US Army Corps of Engineers
Detroit District

Great Lakes Update

Volume 188: 2012 Annual Summary

Background

The U.S. Army Corps of Engineers (USACE) tracks the water levels of each of the Great Lakes. This report highlights hydrologic conditions of the Great Lakes basin in 2012 and summarizes recent water level behavior lake by lake.

Official records of the Great Lakes water levels are monthly averages and not daily averages. The period of record used for each of the lakes includes the years 1918 to 2011 and this data has been coordinated between both the United States and Canada. All 2012 water levels are considered provisional and will be officially coordinated in the spring of 2013. The elevations used are referenced to the 1985 International Great Lakes Datum. The water level of each lake is averaged from a network of individual gages around each lake. Also of note is that Lake Michigan and Lake Huron are hydraulically treated as one lake due to their connection at the Straits of Mackinac.

The water levels of the Great Lakes behave differently than most inland waters because of their huge surface area and volume. A single storm is very unlikely to cause a significant change to the water levels. Rather it takes multiple months, seasons, or even years of persistent wet/dry conditions to really impact the water levels.

The primary factors which determine water level changes are precipitation falling on the lake surface, runoff draining to the lake, evaporation from the lake surface, diversions into or out of the lake, and connecting channel inflows and outflows. The Net Basin Supply (NBS) is an important quantity for understanding the amount of water which arrives to the lake. USACE uses the residual method to compute NBS, shown below in the summarizing equations.

WL:	Water Level Change
I:	Connecting Channel Inflow
O:	Connecting Channel Outflow
D:	Diversion into(+) or out(-) of lake
P:	Precipitation falling on lake
R:	Runoff draining to lake
E:	Evaporation from lake surface

Water balance for each lake:

$$WL = I + D + P + R - E - O$$

Residual Method Net Basin Supply:

$$NBS = WL - I - D + O$$

Altogether, NBS represents the combined effects of precipitation, runoff, and evaporation. NBS is far and away the main driver of water levels, and is discussed in more detail below.

2012 Overview

Overall, the year 2012 was a very warm and dry year for the Great Lakes basin causing the water levels to decline. There was very little snow pack last winter (2011 – 2012) and this led to below average spring runoff for all of the lakes. On top of that, precipitation during the spring and summer of 2012 was very low. Lastly, because of the warm temperatures all year, evaporation was very high during the summer and fall of 2012. This accumulation of multiple dry seasons has severely lowered the water levels.

All of the Great Lakes are currently below their levels of a year ago and also below their long-term averages. Lake Superior's January water level was 1 inch below its level of a year ago while all of the other lakes were 17 to 22 inches below levels of one year ago.

Lake Michigan-Huron set new record low water levels during the months of December 2012 and January 2013, lower than any other December and January in the entire period of record. January's level not only broke the previous January record, but it also broke the all-time record low for Lake Michigan-Huron. Water levels on Superior and Michigan-Huron have been below long-term averages for over 13 years, the longest consecutive period on record for each lake. Michigan-Huron setting new recorded minimums continues to highlight the extreme conditions which have been experienced in the basin.

Lake Superior

The 2012 water levels for Lake Superior were below long-term average (LTA) for the entire year, extending a consecutive 13 year streak of below average levels. This is the longest stretch of below average levels in Lake Superior's recorded history back to 1918. Lake Superior was below chart datum for nearly the entire year of 2012, being above datum only during the months of July and August.

Water supplies to Lake Superior were very dry for the year 2012. As mentioned earlier, the Net Basin Supply (NBS) is a helpful way to understand the total influence of precipitation, runoff, and evaporation. Figure 1 below shows the NBS for each calendar month. Dots in the figure represent the NBS for each year going back to 1900, giving an idea of the historical distribution of NBS. The horizontal line shows the average, and the arrow indicates the estimated 2012 value.

