

OUR WATERS

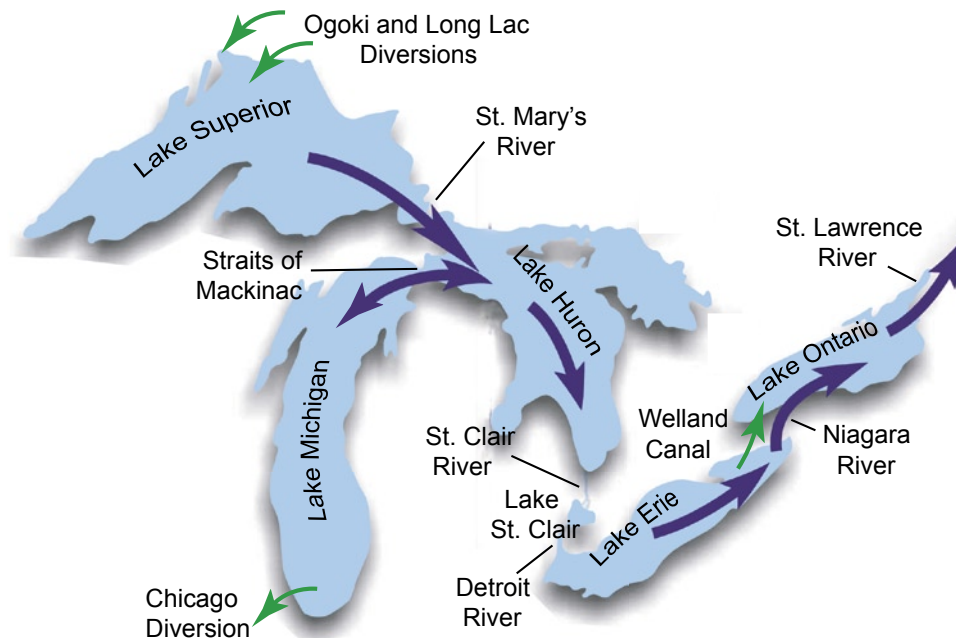
The waters of Southeastern Wisconsin are vast but vulnerable. We depend on our waters for drinking water, irrigation, industry, transportation, power production, recreation and scenic beauty. Understanding our region's water-related issues and future challenges can help us protect clean, abundant water for generations to come.

Great Lakes Water Balance

The Great Lakes system includes the lakes and their connecting channels, as well as rivers, streams and ground water that drain into the lakes.

The lakes are the largest system of fresh surface water on earth. They contain 18 percent of the world's and 90 percent of North America's liquid, surface fresh water.

Flow Through the Great Lakes Connecting Channels and Major Diversions



Original Source: "Water Levels: The Great Lakes," Environment Canada fact sheet, at http://www.on.ec.gc.ca/water/factsheets/pdf/waterlevelfactsheet_eng.pdf.

Diverse plants and animals rely on the Great Lakes for food, water and habitat. The lakes have supported human populations since Native Americans settled the region thousands of years ago.

The first European explorers called the lakes "Sweetwater Seas," because the water was clean and drinkable, not the saltwater they expected. Today the Great Lakes supply water for drinking, irrigating, manufacturing and transportation, as well as hunting and fishing grounds, for 35 million people living around the lakes.

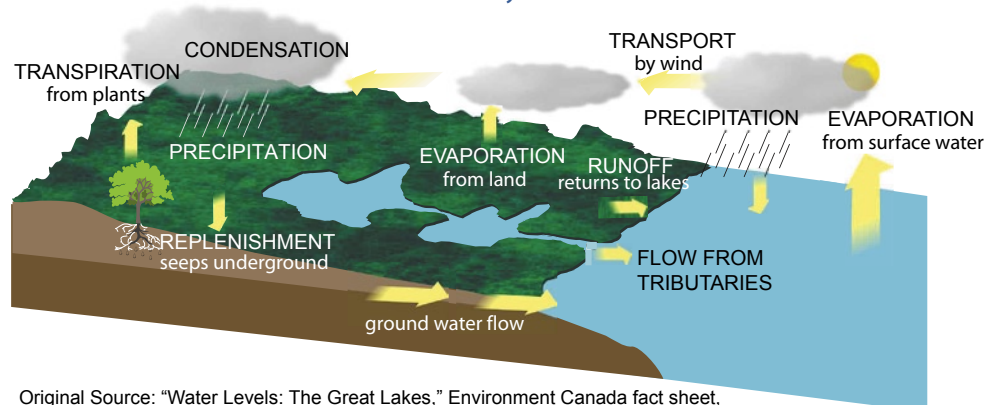
- A *diversion* is the transfer of water across watershed boundaries through a man-made pipeline or canal.

