Groundwater facts

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What is groundwater?

Groundwater is water that is found beneath the Earth's surface and fills the pores in sediment or the cracks in underground rocks. It makes up 30% of all freshwater[1].

Groundwater is regularly pumped from drilled boreholes (wells) for use in farming, industry and homes. The depth we must drill or dig through until we find groundwater (referred to as the water table) varies greatly depending on the location. Sometimes groundwater can be found just below the surface (for example, in bogs or wetlands). In others places, such as deserts, we must drill very deep, often deeper than the length of a rugby pitch.

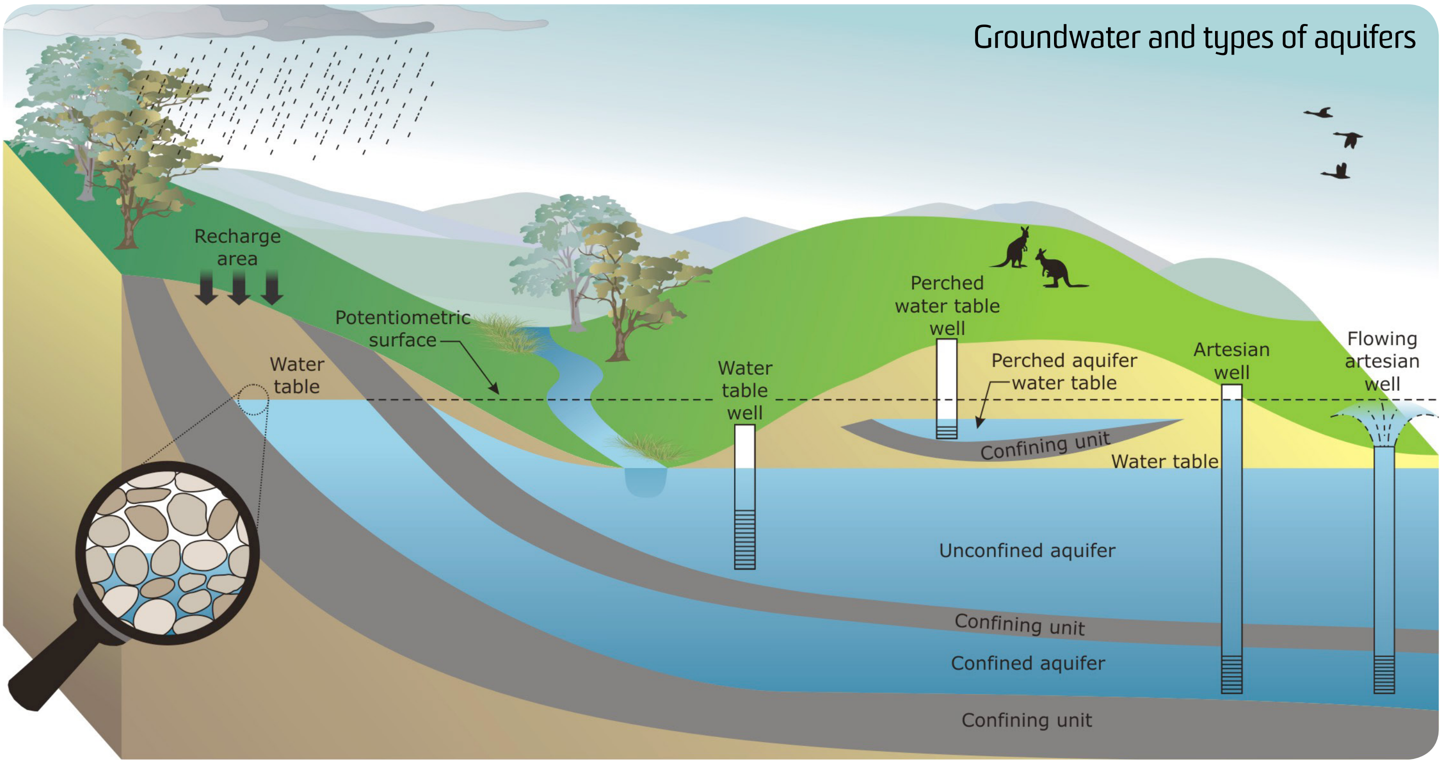
Groundwater is recharged by surface water from rain, rivers, snow or melting ice.

