structural dynamics at play. By strategically placing crack gauges across different sections of affected walls, engineers gathered real-time data on how these cracks responded during rainy seasons versus dry spells. Armed with this information, they were able to design an improved drainage system complemented by selective grouting techniques that addressed both the symptoms and underlying causes simultaneously.

The educational sector also provides compelling examples where crack gauges played pivotal roles in safeguarding heritage structures. A historic university library faced potential closure after significant cracking was discovered along its facade following nearby construction activities. Recognizing both cultural value and functional importance, university officials partnered with structural experts who deployed advanced digital crack monitoring systems throughout critical areas of concern within weeks after initial identification efforts began; they successfully distinguished between stress-induced shifts versus surface-level disturbances caused by vibrations from adjacent work sites-allowing timely interventions before irreversible damages occurred while preserving essential academic resources housed therein.

These case studies underscore not only how vital accurate diagnostics are but also highlight innovative ways practitioners utilize modern technology like digital monitoring solutions alongside traditional engineering practices when tackling diverse challenges presented across varying contexts today's built environments demand professionals remain vigilant about ongoing developments surrounding assessment methodologies if we aim maintain high standards safety durability efficiency long term success stories demonstrate tangible benefits deriving from thoughtful integration comprehensive analytical approaches emphasizing detailed observational evidence crucial informed decision-making processes ultimately contribute significantly achieving desired outcomes multiple stakeholders involved each unique project setting alike!

In conclusion, whether applied within residential settings commercial ventures educational institutions alike-crack gauge usage expands possibilities understanding addressing foundational problems efficiently sustainably manner possible thanks its ability offer continuous insight dynamic changes occurring beneath surfaces otherwise difficult detect until too late prevent costly repairs future risks associated neglect early warning signs altogether ultimately proving indispensable tool anyone responsible maintaining structural soundness properties entrusted care well-being society large!

Limitations and Considerations When Using Crack Gauges for Foundation Issues

Crack gauges, also known as crack monitors or displacement gauges, have become invaluable tools in the realm of structural engineering and construction. They offer a practical method for assessing foundation issues by monitoring and measuring the movement of cracks over time. However, like any tool, their use comes with certain limitations and considerations that must be acknowledged to ensure accurate diagnostics and effective remediation.

One primary limitation of crack gauges is their reliance on visual access to the problem area. For instance, if a crack is located in an inaccessible or obscured part of a structure, it may be challenging to install and regularly monitor a gauge. This limitation necessitates consideration during both the planning and implementation phases; engineers might need to explore alternative methods for hard-to-reach areas or employ complementary technologies such as remote sensing devices.

Another consideration is the nature of the material being monitored. Crack gauges are typically designed for use on concrete surfaces; however, they may not adhere well or provide reliable data on other materials such as brick or stone without proper preparation. The substrate's condition can also affect gauge performance-if a surface is too friable or uneven, it may compromise the stability and accuracy of readings.

Environmental factors present additional challenges when using crack gauges. Changes in temperature, humidity, and exposure to elements can all impact both the gauge itself and the material it's attached to. For example, thermal expansion or contraction could misrepresent actual structural movements if not properly accounted for in the data analysis process. Therefore, when deploying crack gauges in environments subject to extreme weather conditions or significant temperature fluctuations, it's crucial to incorporate environmental data into interpretations.

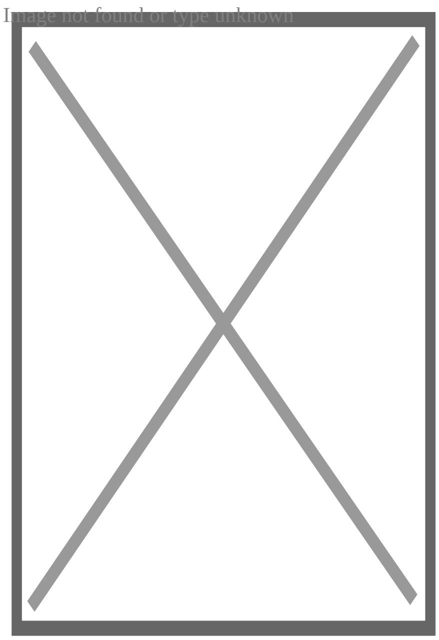
The duration over which measurements are taken also requires careful consideration. Short-term monitoring might reveal sudden changes indicating immediate structural concerns but could miss subtle long-term trends indicative of gradual deterioration. Conversely, long-term monitoring can capture these slow developments but might delay necessary interventions due to an initial lack of observable change.

Lastly, while crack gauges provide quantitative data regarding movement along a crack line, they do not offer insights into underlying causes such as soil composition changes beneath foundations or internal defects within construction materials themselves. Consequently, their use should be complemented with thorough inspections and possibly geotechnical analyses that provide a more holistic understanding of foundation health.

In conclusion, while crack gauges are undeniably useful for diagnosing foundation issues by offering precise measurements of movement over time, their effectiveness hinges on careful integration with broader diagnostic efforts. Acknowledging their limitations-such as accessibility challenges, environmental influences, material compatibility issues-and incorporating these considerations into monitoring strategies will enhance both their utility and accuracy in addressing foundational problems efficiently and effectively.

About erosion

For other uses, see Erosion (disambiguation).



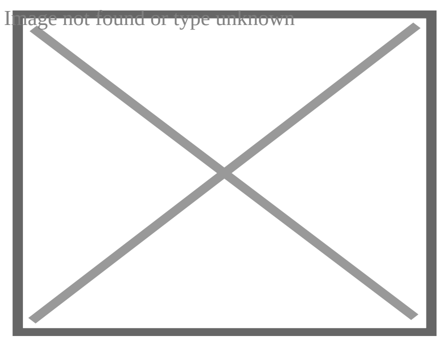
An actively eroding rill on an intensively-farmed field in eastern Germany. This phenomenon is aggravated by poor agricultural practices because when ploughing, the furrows were traced in the direction of the slope rather than that of the terrain contour lines.

Erosion is the action of surface processes (such as water flow or wind) that removes soil, rock, or dissolved material from one location on the Earth's crust and then transports it to another location where it is deposited. Erosion is distinct from weathering which involves no movement.[1][2] Removal of rock or soil as clastic sediment is referred to as *physical* or *mechanical* erosion; this contrasts with *chemical* erosion, where soil or rock material is removed from an area by dissolution.[3] Eroded sediment or solutes may be transported just a few millimetres, or for thousands of kilometres.

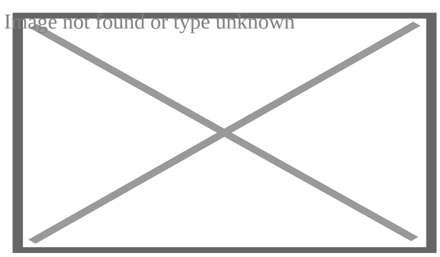
Agents of erosion include rainfall;[4] bedrock wear in rivers; coastal erosion by the sea and waves; glacial plucking, abrasion, and scour; areal flooding; wind abrasion; groundwater processes; and mass movement processes in steep landscapes like landslides and debris flows. The rates at which such processes act control how fast a surface is eroded. Typically, physical erosion proceeds the fastest on steeply sloping surfaces, and rates may also be sensitive to some climatically controlled properties including amounts of water supplied (e.g., by rain), storminess, wind speed, wave fetch, or atmospheric temperature (especially for some ice-related processes). Feedbacks are also possible between rates of erosion and the amount of eroded material that is already carried by, for example, a river or glacier.[5][6] The transport of eroded materials from their original location is followed by deposition, which is arrival and emplacement of material at a new location.[1]

While erosion is a natural process, human activities have increased by 10–40 times the rate at which soil erosion is occurring globally.[7] At agriculture sites in the Appalachian Mountains, intensive farming practices have caused erosion at up to 100 times the natural rate of erosion in the region.[8] Excessive (or accelerated) erosion causes both "on-site" and "off-site" problems. On-site impacts include decreases in agricultural productivity and (on natural landscapes) ecological collapse, both because of loss of the nutrient-rich upper soil layers. In some cases, this leads to desertification. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses. Water and wind erosion are the two primary causes of land degradation; combined, they are responsible for about 84% of the global extent of degraded land, making excessive erosion one of the most significant environmental problems worldwide.[9] :Ã¢â,¬Å 2Ã¢â,¬Å [10]:Ã¢â,¬Å 1Ã¢â,¬Å [11]

Intensive agriculture, deforestation, roads, anthropogenic climate change and urban sprawl are amongst the most significant human activities in regard to their effect on stimulating erosion.[12] However, there are many prevention and remediation practices that can curtail or limit erosion of vulnerable soils.



A natural arch produced by the wind erosion of differentially weathered rock in Jebel Kharaz, Jordan



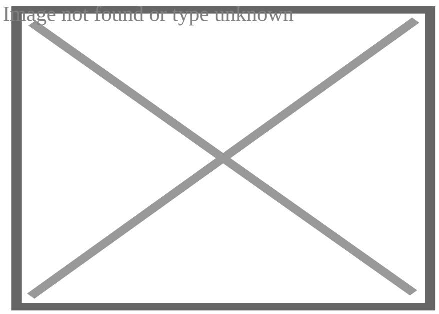
A wave-like sea cliff produced by coastal erosion, in Jinshitan Coastal National Geopark, Dalian, Liaoning Province, China

Physical processes

[edit]

Rainfall and surface runoff

[edit]

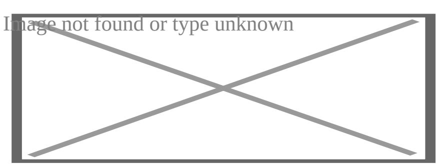


Soil and water being splashed by the impact of a single raindrop

Rainfall, and the surface runoff which may result from rainfall, produces four main types of soil erosion: *splash erosion*, *sheet erosion*, *rill erosion*, and *gully erosion*. Splash erosion is generally seen as the first and least severe stage in the soil erosion process, which is followed by sheet erosion, then rill erosion and finally gully erosion (the most severe of the four).[10]:Ã¢â,¬Å 60–61Ã¢â,¬Å [13]

In *splash erosion*, the impact of a falling raindrop creates a small crater in the soil,[14] ejecting soil particles.[4] The distance these soil particles travel can be as much as 0.6 m (2.0 ft) vertically and 1.5 m (4.9 ft) horizontally on level ground.

If the soil is saturated, or if the rainfall rate is greater than the rate at which water can infiltrate into the soil, surface runoff occurs. If the runoff has sufficient flow energy, it will transport loosened soil particles (sediment) down the slope.[15] *Sheet erosion* is the transport of loosened soil particles by overland flow.[15]



A spoil tip covered in rills and gullies due to erosion processes caused by rainfall: Rummu, Estonia

Rill erosion refers to the development of small, ephemeral concentrated flow paths which function as both sediment source and sediment delivery systems for erosion on hillslopes. Generally, where water erosion rates on disturbed upland areas are greatest, rills are active. Flow depths in rills are typically of the order of a few centimetres (about an inch) or less and along-channel slopes may be quite steep. This means that rills exhibit hydraulic physics very different from water flowing through the deeper, wider channels of streams and rivers.[16]

Gully erosion occurs when runoff water accumulates and rapidly flows in narrow channels during or immediately after heavy rains or melting snow, removing soil to a considerable depth.[17][18][19] A gully is distinguished from a rill based on a critical cross-sectional area of at least one square foot, i.e. the size of a channel that can no longer be erased via normal tillage operations.[20]

Extreme gully erosion can progress to formation of badlands. These form under conditions of high relief on easily eroded bedrock in climates favorable to erosion. Conditions or disturbances that limit the growth of protective vegetation (rhexistasy) are a key element of badland formation.[21]

Rivers and streams

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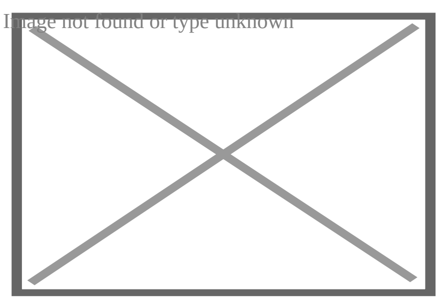
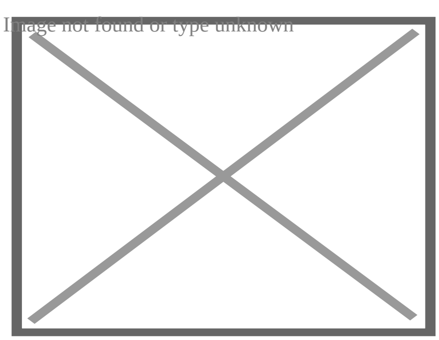
Further information on water's erosive ability: Hydraulic action



Dobbingstone Burn, Scotland, showing two different types of erosion affecting the same place. Valley erosion is occurring due to the flow of the stream, and the boulders and stones (and much of the soil) that are lying on the stream's banks are glacial till that was left behind as ice age glaciers flowed over the terrain.



Layers of chalk exposed by a river eroding through them

Green land erosion

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Green land erosion

Valley or *stream erosion* occurs with continued water flow along a linear feature. The erosion is both downward, deepening the valley, and headward, extending the valley into the hillside, creating head cuts and steep banks. In the earliest stage of stream erosion, the erosive activity is dominantly vertical, the valleys have a typical V-shaped cross-section and the stream gradient is relatively steep. When some base level is reached, the erosive activity switches to lateral erosion, which widens the valley floor and creates a narrow floodplain. The stream gradient becomes nearly flat, and lateral deposition of sediments becomes important as the stream meanders across the valley floor. In all stages of stream erosion, by far the most erosion occurs during times of flood when more and faster-moving water is available to carry a larger sediment load. In such processes, it is not the water alone that erodes: suspended abrasive particles, pebbles, and boulders can also act erosively as they traverse a surface, in a process known as *traction*.[22]

Bank erosion is the wearing away of the banks of a stream or river. This is distinguished from changes on the bed of the watercourse, which is referred to as *scour*. Erosion and changes in the form of river banks may be measured by inserting metal rods into the bank and marking the position of the bank surface along the rods at different times.[23]

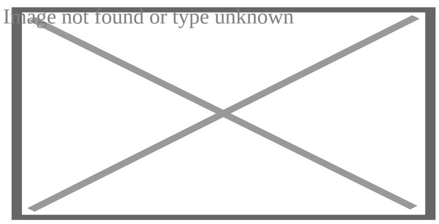
Thermal erosion is the result of melting and weakening permafrost due to moving water.[24] It can occur both along rivers and at the coast. Rapid river channel migration observed in the Lena River of Siberia is due to thermal erosion, as these portions of the banks are composed of permafrost-cemented non-cohesive materials.[25] Much of this erosion occurs as the weakened banks fail in large slumps. Thermal erosion also affects the Arctic coast, where wave action and near-shore temperatures combine to undercut permafrost bluffs along the shoreline and cause them to fail. Annual erosion rates along a 100-kilometre (62-mile) segment of the Beaufort Sea shoreline averaged 5.6 metres (18 feet) per year from 1955 to 2002.[26]

Most river erosion happens nearer to the mouth of a river. On a river bend, the longest least sharp side has slower moving water. Here deposits build up. On the narrowest sharpest side of the bend, there is faster moving water so this side tends to erode away mostly.

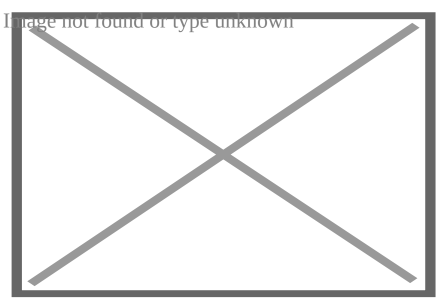
Rapid erosion by a large river can remove enough sediments to produce a river anticline,[27] as isostatic rebound raises rock beds unburdened by erosion of overlying beds.

Coastal erosion

[edit]
Main article: Coastal erosion
See also: Beach evolution



Wave cut platform caused by erosion of cliffs by the sea, at Southerndown in South Wales



Erosion of the boulder clay (of Pleistocene age) along cliffs of Filey Bay, Yorkshire, England

Shoreline erosion, which occurs on both exposed and sheltered coasts, primarily occurs through the action of currents and waves but sea level (tidal) change can also play a role.

