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

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Introduction: This is an update to the January 2021 report of high water levels in the Saugatuck and Douglas harbor area. Saugatuck and Douglas have continued to experience above-normal Kalamazoo Lake and River water levels through April 2021. However, the typical seasonal decline combined with a dry winter and early spring have led to current water levels being down more than a foot from April 2020 (~14 inches). Note that the present water level (approximately 580.5 ft. msl) is still significantly higher (approximately 22 inches) than the long term mean April elevation of Lake Michigan (approximately 578.74 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 likely rise slightly due to spring snowmelt and precipitation but remain below the record highs of last summer. 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.

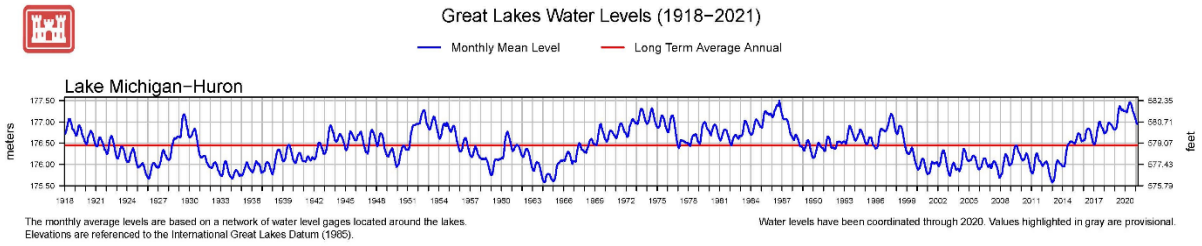

Figure 1: *Historical Lake Michigan water levels*

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 January 2021 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 and the start of 2021 relative to the historic maximum, minimum, and mean water levels. After water levels reached a record high in July-August 2020 (~582.4 ft. msl, 7.3 inches higher than the previous maximum), the water has steadily declined to a present value of approximately 580.5 ft. msl. This is down approximately 23 inches from the record highs of last summer, and 14 inches from the mean April 2020 levels, but still approximately 22 inches higher than the long term April mean.

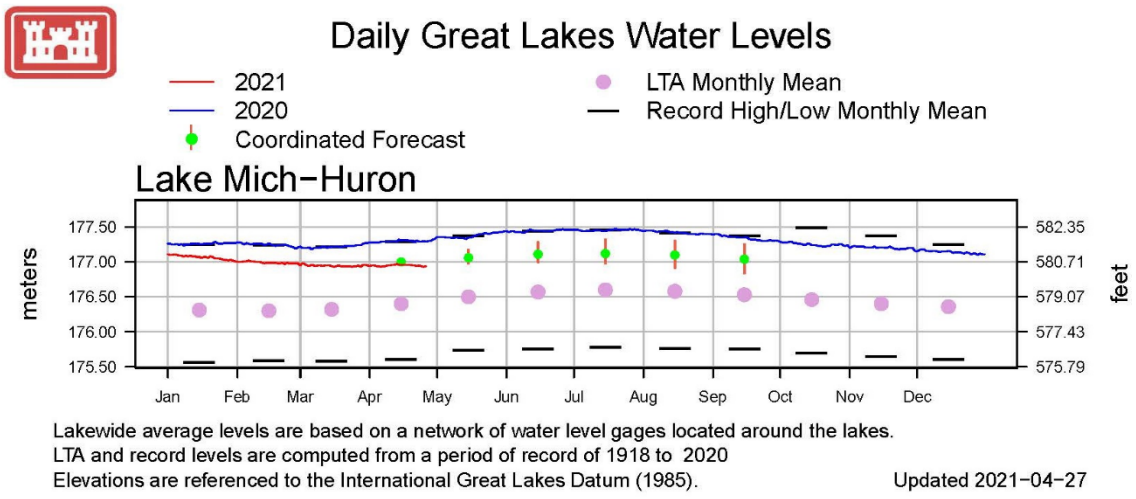

Figure 2: *Mean Daily Lake Michigan water levels for 2020 and the first four months of 2021 compared to the historic mean (pink dots), minimum and maximum (horizontal black bars).*

