January 2021 Update on Kalamazoo Lake Levels- Past, Present and Future

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January 2021

Introduction: This is an update to the July 2020 report of high water levels in the Saugatuck and Douglas harbor area. Saugatuck and Douglas continued to experience high Kalamazoo Lake and River water levels through the end of 2020, but the water level is down significantly (~17 inches) from the record highs of the summer. Note that the present water level (approximately 581 ft. msl) is still significantly higher (approximately 31 inches) than the long term mean January elevation of Lake Michigan (approximately 578.4 ft. msl). The lake level forecast provided by the US Army Corps of Engineers (USACE) indicates that the water level over the next 6 months will be slightly below the record highs of last summer, but again above average in respect to the long-term mean. Many stakeholders are again asking what is going on and will the Lake level significantly go down? We will try to address these questions with this discussion, but note the predictions on future lake level are educated guesses by NOAA and USACE scientists and engineers based on modeling Mother Nature.

First point to reemphasize: Kalamazoo Lake and Lake Michigan are hydrostatically connected! This means that as Lake Michigan rises, so does the Kalamazoo Lake and River. Kalamazoo Lake is what is referred to as a drowned river mouth.

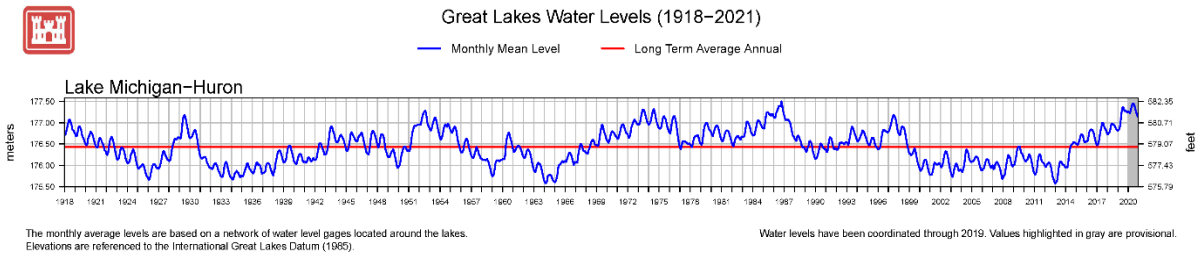


Figure 1: *Historical Lake Michigan water levels*

Historical Lake Levels: Let's again look at the updated historical Lake Michigan water levels going back to the year 1918 (Figure 1). As discussed previously in the July 2020 report Lakes Michigan and Huron are also hydrostatically connected by the Straits of Mackinac. The time history in Figure 1 shows at least six periods of high water and five low water level events, with a near record low occurring in 2013 (remember all the dredging concerns). Some modelers see a periodicity in high to low water levels of eight to fifteen years, but suffice to say the water level goes up and it goes down at least each decade. If we examine the length of high water events during the entire record we observe high water events as short as one year and as long as approximately eight years. The average duration of high water events is approximately four years. We are presently six years into this high water event and the plot shows we are trending downward. Good news.

Figure 2 shows in more detail the mean monthly water levels from 2020 relative to the historic maximum, minimum, and mean water levels. The first nine months of 2020 each set a new record high mean water level. The mean water level for July-August 2020 was ~582.4 ft. msl, 7.3 inches higher than the previous maximum set in 1986 (581.79 ft). Starting in mid-September 2020, the water has receded to a present value of 581 ft. msl, down approximately 17 inches. The presently reported water level of 581 ft. msl typically represents the seasonal low value.