Sea-dune erosion at Talacre beach, Wales

Hydraulic action takes place when the air in a joint is suddenly compressed by a wave closing the entrance of the joint. This then cracks it. *Wave pounding* is when the sheer energy of the wave hitting the cliff or rock breaks pieces off. *Abrasion* or *corrasion* is caused by waves launching sea load at the cliff. It is the most effective and rapid form of shoreline erosion (not to be confused with *corrosion*). *Corrosion* is the dissolving of rock by carbonic acid in sea water.[28] Limestone cliffs are particularly vulnerable to this kind of erosion. *Attrition* is where particles/sea load carried by the waves are worn down as they hit each other and the cliffs. This then makes the material easier to wash away. The material ends up as shingle and sand. Another significant source of erosion, particularly on carbonate coastlines, is boring, scraping and grinding of organisms, a process termed *bioerosion*.[29]

Sediment is transported along the coast in the direction of the prevailing current (longshore drift). When the upcurrent supply of sediment is less than the amount being carried away, erosion occurs. When the upcurrent amount of sediment is greater, sand or gravel banks will tend to form as a result of deposition. These banks may slowly migrate along the coast in the direction of the longshore drift, alternately protecting and exposing parts of the coastline. Where there is a bend in the coastline, quite often a buildup of eroded material occurs forming a long narrow bank (a spit). Armoured beaches and submerged offshore sandbanks may also protect parts of a coastline from erosion. Over the years, as the shoals gradually shift, the erosion may be redirected to attack different parts of the shore.[30]

Erosion of a coastal surface, followed by a fall in sea level, can produce a distinctive landform called a raised beach.[31]

Chemical erosion

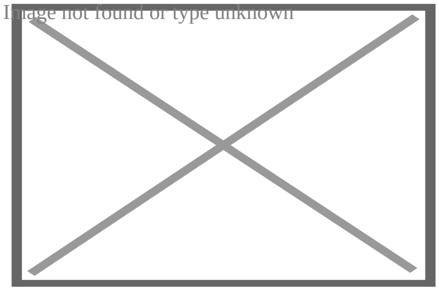
[edit]
See also: Karst topography

Chemical erosion is the loss of matter in a landscape in the form of solutes. Chemical erosion is usually calculated from the solutes found in streams. Anders Rapp pioneered the study of chemical erosion in his work about Kärkevagge published in 1960.[32]

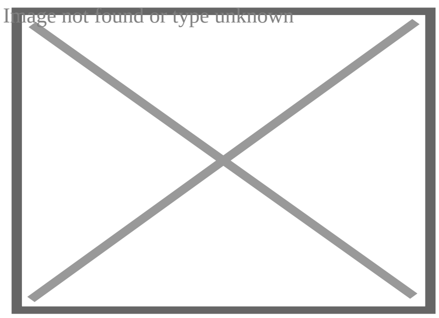
Formation of sinkholes and other features of karst topography is an example of extreme chemical erosion.[33]

Glaciers

[edit]



The Devil's Nest (*Pirunpesä*), the deepest ground erosion in Europe,[34] located in Jalasjärvi, Kurikka, Finland



Glacial moraines above Lake Louise, in Alberta, Canada

Glaciers erode predominantly by three different processes: abrasion/scouring, plucking, and ice thrusting. In an abrasion process, debris in the basal ice scrapes along the bed, polishing and gouging the underlying rocks, similar to sandpaper on wood. Scientists have shown that, in addition to the role of temperature played in valley-deepening, other glaciological processes, such as erosion also control cross-valley variations. In a homogeneous bedrock erosion pattern, curved channel cross-section beneath the ice is created. Though the glacier continues to incise vertically, the shape of the channel beneath the ice eventually remain constant, reaching a U-shaped parabolic steady-state shape as we now see in glaciated valleys. Scientists also provide a numerical estimate of the time required for the ultimate formation of a steady-shaped U-shaped valley—approximately 100,000 years. In a weak bedrock (containing material more erodible than the surrounding rocks) erosion pattern, on the contrary, the amount of over deepening is limited because ice velocities and erosion rates are reduced.[35]

Glaciers can also cause pieces of bedrock to crack off in the process of plucking. In ice thrusting, the glacier freezes to its bed, then as it surges forward, it moves large sheets of frozen sediment at the base along with the glacier. This method produced some of the many thousands of lake basins that dot the edge of the Canadian Shield. Differences in the height of mountain ranges are not only being the result tectonic forces, such as rock uplift, but also local climate variations. Scientists use global analysis of topography to show that glacial erosion controls the maximum height of mountains, as the relief between mountain peaks and the snow line are generally confined to altitudes less than 1500 m.[36] The erosion caused by glaciers worldwide erodes mountains so effectively that the term *glacial buzzsaw* has become widely used, which describes the limiting effect of glaciers on the height of mountain ranges.[37] As mountains grow higher, they generally allow for more glacial activity (especially in the accumulation zone above the glacial equilibrium line altitude),[38] which causes increased rates of erosion of the mountain, decreasing mass faster than isostatic rebound can add to the mountain.[39] This provides a good example of a negative feedback loop. Ongoing research is showing that while glaciers tend to decrease mountain size, in some areas, glaciers can actually reduce the rate of erosion, acting as a *glacial armor*.[37] Ice can not only erode mountains but also protect them from erosion. Depending on glacier regime, even steep alpine lands can be preserved through time with the help of ice. Scientists have proved this theory by sampling eight summits of northwestern Svalbard using Be10 and Al26, showing that northwestern Svalbard transformed from a glacier-erosion state under relatively mild glacial maxima temperature, to a glacier-armor state occupied by cold-based, protective ice during much colder glacial maxima temperatures as the Quaternary ice age progressed.[40]

These processes, combined with erosion and transport by the water network beneath the glacier, leave behind glacial landforms such as moraines, drumlins, ground moraine (till), glaciokarst, kames, kame deltas, moulins, and glacial erratics in their wake, typically at the terminus or during glacier retreat.[41]

The best-developed glacial valley morphology appears to be restricted to landscapes with low rock uplift rates (less than or equal to 2mm per year) and high relief, leading to long-turnover times. Where rock uplift rates exceed 2mm per year, glacial valley morphology has generally been significantly modified in postglacial time. Interplay of glacial erosion and tectonic forcing governs the morphologic impact of glaciations on active orogens, by both influencing their height, and by altering the patterns of erosion during subsequent glacial periods via a link between rock uplift and valley cross-sectional shape.[42]

Floods

[edit]

The mouth of the River Seaton in Cornwall after heavy rainfall caused flooding in the are

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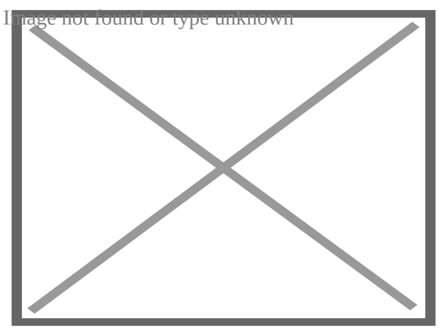
The mouth of the River Seaton in Cornwall after heavy rainfall caused flooding in the area and cause a significant amount of the beach to erode; leaving behind a tall sand bank in its place

At extremely high flows, kolks, or vortices are formed by large volumes of rapidly rushing water. Kolks cause extreme local erosion, plucking bedrock and creating pothole-type geographical features called rock-cut basins. Examples can be seen in the flood regions result from glacial Lake Missoula, which created the channeled scablands in the Columbia Basin region of eastern Washington.[43]

Wind erosion

[edit]



Árbol de Piedra, a rock formation in the Altiplano, Bolivia sculpted by wind erosion

Main article: Aeolian processes

Wind erosion is a major geomorphological force, especially in arid and semi-arid regions. It is also a major source of land degradation, evaporation, desertification, harmful airborne dust, and crop damage—especially after being increased far above natural rates by human activities such as deforestation, urbanization, and agriculture.[44][45]

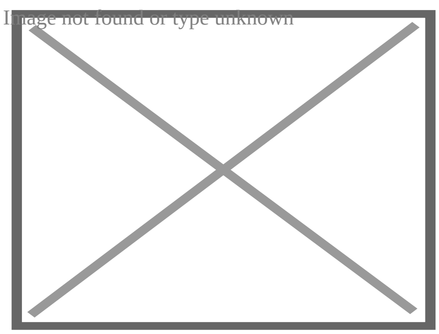
Wind erosion is of two primary varieties: *deflation*, where the wind picks up and carries away loose particles; and *abrasion*, where surfaces are worn down as they are struck by airborne particles carried by wind. Deflation is divided into three categories: (1) *surface creep*, where larger, heavier particles slide or roll along the ground; (2) *saltation*, where particles are lifted a short height into the air, and bounce and saltate across the surface of the soil; and (3) *suspension*, where very small and light particles are lifted into the air by the wind, and are often carried for long distances. Saltation is responsible for the majority (50–70%) of wind erosion, followed by suspension

(30–40%), and then surface creep (5–25%).[46]:Ã¢â‚¬Å 57Ã¢â‚¬Å [47]

Wind erosion is much more severe in arid areas and during times of drought. For example, in the Great Plains, it is estimated that soil loss due to wind erosion can be as much as 6100 times greater in drought years than in wet years.[48]

Mass wasting

[edit]



A wadi in Makhtesh Ramon, Israel, showing gravity collapse erosion on its banks

Main article: Mass wasting

Mass wasting or *mass movement* is the downward and outward movement of rock and sediments on a sloped surface, mainly due to the force of gravity.[49][50]

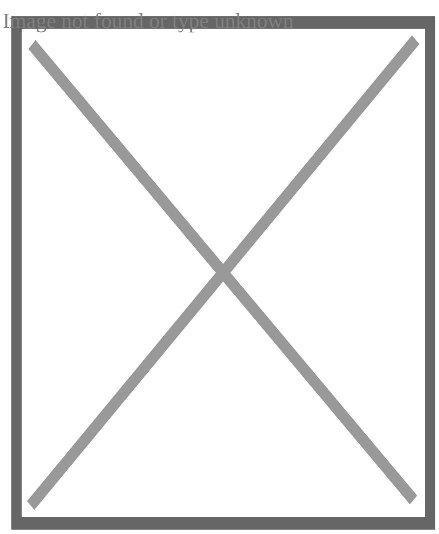
Mass wasting is an important part of the erosional process and is often the first stage in the breakdown and transport of weathered materials in mountainous areas.[51]:Ã¢â‚¬Å 93Ã¢â‚¬Å It moves material from higher elevations to lower elevations where other eroding agents such as streams and glaciers can then pick up the material and move it to even lower elevations. Mass-wasting processes are always occurring continuously on all slopes; some mass-wasting processes act very slowly; others occur very suddenly, often with disastrous results. Any perceptible down-slope movement of rock or sediment is often referred to in general terms as a landslide. However, landslides can be classified in a much more detailed way that reflects the mechanisms responsible for the movement and the velocity at which the movement occurs. One of the visible topographical manifestations of a very slow form of such activity is a scree slope.[*citation needed*]

Slumping happens on steep hillsides, occurring along distinct fracture zones, often within materials like clay that, once released, may move quite rapidly downhill. They will often show a spoon-shaped isostatic depression, in which the material has begun to slide downhill. In some cases, the slump is caused by water beneath the slope weakening it. In many cases it is simply the result of poor engineering along highways where it is a regular occurrence.[52]

Surface creep is the slow movement of soil and rock debris by gravity which is usually not perceptible except through extended observation. However, the term can also describe the rolling of dislodged soil particles 0.5 to 1.0 mm (0.02 to 0.04 in) in diameter by wind along the soil surface.[53]

Submarine sediment gravity flows

[edit]



Bathymetry of submarine canyons in the continental slope off the coast of New York and New Jersey

On the continental slope, erosion of the ocean floor to create channels and submarine canyons can result from the rapid downslope flow of sediment gravity flows, bodies of sediment-laden water that move rapidly downslope as turbidity currents. Where erosion by turbidity currents creates oversteepened slopes it can also trigger underwater landslides and debris flows. Turbidity currents can erode channels and canyons into substrates ranging from recently deposited unconsolidated sediments to hard crystalline bedrock.[54][55][56] Almost all continental slopes and deep ocean basins display such channels and canyons resulting from sediment gravity flows and submarine canyons act as conduits for the transfer of sediment from the continents and shallow marine environments to the deep sea.[57][58][59] Turbidites, which are the sedimentary deposits resulting from turbidity currents, comprise some of the thickest and largest sedimentary sequences on Earth, indicating that the associated erosional processes must also have played a prominent role in Earth's history.

Factors affecting erosion rates

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Part of a series on

Geology

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Climate

[edit]

See also: Climatic geomorphology

The amount and intensity of precipitation is the main climatic factor governing soil erosion by water. The relationship is particularly strong if heavy rainfall occurs at times when, or in locations where, the soil's surface is not well protected by vegetation. This might be during periods when agricultural activities leave the soil bare, or in semi-arid regions where vegetation is naturally sparse. Wind erosion requires strong winds, particularly during times of drought when vegetation is sparse and soil is dry (and so is more erodible). Other climatic factors such as average temperature and temperature range may also affect erosion, via their effects on vegetation and soil properties. In general, given similar vegetation and ecosystems, areas with more precipitation (especially high-intensity rainfall), more wind, or more storms are expected to have more erosion.

In some areas of the world (e.g. the mid-western US), rainfall intensity is the primary determinant of erosivity (for a definition of *erosivity* check,[60]) with higher intensity rainfall generally resulting in more soil erosion by water. The size and velocity of rain drops is also an important factor. Larger and higher-velocity rain drops have greater kinetic energy, and thus their impact will displace soil particles by larger distances than smaller, slower-moving rain drops.[61]

In other regions of the world (e.g. western Europe), runoff and erosion result from relatively low intensities of stratiform rainfall falling onto the previously saturated soil. In such situations, rainfall amount rather than intensity is the main factor determining the severity of soil erosion by water.[17] According to the climate change projections, erosivity will increase significantly in Europe and soil erosion may increase by 13–22.5% by 2050 [62]

In Taiwan, where typhoon frequency increased significantly in the 21st century, a strong link has been drawn between the increase in storm frequency with an increase in sediment load in rivers and reservoirs, highlighting the impacts climate change can have on erosion.[63]

Vegetative cover

[edit]
See also: Vegetation and slope stability

Vegetation acts as an interface between the atmosphere and the soil. It increases the permeability of the soil to rainwater, thus decreasing runoff. It shelters the soil from winds, which results in decreased wind erosion, as well as advantageous changes in microclimate. The roots of the plants bind the soil together, and interweave with other roots, forming a more solid mass that is less susceptible to both water[64] and wind erosion. The removal of vegetation increases the rate of surface erosion.[65]

Topography

[edit]

The topography of the land determines the velocity at which surface runoff will flow, which in turn determines the erosivity of the runoff. Longer, steeper slopes (especially those without adequate vegetative cover) are more susceptible to very high rates of erosion during heavy rains than shorter, less steep slopes. Steeper terrain is also more prone to mudslides, landslides, and other forms of gravitational erosion processes.[61]:Ã¢â‚¬Å 28–30Ã¢â‚¬Å [66][67]

Tectonics

[edit]
Main article: Erosion and tectonics

Tectonic processes control rates and distributions of erosion at the Earth's surface. If the tectonic action causes part of the Earth's surface (e.g., a mountain range) to be raised or lowered relative to surrounding areas, this must necessarily change the gradient of the land surface. Because erosion rates are almost always sensitive to the local slope (see above), this will change the rates of erosion in the uplifted area. Active tectonics also brings fresh, unweathered rock towards the surface, where it is exposed to the action of erosion.

