

Lake Level Fluctuations: Causes and Implications

The rise and fall of water levels in the Great Lakes is a dynamic process influenced by changes in climatic factors and human activities. While there are many variables that affect Great Lakes water levels, the greatest contributors are precipitation and runoff, which add water to the lake, and evaporation and outflow, which remove water from the lake. When the net supply of water is high, lake levels rise; when the supply is low, so too are water levels. Long-term fluctuations in lake levels have occurred throughout history; for example, low water levels were recorded during the 1960s while record setting high levels occurred in the 1980s.

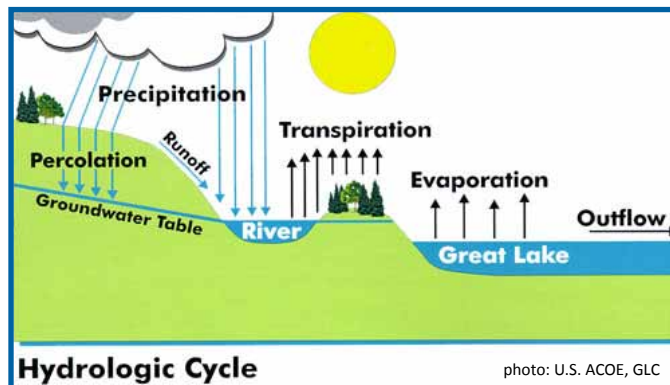
Climatic Factors

Great Lakes water levels fluctuate in response to changes in the climate of the region. Examples of seasonal fluctuations include increased runoff in the spring due to snow melt and accelerated evaporation in the fall and winter caused by an increasing disparity between the temperature of the air (cold) and the water (relatively warmer). Severe weather disturbances with strong winds can cause short-term fluctuations, which last only a few hours to a few days and have little to no effect on the water storage in a lake.

Other climatic factors that can affect Great Lakes water levels include:

- condensation, caused by warm, moist air passing over a relatively cool water surface in spring and early summer;
- decreased water flow in connecting channels due to ice and aquatic vegetation; and,
- shifts in regional weather patterns that can cause an increase or decrease in water supplies.

The term Net Basin Supply (NBS) refers to the combined result of all factors within a lake basin that affect the water levels of the Great Lakes. Net Total Supply (NTS) includes NBS and the inflow from the upstream lake (on Lake Superior, NBS and NTS are the same). While fluctuating lake levels are not a new phenomenon, climate change research indicates possible severe and extended periods of below-average NBS in the future.



Glacial isostatic adjustment, defined as a change in the elevation of the earth's crust rebounding over centuries from the weight of ice age glaciers, is another important factor to assess. Over a very long period of time, changes in the elevation of a lakes' outlet relative to its shoreline cause water levels to recede or advance in a particular shoreline area.

Human Factors

Human factors that affect water level fluctuations include:

- Lake Superior outflow regulation through control structures on the St. Marys River;
- physical changes to the interconnecting channels of the upper Great Lakes;
- habitat and shoreline modifications along the banks of rivers; and
- water diversions both into and out of the basin.

While it is important to consider in specific areas, the overall magnitude of consumptive uses of water is relatively small compared to natural factors.

Impacts of Fluctuating Water Levels

The nearshore and coastal areas of the Great Lakes are disproportionately more influenced by lake levels than are deep waters. In addition, these areas are the most used by human, plant, fish, and wildlife populations. Small shifts in lake levels can alter the extent, structure and functions of coastal habitats. Unlike other aquatic systems in North America, however, Great Lakes systems have evolved under conditions of water level variation over cycles of hours, days, seasons, years, decades, and beyond. A myriad of interest groups may be affected by extreme high and low-water conditions in the Great Lakes and must be taken into account when assessing the impacts of fluctuating levels in the lakes and flows in connecting channels.

Ecosystems

Coastal and nearshore sites are home to most fish and wildlife populations and support a wide array of habitat types such as marshes, beaches and wetlands. Availability of fish and wildlife habitat is directly impacted by Great Lakes water levels. Persistent high or low levels may reduce the diversity of plants and animals that live in, or depend on, these habitats.



Shore Property Interests

High water levels may cause flood damage in flood-prone and low-lying areas. For some shore zones, erosion can be accelerated by storms acting on high water levels. While low water levels reduce flood and erosion potential, they can lead to exposure of shore protection infrastructure, shoreline degradation and loss of access to riparian property owners.

Recreational Boating and Tourism

Low water levels are a concern for recreational boating and tourism industries because docks and ramps can become inaccessible, shorter boating seasons may result, damage to boat propellers may increase and accessibility to lakes and rivers can be reduced. High water can also make docks and marinas inaccessible; in many cases, for marinas and docks built on rocky shores, dredging can be cost-prohibitive.



Municipal, Industrial and Domestic Water Use

In general, municipal and industrial water intakes are not greatly affected by fluctuating water levels. However, very low water levels could lead to increased pumping and water treatment costs while high water may flood treatment facilities located on flood-prone coastlines. Further, most shore-wells, a primary source of water outside of urban areas, are not built to accommodate very high or low levels.

Commercial Navigation

Low water levels reduce a ship's capacity to transport cargo. Smaller cargos require more trips and increase operating costs. High water levels enable ships to carry more cargo, but can also flood low dock facilities. Very high water velocity and cross currents in the river can be hazardous for ship transit in the inter-connecting channels.



Hydropower Operation

The amount of hydropower generated at a plant depends primarily on the amount of water available (flow) and the difference in water levels up- and downstream of the plant (head). High water flow at the plant increases production while low flow results in less power generated. Operation under high head produces more power than when the head is lower.