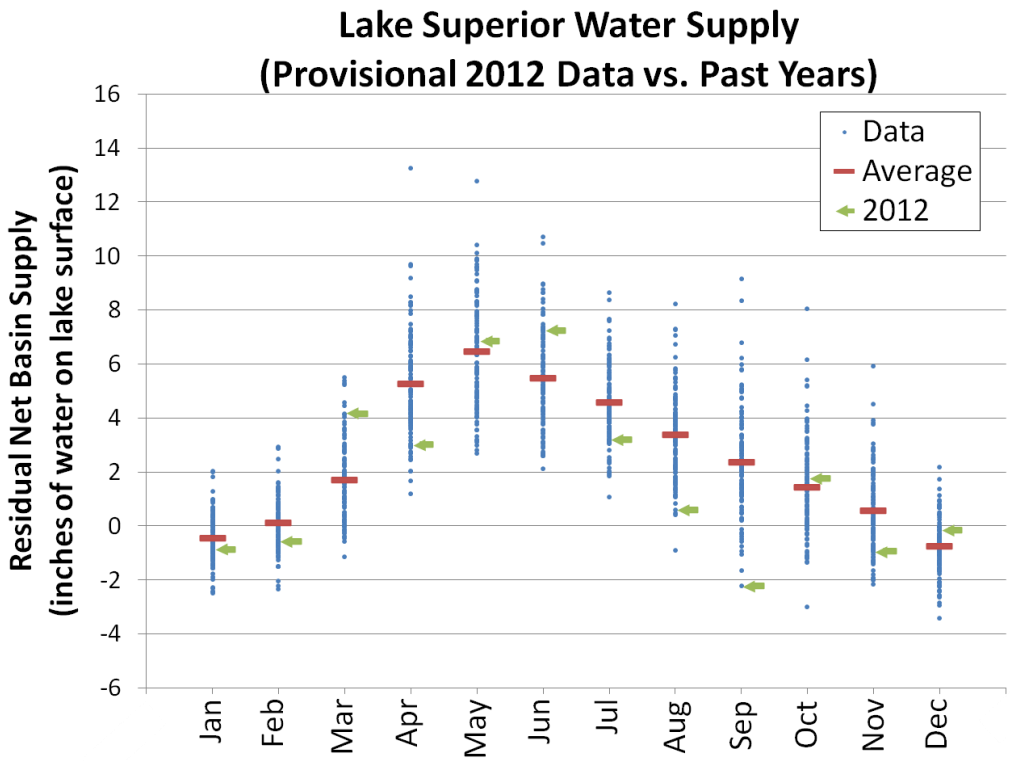

Figure 1: Lake Superior Net Basin Supplies by Month

The month of September 2012 for Lake Superior clearly stands out as extreme. Figure 1 shows that the NBS was the driest it has ever been in September since 1900. In fact, the NBS for September was negative two inches, meaning that evaporation was much larger than precipitation and runoff combined. This contributed to Lake Superior's October water level (600.79 ft) being only one inch above the record low water level for October set in 1925 (600.72 ft).

Overall, the total NBS for 2012 was well below average. During the winter months of January and February, Lake Superior received much less snow than normal and experienced higher than average temperatures. Very dry conditions through the summer and early fall caused the water level to begin declining much earlier than it typically does. Altogether for the year, precipitation and runoff were both below average and evaporation was well above average.

Lake Michigan-Huron

Lake Michigan-Huron set a new record low water level in December 2012 of 576.15 ft, breaking the previous record low set in 1964 of 576.18 ft. The preliminary January 2013 water level of 576.02 ft is below both the previous January minimum of 576.12 ft set in 1965 and the all-time record low of 576.05 ft set in March 1964. As mentioned above, the official period of record for water levels dates back to 1918.

The preliminary 2012 water levels for Lake Michigan-Huron were below LTA for the entire year, extending a consecutive 13 year streak of below average levels. This is the longest stretch of below average levels in Lake Michigan-Huron's recorded history. Lake Michigan-Huron was above chart datum only during the months of April through August in 2012.

Due to the very dry conditions of 2012, Michigan-Huron's water level declined 17 inches from December 2011 to December 2012. A change in the water level of any of the lakes is caused by an offset between inflows and outflows. The 2012 water balance of Michigan-Huron compared to historical averages can be seen in Figure 2. A primary factor causing the