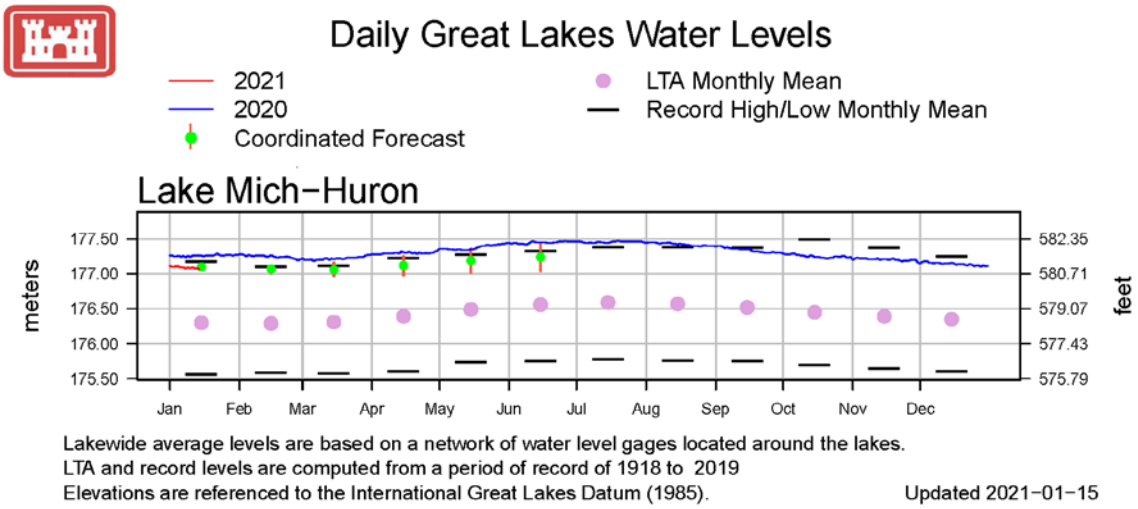


Figure 2: *Mean Daily Lake Michigan water levels for 2020 and the first weeks of 2021 compared to the historic mean (pink dots), minimum and maximum (horizontal black bars).*

The top of the seawall at East Shore Harbor Condos (ESHC) is at approximately 582 ft. msl, thus any Lake Michigan water level above 582 ft results in flooding. The 582 ft. msl is representative of the height of other seawalls in the areas, thus if there is flooding at ESHC flooding will be occurring in other parts of the harbor. The mean daily water level for Lake Michigan exceeded 582 ft every day from May 20, 2020 through early September. After that point, the average monthly water level has not exceeded 581.5 ft. msl, thus no flooding. The Lake Michigan water level gauge at Holland can be easily accessed (see https://tidesandcurrents.noaa.gov/waterlevels.html?id=9087031) to ascertain whether flooding of the shore is occurring. Just remember ~582 ft. msl or lower equals no flooding.

Present Lake Level and Near Term Trends:

Presently Lake Michigan and thus Kalamazoo Lake are at 581 ft. msl which is approximately 42 inches above the low water datum (LWD) value. Water level is down approximately 6.7 inches from the mean January 2020 level (which was a record high for January) and 17 inches from the record high set in July 2020. However, the water level today is still approximately 31 inches higher than the long term average. The water level will rise again in the late spring due to river runoff and snow melt and peak in the July time frame.

Future Lake Levels:

The US Army Corps of Engineers, NOAA, and various Canadian government organizations all monitor the water level in the Great Lakes and make predictions as to future water levels. Some predictions look a few months into the future while others predict next year or five and ten years out. For this discussion we are presenting the USACE Great Lakes Water Level Outlook for a 6 month period starting from January 2021. Recall, three factors determine lake level; precipitation, evaporation, and runoff which is referred to as the Net Basin Supply (NBS).

