The Great Lakes Policy Report

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SPECIAL FOCUS ON GREAT LAKES WATER LEVELS: Factors, Impacts, and Trends.

The Great Lakes Policy Report is a quarterly news report published by the Little Traverse Bay Bands of Odawa Indians Natural Resource Department's Environmental Services Program. The report features Great Lakes policy updates and relevant initiatives, projects, and issues.

The report is meant to be an educational document, and does not express an opinion on the subjects discussed. Stories and information cited in this report are taken from a variety of sources including news articles, non-governmental reports, interviews, and government documents.

Great Lakes Water Levels

2012 was a record-setting year for the Great Lakes, although not in a way that most would consider good. All of the Great Lakes water levels are currently lower than their long term averages. While lakes Erie and Ontario stayed closer to their long term average levels during 2012, lakes Superior, Michigan, and Huron saw low levels rarely experienced. After hovering near the all-time monthly lows during October and November, lakes Michigan and Huron levels dropped to a record low in December 2012 and are projected to stay below all-time monthly lows until April 2012.

Lake Michigan and Lake Huron are hydrologically considered a single lake because the water connection at the Straits of Mackinac keeps their water levels essentially identical. When it comes to water levels, the two lakes are referred to as Lake Michigan-Huron.

Fluctuations in the water levels of Lake Michigan-Huron and the other Great Lakes have occurred continually since the Great Lakes formed at the end of the last ice age, about 10,000 years ago. Fluctuating lake levels (both high and low) are a natural process. Water levels fluctuate based on two main factors: global climate patterns and regional weather patterns. Global climate patterns have long term (e.g. decades or longer) influence over Great Lakes water level fluctuations, whereas regional weather patterns have monthly and yearly influences over lake levels.

Lake Michigan-Huron, pictured above, reached an all time low in December 2012. Photo credit: L. Evans

Fluctuations in lake levels also vary by lake. For example, historically Lake Michigan-Huron has larger variations in its highs and lows compared to Lake Ontario which has a smaller range in its fluctuations. The recent decline of Great Lakes water levels, now at lows not seen since the mid-1960s, is due mostly to evaporation during the warmer-than-usual temperatures of the past three years, a series of warm winters, and below-average precipitation.

The Great Lakes are a large and complex system. Many factors influence their water levels. When considering Great Lakes water levels it is first important to understand the basic hydrology of the lakes. The water level of each Great Lake depends on the balance between the quantities of water received and the quantities of water removed.

"Inflows" refer to water entering each Great Lake; inflows supply water to the lake through natural and man-made processes. According to the U.S. Geological Survey, inflows include (1) over-lake pre-

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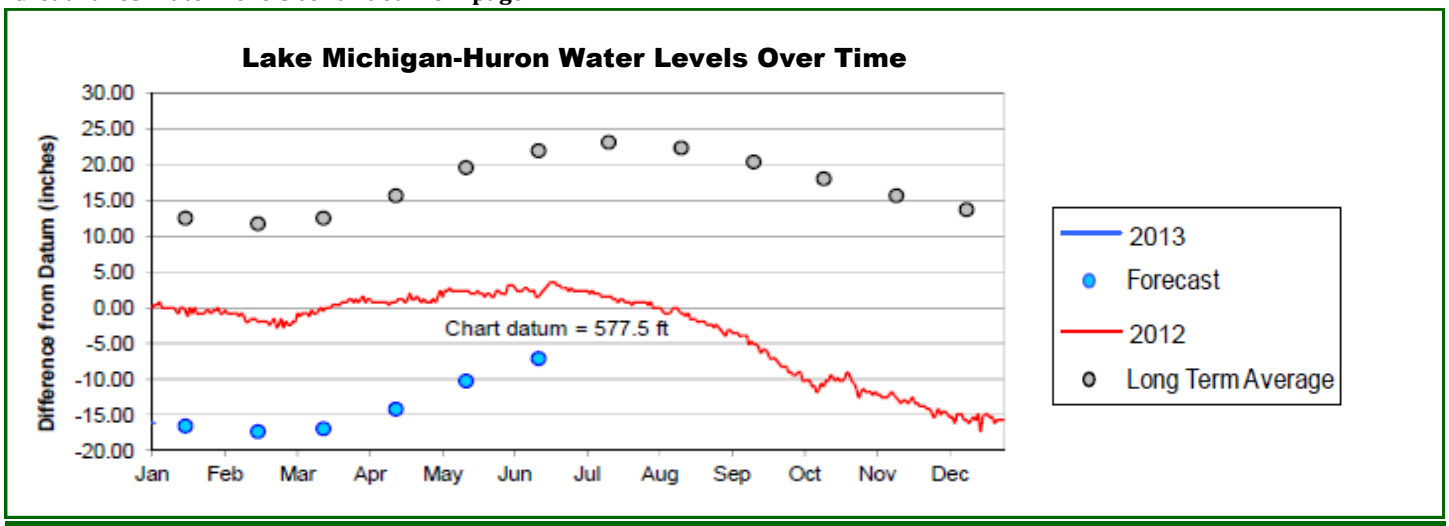