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 580.5 ft. msl which is approximately 42 inches above the low water datum (LWD) value. Water level is down approximately 14 inches from the mean April 2020 level (which was a record high for April) and 23 inches from the record high set in July 2020. However, the water level today is still approximately 22 inches higher than the long term average. The water level will rise again as spring continues 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 12 month period starting from April 2021. Recall, three factors determine lake level; precipitation, evaporation, and runoff which is referred to as the Net Basin Supply (NBS).

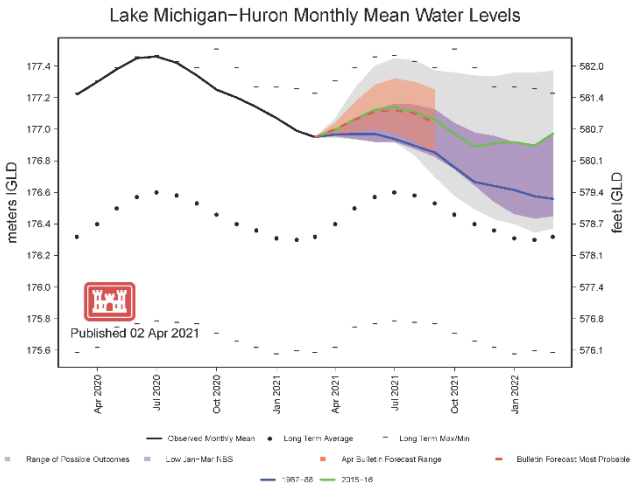

***Figure 3**: Prediction of Lake Level for Lake Michigan*

Dry conditions from January-March 2021 led to a very low three month NBS. Figure 3 shows projected water levels based on a range of scenarios. The purple envelope represents the range of likely water levels based on 10 years that also experienced low January-March NBS similar to 2021. In this range of scenarios, the peak water level over the next year will be in July 2021 and still be 9 inches below the 582 ft msl flooding threshold. The much wider gray area represents the range of possible modeling scenarios based on historical data from 1900 to 2020.

The two solid lines represent water level projections if NBS and hydrologic conditions (i.e. air temperature, winds, precipitation) are similar to those observed in two other low January-March NBS years. The blue curve represents 1987-88 which, in addition to the low early season NBS, had below average ice cover across the Great Lakes (27%). This scenario would entail dry conditions continue through most of the year and result in little water level rise through summer 2021 and an April 2022 level approximately 15 inches below current levels. The green curve represents 2015-16 where the low March-June NBS was followed by a wetter than average late spring and early summer. In this scenario, the 2021 water levels would peak in July approximately 8 inches above current levels, with April 2022 levels within an inch of current levels.

The orange envelope represents a 6-month forecast range based on currently projected weather conditions, with the dashed orange line being the most probable forecast. This forecast would put the next six months close to the green (2015-16) curve, representing a seasonal water level rise, but one that should not result in much flooding.