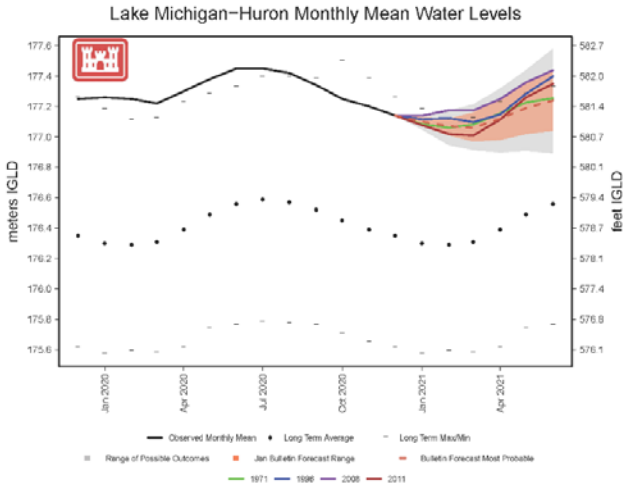


***Figure 3**: Prediction of Lake Level for Lake Michigan*

In the summer of 2020 a La Niña event occurred in the Pacific Ocean. Recall a La Niña is where surface waters of the Pacific at the equator are colder than average. Such events drastically affect the weather in the Great lakes, in this case typically resulting in a wetter and colder winter. The USACE uses historical La Niña (cold) and El Niño (warm) events and how these events influence water level to make better predictions.

Figure 3 shows the range of predicted water level for the next six months based on the influence of the La Niña for Lake Michigan. The gray area represents the range of possible modeling scenarios based on data from 1900 to 2020, from a June 2021 level below 580.4 ft. (~7 in. below the present level and 14 inches above the long term June average) to approximately 582.7 ft. (approximately 4 inches higher than the record high water event of 2020). The four solid lines represent water level projections based on conditions observed in four La Niña years that were similar to 2020. For example, the green curve represents the projected water level if the conditions (i.e. air temperature, winds, precipitation) over the next six months resemble those from 1971. The scenario deemed most probable based on historical precedent would be a relatively safe June water level of approximately 581.48 ft msl (approximately 6 inches below the sea wall). However, three of the four scenarios (1996, 2008, and 2011) project water levels near or above 582 ft msl, lower than last year's record high but still sufficient to cause further flooding. All four modeled years show increased water level, again due to a La Niña generating a wetter winter in our part of the Great Lakes region. Thus, precipitation is the big driver in respect to lake levels.

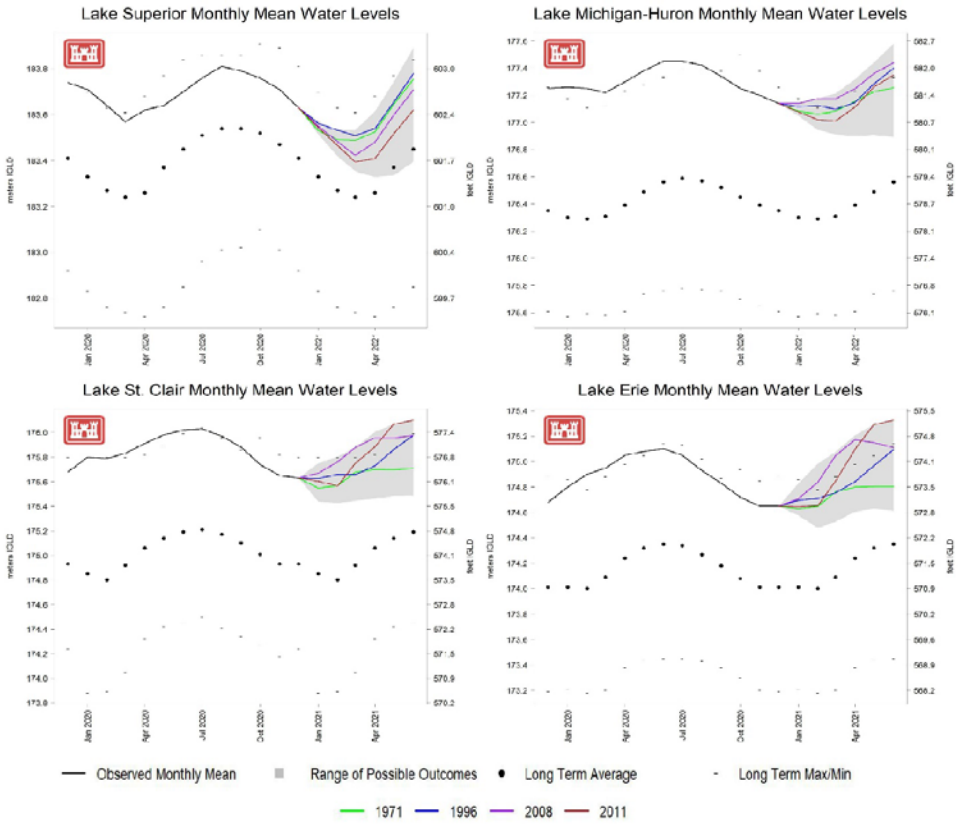
Summary: The high water has created problems and large expenses for the harbor stakeholders. The big question that we do not have a reliable answer for is, when if ever will the water return to normal (i.e. is near average value). It really is mostly about the precipitation and evaporation. The average annual precipitation in the Michigan watershed basin is approximately 32 inches, with a high value of 40 inches occurring in 1985 and a low of 21.6 inches in the year 2016. Last year (2020) the annual precipitation in the Saugatuck area was 39.2 inches, near the high. However, the warm fall Lake Michigan waters (still at 39.9 degrees F) and colder air temperature led to above average evaporation, resulting in the reduced NBS as discussed above. The takeaways are:

