

## *The Water Cycle in New York*

Water is the most familiar natural resource. All of us have had firsthand experience with it in its many forms -- rain, hail, snow, ice, steam, fog, dew.

Yet although we use it daily, water is probably the natural resource we least understand. How does water get into the clouds and what happens to it when it reaches the earth? Why is there sometimes too much and sometimes too little? And is there enough water for all the world's plants and animals, including people?

Water covers nearly 75% of the earth; most is sea water. But sea water contains minerals and other substances, including those that make it salty, that are harmful to most land plants and animals. Still, it is from the vast salty reservoirs of seas and oceans that most of our precipitation comes -- no longer salty or mineral laden. Water moves from clouds to land and back to the ocean in a never-ending cycle. We call this the water cycle, or the hydrologic cycle.

Ocean water evaporates into the atmosphere, leaving salts behind, and moves across the earth as water vapor. Water in lakes, ponds, rivers, and streams also evaporates and joins the moisture in the atmosphere. Soil, people, and other animals contribute moisture to the atmosphere, as do factories, automobiles, and planes.

Plants contribute large amounts of moisture to the atmosphere through transpiration. Plants roots pull up water from the soil and send it to their stems and leaves, where it keeps cells alive and rigid. Some water is used in photosynthesis, but most is lost through leaves as water vapor. In deciduous forests during the summer months when trees are actively photosynthesizing this water loss, called transpiration, is a major input to the water cycle. Since many trees are dormant during the winter months, transpiration plays a smaller role then.

Some of the water vapor in the atmosphere is visible to us as fog, mist, or clouds. Water vapor condenses and falls to earth as rain, snow, sleet, or hail depending on region, climate, season, and topography. Global precipitation over land surfaces averages 26 inches per year, but it is not evenly distributed. Some places get less than 1 inch and others more than 400 inches each year.

While the US receives about 30 inches of precipitation annually (on average-some places receive more than others), only a fraction of this water is available for human use. Over 70% of precipitation is returned to the atmosphere via evaporation or plant transpiration.

If we were to think of the water cycle as a series of possible “stops” for water molecules, those stops or transitions would include natural stops such as precipitation, evaporation, transpiration, runoff, and infiltration; as well as man made stops such as groundwater wells, drinking and wastewater treatment, irrigation, and reservoirs. Below is a table showing the specifics of these stops for New York

Water cycle “stop”	Data examples for New York	Data for the American Southwest
Precipitation	40.2 in/yr, 90 billion gallons/day	13.09 in/yr
Evapotranspiration (combined evaporation from water bodies and plant surfaces)	20 in/yr, 45 billion gallons/day	<10 in/yr
Groundwater recharge (infiltration of precipitation)	Varies across the state from 1-20 inches/year	
Runoff	27-31 billion gallons/day	
Groundwater wells	14-18 billion gallons/day	
Public Water supply	10,200 water treatment systems in New York state provide 1,980 million gallons/day of surface water and 600 million gallons/day of groundwater to the public water supply.	
Irrigation	New York extracts 36 million gallons/day for irrigation (23 million gallons/day from groundwater and 12 million gallons/day from surface water)	
Industrial (the water used for several functions during the creation of commercial products)	New York extracts 300 million gallons/day for industrial uses (150 million gallons/day from groundwater and 150 million gallons/day from surface water)	
Thermoelectric power generation	New York extracts 4040 million gallons/day for thermoelectric power generation from surface water and 5,010 million gallons/day from saline surface water.	
Wastewater treatment	610 wastewater treatment plants in NY state treat 3.7 billion gallons/day of wastewater	
Reservoirs	The total capacity of the reservoirs serving NYC is 2.03 billion m <sup>3</sup>	

**Data Sources**

Descriptive Data of Municipal Wastewater Treatment Plants in New York State. 2004. New York State

Department of Environmental Conservation, Division of Water, Bureau of Water Compliance. Drinking water facts. [http://www.health.state.ny.us/environmental/water/drinking/facts\\_figures.htm](http://www.health.state.ny.us/environmental/water/drinking/facts_figures.htm), accessed January 2008.

Nationalatlas.gov.

New York Reservoir Data, <http://hypertextbook.com/facts/2004/IlyaParizh.shtml>, accessed January 2008.