A graph displaying Lake Michigan-Huron water levels over three time periods: the long term average (gray dots), 2012 lake levels (red line), and projected levels in 2013 (blue dots). Credit: U.S. Army Corps of Engineers.

cipitation, (2) land runoff (including streamflow), (3) groundwater, (4) man-made water diversions into the Great Lakes, and (5) flow from upstream channels and lakes.

"Outflows" refer to water leaving each lake by (1) surface evaporation, (2) downstream outflow, (3) man-made water diversion out of the Great Lakes, and (4) consumptive use of water. Consumptive water uses are human uses where the water is not returned to the Great Lakes (such as water stored in crops or bottles). See graph on page 3.

The most influential inflows and outflows when it comes to water level fluctuations are over-lake precipitation, land runoff from precipitation, and over-lake evaporation, according to the National Oceanic and Atmospheric Administration (NOAA).

Downstream outflow, although a large quantity of water, is a relatively constant influence that does not result in large fluctuations in lake levels. It is much easier to predict discharge rates for a lake compared to over-lake evaporation, which is dependent upon other factors (discussed below).

The largest inflows for Lakes Superior and Michigan-Huron are the least directly influenced by humans: over-lake precipitation and land runoff from precipitation. Therefore changes in precipitation, especially droughts, can impact Great Lakes water levels and over time result in fluctuating water levels. Inflows from over lake precipitation largely depend on regional and global weather patterns.

During 2012, the Great Lakes region experienced an extended drought. Precipitation, both snow and rain, was below average through much of the year, reducing Great Lakes inflows from this source. Additionally, 2012 was the warmest year on record for the United States according to NOAA.

Because land runoff is dependent on precipitation, the drought conditions also impacted inflows from land runoff. Less precipitation over the Great Lakes basin results in less runoff and stream flow into the lakes. Snowfall and rainfall were both low in 2012. Warm winters, such as the 2011-2012 winter, reduce available snowpack. Normally the snow melts and turns into land runoff in the spring, feeding the lakes, but with less snowfall there is less runoff to supply the lakes.

Another major influence over lake levels is seasonal atmospheric (or air) temperatures. Normally, cold air temperatures in the winter cause ice to form over much of the Great Lakes' surfaces. Ice coverage prevents large water loss from evaporation. However, when winter temperatures are above normal and there is little ice cover, surface water evaporation increases and lake levels drop. Monthly temperatures in Great Lakes states were 3 to 16 degrees Fahrenheit above normal through much of last winter, which resulted in less ice coverage. Winter 2011–2012 was the fourth warmest in U.S. history, according to NOAA. This