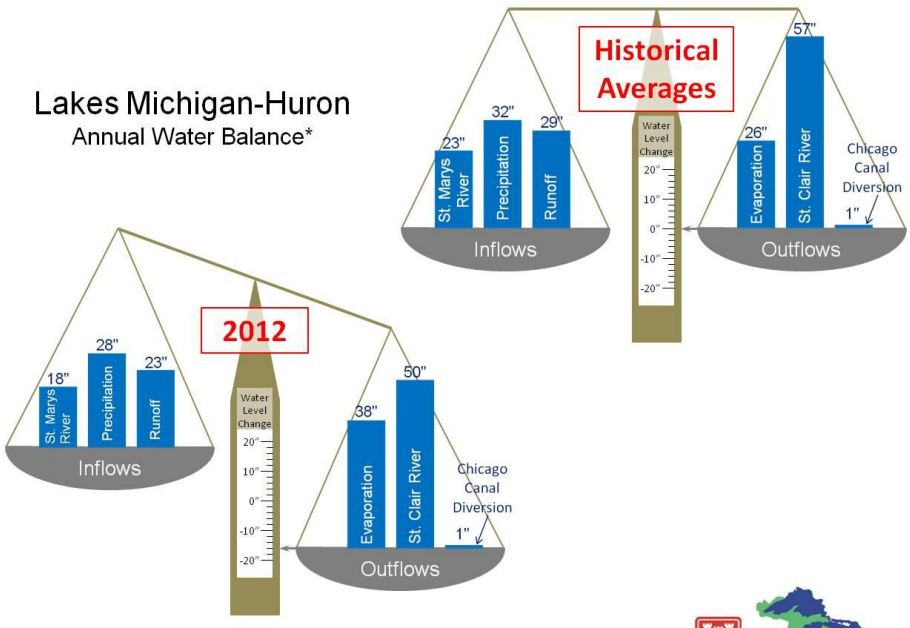

Figure 2: Lake Michigan-Huron Annual Water Balance

water level to decline was the extreme evaporation in 2012. Evaporation is discussed in more detail later in this report, but it was 12 inches above average in 2012 for Michigan-Huron. Altogether, the water level plummeted because the outflows from the lake were much larger than inflows.

Figure 3 shows the month by month NBS for Lake Michigan-Huron. Two months of 2012 clearly stand out as extreme; April and September. Michigan-Huron's NBS is typically the highest in the month of April due to the melting of snow pack accumulated during the winter. The figure shows that the NBS in 2012 was the driest it has ever been for the month of April, due primarily to the extremely small snow pack last winter. The NBS in September 2012 was also the driest it has ever been. In fact, the NBS was negative three inches, meaning that evaporation was much larger than precipitation and runoff combined.

For the six consecutive months from April to September the NBS values for Lake Michigan-Huron were continually below average; indicating extremely dry conditions during these months with very low precipitation and runoff and very high evaporation. Overall, 2012 was the second driest year on record (back to 1900); 1958 remains the driest year on record.

Lake Michigan-Huron experienced a very slight seasonal rise in 2012, rising only 4 inches from February to June 2012 compared to the typical 10 inches of rise. From June to December 2012, the lake declined 18 inches. The lake is expected to continue its seasonal decline into March.