Like the balance in a bank account, the Great Lakes water balance is determined by deposits, or inflows, and withdrawals, or outflows.

Natural systems: the water cycle and flow through connecting channels control the lakes' main inflows and outflows.

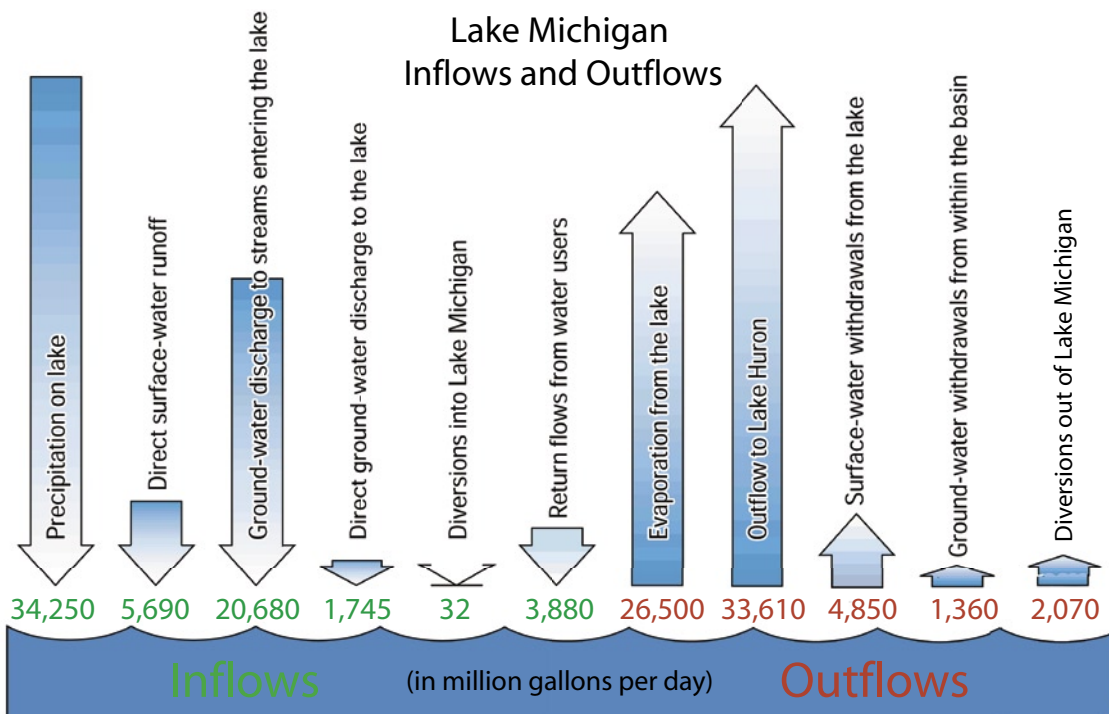
Human activities: building diversions and canals, dredging, regulating flow, and consumptive use can alter inflows and outflows.

The Water Cycle



Original Source: "Water Levels: The Great Lakes," Environment Canada fact sheet, at http://www.on.ec.gc.ca/water/factsheets/pdf/waterlevelfactsheet_eng.pdf.

Water Balance in the Great Lakes



Natural systems control the water balance in the Great Lakes, but human activities can alter this balance.