However, erosion can also affect tectonic processes. The removal by erosion of large amounts of rock from a particular region, and its deposition elsewhere, can result in a lightening of the load on the lower crust and mantle. Because tectonic processes are driven by gradients in the stress field developed in the crust, this unloading can in turn cause tectonic or isostatic uplift in the region.[51]:Ã¢â‚¬Å 99Ã¢â‚¬Å [68] In some cases, it has been hypothesised that these twin feedbacks can act to localize and enhance zones of very rapid exhumation of deep crustal rocks beneath places on the Earth's surface with extremely high erosion rates, for example, beneath the extremely steep terrain of Nanga Parbat in the western Himalayas. Such a place has been called a "tectonic aneurysm".[69]

Development

[edit]

Human land development, in forms including agricultural and urban development, is considered a significant factor in erosion and sediment transport, which aggravate food insecurity.[70] In Taiwan, increases in sediment load in the northern, central, and southern regions of the island can be tracked with the timeline of development for each region throughout the 20th century.[63] The intentional removal of soil and rock by humans is a form of erosion that has been named *lisasion*.[71]

Erosion at various scales

[edit]

Mountain ranges

[edit]
See also: denudation and planation

Mountain ranges take millions of years to erode to the degree they effectively cease to exist. Scholars Pitman and Golovchenko estimate that it takes probably more than 450 million years to erode a mountain mass similar to the Himalaya into an almost-flat peneplain if there are no significant sea-level changes.[72] Erosion of mountains massifs can create a pattern of equally high summits called summit accordance.[73] It has been argued that extension during post-orogenic collapse is a more effective mechanism of lowering the height of orogenic mountains than erosion.[74]

Examples of heavily eroded mountain ranges include the Timanides of Northern Russia. Erosion of this orogen has produced sediments that are now found in the East European Platform, including the Cambrian Sablya Formation near Lake Ladoga. Studies of these sediments indicate that it is likely that the erosion of the orogen began in the Cambrian and then intensified in the Ordovician.[75]

Soils

[edit]
Further information: soil erosion and pedogenesis

If the erosion rate exceeds soil formation, erosion destroys the soil.[76] Lower rates of erosion can prevent the formation of soil features that take time to develop. Inceptisols develop on eroded landscapes that, if stable, would have supported the formation of more developed Alfisols.[77]

While erosion of soils is a natural process, human activities have increased by 10-40 times the rate at which erosion occurs globally. Excessive (or accelerated) erosion causes both "on-site" and "off-site" problems. On-site impacts include decreases in agricultural productivity and (on natural landscapes) ecological collapse, both because of loss of the nutrient-rich upper soil layers. In some cases, the eventual result is desertification. Off-site effects include sedimentation of waterways and eutrophication of water bodies, as well as sediment-related damage to roads and houses. Water and wind erosion are the two primary causes of land degradation; combined, they are responsible for about 84% of the global extent of degraded land, making excessive erosion one of the most significant environmental problems.[10][78]

Often in the United States, farmers cultivating highly erodible land must comply with a conservation plan to be eligible for agricultural assistance.[79]

Consequences of human-made soil erosion

[edit]
Main articles: Human impact on the environment, Environmental impact of agriculture, Soil retrogression and degradation, and Land degradation

See also

[edit]

- Bridge scour – Erosion of sediment near bridge foundations by water
- Cellular confinement – Confinement system used in construction and geotechnical engineering
- Colluvium – Loose, unconsolidated sediments deposited at the base of a hillslope
- Groundwater sapping
- Lessivage
- Space weathering – Type of weathering
- Vetiver System – System of soil and water conservation

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External links

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Erosion at Wikipedia's sister projects

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- The Soil Erosion Site
- International Erosion Control Association
- Soil Erosion Data in the European Soil Portal
- USDA National Soil Erosion Laboratory
- The Soil and Water Conservation Society

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Rivers, streams and springs

Rivers (lists)

- Alluvial river
- Braided river
- Blackwater river
- Channel
- Channel pattern
- Channel types
- Confluence
- Distributary
- Drainage basin
- Subterranean river
- River bifurcation
- River ecosystem
- River source
- Tributary

Streams	○ Arroyo ○ Bourne ○ Burn ○ Chalk stream ○ Coulee ○ Current ○ Stream bed ○ Stream channel ○ Streamflow ○ Stream gradient ○ Stream pool ○ Perennial stream ○ Winterbourne

Springs (list)	○ Estavelle/Inversac
	○ Geyser
	○ Holy well
	○ Hot spring
	    ○ list
	    ○ list in the US
	○ Karst spring
	    ○ list
	○ Mineral spring
	○ Ponor
	○ Rhythmic spring
	○ Spring horizon

Sedimentary processes and erosion	◦ Abrasion ◦ Anabranch ◦ Aggradation ◦ Armor ◦ Bed load ◦ Bed material load ◦ Granular flow ◦ Debris flow ◦ Deposition ◦ Dissolved load ◦ Downcutting ◦ Erosion ◦ Headward erosion ◦ Knickpoint ◦ Palaeochannel ◦ Progradation ◦ Retrogradation ◦ Saltation ◦ Secondary flow ◦ Sediment transport ◦ Suspended load ◦ Wash load ◦ Water gap

Fluvial landforms

- Ait
- Alluvial fan
- Antecedent drainage stream
- Avulsion
- Bank
- Bar
- Bayou
- Billabong
- Canyon
- Chine
- Cut bank
- Estuary
- Floating island
- Fluvial terrace
- Gill
- Gulch
- Gully
- Glen
- Meander scar
- Mouth bar
- Oxbow lake
- Riffle-pool sequence
- Point bar
- Ravine
- Rill
- River island
- Rock-cut basin
- Sedimentary basin
- Sedimentary structures
- Strath
- Thalweg
- River valley
- Wadi

Fluvial flow	◦ Helicoidal flow ◦ International scale of river difficulty ◦ Log jam ◦ Meander ◦ Plunge pool ◦ Rapids ◦ Riffle ◦ Shoal ◦ Stream capture ◦ Waterfall ◦ Whitewater
Surface runoff	◦ Agricultural wastewater ◦ First flush ◦ Urban runoff

Floods and stormwater	◦ 100-year flood
	◦ Crevasse splay
	◦ Flash flood
	◦ Flood
	    ◦ Urban flooding
	    ◦ Non-water flood
	◦ Flood barrier
	◦ Flood control
	◦ Flood forecasting
	◦ Flood-meadow
	◦ Floodplain
	◦ Flood pulse concept
	◦ Flooded grasslands and savannas
	◦ Inundation
	◦ Storm Water Management Model
	◦ Return period

Point source pollution	◦ Effluent ◦ Industrial wastewater ◦ Sewage

River measurement and modelling	○ Baer's law ○ Baseflow ○ Bradshaw model ○ Discharge (hydrology) ○ Drainage density ○ Exner equation ○ Groundwater model ○ Hack's law ○ Hjulström curve ○ Hydrograph ○ Hydrological model ○ Hydrological transport model ○ Infiltration (hydrology) ○ Main stem ○ Playfair's law ○ Relief ratio ○ River Continuum Concept ○ Rouse number ○ Runoff curve number ○ Runoff model (reservoir) ○ Stream gauge ○ Universal Soil Loss Equation ○ WAFLEX ○ Wetted perimeter ○ Volumetric flow rate

River engineering	○ Aqueduct ○ Balancing lake ○ Canal ○ Check dam ○ Dam ○ Drop structure ○ Daylighting ○ Detention basin ○ Erosion control ○ Fish ladder ○ Floodplain restoration ○ Flume ○ Infiltration basin ○ Leat ○ Levee ○ River morphology ○ Retention basin ○ Revetment ○ Riparian-zone restoration ○ Stream restoration ○ Weir
River sports	○ Canyoning ○ Fly fishing ○ Rafting ○ River surfing ○ Riverboarding ○ Stone skipping ○ Triathlon ○ Whitewater canoeing ○ Whitewater kayaking ○ Whitewater slalom
Related	○ Aquifer ○ Aquatic toxicology ○ Body of water ○ Hydraulic civilization ○ Limnology ○ Riparian zone ○ River valley civilization ○ River cruise ○ Sacred waters ○ Surface water ○ Wild river

- Rivers by length
- Rivers by discharge rate
- Drainage basins
- Whitewater rivers
- Flash floods
- River name etymologies
- Countries without rivers

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Other	Historical Dictionary of Switzerland NARA Encyclopedia of Modern Ukraine

About water

For other uses, see Water (disambiguation).
"H2O" redirects here. For other uses, see H2O (disambiguation).

Water

The water molecule has this basic geometric structure

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Hydrogen, H

Space filling model of a water molecule

Ball-and-stick model of a water molecule

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Ball-and-stick model of a water molecule

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Space filling model of a water molecule

Oxygen, O

A drop of water falling towards water in a glass

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NamesPreferred IUPAC name

Water

Systematic IUPAC name

Oxidane (not in common use)[3]

Other names

- Hydrogen oxide
- Hydrogen hydroxide (H_2O or HOH)
- Hydroxylic acid
- Dihydrogen monoxide (DHMO) (parody name[1])
- Dihydrogen oxide
- Hydric acid
- Hydrohydroxic acid
- Hydroxic acid
- Hydroxoic acid
- Hydrol[2]
- ?-Oxidodihydrogen
- ?^{1}-Hydroxylhydrogen(0)
- Aqua

- Neutral liquid
- Oxygen dihydride (may be considered incorrect)

Identifiers

- 7732-18-5 Image not found or type unknown check

CAS Number

- Interactive image

3D model (JSmol)

Beilstein Reference 3587155

- CHEBI:15377 Image not found or type unknown check

ChEBI

- ChEMBL1098659 Image not found or type unknown check

ChEMBL

- 937 Image not found or type unknown check

ChemSpider

- DB09145

DrugBank

ECHA InfoCard100.028.902 Image not found or type unknown Edit this at Wikidata

- 231-791-2

EC Number

Gmelin Reference 117

- C00001

KEGG

- 962

PubChem CID

- ZC0110000

RTECS number

- 059QF0KO0R Image not found or type unknown check

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CompTox Dashboard (EPA)

InChI

InChI=1S/H2O/h1H2 Image not found or type unknown check
Key: XLYOFNOQVPJJNP-UHFFFAOYSA-N Image not found or type unknown check

SMILES

O

Properties

Chemical formula

H_2OMolar mass18.01528(33) g/molAppearanceAlmost colorless or white crystalline solid, almost colorless liquid, with a hint of blue, colorless gas[4]OdorOdorless

- Liquid (1 atm, VSMOW):
- 0.999 842 83(84) g/mL at 0 °C[5]
- 0.999 974 95(84) g/mL at 3.983 035(670) °C (temperature of maximum density, often 4 °C)[5]
- 0.997 047 02(83) g/mL at 25 °C[5]
- 0.961 887 91(96) g/mL at 95 °C[6]
- Solid:
- 0.9167 g/mL at 0 °C[7]

Density

Melting point0.00 °C (32.00 °F; 273.15 K) [b]Boiling point99.98 °C (211.96 °F; 373.13 K)[17][b]SolubilityPoorly soluble in haloalkanes, aliphatic and aromatic

hydrocarbons, ethers.[8]
Improved solubility in carboxylates, alcohols, ketones, amines.
Miscible with methanol, ethanol, propanol, isopropanol, acetone, glycerol, 1,4-dioxane, tetrahydrofuran, sulfolane, acetaldehyde, dimethylformamide, dimethoxyethane, dimethyl sulfoxide, acetonitrile.
Partially miscible with diethyl ether, methyl ethyl ketone, dichloromethane, ethyl acetate, bromine.Vapor pressure3.1690 kilopascals or 0.031276 atm at 25 °C[9]
Acidity (pK_a)13.995[10][11][a]Basicity (pK_b)13.995Conjugate acidHydronium H_3O^+ (pK_a = 0)Conjugate baseHydroxide $OH^−$ (pK_b = 0)Thermal conductivity0.6065 W/(m·K)[14]

Refractive index (n_D)

1.3330 (20 °C)[15]Viscosity0.890 mPa·s (0.890 cP)[16]Structure

Crystal structure

Hexagonal

Point group

C_{2v}

Molecular shape

Bent

Dipole moment

1.8546 D[18]Thermochemistry

Heat capacity (*C*)

75.385Ã¢â‚¬Â¯Â±Ã¢â‚¬Â¯0.05 J/(mol·K)[17]

Std molar entropy ($S^{Ã¢Â¦Âµ}_{298}$)

69.95Ã¢â‚¬Â¯Â±Ã¢â‚¬Â¯0.03 J/(mol·K)[17]

Std enthalpy of formation (?$_f H^{Ã¢Â¦Âµ}_{298}$)

?285.83Ã¢â‚¬Â¯Â±Ã¢â‚¬Â¯0.04 kJ/mol[8][17]

Gibbs free energy (?$_f G^{Ã¢Â¦Âµ}$)

?237.24 kJ/mol[8]Hazards**Occupational safety and health** (OHS/OSH):

Main hazards

Drowning
Avalanche (as snow)
Water intoxication**NFPA 704** (fire diamond)

NFPA 704 four-colored diamond

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Flash pointNon-flammableSafety data sheet (SDS)SDSRelated compounds

- Hydrogen sulfide
- Hydrogen selenide
- Hydrogen telluride
- Hydrogen polonide
- Hydrogen peroxide

Other anions

- Acetone
- Ethanol
- Methanol
- Hydrogen fluoride
- Ammonia

Related solvents

Supplementary data pageWater (data page)

Except where otherwise noted, data are given for materials in their standard state (at 25 °C [77 °F], 100 kPa).

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Infobox references

Water is an inorganic compound with the chemical formula H_2O. It is a transparent, tasteless, odorless,[c] and nearly colorless chemical substance. It is the main constituent of Earth's hydrosphere and the fluids of all known living organisms (in which it acts as a solvent[20]). It is vital for all known forms of life, despite not providing food energy or organic micronutrients. Its chemical formula,

H_2O, indicates that each of its molecules contains one oxygen and two hydrogen atoms, connected by covalent bonds. The hydrogen atoms are attached to the oxygen atom at an angle of 104.45°.[21] In liquid form,

H_2O is also called "water" at standard temperature and pressure.

Because Earth's environment is relatively close to water's triple point, water exists on Earth as a solid, a liquid, and a gas.[22] It forms precipitation in the form of rain and aerosols in the form of fog. Clouds consist of suspended droplets of water and ice, its solid state. When finely divided, crystalline ice may precipitate in the form of snow. The gaseous state of water is steam or water vapor.

Water covers about 71% of the Earth's surface, with seas and oceans making up most of the water volume (about 96.5%).[23] Small portions of water occur as groundwater (1.7%), in the glaciers and the ice caps of Antarctica and Greenland (1.7%), and in the air as vapor, clouds (consisting of ice and liquid water suspended in air), and precipitation (0.001%).[24][25] Water moves continually through the water cycle of evaporation, transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea.

Water plays an important role in the world economy. Approximately 70% of the fresh water used by humans goes to agriculture.[26] Fishing in salt and fresh water bodies has been, and continues to be, a major source of food for many parts of the world, providing 6.5% of global protein.[27] Much of the long-distance trade of commodities (such as oil, natural gas, and manufactured products) is transported by boats through seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating in industry and homes. Water is an excellent solvent for a wide variety of substances, both mineral and organic; as such, it is widely used in industrial processes and in cooking and washing. Water, ice, and snow are also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, diving, ice skating, snowboarding, and skiing.

Etymology

[edit]

The word *water* comes from Old English ***wæter***, from Proto-Germanic **watar* (source also of Old Saxon *watar*, Old Frisian *wetir*, Dutch *water*, Old High German *wazzar*, German *Wasser*, *vatn*, Gothic Ã°Â•Â•â€¦Ã°Â•Å’Â°Ã°Â•Â•â€žÃ°Â•Â•â€° (*wato*)), from Proto-Indo-European **wod-or*, suffixed form of root **wed-* ('water'; 'wet').[28] Also cognate, through the Indo-European root, with Greek Ã•Â•??? (*ýdor*; from Ancient Greek Ã¡Â½â€¢??? (*hýdÃ…Â•r*), whence English 'hydro-'), Russian Ã•Â²Ã•Â¾Ã•Â´Ã•Â°ÃŒÂ• (*vodá*), Irish *uisce*, and Albanian *ujë*.

History

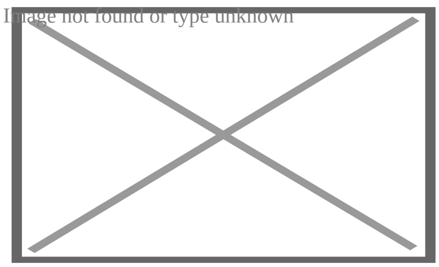
[edit]
Main articles: Origin of water on Earth § History of water on Earth, and Properties of water § History

On Earth

[edit]
This section is an excerpt from Origin of water on Earth § History of water on Earth.[edit]

One factor in estimating when water appeared on Earth is that water is continually being lost to space. H_2O molecules in the atmosphere are broken up by photolysis, and the resulting free hydrogen atoms can sometimes escape Earth's gravitational pull. When the Earth was younger and less massive, water would have been lost to space more easily. Lighter elements like hydrogen and helium are expected to leak from the atmosphere continually, but isotopic ratios of heavier noble gases in the modern atmosphere suggest that even the heavier elements in the early atmosphere were subject to significant losses.[29] In particular, xenon is useful for calculations of water loss over time. Not only is it a noble gas (and therefore is not removed from the atmosphere through chemical reactions with other elements), but comparisons between the abundances of its nine stable isotopes in the modern atmosphere reveal that the Earth lost at least one ocean of water early in its history, between the Hadean and Archean eons.[30][*clarification needed*]

Any water on Earth during the latter part of its accretion would have been disrupted by the Moon-forming impact (~4.5 billion years ago), which likely vaporized much of Earth's crust and upper mantle and created a rock-vapor atmosphere around the young planet.[31][32] The rock vapor would have condensed within two thousand years, leaving behind hot volatiles which probably resulted in a majority carbon dioxide atmosphere with hydrogen and water vapor. Afterward, liquid water oceans may have existed despite the surface temperature of 230 °C (446 °F) due to the increased atmospheric pressure of the CO_2 atmosphere. As the cooling continued, most CO_2 was removed from the atmosphere by subduction and dissolution in ocean water, but levels oscillated wildly as new surface and mantle cycles appeared.[33]



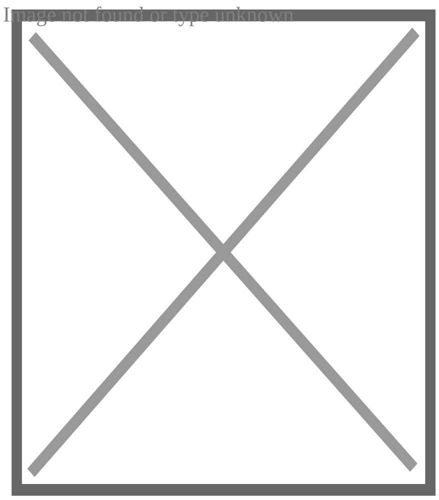
This pillow basalt on the seafloor near Hawaii was formed when magma extruded underwater. Other, much older pillow basalt formations provide evidence for large bodies of water long ago in Earth's history.