1) Kalamazoo Lake and Lake Michigan are hydrostatically connected, if Lake Michigan rises so does Kalamazoo Lake and River.
2) **Remember the number 582 ft. msl.** When the gauge at Holland reads 582 or higher we are going to get flooding.
3) Storm surge and seiche events on Lake Michigan will still occur and result in local flooding due to the high water, in normal times we barely notice these occurrences.
4) The future lake level is all about NBS, really it translates into rain and snow fall. Above average precipitation in the Great Lakes Basin spells trouble.

US Army Corps of Engineers ®
Detroit District

Great Lakes Water Level Future Scenarios

Volume 22: January 2021 La Niña Analysis



*At this time, water level outlooks for Lake Ontario are still under development due to complexities of its weekly regulation process. For the official 6-month forecast of all lakes, including Lake Ontario, see the Monthly Bulletin of Great Lakes Water Levels.

Overview

Over the last three months, water levels continued their decline and are approaching or have reached their seasonal low in water levels. The current Great Lakes water level 6-month forecast indicates water levels to be slightly below record high levels, but still above average. Water levels follow a seasonal cycle where water levels rise in the spring due to increased precipitation and enhanced runoff from snowmelt. In the summer, water levels typically reach their peak level. In the fall, the lakes generally decline due to an increase in evaporation as temperatures decline and cold air moves over the relatively warm lake waters. We refer to the combined effect of precipitation over the lake, evaporation from the lake, and runoff to the lake as Net Basin Supply (NBS).

This past August, La Niña conditions developed in the equatorial Pacific Ocean. This means that the sea surface temperatures in the eastern and central equatorial Pacific Ocean are cooler than normal. When this occurs, there can be impacts to the weather that is experienced in the Great Lakes region, especially in the winter. The current forecast issued by the Climate Prediction Center expects that the La Niña will last through the winter. Figure 1 depicts the weather conditions that typically occur when a La Niña is present in the winter. For the Great Lakes basin, southern portions of the basin could experience wetter than normal conditions and colder air could push further south into the region, increasing the chance for more evaporation across Lakes Superior and Michigan.