Summary: The high water levels of 2020 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, despite the 2020 La Niña event, we had a dry winter, resulting in the continued reduction in water levels. 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 ®
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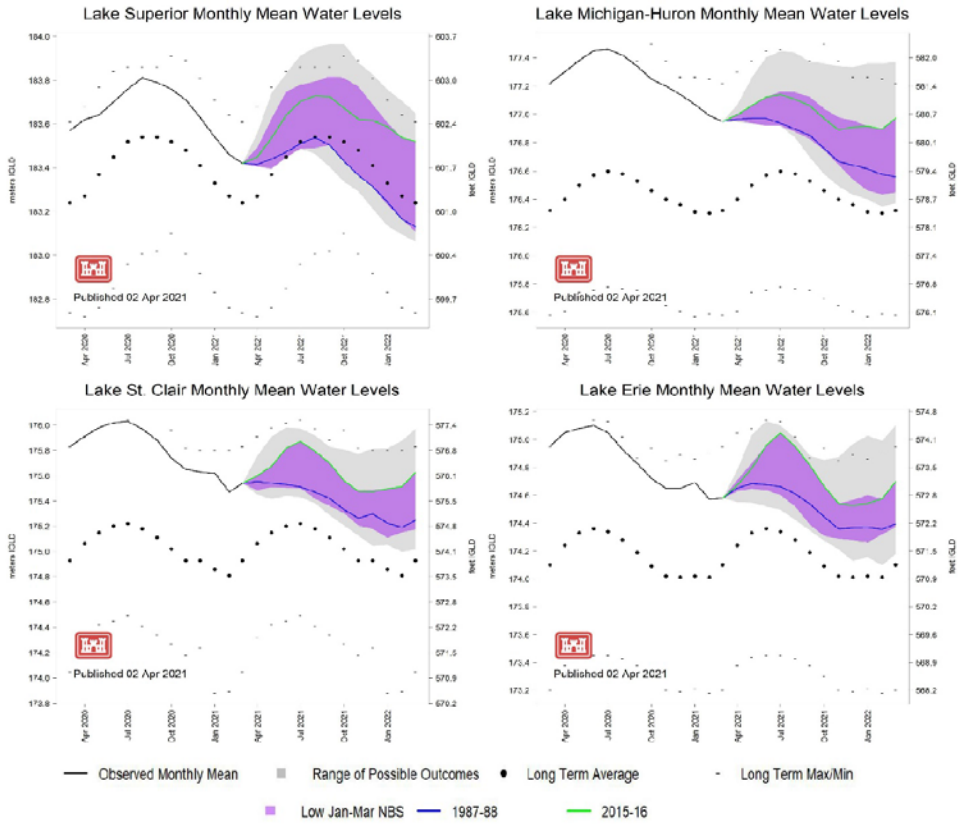
Great Lakes Water Level Future Scenarios

Volume 23 April 2021: Dry January to March

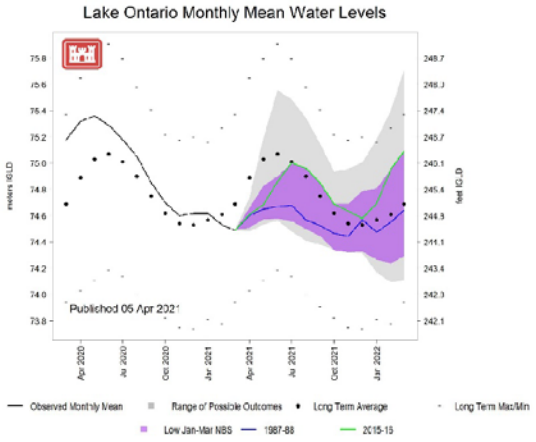


*At this time, water level outlooks for Lake Ontario are still under development due to complexities of its weekly regulation process. For the official 6-month forecast of all lakes, including Lake Ontario, see the Monthly Bulletin of Great Lakes Water Levels.

Overview

Over the last three months, water levels on Lakes Superior and Michigan-Huron continued their seasonal declines, which were aided by drier conditions. Lakes St. Clair and Erie experienced a sharp drop in water levels from January to February due to an ice jam that developed in the St. Clair River in early February. Lake Ontario has also experienced a decline in water levels over the last three months, which contributed to the monthly average levels for February and March to be below long-term average levels. The recent 6-month forecast projects all the lakes to either begin or continue their seasonal rises in water levels. Water levels follow a seasonal cycle where water levels typically 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). In the last three months, from January to March, dry conditions have dominated, which has led to the NBS for the Great Lakes basin to be very low over the 3-month period.

This edition of the Water Level Future Scenarios showcases a purple plume that represents ten years of the lowest NBS from January to March for the Great Lakes basin, which has been similar to 2021. Two of the years within the plume have been called out to show the difference in hydroclimate conditions that could occur over the next 12 months. Also, the gray shaded area on the plot represents the full range of possible outcomes using historical sequences of NBS from 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.