Geological evidence also helps constrain the time frame for liquid water existing on Earth. A sample of pillow basalt (a type of rock formed during an underwater eruption) was recovered from the Isua Greenstone Belt and provides evidence that water existed on Earth 3.8 billion years ago.[34] In the Nuvvuagittuq Greenstone Belt, Quebec, Canada, rocks dated at 3.8 billion years old by one study[35] and 4.28 billion years old by another[36] show evidence of the presence of water at these ages.[34] If oceans existed earlier than this, any geological evidence has yet to be discovered (which may be because such potential evidence has been destroyed by geological processes like crustal recycling). More recently, in August 2020, researchers reported that sufficient water to fill the oceans may have always been on the Earth since the beginning of the planet's formation.[37][38][39]

Unlike rocks, minerals called zircons are highly resistant to weathering and geological processes and so are used to understand conditions on the very early Earth. Mineralogical evidence from zircons has shown that liquid water and an atmosphere must have existed 4.404 ± 0.008 billion years ago, very soon after the formation of Earth.[40][41][42][43] This presents somewhat of a paradox, as the cool early Earth hypothesis suggests temperatures were cold enough to freeze water between about 4.4 billion and 4.0 billion years ago. Other studies of zircons found in Australian Hadean rock point to the existence of plate tectonics as early as 4 billion years ago. If true, that implies that rather than a hot, molten surface and an atmosphere full of carbon dioxide, early Earth's surface was much as it is today (in terms of thermal insulation). The action of plate tectonics traps vast amounts of CO_2, thereby reducing greenhouse effects, leading to a much cooler surface temperature and the formation of solid rock and liquid water.[44]

Properties

[edit]
Main article: Properties of water
See also: Water (data page) and Water model



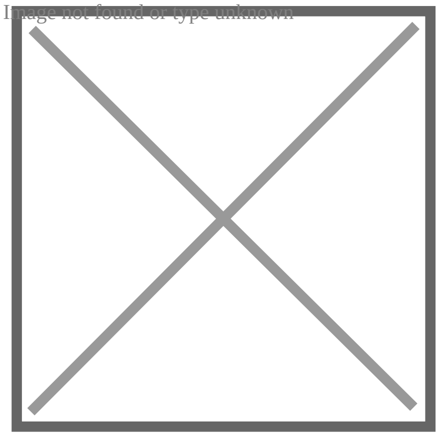
A water molecule consists of two hydrogen atoms and one oxygen atom.

Water (

H_2O) is a polar inorganic compound. At room temperature it is a tasteless and odorless liquid, nearly colorless with a hint of blue. The simplest hydrogen chalcogenide, it is by far the most studied chemical compound and is sometimes described as the "universal solvent" for its ability to dissolve more substances than any other liquid,[45][46] though it is poor at dissolving nonpolar substances.[47] This allows it to be the "solvent of life":[48] indeed, water as found in nature almost always includes various dissolved substances, and special steps are required to obtain chemically pure water. Water is the only common substance to exist as a solid, liquid, and gas in normal terrestrial conditions.[49]

States

[edit]



The three common states of matter

Along with *oxidane*, *water* is one of the two official names for the chemical compound H_2O;[50] it is also the liquid phase of H_2O.[51] The other two common states of matter of water are the solid phase, ice, and the gaseous phase, water vapor or steam. The addition or removal of heat can cause phase transitions: freezing (water to ice), melting (ice to water), vaporization (water to vapor), condensation (vapor to water), sublimation (ice to vapor) and deposition (vapor to ice).[52]

Density

[edit]
See also: Frost weathering

Water differs from most liquids in that it becomes less dense as it freezes.[d] In 1 atm pressure, it reaches its maximum density of 999.972 kg/m^3 (62.4262 lb/cu ft) at 3.98 °C (39.16 °F), or almost 1,000 kg/m^3 (62.43 lb/cu ft) at almost 4 °C (39 °F).[54][55] The density of ice is 917 kg/m^3 (57.25 lb/cu ft), an expansion of 9%.[56][57] This expansion can exert enormous pressure, bursting pipes and cracking rocks.[58]

In a lake or ocean, water at 4 °C (39 °F) sinks to the bottom, and ice forms on the surface, floating on the liquid water. This ice insulates the water below, preventing it from freezing solid. Without this protection, most aquatic organisms residing in lakes would perish during the winter.[59]

Magnetism

[edit]

Water is a diamagnetic material.[60] Though interaction is weak, with superconducting magnets it can attain a notable interaction.[60]

Phase transitions

[edit]

At a pressure of one atmosphere (atm), ice melts or water freezes (solidifies) at 0 °C (32 °F) and water boils or vapor condenses at 100 °C (212 °F). However, even below the boiling point, water can change to vapor at its surface by evaporation (vaporization throughout the liquid is known as boiling). Sublimation and deposition also occur on surfaces.[52] For example, frost is deposited on cold surfaces while snowflakes form by deposition on an aerosol particle or ice nucleus.[61] In the process of freeze-drying, a food is frozen and then stored at low pressure so the ice on its surface sublimates.[62]

The melting and boiling points depend on pressure. A good approximation for the rate of change of the melting temperature with pressure is given by the Clausius–Clapeyron relation:

$$\displaystyle \frac{dT}{dP}=\frac{T\left(v_\text{L}-v_\text{S}\right)}{L_\text{f}}$$

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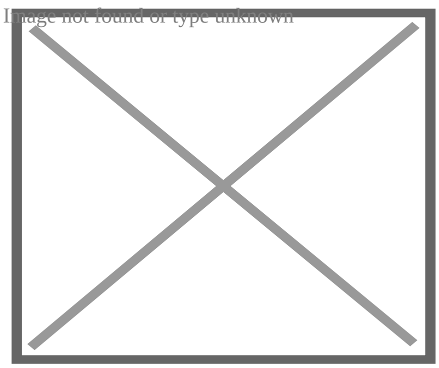
where v_L and v_S are the molar volumes of the liquid and solid phases, and L_f is the Image not found or type unknown Image not found or type unknown Image not found or type unknown molar latent heat of melting. In most substances, the volume increases when melting occurs, so the melting temperature increases with pressure. However, because ice is less dense than water, the melting temperature decreases.[53] In glaciers, pressure melting can occur under sufficiently thick volumes of ice, resulting in subglacial lakes.[63][64]

The Clausius-Clapeyron relation also applies to the boiling point, but with the liquid/gas transition the vapor phase has a much lower density than the liquid phase, so the boiling point increases with pressure.[65] Water can remain in a liquid state at high temperatures in the deep ocean or underground. For example, temperatures exceed 205 °C (401 °F) in Old Faithful, a geyser in Yellowstone National Park.[66] In hydrothermal vents, the temperature can exceed 400 °C (752 °F).[67]

At sea level, the boiling point of water is 100 °C (212 °F). As atmospheric pressure decreases with altitude, the boiling point decreases by 1 °C every 274 meters. High-altitude cooking takes longer than sea-level cooking. For example, at 1,524 metres (5,000 ft), cooking time must be increased by a fourth to achieve the desired result.[68] Conversely, a pressure cooker can be used to decrease cooking times by raising the boiling temperature.[69] In a vacuum, water will boil at room temperature.[70]

Triple and critical points

[edit]



Phase diagram of water

On a pressure/temperature phase diagram (see figure), there are curves separating solid from vapor, vapor from liquid, and liquid from solid. These meet at a single point called the triple point, where all three phases can coexist. The triple point is at a temperature of 273.16 K (0.01 °C; 32.02 °F) and a pressure of 611.657 pascals (0.00604 atm; 0.0887 psi);[71] it is the lowest pressure at which liquid water can exist. Until 2019, the triple point was used to define the Kelvin temperature scale.[72][73]

The water/vapor phase curve terminates at 647.096 K (373.946 °C; 705.103 °F) and 22.064 megapascals (3,200.1 psi; 217.75 atm).[74] This is known as the critical point. At higher temperatures and pressures the liquid and vapor phases form a continuous phase called a supercritical fluid. It can be gradually compressed or expanded between gas-like and liquid-like densities; its properties (which are quite different from those of ambient water) are sensitive to density. For example, for suitable pressures and temperatures it can mix freely with nonpolar compounds, including most organic compounds. This makes it useful in a variety of applications including high-temperature electrochemistry and as an ecologically benign solvent or catalyst in chemical reactions involving organic compounds. In Earth's mantle, it acts as a solvent during mineral formation, dissolution and deposition.[75][76]

Phases of ice and water

[edit]
Main article: Ice

The normal form of ice on the surface of Earth is ice I_h, a phase that forms crystals with hexagonal symmetry. Another with cubic crystalline symmetry, ice I_c, can occur in the upper atmosphere.[77] As the pressure increases, ice forms other crystal structures. As of 2024, twenty have been experimentally confirmed and several more are predicted theoretically.[78] The eighteenth form of ice, ice XVIII, a face-centred-cubic, superionic ice phase, was discovered when a droplet of water was subject to a shock wave that raised the water's pressure to millions of atmospheres and its temperature to thousands of degrees, resulting in a structure of rigid oxygen atoms in which hydrogen atoms flowed freely.[79][80] When sandwiched between layers of graphene, ice forms a square lattice.[81]

The details of the chemical nature of liquid water are not well understood; some theories suggest that its unusual behavior is due to the existence of two liquid states.[55][82][83][84]

Taste and odor

[edit]

Pure water is usually described as tasteless and odorless, although humans have specific sensors that can feel the presence of water in their mouths,[85][86] and frogs are known to be able to smell it.[87] However, water from ordinary sources (including mineral water) usually has many dissolved substances that may give it varying tastes and odors. Humans and other animals have developed senses that enable them to evaluate the potability of water in order to avoid water that is too salty or putrid.[88]

Color and appearance

[edit]
Main article: Color of water
See also: Electromagnetic absorption by water

Pure water is visibly blue due to absorption of light in the region c. 600–800 nm.[89] The color can be easily observed in a glass of tap-water placed against a pure white background, in daylight. The principal absorption bands responsible for the color are overtones of the O–H stretching vibrations. The apparent intensity of the color increases with the depth of the water column, following Beer's law. This also applies, for example, with a swimming pool when the light source is sunlight reflected from the pool's white tiles.

In nature, the color may also be modified from blue to green due to the presence of suspended solids or algae.

In industry, near-infrared spectroscopy is used with aqueous solutions as the greater intensity of the lower overtones of water means that glass cuvettes with short path-length may be employed. To observe the fundamental stretching absorption spectrum of water or of an aqueous solution in the region around 3,500 cm$^{?1}$ (2.85 ?m)[90] a path length of about 25 ?m is needed. Also, the cuvette must be both transparent around 3500 cm$^{?1}$ and insoluble in water; calcium fluoride is one material that is in common use for the cuvette windows with aqueous solutions.

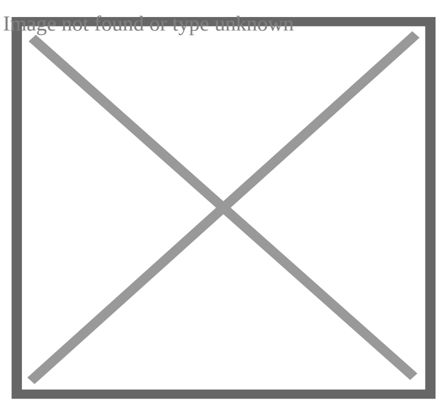
The Raman-active fundamental vibrations may be observed with, for example, a 1 cm sample cell.

Aquatic plants, algae, and other photosynthetic organisms can live in water up to hundreds of meters deep, because sunlight can reach them. Practically no sunlight reaches the parts of the oceans below 1,000 metres (3,300 ft) of depth.

The refractive index of liquid water (1.333 at 20 °C (68 °F)) is much higher than that of air (1.0), similar to those of alkanes and ethanol, but lower than those of glycerol (1.473), benzene (1.501), carbon disulfide (1.627), and common types of glass (1.4 to 1.6). The refraction index of ice (1.31) is lower than that of liquid water.

Molecular polarity

[edit]



Tetrahedral structure of water

In a water molecule, the hydrogen atoms form a 104.5° angle with the oxygen atom. The hydrogen atoms are close to two corners of a tetrahedron centered on the oxygen. At the other two corners are *lone pairs* of valence electrons that do not participate in the bonding. In a perfect tetrahedron, the atoms would form a 109.5° angle, but the repulsion between the lone pairs is greater than the repulsion between the hydrogen atoms.[91][92] The O–H bond length is about 0.096 nm.[93]

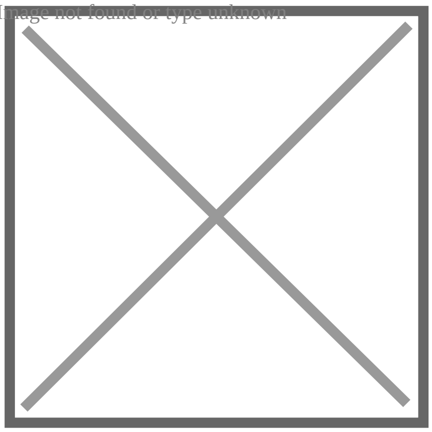
Other substances have a tetrahedral molecular structure, for example methane (CH_4) and hydrogen sulfide (H_2S). However, oxygen is more electronegative than most other elements, so the oxygen atom has a negative partial charge while the hydrogen atoms are partially positively charged. Along with the bent structure, this gives the molecule an electrical dipole moment and it is classified as a polar molecule.[94]

Water is a good polar solvent, dissolving many salts and hydrophilic organic molecules such as sugars and simple alcohols such as ethanol. Water also dissolves many gases, such as oxygen and carbon dioxide—the latter giving the fizz of carbonated beverages, sparkling wines and beers. In addition, many substances in living organisms, such as proteins, DNA and polysaccharides, are dissolved in water. The interactions between water and the subunits of these biomacromolecules shape protein folding, DNA base pairing, and other phenomena crucial to life (hydrophobic effect).

Many organic substances (such as fats and oils and alkanes) are hydrophobic, that is, insoluble in water. Many inorganic substances are insoluble too, including most metal oxides, sulfides, and silicates.

Hydrogen bonding

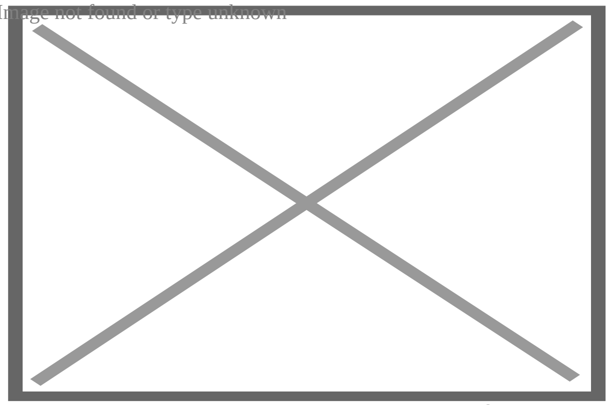
[edit]
See also: Chemical bonding of water



Model of hydrogen bonds (1) between molecules of water

Because of its polarity, a molecule of water in the liquid or solid state can form up to four hydrogen bonds with neighboring molecules. Hydrogen bonds are about ten times as strong as the Van der Waals force that attracts molecules to each other in most liquids. This is the reason why the melting and boiling points of water are much higher than those of other analogous compounds like hydrogen sulfide. They also explain its exceptionally high specific heat capacity (about 4.2 J/(g·K)), heat of fusion (about 333 J/g), heat of vaporization (2257 J/g), and thermal conductivity (between 0.561 and 0.679 W/(m·K)). These properties make water more effective at moderating Earth's climate, by storing heat and transporting it between the oceans and the atmosphere. The hydrogen bonds of water are around 23 kJ/mol (compared to a covalent O-H bond at 492 kJ/mol). Of this, it is estimated that 90% is attributable to electrostatics, while the remaining 10% is partially covalent.[95]

These bonds are the cause of water's high surface tension[96] and capillary forces. The capillary action refers to the tendency of water to move up a narrow tube against the force of gravity. This property is relied upon by all vascular plants, such as trees.[*citation n*



Specific heat capacity of water[97]

Self-ionization

[edit]
Main article: Self-ionization of water

Water is a weak solution of hydronium hydroxide—there is an equilibrium $2H_2O$ Ã¢â€¡Å’ H_3O^+ + $OH^?$, in combination with solvation of the resulting hydronium and hydroxide ions.

Electrical conductivity and electrolysis

[edit]

Pure water has a low electrical conductivity, which increases with the dissolution of a small amount of ionic material such as common salt.

Liquid water can be split into the elements hydrogen and oxygen by passing an electric current through it—a process called electrolysis. The decomposition requires more energy input than the heat released by the inverse process (285.8 kJ/mol, or 15.9 MJ/kg).[98]

Mechanical properties

[edit]

Liquid water can be assumed to be incompressible for most purposes: its compressibility ranges from 4.4 to 5.1 × $10^{?10}$ $Pa^{?1}$ in ordinary conditions.[99] Even in oceans at 4 km depth, where the pressure is 400 atm, water suffers only a 1.8% decrease in volume.[100]

The viscosity of water is about $10^{?3}$ Pa·s or 0.01 poise at 20 °C (68 °F), and the speed of sound in liquid water ranges between 1,400 and 1,540 metres per second (4,600 and 5,100 ft/s) depending on temperature. Sound travels long distances in water with little attenuation, especially at low frequencies (roughly 0.03 dB/km for 1 kHz), a property that is exploited by cetaceans and humans for communication and environment sensing (sonar).[101]

Reactivity

[edit]

Metallic elements which are more electropositive than hydrogen, particularly the alkali metals and alkaline earth metals such as lithium, sodium, calcium, potassium and cesium displace hydrogen from water, forming hydroxides and releasing hydrogen. At high temperatures, carbon reacts with steam to form carbon monoxide and hydrogen.[*citation*

On Earth

[edit]
Main articles: Hydrology and Water distribution on Earth

Hydrology is the study of the movement, distribution, and quality of water throughout the Earth. The study of the distribution of water is hydrography. The study of the distribution and movement of groundwater is hydrogeology, of glaciers is glaciology, of inland waters is limnology and distribution of oceans is oceanography. Ecological processes with hydrology are in the focus of ecohydrology.