How much groundwater exists on Earth?

Based on some rough resource estimates, if we pooled all of the Earth's groundwater on the land surface we would find ourselves under an impressive 200 metres of water. That's the equivalent of 40 million Sydney Harbours[6]. However, the majority of this water is not easily extractable.

Some groundwater is young, meaning it has infiltrated into the Earth's subsurface within the past 50 years. If we took all of this young groundwater and pooled it on the Earth's continents, we would all be under 3 metres of water[7].

Young groundwater is replenished relatively rapidly and its use is therefore more sustainable.



Groundwater and types of aquifers

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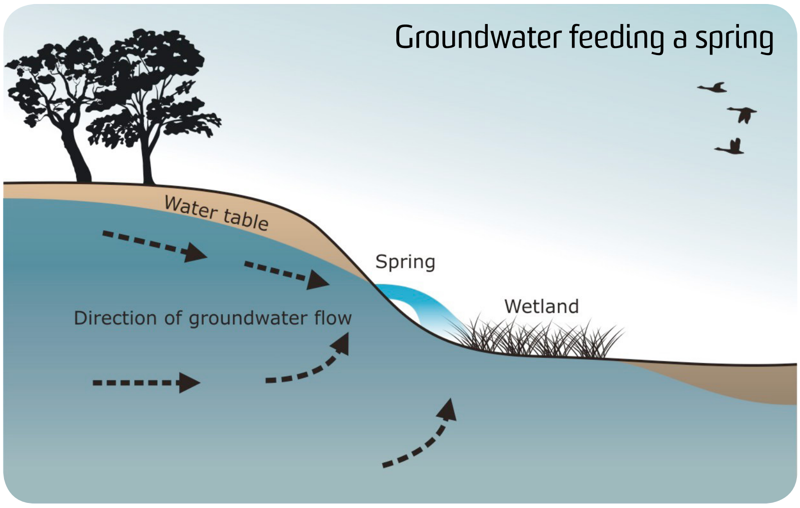
99% of all water on Earth that is available for use is groundwater[2]

Can we see groundwater?

While groundwater is mostly hidden to our eyes, we can see it when it comes to the surface. Water at the surface and underground is connected through the water cycle.

For example, springs are locations where groundwater comes to the surface and feeds a stream or a lake.

Another example is when streams or rivers often flow even if it has not rained for some time. This is made possible by the slow seep of groundwater adding to the water in the stream.



One third of all the water used in Australia is groundwater

Why is groundwater important?

Despite the fact that we don't normally see groundwater (unlike rivers and lakes), it is a vital resource for both ecosystems and human activity. It plays a very important role in the water cycle.

Many parts of the world are heavily dependent on groundwater due to low levels of rainfall. In the Australian Outback, most communities could not exist without access to groundwater.

For example, Alice Springs in the Northern Territory relies on groundwater for nearly 100% of its water needs[3]. Even many bigger cities, such as Perth[4] rely on groundwater to supply a large amount of their water. Overall, Australia uses groundwater for approximately one third of its water supply[5].

Can we help protect and replenish groundwater?

The easiest way to limit impacts on groundwater levels (and all water resources) is to reduce consumption of water-intensive products. There are also engineering solutions that can help. Managed aquifer recharge (MAR) is the practice of putting water back into the ground to limit groundwater depletion[15]. It can be accomplished by pumping storm, river, lake, or recycled water into special wells to replenish an aquifer.