Source: Grannemann and others, 2000, "The Importance of Ground Water in the Great Lakes Region," Water-Resources Investigations Report 00-408, USGS

Natural Systems

Major inflows:

- Precipitation on lake surfaces
- Flow from tributary rivers and streams (much of this flow is from shallow ground water that originates as rainfall on land)

Minor inflows:

- Runoff from nearshore land
- Ground water seeping directly into the lake

Major outflows:

- Evaporation from lake surfaces
- Flow through connecting channels

Human Activities

Inflows from diversions:

- The Ogoki and Long Lac diversions into Lake Superior redirect water that would naturally flow to Hudson Bay
- Average combined inflow - 3,606 mgd

Outflows from diversions:

- Chicago's diversion out of Lake Michigan supplies drinking water, carries wastewater and shipping traffic toward the Mississippi River
- Average outflow - 2,068 mgd (6.5 times the average flow of the Milwaukee River through Milwaukee)

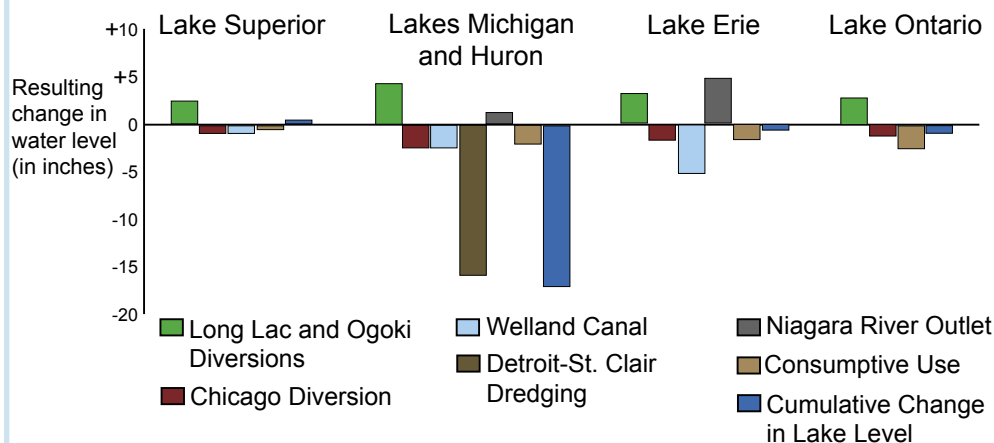
Connecting channel regulation:

- The Welland Canal between Lakes Erie and Ontario provides a shipping route
- The canal increases outflows from Lake Erie, impacting lake levels*

Outflows from dredging:

- Past dredging and mining projects in the Detroit and St. Clair Rivers increased outflows, permanently impacting Lake Michigan and Huron levels*
- Obstructions and fills in the Niagara River have decreased outflows, impacting lake levels*

Effects of Human Activities on Lake Levels



Source: "Protection of the Waters of the Great Lakes," International Joint Commission Interim Report, 1999.

Consumptive use:

- An average five percent of surface and ground water withdrawn from the Great Lakes system is lost or not returned due to "consumptive use"

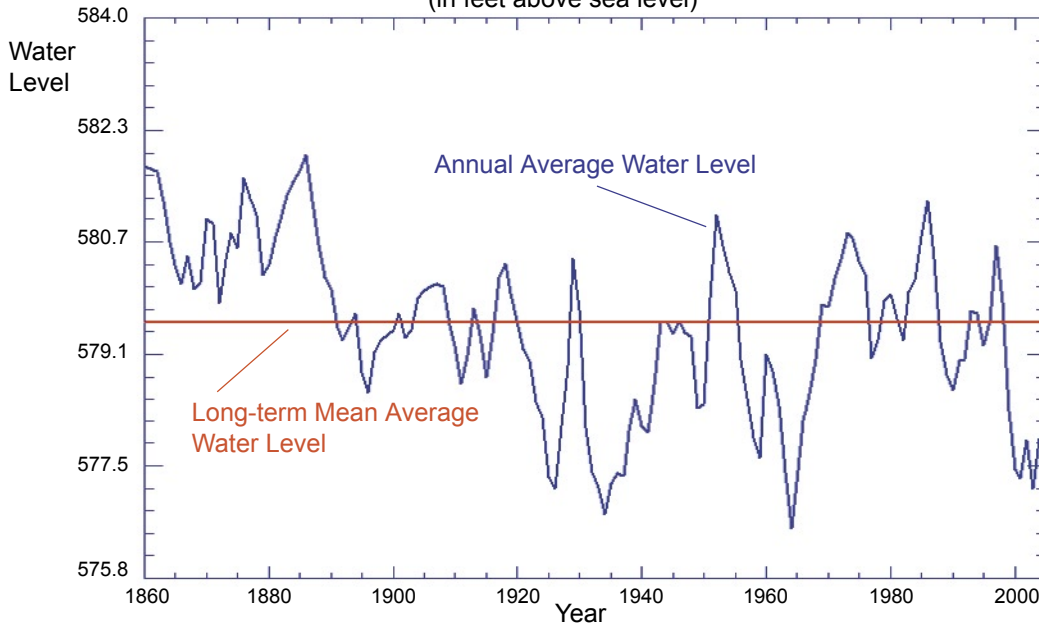
Connecting channel regulation:

- The International Joint Commission (IJC) manages outflows from Lakes Superior and Ontario under U.S. and Canadian agreements
- This helps maintain levels that protect shoreline properties, hydropower generation and shipping routes

*Source: "Protection of the Waters of the Great Lakes," IJC Interim Report, 1999.