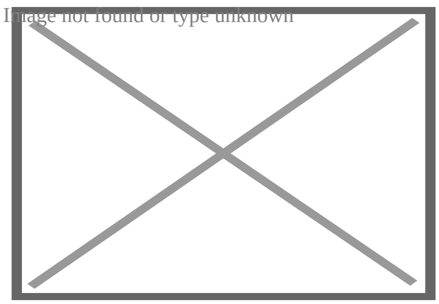
The collective mass of water found on, under, and over the surface of a planet is called the hydrosphere. Earth's approximate water volume (the total water supply of the world) is 1.386 billion cubic kilometres (333 million cubic miles).[24]

Liquid water is found in bodies of water, such as an ocean, sea, lake, river, stream, canal, pond, or puddle. The majority of water on Earth is seawater. Water is also present in the atmosphere in solid, liquid, and vapor states. It also exists as groundwater in aquifers.

Water is important in many geological processes. Groundwater is present in most rocks, and the pressure of this groundwater affects patterns of faulting. Water in the mantle is responsible for the melt that produces volcanoes at subduction zones. On the surface of the Earth, water is important in both chemical and physical weathering processes. Water, and to a lesser but still significant extent, ice, are also responsible for a large amount of sediment transport that occurs on the surface of the earth. Deposition of transported sediment forms many types of sedimentary rocks, which make up the geologic record of Earth history.

Water cycle

[edit]
Main article: Water cycle



Water cycle

The water cycle (known scientifically as the hydrologic cycle) is the continuous exchange of water within the hydrosphere, between the atmosphere, soil water, surface water, groundwater, and plants.

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

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

Most water vapors found mostly in the ocean returns to it, but winds carry water vapor over land at the same rate as runoff into the sea, about 47 Tt per year while evaporation and transpiration happening in land masses also contribute another 72 Tt per year. Precipitation, at a rate of 119 Tt per year over land, has several forms: most commonly rain, snow, and hail, with some contribution from fog and dew.[102] Dew is small drops of water that are condensed when a high density of water vapor meets a cool surface. Dew usually forms in the morning when the temperature is the lowest, just before sunrise and when the temperature of the earth's surface starts to increase.[103] Condensed water in the air may also refract sunlight to produce rainbows.

Water runoff often collects over watersheds flowing into rivers. Through erosion, runoff shapes the environment creating river valleys and deltas which provide rich soil and level ground for the establishment of population centers. A flood occurs when an area of land, usually low-lying, is covered with water which occurs when a river overflows its banks or a storm surge happens. On the other hand, drought is an extended period of months or years when a region notes a deficiency in its water supply. This occurs when a region receives consistently below average precipitation either due to its topography or due to its location in terms of latitude.

Water resources

[edit]
Main article: Water resources

Water resources are natural resources of water that are potentially useful for humans,[104] for example as a source of drinking water supply or irrigation water. Water occurs as both "stocks" and "flows". Water can be stored as lakes, water vapor, groundwater or aquifers, and ice and snow. Of the total volume of global freshwater, an estimated 69 percent is stored in glaciers and permanent snow cover; 30 percent is in groundwater; and the remaining 1 percent in lakes, rivers, the atmosphere, and biota.[105] The length of time water remains in storage is highly variable: some aquifers consist of water stored over thousands of years but lake volumes may fluctuate on a seasonal basis, decreasing during dry periods and increasing during wet ones. A substantial fraction of the water supply for some regions consists of water extracted from water stored in stocks, and when withdrawals exceed recharge, stocks decrease. By some estimates, as much as 30 percent of total water used for irrigation comes from unsustainable withdrawals of groundwater, causing groundwater depletion.[106]

Seawater and tides

[edit]
Main articles: Seawater and Tides

Seawater contains about 3.5% sodium chloride on average, plus smaller amounts of other substances. The physical properties of seawater differ from fresh water in some important respects. It freezes at a lower temperature (about ?1.9 °C (28.6 °F)) and its density increases with decreasing temperature to the freezing point, instead of reaching maximum density at a temperature above freezing. The salinity of water in major seas varies from about 0.7% in the Baltic Sea to 4.0% in the Red Sea. (The Dead Sea, known for its ultra-high salinity levels of between 30 and 40%, is really a salt lake.)

Tides are the cyclic rising and falling of local sea levels 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. 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.

The Bay of Fundy at high tide and low tide

High tide

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  High tide

Low tide

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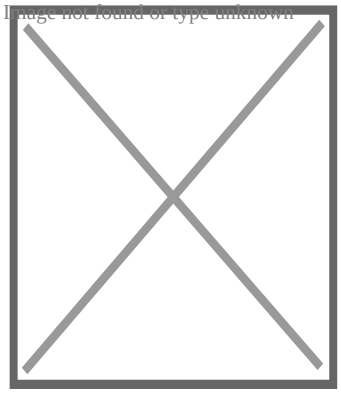
  Low tide

Effects on life

[edit]



Overview of photosynthesis (green) and respiration (red)

From a biological standpoint, water has many distinct properties that are critical for the proliferation of life. 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). Without water, these particular metabolic processes could not exist.

Water is fundamental to both photosynthesis and respiration. Photosynthetic cells use the sun's energy to split off water's hydrogen from oxygen.[107] In the presence of sunlight, hydrogen is combined with CO_2 (absorbed from air or water) to form glucose and release oxygen.[108] 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 a 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 in an ideal state. Acids have pH values less than 7 while bases have values greater than 7.

Aquatic life forms

[edit]
Further information: Hydrobiology, Marine life, and Aquatic plant

Earth's surface waters are filled with life. The earliest life forms appeared in water; nearly all fish live exclusively in water, and there are many types of marine mammals, such as dolphins and whales. 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.

Aquatic vertebrates must obtain oxygen to survive, and they do so in various ways. Fish have gills instead of lungs, although 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. Some amphibians are able to absorb oxygen through their skin. Invertebrates exhibit a wide range of modifications to survive in poorly oxygenated waters including breathing tubes (see insect and mollusc siphons) and gills (*Carcinus*). However, as invertebrate life evolved in an aquatic habitat most have little or no specialization for respiration in water.

Some of the biodiversity of a coral reef

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Some of the biodiversity of a coral reef

Some marine diatoms Ã¢â‚¬â€œ a key phytoplankton group

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Some marine diatoms – a key phytoplankton group
Squat lobster and Alvinocarididae shrimp at the Von Damm hydrothermal field survive by

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Squat lobster and Alvinocarididae shrimp at the Von Damm hydrothermal field survive by altered water chemistry.

Effects on human civilization

[edit]

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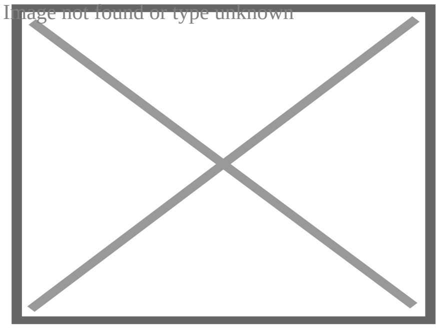
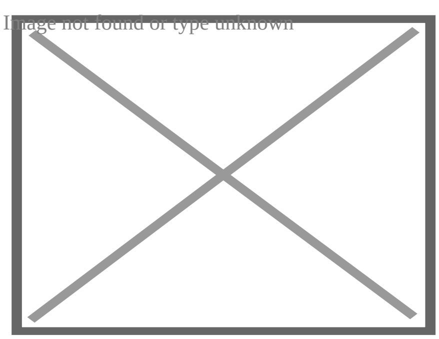


Water fountain

Civilization has historically flourished around rivers and major waterways; Mesopotamia, one of the so-called cradles of civilization, was situated between the major rivers Tigris and Euphrates; the ancient society of the Egyptians depended entirely upon the Nile. The early Indus Valley civilization (c. 3300 BCE – c. 1300 BCE) developed along the Indus River and tributaries that flowed out of the Himalayas. Rome was also founded on the banks of the Italian river Tiber. Large metropolises like Rotterdam, London, Montreal, Paris, New York City, Buenos Aires, Shanghai, Tokyo, Chicago, and Hong Kong owe their success in part to their easy accessibility via water and the resultant expansion of trade. Islands with safe water ports, like Singapore, 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.

Health and pollution

[edit]



An environmental science program – a student from Iowa State University sampling water

Water fit for human consumption is called drinking water or potable water. Water that is not potable may be made potable by filtration or distillation, or by a range of other methods. More than 660 million people do not have access to safe drinking water.[109

][110]

Water that is not fit for drinking but is not harmful to humans when used for swimming or bathing is called by various names other than potable or drinking water, and is sometimes called safe water, or "safe for bathing". Chlorine is a skin and mucous membrane irritant that is used to make water safe for bathing or drinking. Its use is highly technical and is usually monitored by government regulations (typically 1 part per million (ppm) for drinking water, and 1–2 ppm of chlorine not yet reacted with impurities for bathing water). Water for bathing may be maintained in satisfactory microbiological condition using chemical disinfectants such as chlorine or ozone or by the use of ultraviolet light.

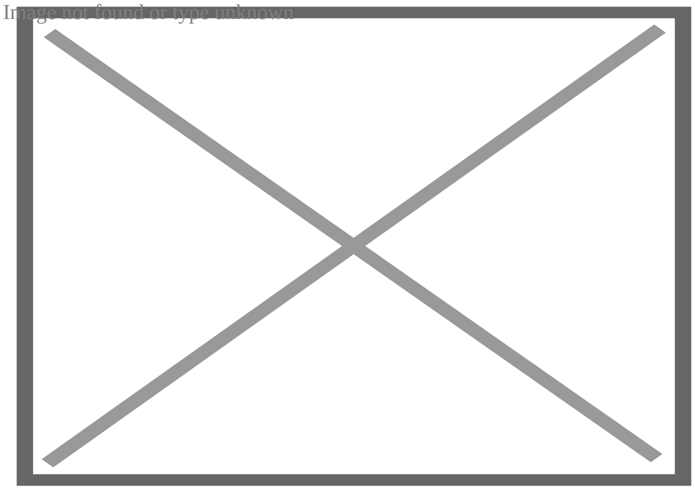
Water reclamation is the process of converting wastewater (most commonly sewage, also called municipal wastewater) into water that can be reused for other purposes. There are 2.3 billion people who reside in nations with water scarcities, which means that each individual receives less than 1,700 cubic metres (60,000 cu ft) of water annually. 380 billion cubic metres (13×10^{12} cu ft) of municipal wastewater are produced globally each year.[111][112][113]

Freshwater is a renewable resource, recirculated by the natural hydrologic cycle, but pressures over access to it result from the naturally uneven distribution in space and time, growing economic demands by agriculture and industry, and rising populations. Currently, nearly a billion people around the world lack access to safe, affordable water. In 2000, the United Nations established the Millennium Development Goals for water to halve by 2015 the proportion of people worldwide without access to safe water and sanitation. Progress toward that goal was uneven, and in 2015 the UN committed to the Sustainable Development Goals of achieving universal access to safe and affordable water and sanitation by 2030. Poor water quality and bad sanitation are deadly; some five million deaths a year are caused by water-related diseases. The World Health Organization estimates that safe water could prevent 1.4 million child deaths from diarrhea each year.[114]

In developing countries, 90% of all municipal wastewater still goes untreated into local rivers and streams.[115] Some 50 countries, with roughly a third of the world's population, also suffer from medium or high water scarcity and 17 of these extract more water annually than is recharged through their natural water cycles.[116] The strain not only affects surface freshwater bodies like rivers and lakes, but it also degrades groundwater resources.

Human uses

[edit]
Further information: Water supply



Total water withdrawals for agricultural, industrial and municipal purposes per capita, measured in cubic metres (m^3) per year in 2010[117]

Agriculture

[edit]

The most substantial human use of water is for agriculture, including irrigated agriculture, which accounts for as much as 80 to 90 percent of total human water consumption.[118] In the United States, 42% of freshwater withdrawn for use is for irrigation, but the vast majority of water "consumed" (used and not returned to the environment) goes to agriculture.[119]

Access to fresh water is often taken for granted, especially in developed countries that have built sophisticated water systems for collecting, purifying, and delivering water, and removing wastewater. But growing economic, demographic, and climatic pressures are increasing concerns about water issues, leading to increasing competition for fixed water resources, giving rise to the concept of peak water.[120] As populations and economies continue to grow, consumption of water-thirsty meat expands, and new demands rise for biofuels or new water-intensive industries, new water challenges are likely.[121]

An assessment of water management in agriculture was conducted in 2007 by the International Water Management Institute in Sri Lanka to see if the world had sufficient water to provide food for its growing population.[122] 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, where there is not enough water to meet all demands. A further 1.6 billion people live in areas experiencing 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 the 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 industries and cities find ways to use water more efficiently.[123]

Water scarcity is also caused by production of water intensive products. For example, cotton: 1 kg of cotton—equivalent of a pair of jeans—requires 10.9 cubic metres (380 cu ft) water to produce. While cotton accounts for 2.4% of world water use, the water is consumed in regions that are already at a risk of water shortage. Significant environmental damage has been caused: for example, the diversion of water by the former Soviet Union from the Amu Darya and Syr Darya rivers to produce cotton was largely responsible for the disappearance of the Aral Sea.[124]

Water requirement per tonne of food product

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  Water requirement per tonne of food product

-

Water distribution in subsurface drip irrigation

Irrigation of field crops

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Irrigation of field crops

As a scientific standard

[edit]

On 7 April 1795, the gram was defined in France to be equal to "the absolute weight of a volume of pure water equal to a cube of one-hundredth of a meter, and at the temperature of melting ice".[125] For practical purposes though, a metallic reference standard was required, one thousand times more massive, the kilogram. Work was therefore commissioned to determine precisely the mass of one liter of water. In spite of the fact that the decreed definition of the gram specified water at 0 °C (32 °F)—a highly reproducible *temperature*—the scientists chose to redefine the standard and to perform their measurements at the temperature of highest water *density*, which was measured at the time as 4 °C (39 °F).[126]

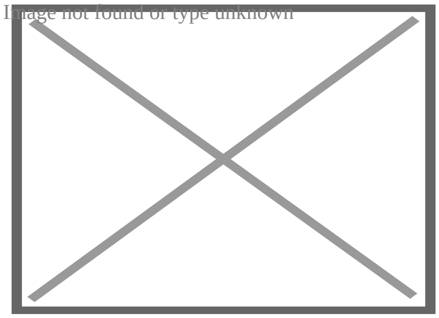
The Kelvin temperature scale of the SI system was based on the triple point of water, defined as exactly 273.16 K (0.01 °C; 32.02 °F), but as of May 2019 is based on the Boltzmann constant instead. The scale is an absolute temperature scale with the same increment as the Celsius temperature scale, which was originally defined according to the boiling point (set to 100 °C (212 °F)) and melting point (set to 0 °C (32 °F)) of water.

Natural water consists mainly of the isotopes hydrogen-1 and oxygen-16, but there is also a small quantity of heavier isotopes oxygen-18, oxygen-17, and hydrogen-2 (deuterium). The percentage of the heavier isotopes is very small, but it still affects the properties of water. Water from rivers and lakes tends to contain less heavy isotopes than seawater. Therefore, standard water is defined in the Vienna Standard Mean Ocean Water specification.