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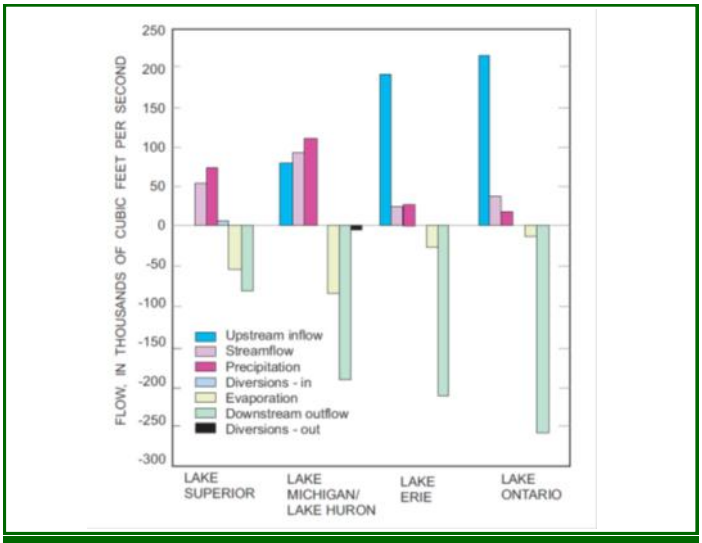

A graph displaying the Great Lakes' hydrology: water coming into each lake (above zero) vs. water leaving each lake (below zero). Credit: USGS.

development is likely to continue; air temperatures are increasing over time, especially in winter. Winter in 2013 is expected to have higher than normal temperatures as well.

A seldom discussed factor influencing water levels is the adjustment of the earth's crust, called glacial isostatic adjustment (GIA). GIA is caused by the rebound of the Earth's crust after dense glaciers retreated from the region 10,000 years ago. GIA results in both the rise and fall in the Earth's crust and is particularly visible along the shoreline of the Great Lakes. "For example, the shoreline of Parry Sound, ON, in Georgian Bay, is rising at a rate of about 24 cm (9.4 in) per century," which gives the appearance of decreasing water levels in the bay, according to a recent International Joint Commission (IJC) study. "At the same time, the shoreline around Milwaukee, WI, is subsiding (dropping) at a rate of about 14 cm (5.5 in) per century" which gives the appearance of increasing water levels. GIA will continue to shape the shoreline of the Great Lakes.

Human Influences

The inflow from upstream channels is complex due to human engineering. For example, lake inflows are regulated on the St. Marys River, which flows from Lake Superior into Lake Michigan-Huron. Lake Superior regulations only affect about 27% of Lake Michigan-Huron inputs. Because Lake Superior

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only accounts for a quarter of all Lake Michigan-Huron inputs, using Lake Superior to increase the levels downstream, by increasing flow through the control structures, would have minimal success. For example, if Lake Superior water levels were lowered by three feet, Lake Michigan-Huron levels would only increase by 1 to 2 inches.

Another human factor that gets attention is the diversion of great Lakes water. Most attention is focused on diversions that remove water from the Great Lakes. These diversions are regulated. For example, the Chicago diversion of Lake Michigan water for navigation, drinking water, and sanitation cannot exceed 3,200 cfs of water. Perhaps not as famous as the Chicago diversion are two noteworthy inflows from man-made diversions into the Great Lakes. The Long Lac and Ogoki diversions flowing into northern Lake Superior supply about 5,600 cubic feet per second (cfs). These two diversions into the great Lakes are larger than all the diversions out of the Great Lakes, resulting in a net gain of water for the Great Lakes system.

When it comes to outflows, a commonly cited source impacting Lake Michigan-Huron water levels is the St. Clair River. Dredging of the St. Clair River in the early 1960s, and throughout the 20th century, by the U.S. Army Corps of Engineers resulted in increased flow through the river. It is estimated that all dredging activities resulted in a 14-16 inch permanent drop of Lake Michigan-Huron water levels. However this action does not account for fluctuations in lake levels since the dredging occurred. Nonetheless, there is a theory that the initial dredging caused erosion in the St. Clair channel and thus increased the outflow since the dredging has stopped.

The International Joint Commission released a report in 2009 titled Impacts on Upper Great Lakes Water Levels: St. Clair River Report, which did not find increased erosion due to the dredging. The report found that there has been no significant erosion in the St. Clair River since 2000. Any erosion that has occurred over the 50 years is estimated to account for 3 to 5 inches of decline in Lakes Michigan-Huron.

