

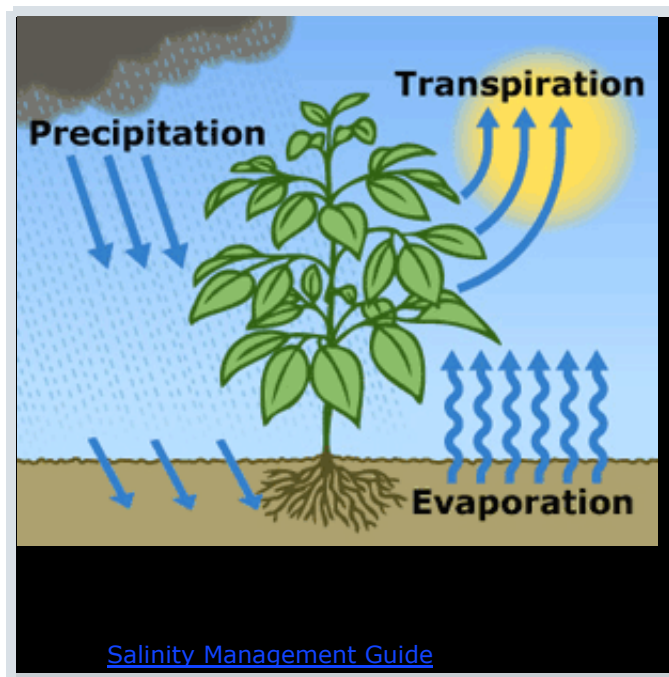


The Water Cycle - USGS Water Science School

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Evapotranspiration - The Water Cycle

What is



New!



[Water cycle for kids poster.](#)

evapotranspiration?

If you search for the definition of evapotranspiration, you will find that it varies. In general, evapotranspiration is the sum of evaporation and transpiration. Some definitions include evaporation from surface-water bodies, even the oceans. But, since we have a Web page just about evaporation, our definition of evapotranspiration will not include evaporation from surface water. Here, evapotranspiration is defined as the water lost to the atmosphere from the ground surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants whose roots tap the capillary fringe of the groundwater table. The banner at the top of this page offers an even more simple definition.

The transpiration aspect of evapotranspiration is essentially evaporation of water from plant leaves. Studies have revealed that transpiration accounts for about 10 percent of the moisture in the atmosphere, with oceans, seas, and other bodies of water (lakes, rivers, streams) providing nearly 90 percent, and a tiny amount coming from sublimation (ice changing into water vapor without first becoming liquid).

Transpiration: The release of water from plant leaves

Just as you release water vapor when you breathe, plants do, too – although the term "transpire" is more appropriate than "breathe." This picture shows water vapor transpired from plant leaves after a plastic bag has been tied around the stem for about an hour. If the bag had been wrapped around the soil below it, too, then even more water vapor would have been released, as water also evaporates from the soil.

Plants put down roots into the soil to draw water and nutrients up into the stems and leaves.



[Ming Kei College, Hong Kong](#)

Some of this water is returned to the air by transpiration. Transpiration rates vary widely depending on weather conditions, such as temperature, humidity, sunlight availability and intensity, precipitation, soil type and saturation, wind, and land slope. During dry periods, transpiration can contribute to the loss of moisture in the upper soil zone, which can have an effect on vegetation and food-crop fields.

How much water do plants transpire?

Plant transpiration is pretty much an invisible process. Since the water is evaporating from the leaf surfaces, you don't just go out and see the leaves "breathing". Just because you can't see the water doesn't mean it is not being put into the air, though. One way to visualize transpiration is to put a plastic bag around some plant leaves. As this picture shows, transpired water will condense on the inside of the bag. During a growing season, a leaf will transpire many times more water than its own weight. An

acre of corn gives off about 3,000-4,000 gallons (11,400-15,100 liters) of water each day, and a large oak tree can transpire 40,000 gallons (151,000 liters) per year.