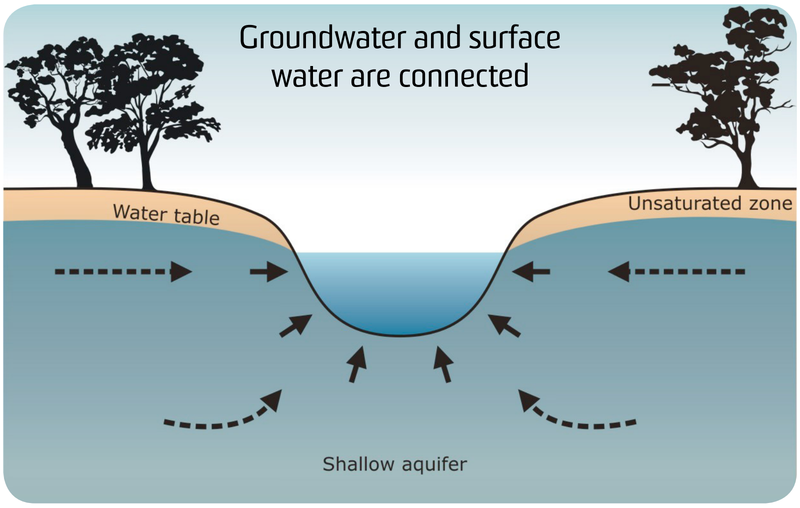
The management of the Earth's precious freshwater resources must treat groundwater and surface water (lakes, rivers, etc.) as a connected resource. In recognising that groundwater is not an infinite and separate resource, better decisions regarding its sustainable management can be made.

What is hydrogeology?

Hydrogeology is the study of groundwater. In Greek: "hydro" means water, "geology" means study of earth.

Hydrogeologists are practitioners and scientists who study and work with groundwater.

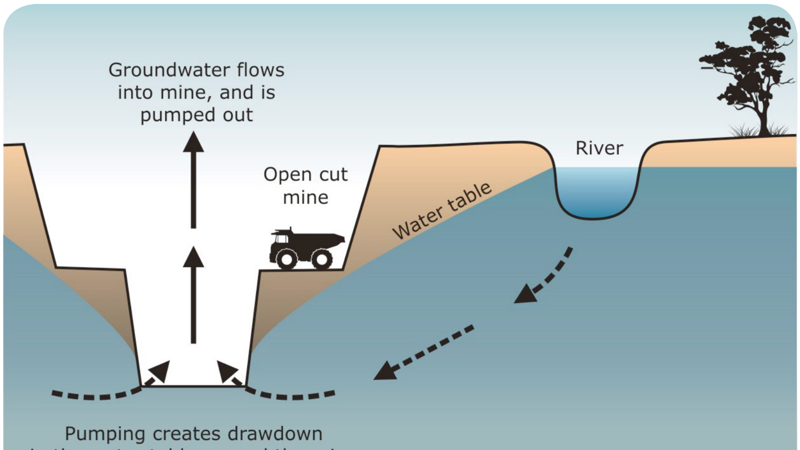
Hydrogeology is a very diverse field of study which involves aspects of chemistry, physics, geology, and engineering.



What do hydrogeologists do?

Hydrogeologists investigate many types of problems involving groundwater. For example, its interaction with streams, climate, human activity, ecology, etc.

These investigations are often related to issues in: water supply, agriculture, mining, subsurface contamination from spills, or industrial leakage, etc.



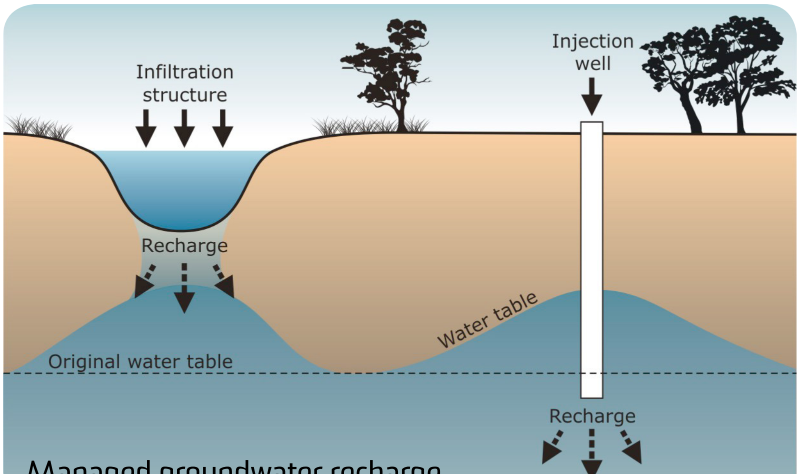
Groundwater and mining

Interesting examples of what hydrogeologists do

Hydrogeologists recently developed new techniques to use naturally occurring radioactive Xenon to estimate the age of water seeping into a Canadian mine 2.4 km deep (that's deeper than Australia's highest point is high[8]). They discovered that the water was 2.64 billion years old.