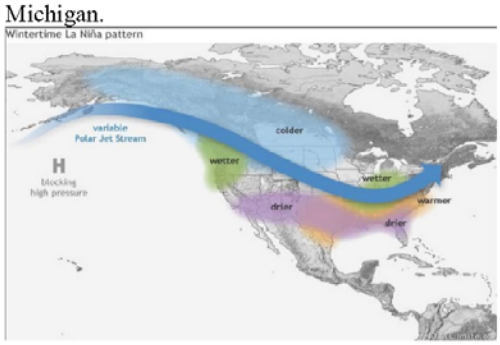
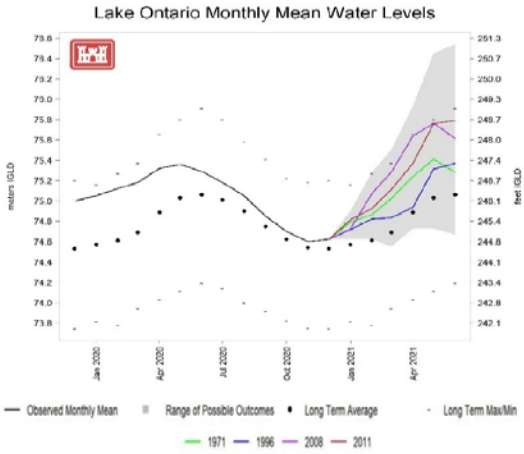


Figure 1: An example of the weather conditions across North America during a typical La Niña winter. (Climate Prediction Center)

2020 was warmer than normal across the globe, despite La Niña years typically being colder than normal. In a recent blog post by the Climate Prediction Center, they compared the 2020 La Niña year, to four other La Niña years that also developed in the summer or fall and experienced warmer than normal conditions. (https://www.climate.gov/news-features/blogs/enso/december-2020-la-ni%C3%B1a-update-walking-la-ni%C3%B1a-winter-wonderland). This edition of the Water Level Future Scenarios showcases these 4 years 1970, 1995, 2007, and 2010, which were similar to 2020, and what the conditions were like during the first 6 months of the following year. The scenarios go out 6 months to show the potential impact of a La Niña lasting through the winter and any lingering effects that could occur as the La Niña diminishes this spring. Therefore, it is likely that most of the impact from the La Niña will be in the first few months of the year. The water levels that would result if the hydrologic conditions are similar to what occurred in these four years are represented by the green, blue, purple, and brown lines.

Also, the gray shaded area on the plot represents the full range of possible outcomes using historical sequences of NBS back to 1900 through 2020. This version also incorporates an experimental version of a Lake Ontario graphic.



For Lake Ontario, the range of possible outcomes (gray shaded area) is based on historical NBS from 1900-2017.

1971 Scenario

The green line represents water levels if NBS and hydrologic conditions over the next 6 months are similar to what occurred during the first 6 months of 1971. The green line indicates that the seasonal decline would continue into January on Lakes Superior to Erie. This was likely a result of above average evaporation in January on all lakes and a combination of below average precipitation on Lake St. Clair and Erie. Lake Ontario would continue its seasonal rise, despite the above average evaporation in January. February in 1971 was quite wet with above average precipitation across the basin, while March precipitation was closer to average. However, the runoff during these two months was above average. In April and May, precipitation was below average across the basin, except for precipitation in May on Lake Superior. This would lead to diminished seasonal rises on Lakes Michigan-Huron, St. Clair, and Erie. In June, precipitation and runoff were near average. The predominantly drier conditions on all the lakes, besides Lake Superior, led to water levels staying below record high monthly levels on all the lakes.

1996 Scenario

The 1996 scenario shown by the blue line depicts water levels if NBS and hydrologic conditions for the next 6 months are similar to what occurred during the first 6 months of 1996. NBS was above average in all months, except March across all the Great Lakes. In March, precipitation and runoff were below average, which led to the drier month. In January and February, precipitation was near to above average, while in April, May, and June conditions were very wet throughout the majority of the Great Lakes basin. These wetter conditions led to large spring rises on Lakes Michigan-Huron, St. Clair, and Erie, which would push water levels towards record high levels by the end of the 6 months. Lakes Superior and Ontario would stay below record high levels, despite the wetter conditions from April to June.