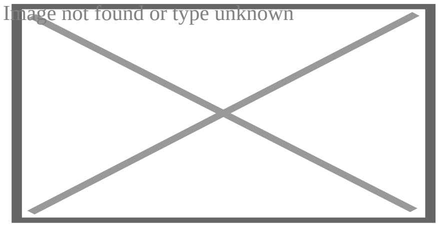
For drinking

[edit]

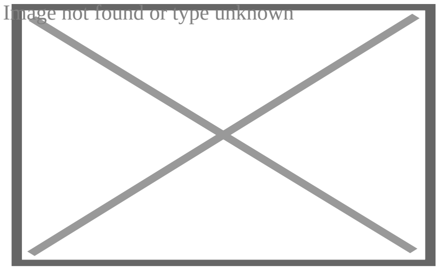
Main article: Drinking water



A young girl drinking bottled water



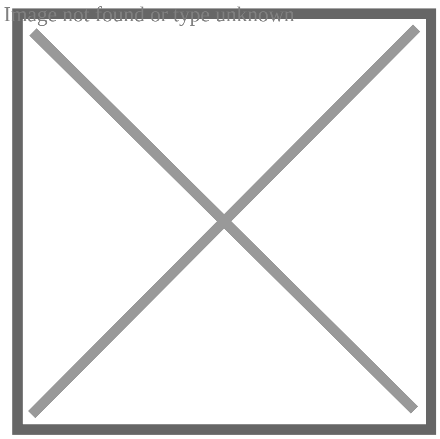
Water availability: the fraction of the population using improved water sources by country



Roadside fresh water outlet from glacier, Nubra

The human body contains from 55% to 78% water, depending on body size.[127][*user-genera* To function properly, the body requires between one and seven litres (0.22 and 1.54 imp gal; 0.26 and 1.85 US gal)[*citation needed*] 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 the British Dietetic Association advises that 2.5 liters of total water daily is the minimum to maintain proper hydration, including 1.8 liters (6 to 7 glasses) obtained directly from beverages.[128] Medical literature favors a lower consumption, typically 1 liter of water for an average male, excluding extra requirements due to fluid loss from exercise or warm weather.[129]

Healthy kidneys can excrete 0.8 to 1 liter of water per hour, but stress such as exercise can reduce this amount. People can drink far more water than necessary while exercising, putting them at risk of water intoxication (hyperhydration), which can be fatal.[130][131] The popular claim that "a person should consume eight glasses of water per day" seems to have no real basis in science.[132] Studies have shown that extra water intake, especially up to 500 millilitres (18 imp fl oz; 17 US fl oz) at mealtime, was associated with weight loss.[133][134][135][136][137][138] Adequate fluid intake is helpful in preventing constipation.[139]



Hazard symbol for non-potable water

An original recommendation for water intake in 1945 by the Food and Nutrition Board of the U.S. 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."[140] The latest dietary reference intake report by the U.S. National Research Council in general recommended, based on the median total water intake from US survey data (including food sources): 3.7 litres (0.81 imp gal; 0.98 US gal) for men and 2.7 litres (0.59 imp gal; 0.71 US gal) of water total for women, noting that water contained in food provided approximately 19% of total water intake in the survey.[141]

Specifically, pregnant and breastfeeding women need additional fluids to stay hydrated. The US Institute of Medicine recommends that, on average, men consume 3 litres (0.66 imp gal; 0.79 US gal) and women 2.2 litres (0.48 imp gal; 0.58 US gal); pregnant women should increase intake to 2.4 litres (0.53 imp gal; 0.63 US gal) and breastfeeding women should get 3 liters (12 cups), since an especially large amount of fluid is lost during nursing.[142] Also noted is that normally, about 20% 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.

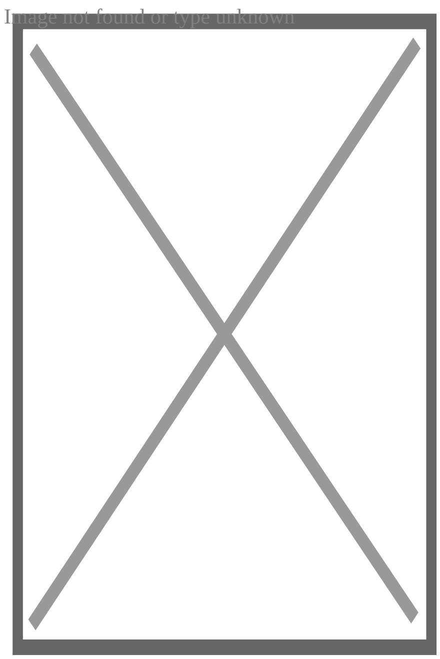
Humans require water with few impurities. Common impurities include metal salts and oxides, including copper, iron, calcium and lead,[143][*full citation needed*] and harmful bacteria, such as *Vibrio*. Some solutes are acceptable and even desirable for taste enhancement and to provide needed electrolytes.[144]

The single largest (by volume) freshwater resource suitable for drinking is Lake Baikal in Siberia.[145]

Washing

[edit]

This section is an excerpt from Washing.[edit]



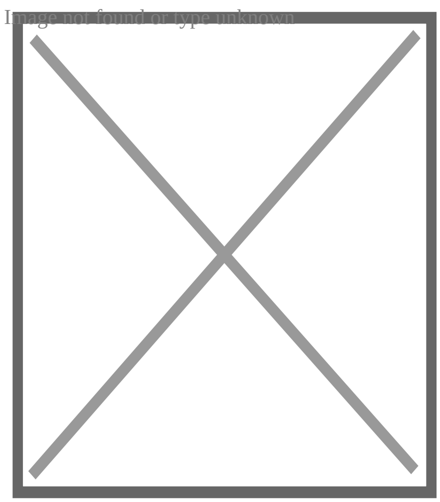
A woman washes her hands with soap and water.

Washing is a method of cleaning, usually with water and soap or detergent. Regularly washing and then rinsing both body and clothing is an essential part of good hygiene and health.[146][147][148]

Often people use soaps and detergents to assist in the emulsification of oils and dirt particles so they can be washed away. The soap can be applied directly, or with the aid of a washcloth or assisted with sponges or similar cleaning tools.

In social contexts, washing refers to the act of bathing, or washing different parts of the body, such as hands, hair, or faces. Excessive washing may damage the hair, causing dandruff, or cause rough skin/skin lesions.[149][150] Some washing of the body is done ritually in religions like Christianity and Judiasm, as an act of purification.

Washing can also refer to washing objects. For example, washing of clothing or other cloth items, like bedsheets, or washing dishes or cookwear. Keeping objects clean, especially if they interact with food or the skin, can help with sanitation. Other kinds of washing focus on maintaining cleanliness and durability of objects that get dirty, such washing one's car, by lathering the exterior with car soap, or washing tools used in a dirty process.



A private home washing machine

Transportation

[edit]

These paragraphs are an excerpt from Maritime transport.[edit]

Maritime transport (or ocean transport) or more generally waterborne transport, is the transport of people (passengers) or goods (cargo) via waterways. Freight transport by sea has been widely used throughout recorded history. The advent of aviation has diminished the importance of sea travel for passengers, though it is still popular for short trips and pleasure cruises. Transport by water is cheaper than transport by air or ground,[151] but significantly slower for longer distances. Maritime transport accounts for roughly 80% of international trade, according to UNCTAD in 2020.

Maritime transport can be realized over any distance by boat, ship, sailboat or barge, over oceans and lakes, through canals or along rivers. Shipping may be for commerce, recreation, or military purposes. While extensive inland shipping is less critical today, the major waterways of the world including many canals are still very important and are integral parts of worldwide economies. Particularly, especially any material can be moved by water; however, water transport becomes impractical when material delivery is time-critical such as various types of perishable produce. Still, water transport is highly cost effective with regular schedulable cargoes, such as trans-oceanic shipping of consumer products – and especially for heavy loads or bulk cargos, such as coal, coke, ores, or grains. Arguably, the Industrial Revolution had its first impacts where cheap water transport by canal, navigations, or shipping by all types of watercraft on natural waterways supported cost-effective bulk transport. Containerization revolutionized maritime transport starting in the 1970s. "General cargo" includes goods packaged in boxes, cases, pallets, and barrels. When a cargo is carried in more than one mode, it is intermodal or co-modal.

Chemical uses

[edit]

Water is widely used in chemical reactions as a solvent or reactant and less commonly as a solute or catalyst. In inorganic reactions, water is a common solvent, dissolving many ionic compounds, as well as other polar compounds such as ammonia and compounds closely related to water. In organic reactions, it is not usually used as a reaction solvent, because it does not dissolve the reactants well and is amphoteric (acidic *and* basic) and nucleophilic. Nevertheless, these properties are sometimes desirable. Also, acceleration of Diels-Alder reactions by water has been observed. Supercritical water has recently been a topic of research. Oxygen-saturated supercritical water combusts organic pollutants efficiently.

Heat exchange

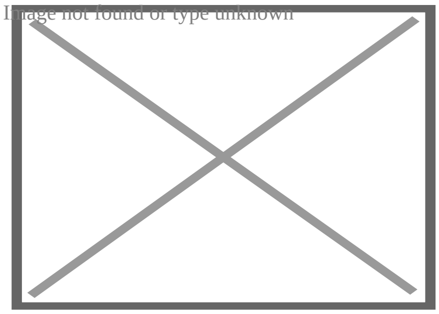
[edit]

Water and steam are a common fluid used for heat exchange, due to its availability and high heat capacity, both for cooling and heating. Cool water may even be naturally available from a lake or the sea. It is especially effective to transport heat through vaporization and condensation of water because of its large latent heat of vaporization. A disadvantage is that metals commonly found in industries such as steel and copper are oxidized faster by untreated water and steam. In almost all thermal power stations, water is used as the working fluid (used in a closed-loop between boiler, steam turbine, and condenser), and the coolant (used to exchange the waste heat to a water body or carry it away by evaporation in a cooling tower). In the United States, cooling power plants is the largest use of water.[152]

In the nuclear power industry, water can also be used as a neutron moderator. In most nuclear reactors, water is both a coolant and a moderator. This provides something of a passive safety measure, as removing the water from the reactor also slows the nuclear reaction down. However other methods are favored for stopping a reaction and it is preferred to keep the nuclear core covered with water so as to ensure adequate cooling.

Fire considerations

[edit]



Water is used for fighting wildfires.

Water has a high heat of vaporization and is relatively inert, which makes it a good fire extinguishing fluid. The evaporation of water carries heat away from the fire. It is dangerous to use water on fires involving oils and organic solvents because many organic materials float on water and the water tends to spread the burning liquid.

Use of water in fire fighting should also take into account the hazards of a steam explosion, which may occur when water is used on very hot fires in confined spaces, and of a hydrogen explosion, when substances which react with water, such as certain metals or hot carbon such as coal, charcoal, or coke graphite, decompose the water, producing water gas.

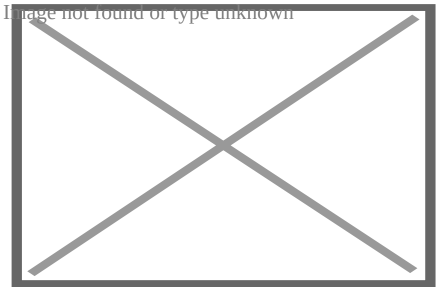
The power of such explosions was seen in the Chernobyl disaster, although the water involved in this case did not come from fire-fighting but from the reactor's own water cooling system. A steam explosion occurred when the extreme overheating of the core caused water to flash into steam. A hydrogen explosion may have occurred as a result of a reaction between steam and hot zirconium.

Some metallic oxides, most notably those of alkali metals and alkaline earth metals, produce so much heat in reaction with water that a fire hazard can develop. The alkaline earth oxide quicklime, also known as calcium oxide, is a mass-produced substance that is often transported in paper bags. If these are soaked through, they may ignite as their contents react with water.[153]

Recreation

[edit]

Main article: Water sport (recreation)



San Andrés island, Colombia

Humans use water for many recreational purposes, as well as for exercising and for sports. Some of these include swimming, waterskiing, boating, surfing and diving. In addition, some sports, like ice hockey and ice skating, are played on ice. Lakesides, beaches and water parks are popular places for people to go to relax and enjoy recreation. Many find the sound and appearance of flowing water to be calming, and fountains and other flowing water structures are popular decorations. Some keep fish and other flora and fauna inside aquariums or ponds for show, fun, and companionship. Humans also use water for snow sports such as skiing, sledding, snowmobiling or snowboarding, which require the water to be at a low temperature either as ice or crystallized into snow.

Water industry

[edit]

The water industry provides drinking water and wastewater services (including sewage treatment) to households and industry. Water supply facilities include water wells, cisterns for rainwater harvesting, water supply networks, and water purification facilities, water tanks, water towers, water pipes including old aqueducts. Atmospheric water generators are in development.

Drinking water is often collected at springs, extracted from artificial borings (wells) in the ground, or pumped from lakes and rivers. 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 include rainwater collection. Water may require purification for human consumption. This may involve the 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 seawater is a more expensive solution used in coastal arid climates.

The distribution of drinking water is done through municipal water systems, tanker delivery or as bottled water. Governments in many countries have programs to distribute water to the needy at no charge.

Reducing usage by using drinking (potable) water only for human consumption is another option. In some cities such as Hong Kong, seawater is extensively used for flushing toilets citywide in order to conserve freshwater 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, victims 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.

Municipal and industrial wastewater are typically treated at wastewater treatment plants. Mitigation of polluted surface runoff is addressed through a variety of prevention and treatment techniques.

A water-carrier in India, 1882. In many places where running water is not available, wate

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

A manual water pump in China

○

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A manual water pump in
China
Water purification facility

○

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Water purification facility
Reverse osmosis (RO) desalination plant in Barcelona, Spain

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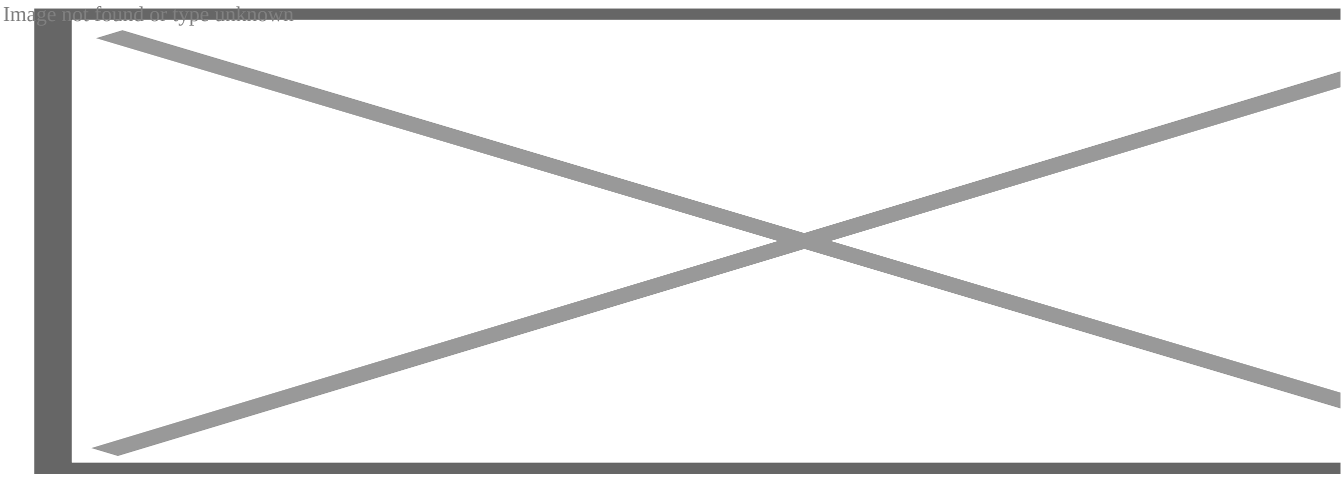
Reverse osmosis (RO)
desalination plant in
Barcelona, Spain

Industrial applications

[edit]

Many industrial processes rely on reactions using chemicals dissolved in water, suspension of solids in water slurries or using water to dissolve and extract substances, or to wash products or process equipment. Processes such as mining, chemical pulping, pulp bleaching, paper manufacturing, textile production, dyeing, printing, and cooling of power plants use large amounts of water, requiring a dedicated water source, and often cause significant water pollution.

Water is used in 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. The energy is supplied by the motion of water. Typically a dam is constructed on a river, creating an artificial lake behind it. Water flowing out of the lake is forced through turbines that turn generators.



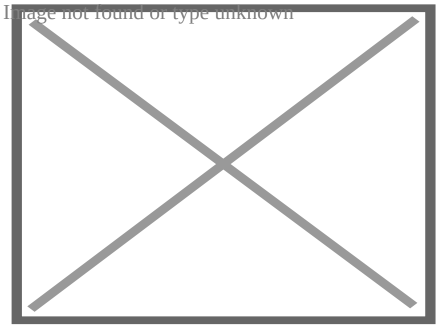
Three Gorges Dam is the largest hydro-electric power station in the world.

Pressurized water is used in water blasting and water jet cutters. High pressure water guns are used for precise cutting. It works very well, is relatively safe, and is not harmful to the environment. It is also used in the cooling of machinery to prevent overheating, or prevent saw blades from overheating.

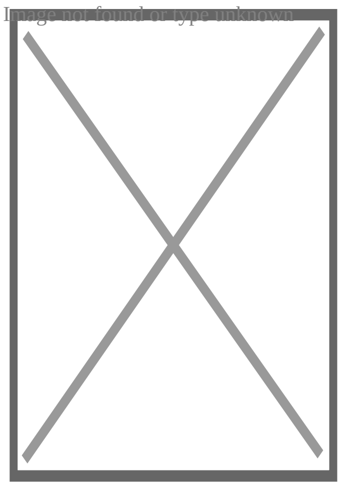
Water is also used in many industrial processes and machines, such as the steam turbine and heat exchanger, in addition to its use as a chemical solvent. Discharge of untreated water from industrial uses is pollution. Pollution includes discharged solutes (chemical pollution) and discharged coolant water (thermal pollution). Industry requires pure water for many applications and uses a variety of purification techniques both in water supply and discharge.

Food processing

[edit]



Water can be used to cook foods such as noodles.