Economic and Environmental Impacts

Reduced ice coverage and lower lake levels have economic

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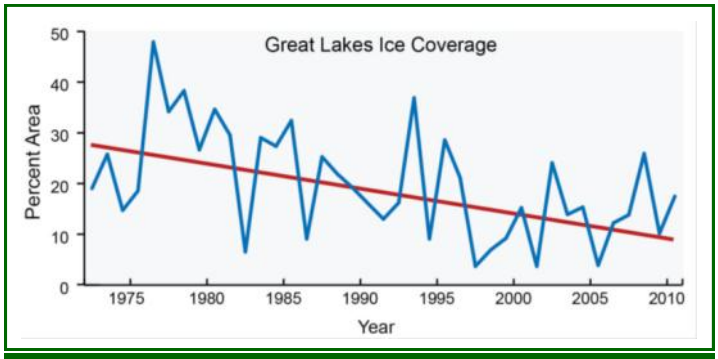

A graph displaying Great Lakes ice coverage from 1972 to 2010. Coverage has decreased by 71%.

and ecosystem impacts. Economic impacts may not all be bad however. With less ice cover there is a potential for a longer shipping season. But lower lake levels are already requiring more dredging in navigation channels and harbors, a costly activity. Michigan SeaGrant notes that commercial fishing boats are having increased difficult y navigating in harbors as well. Lower lake levels also require ships to decrease their cargo capacity, reducing profits.

Less ice coverage reduces winter recreational activities, such as ice fishing. During the summer months water dependent tourism, such as boating, may be impacted by lower lake water levels as well. And, reduced property value on the Great Lakes is a concern with lower lake levels.

Scientists are expecting a variety of ecosystem impacts if lake levels and ice coverage stay below normal. Some fish species will have reduced winter habitat and there may be a change in the Great Lakes fishery species composition. Coastal wetlands will likely decrease due to low water levels impacting a variety of coastal species. And, increased phosphorus concentrations in the Great Lakes are also possible, which would impact water quality.

Will the Trend Continue?

The most influential factors for Great Lakes' water levels (precipitation and evaporation) cannot directly be controlled by humans. The factors are natural climate processes. Even so, much attention is given to human-managed factors such as water diversions and lake regulations. Even if these issues are resolved it is unlikely that the results would lead to increased and more consistent lake levels.

It is unlikely that lake levels will see an increase in the near term. Scientists believe that above normal precipitation would be needed to be sustained for six months before we see a return to normal levels. The Army Corps of Engineers projects that lake levels will remain below their long term averages for at least the first six months of 2013. It would take a massive amount of precipitation to change that projection.

Perhaps the most effective way to deal with low lake levels in the long term is to address human greenhouse gas emissions, mainly carbon dioxide (CO_2). The Earth's atmosphere is warming and humans are almost certainly the cause. If temperatures continue to increase, we will have less ice coverage on the Great Lakes and increased evaporation of surface water. According to a recent American Meteorological Society report, overall Great Lakes ice coverage declined 71% over the past 40 years (see graph). A (draft) government climate assessment recently linked the declining ice coverage to climate change: "The Great Lakes, North America's largest freshwater feature, have recently recorded…less ice cover as a result of changes in regional climate." Precipitation may increase, due to global climate change, but where and when it falls is uncertain.

A recent report by the International Joint Commission found that global climate change will continue to impact Great Lakes water levels in the future. There is uncertainty in exactly what those changes will be, but reducing the impacts of climate change, by reducing greenhouse gas emissions, may be the best option for reducing extreme lake level fluctuations.

Resources:

Army Corps Monthly Bulletin of Great Lakes Water Levels: http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/waterlevelforecasts/monthlybulletinofgreatlakeswaterlevels/

NOAA Interactive Water Level Dashboard and data: http://www.glerl.noaa.gov/data/now/wlevels/levels.html

IJC International Upper great Lakes Study: http://www.iugls.org/

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