2008 Scenario

The purple line represents water levels if NBS and hydrologic conditions for the next 6 months are similar to what occurred during the first 6 months of 2008. In January of 2008 the NBS was above average across all lake basins. Despite above average evaporation on Lakes Superior and Michigan-Huron in January, precipitation was near to above average with the combination of above average runoff leading to the wetter conditions to start the year. February and March were drier than normal with below average precipitation and above average evaporation on Lake Superior, which led to a fairly steep water level decline. February and March on the other lakes experienced above average NBS due to predominantly above average precipitation and increased runoff. In April, all of the lakes experienced above average NBS, due to the high runoff that continued on the lower lakes. The wetter than normal conditions for the southern part of the basin is typical for a La Niña. The upper lakes also experienced above average precipitation in April. In May, overall basin conditions were near average, but in June precipitation and runoff were again above average across all lake basins. These wetter conditions, especially on Lakes Michigan-Huron, St. Clair, and Erie, would lead to water levels surpassing record high levels in most months of the new year. On Lake Ontario, water levels would also approach record high levels in April and May, while Lake Superior would stay below record high levels over the next 6 months.

2011 Scenario

The 2011 scenario is shown with the brown solid line and depicts water levels if NBS and hydrologic conditions are similar to what occurred from January to June 2011. The first 3 months of 2011 were dry in the Lake Superior and Michigan-Huron basins with near to below average precipitation and above average evaporation, which led to a steeper seasonal decline on both lakes. On the lower lakes, NBS was near average during January and February, but in February there was a transition to increased precipitation that lasted through May. The very wet conditions in the spring of 2011, even set some monthly records for precipitation in some lake basins. Precipitation in

April 2011 set a monthly record high on Lakes Michigan-Huron, Erie, and Ontario. May 2011 was also a record high for precipitation for the Lake Erie basin. Again, this wetter than normal conditions for the southern part of the basin is typical for a La Niña. The above average precipitation during these 4 consecutive months led to large spring rises on Lakes St. Clair, Erie, and Ontario. This would lead to record high water levels on Lake St. Clair and Erie in April, May, and June. Also, record high water levels would be possible on Lake Michigan-Huron in June. Lake Ontario would come close to record high levels in May and June. The precipitation in the Lake Superior basin was closer to average during the spring of 2011, which would lead to a moderated spring rise and keep water levels below record highs, but above average.

Climatic Outlook for January 2021

The recent 1-month climate forecast updated by the Climate Prediction Center shows a likelihood of above normal temperatures for the month of January. The forecast for precipitation in January indicates the likelihood of above normal precipitation for the entire Great Lakes basin. The seasonal three-month outlooks for temperatures in the winter and early spring (January, February, March) indicate a likelihood of above normal temperatures for all of the Great Lakes basin besides the Lake Superior basin. The seasonal three-month outlook for precipitation indicates a likelihood for above normal precipitation. The seasonal outlook guidance for a likelihood of above normal precipitation is supported by the La Niña conditions that are expected to persist through the winter months. Although the current forecast for La Niña is expected to weaken in the spring the chances for wetter than normal conditions in the Great Lakes region are forecast to persist. As shown in Figure 1, a typical La Niña winter would lead to cooler than normal temperatures in the western portions of the Great Lakes basin, and wetter than normal conditions in the southern portion of the basin. This could indicate a chance for some higher evaporation rates on Lake Superior or Lake Michigan, while Lakes St. Clair, Erie and Ontario could see greater precipitation and runoff during the winter months. So far, the 2020-21 La Niña has been warmer than normal throughout the region and precipitation has been less than normal. It is important to note that no two La Niña's are the same and can be impacted by other weather and climate phenomena. This can be further emphasized by the differences in conditions between the four scenario years. Even though during all four winters La Niña conditions were present, the conditions during the first few months of each year varied. Therefore, although it is likely wetter and cooler conditions could occur in parts of the basin this winter, it is not guaranteed.