Sterile water for injection

Boiling, steaming, and simmering are popular cooking methods that often require immersing food in water or its gaseous state, steam.[154] Water is also used for dishwashing. Water also plays many critical roles within the field of food science.

Solutes such as salts and sugars found in water affect the physical properties of water. The boiling and freezing points of water are affected by solutes, as well as air pressure, which is in turn affected by altitude. Water boils at lower temperatures with the lower air pressure that occurs at higher elevations. One mole of sucrose (sugar) per kilogram of water raises the boiling point of water by 0.51 °C (0.918 °F), and one mole of salt per kg raises the boiling point by 1.02 °C (1.836 °F); similarly, increasing the number of dissolved particles lowers water's freezing point.[155]

Solutes in water also affect water activity that affects many chemical reactions and the growth of microbes in food.[156] Water activity can be described as a ratio of the vapor pressure of water in a solution to the vapor pressure of pure water.[155] Solutes in water lower water activity—this is important to know because most bacterial growth ceases at low levels of water activity.[156] 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 and may be altered or treated by using a chemical ion exchange system. It can dramatically affect the quality of a product, as well as playing a role in sanitation. Water hardness is classified based on concentration of calcium carbonate the water contains. Water is classified as soft if it contains less than 100 mg/L (UK)[157] or less than 60 mg/L (US).[158]

According to a report published by the Water Footprint organization in 2010, a single kilogram of beef requires 15 thousand litres (3.3×10^3 imp gal; 4.0×10^3 US gal) of water; however, the authors also make clear that this is a global average and circumstantial factors determine the amount of water used in beef production.[159]

Medical use

[edit]

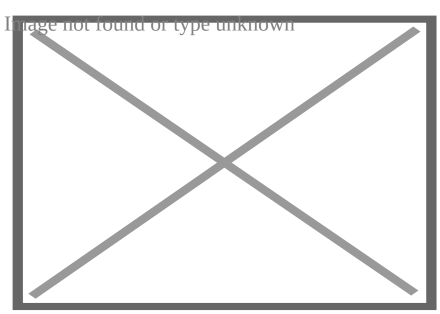
Water for injection is on the World Health Organization's list of essential medicines.[160]

Distribution in nature

[edit]

In the universe

[edit]



Band 5 ALMA receiver is an instrument specifically designed to detect water in the universe.[161]

Much of the universe's water is produced as a byproduct of star formation. The formation of stars 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 observed is quickly produced in this warm dense gas.[162]

On 22 July 2011, a report described the discovery of a gigantic cloud of water vapor containing "140 trillion times more water than all of Earth's oceans combined" around a quasar located 12 billion light years from Earth. According to the researchers, the "discovery shows that water has been prevalent in the universe for nearly its entire existence".[163][164]

Water has been detected in interstellar clouds within the Milky Way.[165] Water probably exists in abundance in other galaxies, too, because its components, hydrogen, and oxygen, are among the most abundant elements in the universe. Based on models of the formation and evolution of the Solar System and that of other star systems, most other planetary systems are likely to have similar ingredients.

Water vapor

[edit]

Water is present as vapor in:

- Atmosphere of the Sun: in detectable trace amounts[166]
- Atmosphere of Mercury: 3.4%, and large amounts of water in Mercury's exosphere[167]
- Atmosphere of Venus: 0.002%[168]
- Earth's atmosphere: ?0.40% over full atmosphere, typically 1–4% at surface; as well as that of the Moon in trace amounts[169]
- Atmosphere of Mars: 0.03%[170]
- Atmosphere of Ceres[171]
- Atmosphere of Jupiter: 0.0004%[172] – in ices only; and that of its moon Europa[173]
- Atmosphere of Saturn – in ices only; Enceladus: 91%[174] and Dione (exosphere)[*citation needed*]
- Atmosphere of Uranus – in trace amounts below 50 bar
- Atmosphere of Neptune – found in the deeper layers[175]
- Extrasolar planet atmospheres: including those of HD 189733 b[176] and HD 209458 b,[177] Tau Boötis b,[178] HAT-P-11b,[179][180] XO-1b, WASP-12b, WASP-17b, and WASP-19b.[181]
- Stellar atmospheres: not limited to cooler stars and even detected in giant hot stars such as Betelgeuse, Mu Cephei, Antares and Arcturus.[180][182]
- Circumstellar disks: including those of more than half of T Tauri stars such as AA Tauri[180] as well as TW Hydrae,[183][184] IRC +10216[185] and APM 08279+5255,[163][164] VY Canis Majoris and S Persei.[182]

Liquid water

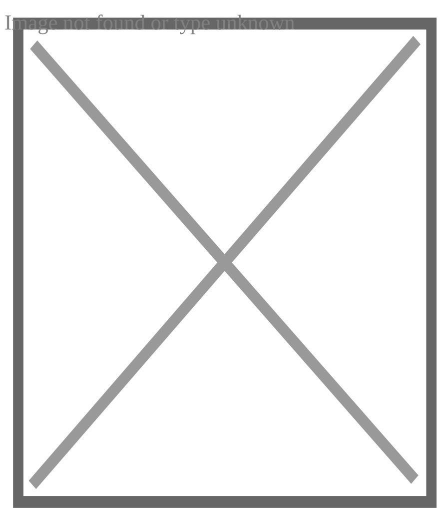
[edit]

Liquid water is present on Earth, covering 71% of its surface.[23] Liquid water is also occasionally present in small amounts on Mars.[186] Scientists believe liquid water is present in the Saturnian moons of Enceladus, as a 10-kilometre thick ocean approximately 30–40 kilometers below Enceladus' south polar surface,[187][188] and Titan, as a subsurface layer, possibly mixed with ammonia.[189] Jupiter's moon Europa has surface characteristics which suggest a subsurface liquid water ocean.[190] Liquid water may also exist on Jupiter's moon Ganymede as a layer sandwiched between high pressure ice and rock.[191]

Water ice

[edit]

Water is present as ice on:

- 

Water ice in the Korolev crater on Mars

  Mars: under the regolith and at the poles.[192][193]
- Earth–Moon system: mainly as ice sheets on Earth and in Lunar craters and volcanic rocks[194] NASA reported the detection of water molecules by NASA's Moon Mineralogy Mapper aboard the Indian Space Research Organization's Chandrayaan-1 spacecraft in September 2009.[195]
- Ceres[196][197][198]

- Jupiter's moons: Europa's surface and also that of Ganymede[199] and Callisto[200][201]
- Saturn: in the planet's ring system[202] and on the surface and mantle of Titan[203] and Enceladus[204]
- Pluto–Charon system[202]
- Comets[205][206] and other related Kuiper belt and Oort cloud objects[207]

And is also likely present on:

- Mercury's poles[208]
- Tethys[209]

Exotic forms

[edit]

Water and other volatiles probably comprise much of the internal structures of Uranus and Neptune and the water in the deeper layers may be in the form of ionic water in which the molecules break down into a soup of hydrogen and oxygen ions, and deeper still as superionic water in which the oxygen crystallizes, but the hydrogen ions float about freely within the oxygen lattice.[210]

Water and planetary habitability

[edit]
Further information: Water distribution on Earth and Planetary habitability

The existence of liquid water, and to a lesser extent its gaseous and solid forms, on Earth are vital to the existence of life on Earth as we know it. The Earth is located in the habitable zone of the Solar System; if it were slightly closer to or farther from the Sun (about 5%, or about 8 million kilometers), the conditions which allow the three forms to be present simultaneously would be far less likely to exist.[211][212]

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

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.[*citation ne*

The state of water on a planet depends on ambient pressure, which is determined by the planet's gravity. If a planet is sufficiently massive, the water on it may be solid even at high temperatures, because of the high pressure caused by gravity, as it was observed on exoplanets Gliese 436 b[213] and GJ 1214 b.[214]

Law, politics, and crisis

[edit]

Main articles: Water law, Water right, and Water scarcity

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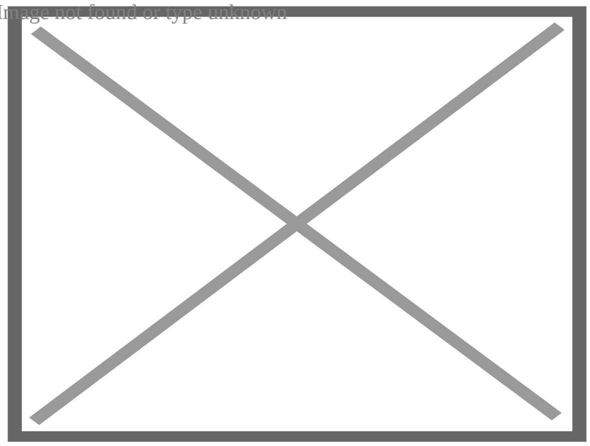


An estimate of the proportion of people in developing countries with access to potable water 1970–2000

Water politics is politics affected by water and water resources. Water, particularly fresh water, is a strategic resource across the world and an important element in many political conflicts. It causes health impacts and damage to biodiversity.

Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation.[215] However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability.[216] A report, issued in November 2009, suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%.[217]

1.6 billion people have gained access to a safe water source since 1990.[218] The proportion of people in developing countries with access to safe water is calculated to have improved from 30% in 1970[219] to 71% in 1990, 79% in 2000, and 84% in 2004.[215]

A 2006 United Nations report stated that "there is enough water for everyone", but that access to it is hampered by mismanagement and corruption.[220] In addition, global initiatives to improve the efficiency of aid delivery, such as the Paris Declaration on Aid Effectiveness, have not been taken up by water sector donors as effectively as they have in education and health, potentially leaving multiple donors working on overlapping projects and recipient governments without empowerment to act.[221]

The authors of the 2007 Comprehensive Assessment of Water Management in Agriculture cited poor governance as one reason for some forms of water scarcity. Water governance is the set of formal and informal processes through which decisions related to water management are made. Good water governance is primarily about knowing what processes work best in a particular physical and socioeconomic context. Mistakes have sometimes been made by trying to apply 'blueprints' that work in the developed world to developing world locations and contexts. The Mekong river is one example; a review by the International Water Management Institute of policies in six countries that rely on the Mekong river for water found that thorough and transparent cost-benefit analyses and environmental impact assessments were rarely undertaken. They also discovered that Cambodia's draft water law was much more complex than it needed to be.[222]

In 2004, the UK charity WaterAid reported that a child dies every 15 seconds from easily preventable water-related diseases, which are often tied to a lack of adequate sanitation.[223][224]

Since 2003, the UN World Water Development Report, produced by the UNESCO World Water Assessment Programme, has provided decision-makers with tools for developing sustainable water policies.[225] The 2023 report states that two billion people (26% of the population) do not have access to drinking water and 3.6 billion (46%) lack access to safely managed sanitation.[226] People in urban areas (2.4 billion) will face water scarcity by 2050.[225] Water scarcity has been described as endemic, due to overconsumption and pollution.[227] The report states that 10% of the world's population lives in countries with high or critical water stress. Yet over the past 40 years, water consumption has increased by around 1% per year, and is expected to grow at the same rate until 2050. Since 2000, flooding in the tropics has quadrupled, while flooding in northern mid-latitudes has increased by a factor of 2.5.[228] The cost of these floods between 2000 and 2019 was 100,000 deaths and $650 million.[225]

Organizations concerned with water protection include the International Water Association (IWA), WaterAid, Water 1st, and the American Water Resources

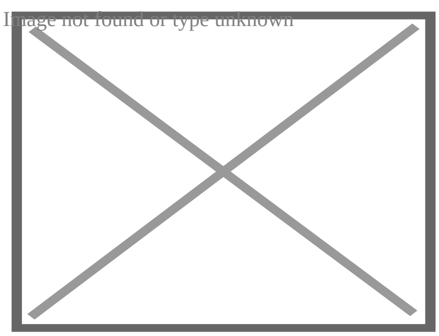
Association. The International Water Management Institute undertakes projects with the aim of using effective water management to reduce poverty. Water related conventions are United Nations Convention to Combat Desertification (UNCCD), International Convention for the Prevention of Pollution from Ships, United Nations Convention on the Law of the Sea and Ramsar Convention. World Day for Water takes place on 22 March[229] and World Oceans Day on 8 June.[230]

In culture

[edit]

Religion

[edit]
Main article: Water and religion
See also: Sacred waters



People come to Inda Abba Hadera spring (Inda Sillasie, Ethiopia) to wash in holy water.

Water is considered a purifier in most religions. Faiths that incorporate ritual washing (ablution) include Christianity,[231] Hinduism, Islam, Judaism, the Rastafari movement, Shinto, Taoism, and Wicca. Immersion (or aspersion or affusion) of a person in water is a central Sacrament of Christianity (where it is called baptism); it is also a part of the practice of other religions, including Islam (*Ghusl*), Judaism (*mikvah*) and Sikhism (*Amrit Sanskar*). In addition, a ritual bath in pure water is performed for the dead in many religions including Islam and Judaism. In Islam, the five daily prayers can be done in most cases after washing certain parts of the body using clean water (*wudu*), unless water is unavailable (see *Tayammum*). In Shinto, water is used in almost all rituals to cleanse a person or an area (e.g., in the ritual of *misogi*).

In Christianity, holy water is water that has been sanctified by a priest for the purpose of baptism, the blessing of persons, places, and objects, or as a means of repelling evil.[232][233]

In Zoroastrianism, water (*Ã„Â•Ã*) is respected as the source of life.[234]

Philosophy

[edit]

Icosahedron as a part of Spinoza monument in Amsterdam.

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Icosahedron as a part of Spinoza monument in Amsterdam

The Ancient Greek philosopher Empedocles saw water as one of the four classical elements (along with fire, earth, and air), and regarded it as an ylem, or basic substance of the universe. Thales, whom Aristotle portrayed as an astronomer and an engineer, theorized that the earth, which is denser than water, emerged from the water. Thales, a monist, believed further that all things are made from water. Plato believed that the shape of water is an icosahedron – flowing easily compared to the cube-shaped earth.[235]

The theory of the four bodily humors associated water with phlegm, as being cold and moist. The classical element of water was also one of the five elements in traditional Chinese philosophy (along with earth, fire, wood, and metal).

Some traditional and popular Asian philosophical systems take water as a role-model. James Legge's 1891 translation of the *Dao De Jing* states, "The highest excellence is like (that of) water. The excellence of water appears in its benefiting all things, and in its occupying, without striving (to the contrary), the low place which all men dislike. Hence (its way) is near to (that of) the Tao" and "There is nothing in the world more soft and weak than water, and yet for attacking things that are firm and strong there is nothing that can take precedence of it—for there is nothing (so effectual) for which it can be changed."[236] *Guanzi* in the "Shui di" Ã¦Â°Â´Ã¥Å“Â° chapter further elaborates on the symbolism of water, proclaiming that "man is water" and attributing natural qualities of the people of different Chinese regions to the character of local water resources.[237]

Folklore

[edit]

"Living water" features in Germanic and Slavic folktales as a means of bringing the dead back to life. Note the Grimm fairy-tale ("The Water of Life") and the Russian dichotomy of living [ru] and dead water [ru]. The Fountain of Youth represents a related concept of magical waters allegedly preventing aging.

Art and activism

[edit]

In the significant modernist novel *Ulysses* (1922) by Irish writer James Joyce, the chapter "Ithaca" takes the form of a catechism of 309 questions and answers, one of which is known as the "water hymn".[238]:Ã¢â,¬Å 91Ã¢â,¬Å According to Richard E. Madtes, the hymn is not merely a "monotonous string of facts", rather, its phrases, like their subject, "ebb and flow, heave and swell, gather and break, until they subside into the calm quiescence of the concluding 'pestilential fens, faded flowerwater, stagnant pools in the waning moon.'"[238]:Ã¢â,¬Å 79Ã¢â,¬Å The hymn is considered one of the most remarkable passages in Ithaca, and according to literary critic Hugh Kenner, achieves "the improbable feat of raising to poetry all the clutter of footling information that has accumulated in schoolbooks."[238]:Ã¢â,¬Å 91Ã¢â,¬Å The literary motif of water represents the novel's theme of "everlasting, everchanging life," and the hymn represents the culmination of the motif in the novel.[238]:Ã¢â,¬Å 91Ã¢â,¬Å The following is the hymn quoted in full.[239]

> What in water did Bloom, waterlover, drawer of water, watercarrier returning to the range, admire?
> Its universality: its democratic equality and constancy to its nature in seeking its own level: its vastness in the ocean of Mercator’s projection: its unplumbed profundity in the Sundam trench of the Pacific exceeding 8,000 fathoms: the restlessness of its waves and surface particles visiting in turn

all points of its seaboard: the independence of its units: the variability of states of sea: its hydrostatic quiescence in calm: its hydrokinetic turgidity in neap and spring tides: its subsidence after devastation: its sterility in the circumpolar icecaps, arctic and antarctic: its climatic and commercial significance: its preponderance of 3 to 1 over the dry land of the globe: its indisputable hegemony extending in square leagues over all the region below the subequatorial tropic of Capricorn: the multisecular stability of its primeval basin: its luteofulvous bed: its capacity to dissolve and hold in solution all soluble substances including millions of tons of the most precious metals: its slow erosions of peninsulas and downwardtending promontories: its alluvial deposits: its weight and volume and density: its imperturbability in lagoons and highland tarns: its gradation of colours in the torrid and temperate and frigid zones: its vehicular ramifications in continental lakecontained streams and confluent oceanflowing rivers with their tributaries and transoceanic currents: gulfstream, north and south equatorial courses: its violence in seaquakes, waterspouts, artesian wells, eruptions, torrents, eddies, freshets, spates, groundswells, watersheds, waterpartings, geysers, cataracts, whirlpools, maelstroms, inundations, deluges, cloudbursts: its vast circumterrestrial ahorizontal curve: its secrecy in springs, and latent humidity, revealed by rhabdomantic or hygrometric instruments and exemplified by the well by the hole in the wall at Ashtown gate, saturation of air, distillation of dew: the simplicity of its composition, two constituent parts of hydrogen with one constituent part of oxygen: its healing virtues: its buoyancy in the waters of the Dead Sea: its persevering penetrativeness in runnels, gullies, inadequate dams, leaks on shipboard: its properties for cleansing, quenching thirst and fire, nourishing vegetation: its infallibility as paradigm and paragon: its metamorphoses as vapour, mist, cloud, rain, sleet, snow, hail: its strength in rigid hydrants: its variety of forms in loughs and bays and gulfs and bights and guts and lagoons and atolls and archipelagos and sounds and fjords and minches and tidal estuaries and arms of sea: its solidity in glaciers, icebergs, icefloes: its docility in working hydraulic millwheels, turbines, dynamos, electric power stations, bleachworks, tanneries, scutchmills: its utility in canals, rivers, if navigable, floating and graving docks: its potentiality derivable from harnessed tides or watercourses falling from level to level: its submarine fauna and flora (anacoustic, photophobe) numerically, if not literally, the inhabitants of the globe: its ubiquity as constituting 90% of the human body: the noxiousness of its effluvia in lacustrine marshes, pestilential fens, faded flowerwater, stagnant pools in the waning moon.

