Update on Kalamazoo Lake Levels- Past, Present and Future

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Introduction: This is an update to the December 2019 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 and flooding this past spring and it is continuing this summer based on rain and strong wind events occurring on Lake Michigan. Many marinas, commercial business owners along the river and lake, as well as property owners have been forced to raise the height of docks and other structures as well as put in barriers to stem the flow of water on to shoreline properties and roads. Many folks are again asking what is going on and will the Lake level ever 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 understand: 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.

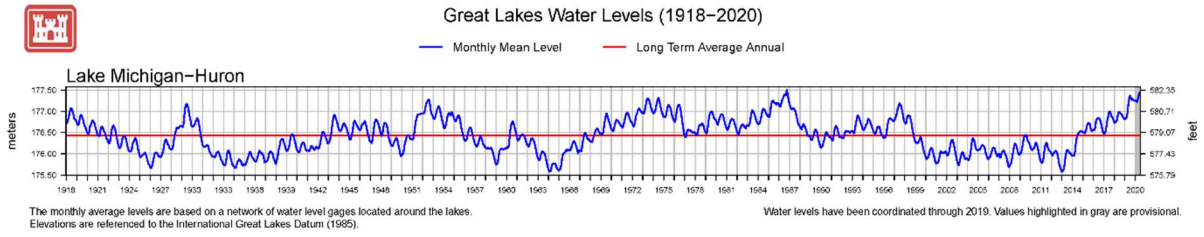

Figure 1: *Historical Lake Michigan water levels*

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 December 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 so perhaps the end is in sight.

Figure 2 shows the mean monthly water levels from the past two years (2019-2020) relative to the historic maximum, minimum, and mean water levels. The first six months of 2020 each set a new record high mean water level. The mean water level for June 2020 was 582.18 ft, nearly 5 inches higher than the previous maximum set in 1986 (581.79 ft).

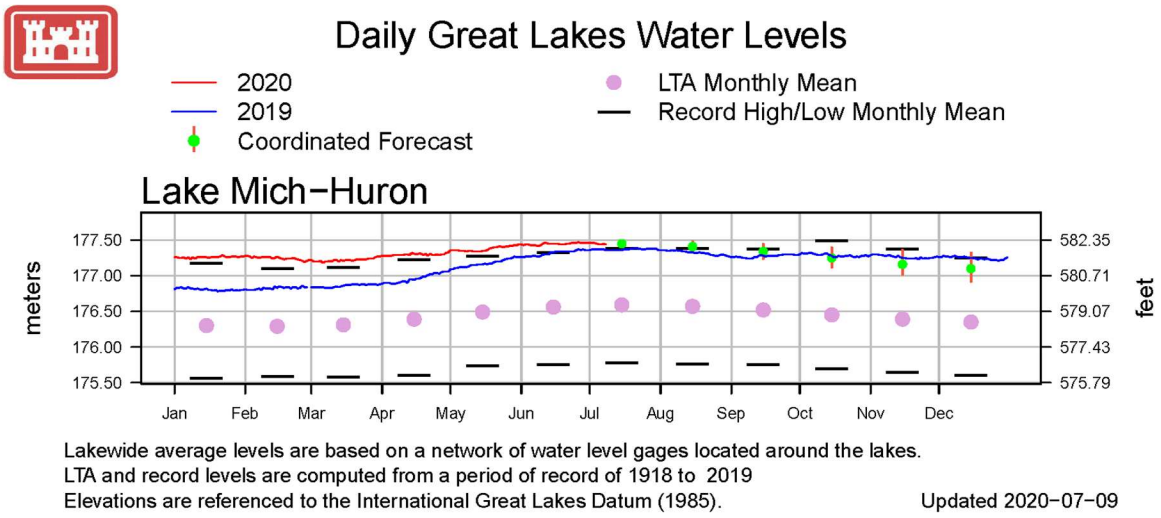

Figure 2: *Mean Daily Lake Michigan water levels for 2019-2020 compared to the historic mean (pink dots), minimum and maximum (horizontal black bars).*

The top of the seawall at ESHC is at approximately 582 ft msl, thus any Lake Michigan water level above 582 ft results in flooding. The mean daily water level for Lake Michigan has exceeded 582 ft every day since May 20, 2020. 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.