Purple Plume: Low Jan.-Mar. NBS

The purple plume represents ten years that also had low January to March NBS, which was similar to what occurred in 2021. The purple plume on each of the lakes remains predominantly toward the bottom half of the full range of possible outcomes (gray shaded area). Two years within the plume, 1987-88 and 2015-16 have been called out and represented by the blue and green lines. The 1987-88 scenario is represented by the blue line and indicates water levels that would occur if the NBS sequence for the rest of 1987 and early 1988 occurred. The 2015-16 scenario is shown by the green line and represents water levels that would occur if NBS was similar to the rest of 2015 through the beginning of 2016.

1987-88 Scenario

The blue line represents water levels if NBS and hydrologic conditions over the next 12 months are similar to what occurred during the next 9 months of 1987 and first three months of 1988. Similar to 2021, the January to March NBS was low and winter ice cover on the Great Lakes was below average in 1987 at 27.3%. The blue line indicates that the seasonal rises would be very small across all lakes. After predominantly below average precipitation for the first three months of 1987, the drier conditions would continue into the late spring and early summer. April and May would bring below average precipitation to most of the lake basins, while runoff would be below average

across the Great Lakes region. Near to below average NBS would continue for the summer months, which would keep the seasonal peaks low on all the lakes. September and October would be exceptionally dry for Lake Superior and aided in the sharp seasonal decline seen on the lake. On the other lakes, NBS was closer to average in September and October, but still helped in the seasonal declines on the lakes, especially in October when evaporation was well above average. The last two months of the year would be slightly on the wetter side of average, with predominantly increased precipitation and runoff. The beginning of 1988 would bring NBS near to below average across the lakes with evaporation well above average. The generally dry conditions throughout the year would lead to diminished seasonal rises and some larger seasonal declines, especially on Lake Superior that experienced a steep decline in water levels that brought water levels below average.

2015-16 Scenario

The 2015-16 scenario shown by the green line depicts water levels if NBS and hydrologic conditions for the next 12 months are similar to what occurred during the rest of 2015 and beginning of 2016. Contrary to the 1987-88 scenario, winter ice cover was much higher during the winter of 2015 at 88.8%. Also, after the first three months of the year experiencing drier conditions the late spring and early summer experienced NBS that was near to above average. This was especially true in June on the lower lakes that saw well above average precipitation. This led to large seasonal rises on the lakes, especially on Lake St. Clair and Erie. For the rest of the summer months, NBS was generally near average across the lakes. Entering the fall, and the period of seasonal decline on the lakes, conditions on the upper lakes of Lakes Superior and Michigan-Huron were wetter than on the lower lakes. This was especially true in November and December when precipitation was mainly above average, and evaporation was well below average. This helped to lessen the seasonal declines on those lakes. On Lakes St. Clair, Erie and Ontario, precipitation was less during the late fall and early winter leading to NBS closer to average, with evaporation during November and December remaining below average on these lakes. However, the drier conditions generally led to steeper seasonal declines on these lakes. The beginning of 2016 brought some wetter conditions, especially in February and March when precipitation and runoff would be above average. Overall, during the 2015-16 scenario water levels would remain below record high levels and remain above average on Lakes Superior, Michigan-Huron, St. Clair, and Erie.

Climatic Outlook for April 2021

The recent 1-month climate forecast updated by the Climate Prediction Center shows a likelihood of above normal temperatures for the month of April. The forecast for precipitation in April is equal chances for most of the basin. This means that there is an equal chance of the basin experiencing above, below, or near normal precipitation. The seasonal three-month outlooks for temperatures and precipitation in the late spring and early summer (April, May, June) indicate a likelihood of above normal temperatures and above normal precipitation for all the Great Lakes basin. The seasonal outlook of above normal precipitation can be partially attributed to the ongoing La Niña. However, the La Niña conditions are forecast to transition to ENSO neutral later this spring.