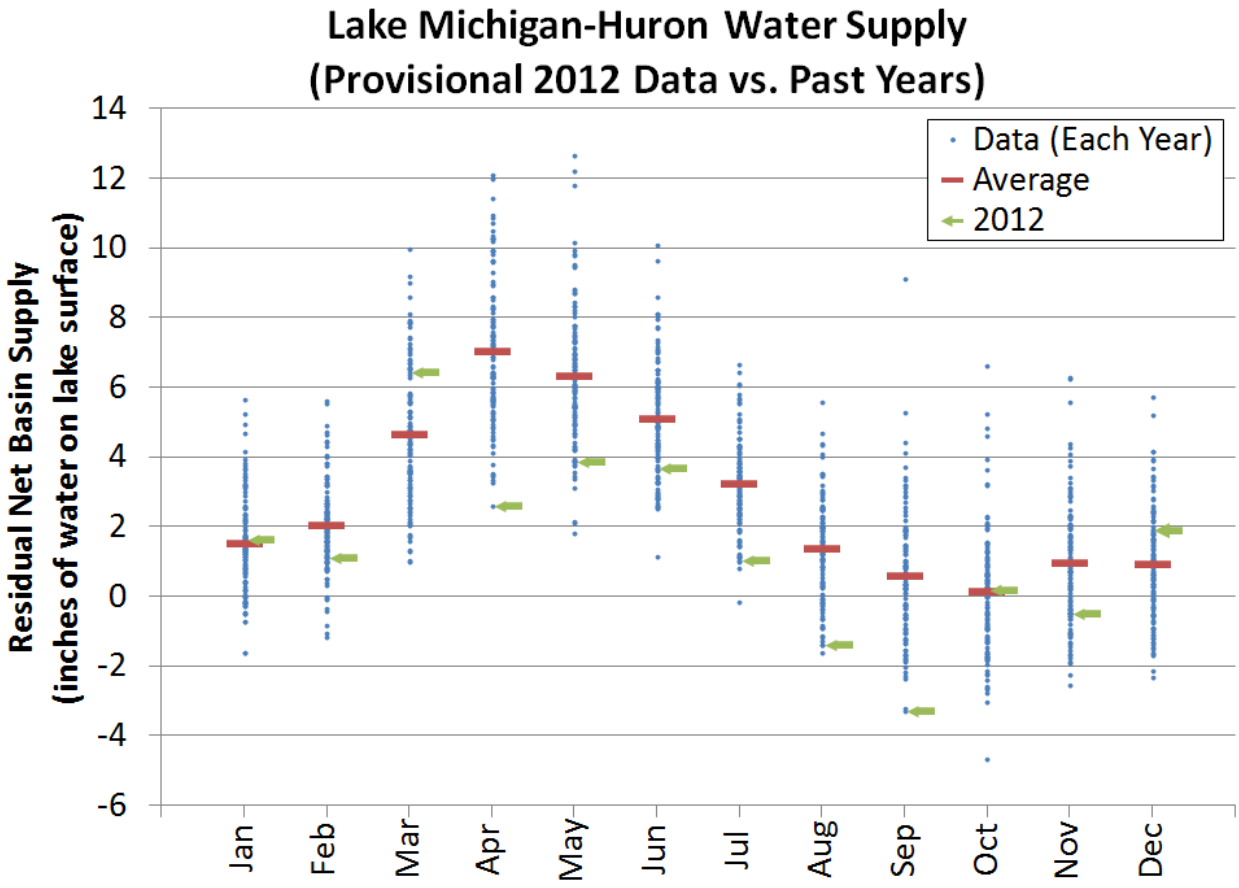

Figure 3: Lake Michigan-Huron Net Basin Supplies by Month

Lake St. Clair

From January 2012 to January 2013, the water level of Lake St. Clair declined 20 inches. Typically the water level rises from February to July each year, but this was not the pattern of 2012. Instead, the monthly water levels have never once increased since December of 2011, as shown in Figure 4.

The preliminary water levels of Lake St. Clair started off above LTA in 2012. In April, the water level dropped below LTA and has ranged 2 to 15 inches below LTA since then. Even though preliminary estimates of NBS in 2012 were not as low as the other lakes, Lake St. Clair's water level still declined, primarily because low water levels on Michigan-Huron caused the flow through the St. Clair River into Lake St. Clair to be below average.