Present Lake Level and Near Term Trends:

Presently Lake Michigan and thus Kalamazoo Lake are at 582.4 ft. msl which is approximately 60 inches above the low water datum (LWD) value. Since June 3, 2020 water level is up one inch, and up 4 inches from the July 2019 level. The difference in water level today and the long term average is approximately 34 inches and up 3 inches from the previous record high in 1986. The good news is the water level is projected to go down in August between 1-2 inches and continue to decrease through the end of the calendar year, with a level below the 582 ft mark which will result in less shoreline flooding.

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 June 2020. Three factors determine lake level; precipitation, evaporation, and runoff which is referred to as the Net Basin Supply (NBS). Figure 3 shows the range of predicted water levels for Lake Michigan. The gray area represents the range of possible modeling scenarios, from a June 2021 level below 579.7 ft (nearly 3 ft below the present level) to approximately 583.3 ft, a new record high water event. The blue curves represent the projected water level if precipitation is similar to years that were significantly wetter than average (1986 and 1977) and the brown curves represent the projection if precipitation is similar to years that were drier than average (1930 and 1976). Precipitation is the big driver in respect to lake levels. We mentioned based on Figure 1 the periodicity of high and low water events. The USACE reports precipitation in the Lake Michigan basin shows no sign of an upward trend. This is good news.

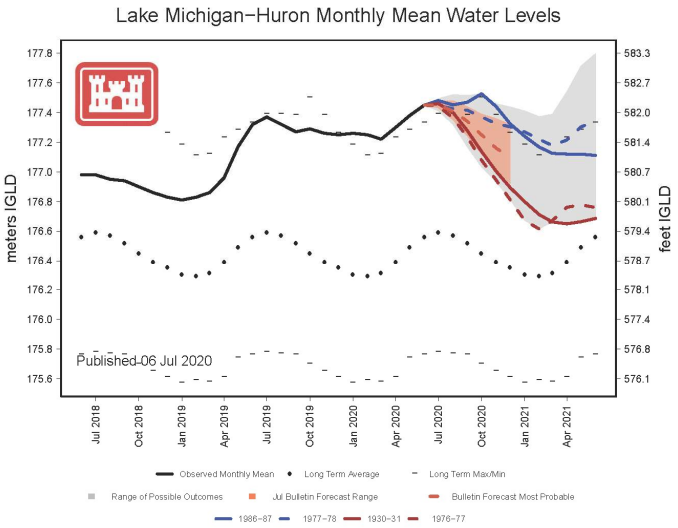

***Figure 3**: Prediction of Lake Level for Lake Michigan*

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 the water will return to normal (i.e. is near average value). It really is mostly about the precipitation. 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. Presently the cumulative precipitation value for Saugatuck since the first of the year is approximately 25 inches. Let's hope we have a dry fall. 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 ft or higher we are going to get flooding.
3) Storm surge and seiche events on Lake Michigan are a big problem 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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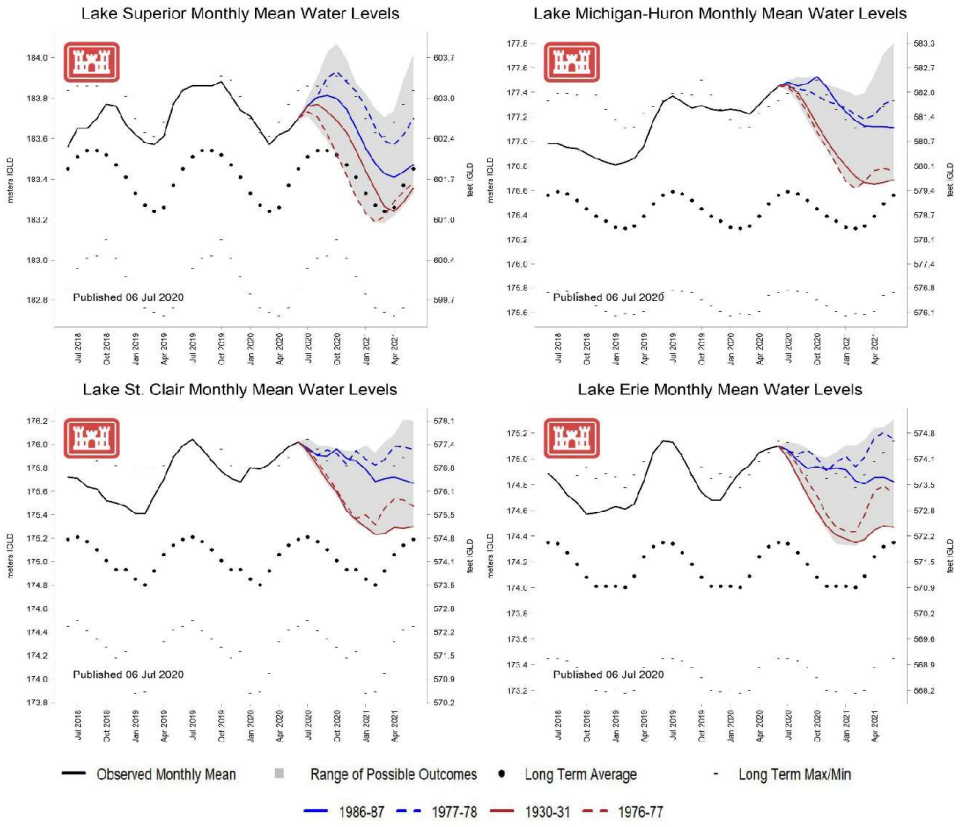
Great Lakes Water Level Outlook