New York State Department of Environmental Conservation. "Facts About NYS Waters" (2008). Retrieved Jan 7, 2008 from <http://www.dec.ny.gov/about/865.html>.

Winkley, S. 2006. Rates of Groundwater Recharge in New York. *Aquafacts* <http://www.nyruralwater.org/publications/aquafacts.cfm>

Humans can exist on a gallon or so of water a day for drinking, cooking, and washing but we rarely do. In medieval times people used no more than 3 to 5 gallons a day. In the 1800s in the United States daily water use averaged around 95 gallons. Currently, each of us uses approximately 2,000 gallons of water each day for our needs and comforts including recreation, cooling, food production, and industrial supply.

When water hits the ground some of it soaks into the soil and the rest runs off over the surface. The water that soaks into the soil sustains plant and animal life in the soil. Some of this water seeps into underground reservoirs called groundwater. Almost all of this water eventually enters the cycle once more.

Humans can do little to alter the input side of the water cycle, so our primary supply of water is firmly fixed. But our land use activities can alter the quality and quantity of the water that is available to us.

Because much of our water supply comes to us as precipitation falling on the land, the fate of each drop of rain, each snowflake, each hailstone depends largely on where it falls -- on the kind of soil and its cover.

Surface runoff from rain or melting snow can carry away huge amounts of soil via erosion. Freshly plowed farmland, cleared areas in new housing developments, and highway fills and banks are especially vulnerable. The water loosens soil particles and carries them away. Soil erosion by surface runoff is the source of sediment that fills streams, polluting water and killing aquatic life. It also shortens the useful life of dams by filling the reservoirs behind them.

In cities and suburbs, where much of the land is paved or covered with streets, buildings, parking lots, and airport runways, water runs off as much as 10 times faster than on unpaved land. Since this water cannot soak into the soil, it flows rapidly down storm drains or through sewer systems, contributing to floods and often carrying debris and other pollutants to streams.

Throughout the world the need for water continues to increase. Per capita use of water, especially in industrialized countries, is increasing rapidly. Population growth also brings demands for more water.

Our land use activities and our management of the water available to us determines whether or not we have both the quantity and quality of water to meet our needs. It is our obligation to return water to streams, lakes, and oceans as clean as possible and with the least waste.

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## Groundwater

Isn't it interesting how easily we forget the parts of the natural world that are generally out of our sight? This is true for microorganisms, because they are so small, and it is certainly true for groundwater because it is, of course, underground. However, we are walking on water everyday and, moreover, each of us depends on groundwater to some degree. A portion of our food is grown in regions of the country that have extensive groundwater, like the famous (and dwindling) Ogallala aquifer located from Texas to South Dakota. In addition, about half of the American population gets their drinking water from groundwater wells and, according to the United States Geological Survey, New Yorkers use about 900 million gallons of groundwater per day. In particular, Long Island has some of the most productive aquifers in the United States.

Groundwater does not exist as pools of water under the ground. Rather, the water moves through the spaces available among soil particles or cracks in bedrock. Groundwater, then, looks like wet sand or soil. An aquifer is formed when this wet soil can provide enough water for human use. Groundwater, just like surface water, flows downhill. The speed at which groundwater flows depends on the size and type of soil and rock, and it depends on the slope of the water table. This tremendous variation can cause groundwater to move as quickly as 0.1 feet per second (about the speed of a garden snail) or as slowly as 0.000001 feet per second (6 times slower than the snail!).

Of course, groundwater is not unconnected to the rest of the water cycle. After a rain, or after someone waters their garden or irrigates their farm, some of the water will move over ground, some of it will evaporate, and the rest will infiltrate down into the groundwater. This groundwater will then provide water to nearby water bodies, wells and plant roots.

Due to its role in the water cycle and human health, groundwater contamination is an important environmental issue. The major sources of groundwater pollution include agricultural chemicals like pesticides and fertilizers, road salt and other toxins that run off the roads and infiltrate into the ground, landfills, leaking septic tanks and other underground storage tanks.

### Resources

#### Maps:

1. Groundwater and land use in the water cycle:  
<http://www.dnr.state.wi.us/org/water/dwg/gw/whp/poster.pdf>
2. Aquifers of New York State  
<http://www.dec.ny.gov/lands/36115.html>

#### Information:

[www.groundwater.org](http://www.groundwater.org); <http://www.dec.ny.gov/lands/36064.html>