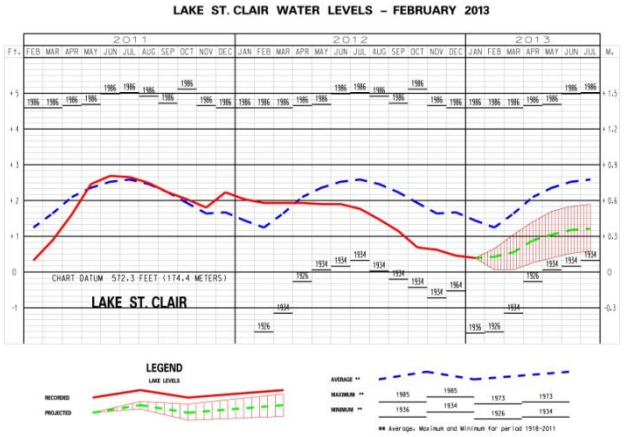

Figure 4: Lake St. Clair Water Levels

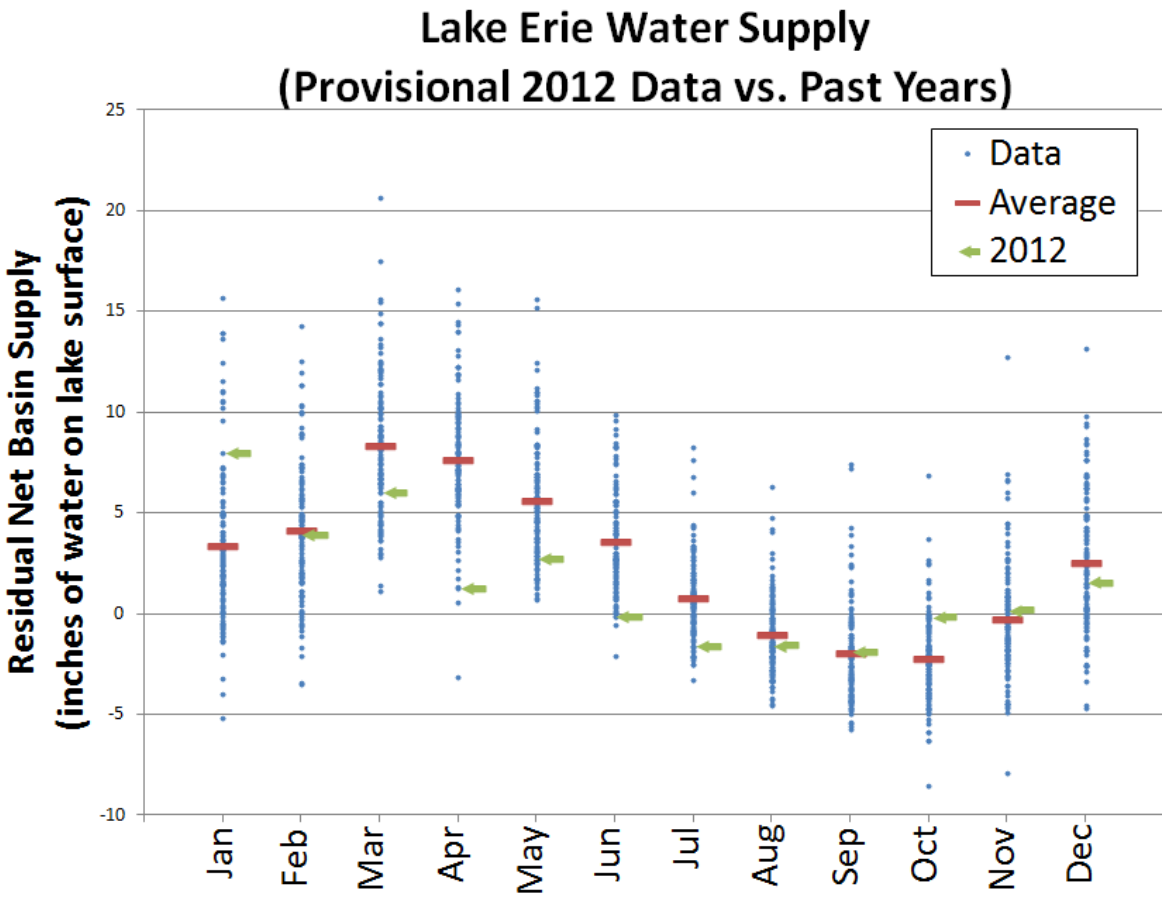

Figure 5: Lake Erie Net Basin Supplies by Month

Lake Erie

Lake Erie's water level declined 22 inches from January 2012 to January 2013. This is actually the largest drop over the past year among the Great Lakes. Normally, Lake Erie experiences a seasonal rise in March through May. In 2012, however, Lake Erie did not experience a seasonal rise, and was in decline for 10 consecutive months, from December 2011 to October 2012. The lake rose slightly in November 2012, but has continued to decline since then. Lake Erie began 2012 above LTA, but since May it has ranged 1 to 9 inches below LTA.

Figure 5 shows the net basin supplies to Lake Erie for each calendar month, comparing 2012 with each year in the historical record back to 1900. Overall, it was a very dry year for Lake Erie as well. The NBS was at or below average for 8 out of 12 months. The NBS was actually negative from June through October, meaning that evaporation was greater than the combined precipitation plus runoff for each of those months.

Lake Ontario

Lake Ontario's water level dropped 17 inches from January 2012 to January 2013. In February 2012, the water level rose to 15 inches above LTA. From February to December, Lake Ontario declined 28 inches. Lake Ontario's preliminary January 2013 water level was 7 inches below LTA.

The explanation for the drop in Lake Ontario water level can be seen in Figure 6 showing the NBS for each month. Water supplies were near their driest ever for April, July, and August due to very low snow pack last winter and very low precipitation all year. The NBS was at or below average for 8 out of 12 months. Only 11 other years since 1900 have been drier than 2012 for the Lake Ontario basin.