Changing Lake Levels

Lake Michigan Water Levels Over Time
(in feet above sea level)



Source: NOAA Great Lakes Research Laboratory, at www.glerl.noaa.gov/data/now/wlevels/levels.html

The balance in the Great Lakes system is stable over time, but fluctuates seasonally, annually and over many years. The fluctuations are mainly due to changes in weather and climate. We see this as changing lake levels.

Seasonal Variation

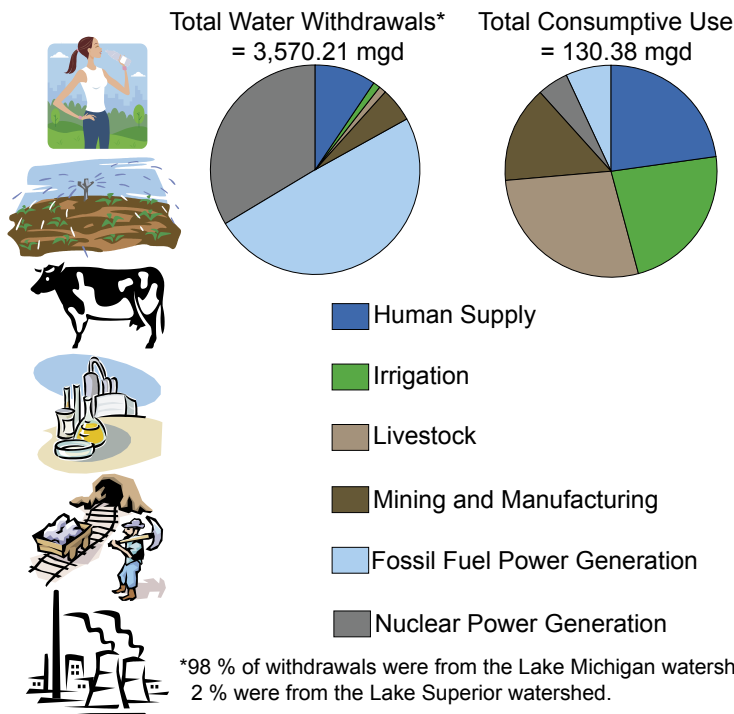
In spring, melting snow and rainy weather increase inflows. Spring water temperatures are cool, so evaporation decreases and lake levels usually rise.

In fall, air temperatures cool while the lakes are still warm, so evaporation increases and lake levels may fall. Seasonal variations usually range from 12 to 20 inches.

Long Term, Climatic Variation

Long term changes in lakes levels are driven by climate, especially by precipitation trends. Lake Michigan dropped to an historic low in March 1964 at 576 feet above sea level, and hit an historic high in October 1986 at 582.3 feet above sea level. The lake's long term average is 579 feet above sea level.

Wisconsin's Withdrawals and Consumptive Use of Great Lakes Surface and Ground Water



Source: "Annual Report of the Great Lakes Regional Water Use Database Repository," representing 2002 water use, Great Lakes Commission, 2005.

Consumptive Use - The amount of withdrawn water not returned as treated wastewater because it is evaporated, incorporated into products, crops, or plants, consumed by humans or livestock, or otherwise lost to the immediate water environment.

Consumptive use includes:

- Water that evaporates from irrigated fields, lawns and golf courses
- Water incorporated into dairy products, canned foods and drinks, and chemicals
- Water that cannot reasonably be reused because of time delays or degraded quality at its return (i.e. evaporation, animal waste)

To calculate total consumptive use, the Wisconsin DNR estimates the average percent of water consumed by different water uses. The state estimates 10-15% consumptive use for water withdrawn for human supply, 70% for irrigation, 90% for livestock, 10.2% for mining and manufacturing, and less than 1% for power generation.