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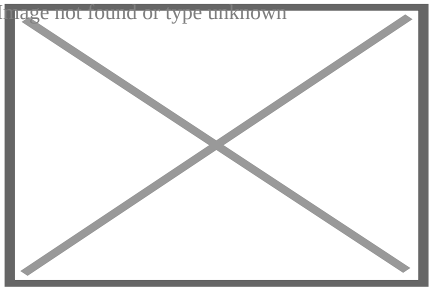

The vast "water hymn" in James Joyce's novel *Ulysses* is occasioned when the protagonist Leopold Bloom fills a kettle with water from a kitchen faucet.[239]

Painter and activist Fredericka Foster curated *The Value of Water*, at the Cathedral of St. John the Divine in New York City,[240] which anchored a year-long initiative by the Cathedral on our dependence on water.[241][242] The largest exhibition to ever appear at the Cathedral,[243] it featured over forty artists, including Jenny Holzer, Robert Longo, Mark Rothko, William Kentridge, April Gornik, Kiki Smith, Pat Steir, Alice Dalton Brown, Teresita Fernandez and Bill Viola.[244][245] Foster created Think About Water,[246][*full citation needed*] an ecological collective of artists who use water as their subject or medium. Members include Basia Irland,[247][*full citation needed*] Aviva Rahmani, Betsy Damon, Diane Burko, Leila Daw, Stacy Levy, Charlotte Coté,[248] Meridel Rubenstein, and Anna Macleod.

To mark the 10th anniversary of access to water and sanitation being declared a human right by the UN, the charity WaterAid commissioned ten visual artists to show the impact of clean water on people's lives.[249][250]

Dihydrogen monoxide parody

[edit]
Main article: Dihydrogen monoxide parody

'Dihydrogen monoxide' is a technically correct but rarely used chemical name of water. This name has been used in a series of hoaxes and pranks that mock scientific illiteracy. This began in 1983, when an April Fools' Day article appeared in a newspaper in Durand, Michigan. The false story consisted of safety concerns about the substance.[251]

Music

[edit]

The word "Water" has been used by many Florida based rappers as a sort of catchphrase or adlib. Rappers who have done this include BLP Kosher and Ski Mask the Slump God.[252] To go even further some rappers have made whole songs dedicated to the water in Florida, such as the 2023 Danny Towers song "Florida Water".[253] Others have made whole songs dedicated to water as a whole, such as XXXTentacion, and Ski Mask the Slump God with their hit song "H2O".

See also

[edit]

- icon Image not found or type unknown Oceans portal
- icon Image not found or type unknown Renewable energy portal
- icon Image not found or type unknown Water portal
- icon Image not found or type unknown Weather portal
- Outline of water – Overview of and topical guide to water
- Water (data page) – Chemical data page for water is a collection of the chemical and physical properties of water.
- Aquaphobia – Persistent and abnormal fear of water
- Blue roof – Roof of a building that is designed to provide temporary water storage
- Catchwater – Runoff catching or channeling device
- Human right to water and sanitation
- Hydroelectricity – Electricity generated by hydropower
- Marine current power – Extraction of power from ocean currents
- Marine energy – Energy available from oceans
- Mpemba effect – Natural phenomenon that hot water freezes faster than cold
- Oral rehydration therapy – Type of fluid replacement used to prevent and treat dehydration
- Osmotic power – Energy available from the difference in the salt concentration between seawater and river water
- Oxyhydrogen – Explosive mixture of hydrogen and oxygen gases
- Properties of water – Physical and chemical properties of pure water
- Rainwater tank – container used to collect rainwater
- Thirst – Craving for potable fluids experienced by animals
- Tidal power – Technology to convert the energy from tides into useful forms of power

- Water pinch analysis – A systematic technique for reducing water consumption and wastewater generation
- Wave power – Transport of energy by wind waves, and the capture of that energy to do useful work
- Water filter – Device that removes impurities in water
- Water heat recycling – Use of a heat exchanger to recover energy and reuse heat from drain water
- Water recycling shower
- Water-sensitive urban design – Integrated approach to urban water cycle

Notes

[edit]

1. **^** A commonly quoted value of 15.7 used mainly in organic chemistry for the pK_a of water is incorrect.[12][13]
2. ^ ***a b*** Vienna Standard Mean Ocean Water (VSMOW), used for calibration, melts at 273.1500089(10) K (0.000089(10) °C, and boils at 373.1339 K (99.9839 °C). Other isotopic compositions melt or boil at slightly different temperatures.
3. **^** see the taste and odor section
4. **^** Other substances with this property include bismuth, silicon, germanium and gallium.[53]

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Water

Overviews	Outline Data Model Properties	Water droplet Image not found or type unknown Water droplet

States

- Liquid
- Ice
- Vapor
- Steam
  - superheated

Forms

- Deuterium-depleted
- Semiheavy
- Heavy
- Tritiated
- Doubly labeled water
- Hydronium

On Earth

- Cycle
- Distribution
- Hydrosphere
  - Hydrology
  - Hydrobiology
- Origin
- Pollution
- Resources
  - management
  - policy
- Supply

Extraterrestrial

- Extraterrestrial liquid water
  - Asteroidal water
  - Planetary oceanography
  - Ocean world
  - Hycean planet
  - List of Candidates
- Specific
  - Europa
  - Mars
  - Moon
  - Enceladus

Physical parameters

- Stratification
  - Ocean stratification
  - Lake stratification
- Ocean temperature

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Food chemistry

- Additives
- Carbohydrates
- Coloring
- Enzymes
- Essential fatty acids
- Flavors
- Fortification
- Lipids
- "Minerals" (Chemical elements)
- Proteins
- Vitamins
- Water

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Natural resources

Air	Pollution / quality	Ambient standards (US) Index Indoor Law – Clean Air Act (US) Ozone depletion
	Emissions	Airshed Trading Deforestation (REDD)

Energy

- Bio
- Law
- Resources
- Fossil fuels (gas, peak coal, peak gas, peak oil)
- Geothermal
- Hydro
- Nuclear
- Solar
    - sunlight
    - shade
- Wind

Land

- Agricultural
  - arable
    - peak farmland
- Degradation
- Field
- Landscape
  - cityscape
  - seascape
  - soundscape
  - viewshed
- Law
  - property
- Management
  - habitat conservation
- Minerals
  - gemstone
  - industrial
  - ore
    - metal
  - mining
    - law
    - sand
  - peak
    - copper
    - phosphorus
  - rights
- Soil
  - conservation
  - fertility
  - health
  - resilience
- Use
  - planning
  - reserve

Life

- Biodiversity
- Bioprospecting
  - biopiracy
- Biosphere
- Bushfood
- Bushmeat
- Fisheries
  - climate change
  - law
  - management
- Forests
  - genetic resources
  - law
  - management
  - non-timber products
- Game
  - law
- Marine conservation
- Meadow
- Pasture
- Plants
  - FAO Plant Treaty
  - food
  - genetic resources
  - gene banks
  - herbal medicines
  - UPOV Convention
  - wood
- Rangeland
- Seed bank
- Wildlife
  - conservation
  - management

Water

Types / location

- Aquifer
  - storage and recovery
- Drinking
- Fresh
- Groundwater
  - pollution
  - recharge
  - remediation
- Hydrosphere
- Ice
  - bergs
  - glacial
  - polar
- Irrigation
  - *huerta*
- Marine
- Rain
  - harvesting
- Stormwater
- Surface water
- Sewage
  - reclaimed water
- Watershed

Aspects

- Desalination
- Floods
- Law
- Leaching
- Sanitation
  - improved
- Scarcity
- Security
- Supply
- Efficiency
- Conflict
- Conservation
- Peak water
- Pollution
- Privatization
- Quality
- Right
- Resources
  - improved
  - policy

Related

- Commons
  - enclosure
  - global
  - land
  - tragedy of
- Economics
  - ecological
  - land
- Ecosystem services
- Exploitation
  - overexploitation
  - Earth Overshoot Day
- Management
  - adaptive
- Natural capital
  - accounting
  - good
- Natural heritage
- Nature reserve
  - remnant natural area
- Systems ecology
- Urban ecology
- Wilderness

Resource

- Common-pool
- Conflict (perpetuation)
- Curse
- Depletion
- Extraction
- Nationalism
- Renewable / Non-renewable

Politics

- Oil war
- Petrostate
- Resource war

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Molecules detected in outer space

Diatomic

- Aluminium monochloride
- Aluminium monofluoride
- Aluminium(II) oxide
- Argonium
- Carbon cation
- Carbon monophosphide
- Carbon monosulfide
- Carbon monoxide
- Cyano radical
- Diatomic carbon
- Fluoromethylidynium
- Helium hydride ion
- Hydrogen chloride
- Hydrogen fluoride
- Hydrogen (molecular)
- Hydroxyl radical
- Iron(II) oxide
- Magnesium monohydride
- Methylidyne radical
- Nitric oxide
- Nitrogen (molecular)
- Imidogen
- Sulfur mononitride
- Oxygen (molecular)
- Phosphorus monoxide
- Phosphorus mononitride
- Potassium chloride
- Silicon carbide
- Silicon monoxide
- Silicon monosulfide
- Sodium chloride
- Sodium iodide
- Sulfanyl
- Sulfur monoxide
- Titanium(II) oxide
- Aluminium(I) hydroxide
- Aluminium isocyanide
- Amino radical
- Carbon dioxide
- Carbonyl sulfide
- CCP radical
- Chloronium
- Diazenylium
- Dicarbon monoxide
- Disilicon carbide
- Ethynyl radical
- Formyl radical

Deuterated molecules	○ Ammonia ○ Ammonium ion ○ Formaldehyde ○ Formyl radical ○ Heavy water ○ Hydrogen cyanide ○ Hydrogen deuteride ○ Hydrogen isocyanide ○ Propyne ○ N_2D^+ ○ Trihydrogen cation
Unconfirmed	○ Anthracene ○ Dihydroxyacetone ○ Methoxyethane ○ Glycine ○ Graphene ○ Hemolithin ○ H_2NCO^+ ○ Linear C_5 ○ Naphthalene cation ○ Phosphine ○ Pyrene ○ Silylidyne

Related

- Abiogenesis
- Astrobiology
- Astrochemistry
- Atomic and molecular astrophysics
- Chemical formula
- Circumstellar dust
- Circumstellar envelope
- Cosmic dust
- Cosmic ray
- Cosmochemistry
- Diffuse interstellar band
- Earliest known life forms
- Extraterrestrial life
- Extraterrestrial liquid water
- Forbidden mechanism
- Homochirality
- Intergalactic dust
- Interplanetary medium
- Interstellar medium
- Photodissociation region
- Iron–sulfur world theory
- Kerogen
- Molecules in stars
- Nexus for Exoplanet System Science
- Organic compound
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- PAH world hypothesis
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Things To Do in Cook County

Photo

Navy Pier

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Driving Directions in Cook County

Driving Directions From Comfort Inn Hoffman Estates - Schaumburg to United Structural Systems of Illinois, Inc

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Reviews for United Structural Systems of Illinois, Inc

United Structural Systems of Illinois, Inc

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Dave Kari

(5)

What a fantastic experience! Owner Rick Thomas is a trustworthy professional. Nick and the crew are hard working, knowledgeable and experienced. I interviewed every company in the area, big and small. A homeowner never wants to hear that they have foundation issues. Out of every company, I trusted USS the most, and it paid off in the end. Highly recommend.

United Structural Systems of Illinois, Inc

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Paul Gunderlock

(4)

The staff was helpful, very nice and easy to work with and completed the work timely and cleaned up well. Communications faltered a bit at times and there was an email communications glitch which was no fault of anyone, but no big deal and all ended up fine. We sure feel better to have this done and hope that is the end of our structural issues. It does seem like (after talking to several related companies), that it would be great if some of these related companies had a structural engineer on staff vs using on the job expertise gained over years - which is definitely valuable! But leaves a bit of uncertainty - and probably saves money for both sides may be the trade-off? So far, so good though! Thank you.

United Structural Systems of Illinois, Inc

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Sarah McNeily

(5)

USS was excellent. They are honest, straightforward, trustworthy, and conscientious. They thoughtfully removed the flowers and flower bulbs to dig where they needed in the yard, replanted said flowers and spread the extra dirt to fill in an area of the yard. We've had other services from different companies and our yard was really a mess after. They kept the job site meticulously clean. The crew was on time and friendly. I'd recommend them any day! Thanks to Jessie and crew.

United Structural Systems of Illinois, Inc

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Jim de Leon

(5)

It was a pleasure to work with Rick and his crew. From the beginning, Rick listened to my concerns and what I wished to accomplish. Out of the 6 contractors that quoted the project, Rick seemed the MOST willing to accommodate my wishes. His pricing was definitely more than fair as well. I had 10 push piers installed to stabilize and lift an addition of my house. The project commenced at the date that Rick had disclosed initially and it was completed within the same time period expected (based on Rick's original assessment). The crew was well informed, courteous, and hard working. They were not loud (even while equipment was being utilized) and were well spoken. My neighbors were very impressed on how polite they were when they entered / exited my property (saying hello or good morning each day when they crossed paths). You can tell they care about the customer concerns. They ensured that the property would be put back as clean as possible by placing MANY sheets of plywood down prior to excavating. They compacted the dirt back in the holes extremely well to avoid large stock piles of soils. All the while, the main office was calling me to discuss updates and expectations of completion. They provided waivers of lien, certificates of insurance, properly acquired permits, and JULIE locates. From a construction background, I can tell you that I did not see any flaws in the way they operated and this an extremely professional company. The pictures attached show the push piers added to the foundation (pictures 1, 2 & 3), the amount of excavation (picture 4), and the restoration after dirt was placed back in the pits and compacted (pictures 5, 6 & 7). Please notice that they also sealed two large cracks and steel plated these cracks from expanding further (which you can see under my sliding glass door). I, as well as my wife, are extremely happy that we chose United Structural Systems for our contractor. I would happily tell any of my friends and family to use this contractor should the opportunity arise!

United Structural Systems of Illinois, Inc

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Chris Abplanalp

(5)

USS did an amazing job on my underpinning on my house, they were also very courteous to the proximity of my property line next to my neighbor. They kept things in order with all the dirt/mud they had to excavate. They were done exactly in the timeframe they indicated, and the contract was very details oriented with drawings of what would be done. Only thing that would have been nice, is they left my concrete a little muddy with boot prints but again, all-in-all a great job

Exploring Practical Uses for Crack Gauges**View GBP**

Frequently Asked Questions

How do crack gauges help in assessing foundation cracks?

Crack gauges provide precise measurements of crack width changes over time, helping to determine if a foundation crack is stable or worsening. This information is crucial for deciding whether immediate repair is necessary or if the situation can be monitored further.

Can crack gauges indicate the type of repair needed for a foundation crack?

While crack gauges themselves dont specify the repair method, they offer critical data on crack movement and behavior. This data helps engineers or professionals decide on appropriate repairs, such as underpinning, epoxy injection, or other stabilization techniques.

Are there different types of crack gauges suitable for various foundation issues?

Yes, there are different types of crack gauges designed for specific applications. For example, some are better suited for vertical displacement measurement while others track horizontal movement. Selecting the right type depends on the nature and orientation of the foundation cracks being monitored.

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