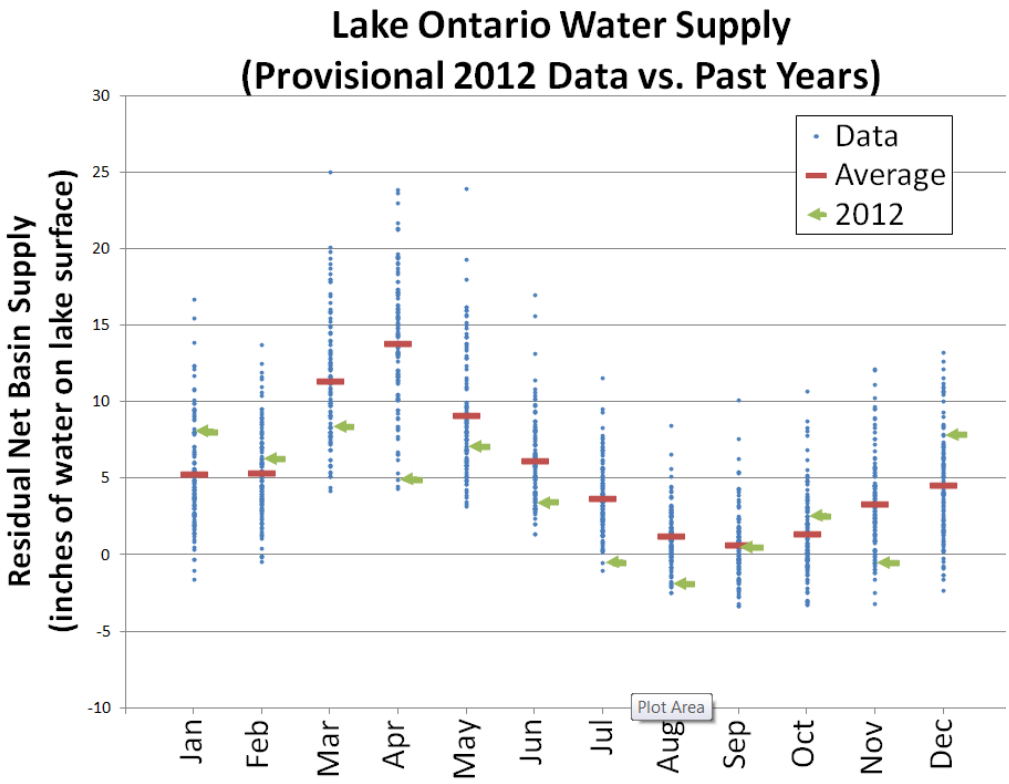

Figure 6: Lake Ontario Net Basin Supplies by Month

Evaporation

The water lost due to evaporation was a huge factor in the declining water levels of 2012. The warm air temperatures during the year caused well above average water temperatures. Though evaporation can happen at any time of the year, it is typically at its peak in the late summer to early winter when cool, dry air blows across a warm water surface.

Evaporation during 2012 was extremely high. To put it in perspective, evaporation from just the surface of Lake Michigan-Huron alone was greater than the water flowing over the Niagara Falls during the months of September and October 2012. Over four inches of water has left Lake Michigan-Huron each month since August 2012 through evaporation.

Figure 7 below shows the total evaporation per year, averaged by decade. Estimates of evaporation come from the National Oceanic and Atmospheric Administration (NOAA) Advanced Hydrologic Prediction System developed by the Great Lakes Environmental Research Laboratory. Evaporation has clearly increased over the last few decades across the Great Lakes basin.