In Bangladesh, hydrogeologists identified and measured high levels of naturally occurring arsenic in groundwater. As millions of people in Bangladesh rely on groundwater, especially as drinking water, the problem was quickly recognised to be very significant.

Water scientists recommend pre-treatment and aeration of groundwater to reduce arsenic concentrations in groundwater to levels that are safe for human consumption[10]. Hydrogeologists have also used satellites to measure groundwater levels in a region of India where over 100 million people rely on groundwater for much of their water needs. These measurements have shown that groundwater is being used much faster than it is being replenished[11] - which is unsustainable.



Managed groundwater recharge

2.64 billion years is the oldest measured water in the world! More than 10 times older than the earliest dinosaur[9]

What controls the flow of groundwater?

Simply put, larger changes in groundwater level (for example, due to rainfall or groundwater pumping) lead to higher flow rates. However, the direction and speed of groundwater flow is actually quite complex due to the massive range in **permeability** of the rocks or sediments that make up the Earth's subsurface.

In some places, groundwater can become heavily pressurised due to very slow geological changes or variations in the local land surface that lead to water under pressure, called confined **aquifers**.

In other places, these aquifers may be under so much pressure that water can gush out of wells without the need for pumps (much like poking a hole in a water balloon). A well that has free-flowing water at the surface is called an artesian well. These wells are common in the Great Artesian Basin (GAB) of the Australian Outback.

What are some of the challenges facing groundwater today?

Natural recharge of groundwater is a gradual and very slow process in many parts of the world. The fast extraction of groundwater is unsustainable and has led to negative effects on the environment, conflict between water users, and deteriorated water quality[12].

Cities are full of human activity and therefore rely on groundwater to supply their water needs. When the water is taken away from an underground aquifer, the material can start to compress like a sponge as it is no longer able to support the heavy load of the rock and infrastructure above. As a result the land surface moves downward.

This process is called land subsidence and has become a big problem in many parts of the world. For example, in Bangkok (Thailand) subsidence caused by over-extraction of groundwater once reached a speed of over 1 metre per year[13]. This may sound slow, but when the Earth's surface sinks, roads, buildings and water pipes start to break apart causing significant damage and disruption to human activity.

Groundwater is not the only resource found underground. Mining underground resources (e.g., iron ore, coal or gas) requires removal of groundwater which involves significant challenges. These operations can produce large amounts of groundwater with undesirable mineral properties as a by-product.

Underground mining can have negative effects on ecology, including fish and plants[14]. Furthermore, new techniques in gas extraction create cracks in rocks (referred to as fracking) which may connect aquifers that have been disconnected for millions of years. These new cracks can create pathways for contaminants which might end up in water that is used for consumption or production.

What are aquifers and aquitards?

The word **aquifer** refers to rock or sediment that contains water and allows it to flow relatively easily.

By comparison, an **aquitard** may contain water but does not allow water to flow easily. Think of beach sand or gravel compared to a brick or clay bowl.

An aquifer is said to have high **permeability** while aquitard has low permeability.

In aquifers water can move through the tiny spaces in between sand grains or a network of cracks in the rock.

When people drill in search of water, they are actually searching for an aquifer from which they can readily pump water.

Glossary

Potentiometric surface: the level to which water rises in a well.

Recharge: the replenishing of groundwater by rain, rivers, etc.

Permeability: a measure of the ease with which water can flow through a material.

Confining unit: a layer of low permeability material above a confined aquifer.

References

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Humans are currently extracting groundwater **faster** than it is replenished