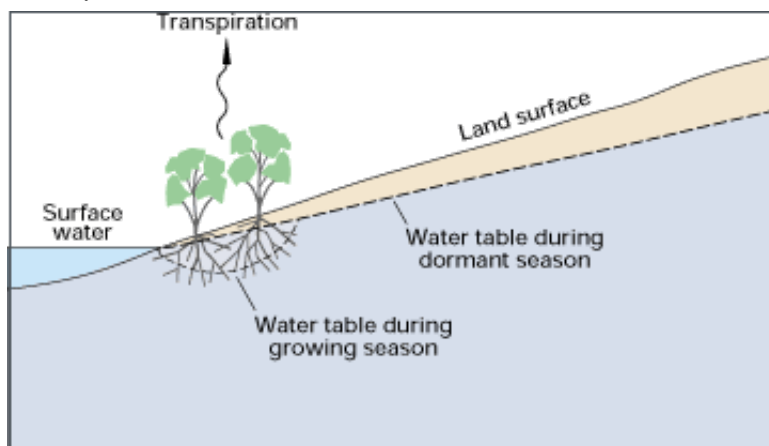
Atmospheric factors affecting transpiration

The amount of water that plants transpire varies greatly geographically and over time. There are a number of factors that determine transpiration rates:

- **Temperature:** Transpiration rates go up as the temperature goes up, especially during the growing season, when the air is warmer due to stronger sunlight and warmer air masses. Higher temperatures cause the plant cells which control the openings (stoma) where water is released to the atmosphere to open, whereas colder temperatures cause the openings to close.
- **Relative humidity:** As the relative humidity of the air surrounding the plant rises the transpiration rate falls. It is easier for water to evaporate into dryer air than into more saturated air.
- **Wind and air movement:** Increased movement of the air around a plant will result in a higher transpiration rate. Wind will move the air around, with the result that the more saturated air close to the leaf is replaced by drier air.
- **Soil-moisture availability:** When moisture is lacking, plants can begin to senesce (premature ageing, which can result in leaf loss) and transpire less water.
- **Type of plant:** Plants transpire water at different rates. Some plants which grow in arid regions, such as cacti and succulents, conserve precious water by transpiring less water than other plants.

Transpiration and groundwater

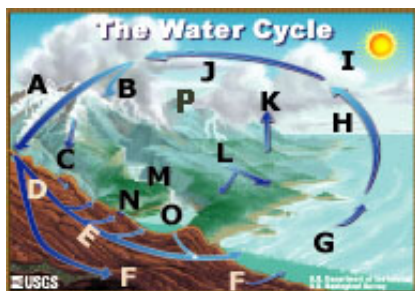
In many places, the top layer of the soil where plant roots are located is above the water table and thus is often wet to some extent, but is not totally saturated, as is soil below the water table. The soil above the water table gets wet when it rains as water [infiltrates](#) into it from the surface. But, it will dry out without additional precipitation. Since the water table is usually below the depth of the plant roots, the plants are dependent on water supplied by precipitation. As this diagram shows, in places where the water table is near the land surface, such as next to lakes and oceans, plant roots can penetrate into the saturated zone below the water table, allowing the plants to transpire water directly from the groundwater system. Here, transpiration of groundwater commonly results in a drawdown of the water table much like the effect of a pumped well (cone of depression—the dotted line surrounding the plant roots in the diagram).



Sources and more information

- [Evapotranspiration and Droughts](#), USGS, U.S. Global Change Research Program
- [The Water Cycle](#), NASA Earth Observatory
- A Primer on Water, by Leopold, Luna, and Langbein, Walter, U.S. Geological Survey General Purpose Publication, 1960

Choose a water-cycle topic



A - Storage in ice and snow
B - Precipitation
C - Snowmelt runoff to streams
D - Infiltration
E - Groundwater discharge
F - Groundwater storage
G - Water storage in oceans
H - Evaporation

I - Condensation
J - Water storage in the atmosphere
K - Evapotranspiration
L - Surface runoff
M - Streamflow
N - Springs
O - Freshwater storage
P - Sublimation

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URL: <http://water.usgs.gov/edu/watercycleevapotranspiration.html>

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