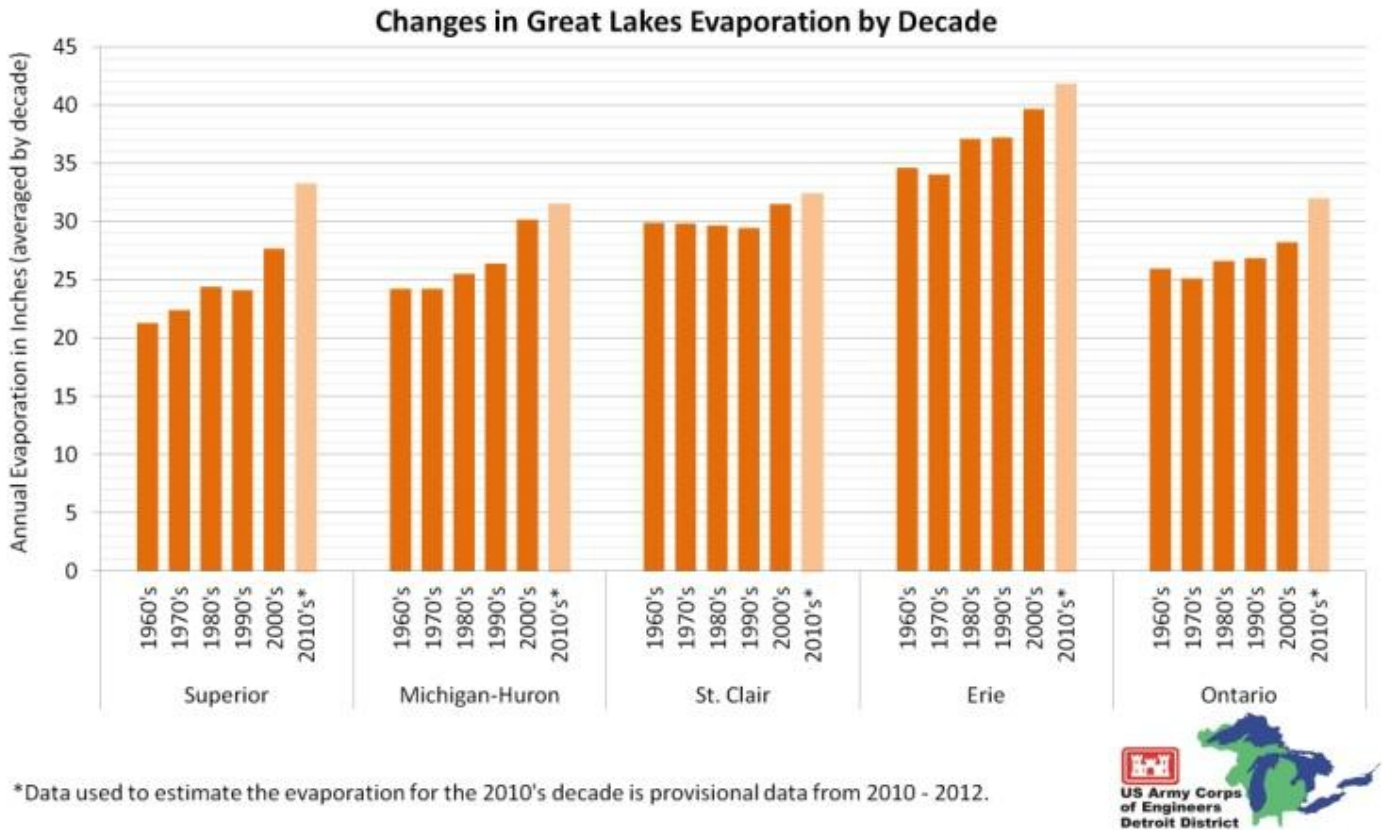

Figure 7: Great Lakes Evaporation by Decade

More Information

Future update articles will be included in the February and August *Monthly Bulletins* highlighting topics and explanations relevant to Great Lakes water levels. February's *Monthly Bulletin* will typically include an annual summary from the year before and each August *Monthly Bulletin* will typically include a summary of the first six months of the year.

The *Monthly Bulletin* can be received either by postal mail or electronically. To receive it by email, you can visit our website (http://www.lre.usace.army.mil/glhh), navigate to the "Water Levels Forecasts" section, and choose to subscribe to the water level forecast(s) of your choice. To receive the *Monthly Bulletin* by postal mail, please email hhpm@usace.army.mil or call 1-888-694-8313 and select option 1. If you wish to remove yourself from the postal mail subscription list or change your address please email us or call us with the contact information just mentioned.

In addition to the *Monthly Bulletin*, the Detroit District issues the *Weekly Great Lakes Water Level Update* and the *Weekly Great Lakes Connecting Channels Water Levels and Depths*. Both products are updated each Thursday and can be located here:

http://www.lre.usace.army.mil/greatlakes/hh/greatlakeswaterlevels/waterlevelforecasts/

In the near future, you may notice changes to our website as we migrate to a new website. We will include a note along with the *Monthly Bulletin* for assistance in navigating the new site when it is complete. We appreciate your patience through this transition.

The Detroit District welcomes comments on all of our forecast products. Please email questions and comments to hhpm@usace.army.mil. To contact the District by phone call toll free 1-888-694-8313 and select option 1.

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