Source: Great Lakes Commission, 2005.

The Future of Great Lakes Water Resources

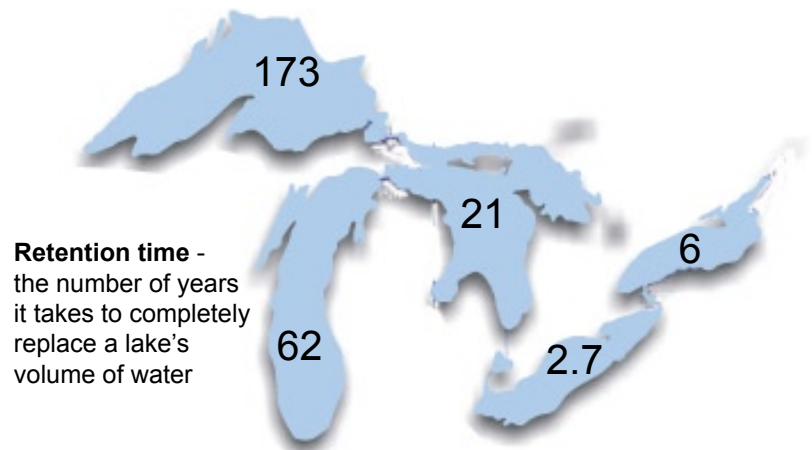
The Great Lakes are basically a “closed system.” Water - and pollutants - are held in the lakes for a long time.

In Lake Michigan, for example, less than two percent of the lake’s water is renewed each year.

Persistent contaminants, like mercury and PCB’s that cause fish consumption advisories, settle into sediments and enter the food chain, becoming a problem for future generations.

As populations grow and development continues, the lakes’ slow renewal and the long-term effects of pollutants should shape our management of Great Lakes water resources.

Great Lakes Retention Times in Years



Source: Extension Bulletins E-1865-1870, Michigan Sea Grant College Program, Cooperative Extension Service, Michigan State University, 2000.

Changing Climates

The historic response of Great Lakes levels to rainfall and drought shows their climate sensitivity. Changing lake levels could impact water supplies, shoreline property, shipping, power production, boating, fishing, and ecosystems.

Understanding the lakes’ water balance can help us plan for these impacts. The lakes, however, are a huge, dynamic system, and estimating inflows and outflows is a challenge. Improving our monitoring of the lakes can help develop forward-looking, science-based management plans.

What We Know

- Atmospheric carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O), the main human-influenced greenhouse gases, have increased significantly from 1000-1759 levels
- Other greenhouse gases have increased in the last 50 years
- Most warming over the last 50 years is due to human activities; natural factors cannot explain it

Since 1900:

- Global sea level increased an average 1-2 mm annually
- Global mean surface temperature increased about 0.6°C
- Arctic sea ice thinned 10-15% in spring; 40% in summer
- Northern Hemisphere continents received 5-10% more precipitation; rivers and lakes had 2 weeks less ice cover

What We Don’t Know

- Projections for local and regional areas are less certain than global predictions

- Scientists are unsure if or when climate change could be irreversible, even with reduction of greenhouse gases

What Science Predicts Worldwide

By 2100:

- CO₂ levels will continue to rise
- Global mean surface temperature will rise 1.4-5.8°C (the greatest warming rate in at least 10,000 years)
- Sea level will rise 0.3-2.89 feet
- Extreme events (heat waves, heavy precipitation) and climate variability may increase
- Climate change will reduce available water in many water-scarce areas

What Science Predicts for Our Region*

- Increases in precipitation, evaporation, and transpiration (water returned to the atmosphere by plants) are likely
- Winter runoff and streamflow will likely increase, with a related decrease in summer runoff and streamflow
- Water quality may be degraded by warmer temperatures, or more frequent extreme rainfall and drought events
- Duration and thickness of ice cover may decrease, shipping and boating season could lengthen
- Most scenarios predict lower lake levels (from changes in temperature, ice cover and evaporation)

Sources: “Climate Change 2001: Impacts, Adaptation and Vulnerability,” Intergovernmental Panel on Climate Change (IPCC), 2001. **Special Report: The Regional Impacts of Climate Change,” IPCC, 1997.

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Find more information online at www.glwi.uwm.edu/ourwaters.



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