Volume 20: July 2020 12-Month Outlook



*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

Near or above record high water levels continue on some of the Great Lakes. Lakes Michigan-Huron and St. Clair set new record high monthly mean water levels in June, but only Lake Michigan-Huron is currently forecast to continue to set records this summer. Although water levels on the other lakes are forecast to be below record high levels, water levels are still forecast to be 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 edition of the Water Level Outlook compares years that experienced very wet or very dry conditions over the next 3 months (July – Sept.). Two years that had significantly wetter than average conditions over the next 3 months were 1986 and 1977. Two years that had significantly drier than average conditions from July to September were 1930 and 1976. This publication of the Water Level Outlook incorporates the projection of water levels if the NBS over the next 12 months is similar to what occurred in 1986-87, 1977-78, 1930-31, and 1976-77.

The blue lines, 1986-87 and 1977-78, represent the scenarios that have substantially wetter than average conditions from July to September, while the brown lines, 1930-31 and 1976-77, represent the scenarios that have substantially drier than average conditions. Also, the gray shaded area on the plot represents the full range of possible outcomes using historical sequences of NBS back to 1900. Model output using these NBS sequences shows that even under the driest conditions, water levels for Lakes Michigan-Huron, St. Clair, and Erie all stay well above average (black dots). Lake Superior's water levels could be near average under its driest scenarios.

1986-87 Scenario

The 1986-87 scenario (blue solid line) depicts water levels if NBS for the next 12 months is similar to what occurred during the rest of 1986 and first half of 1987. This scenario is characterized by a wet July to September. Precipitation would be above average across the basin in each of the three months (Jul-Sep), with exceptionally wet conditions in September. Precipitation in September 1986 was a monthly record high for the Great Lakes basin at 6.54 inches. It was also a record high for Lake Michigan-Huron, which accumulated 8.39 inches during September 1986. In October, precipitation continued to be above average and runoff was significantly high after the previous record wet month. Conditions in November were slightly drier, but NBS was generally above average for most lake basins through December. These wetter than average conditions also occurred during a period of high water, which led to record high water levels on Lakes Michigan-Huron, St. Clair, and Erie during the fall of 1986. The first half of the following year, conditions were drier and water levels declined toward their seasonal low before beginning a modest rise.

In a scenario that has similar NBS over the next 12 months as was seen in 1986-87, water levels on Lake Superior would experience a slight rise with the wetter summer conditions, but water levels would remain below record high levels. On Lake Michigan-Huron, water level records would be set from July to December, while on Lake St. Clair records high water levels would occur from September to December. Lake Erie would also set record high water levels in September and November to February.

1977-78 Scenario

The 1977-78 scenario is shown with the blue dashed line and was developed using historical NBS data from July 1977 to June 1978. The 1977-78 NBS scenario is also characterized by a wet July to September, with exceptionally high precipitation in August and September. In August 1977, the Great Lakes basin experienced record high precipitation with 5.04 inches of rain falling during

the month. Precipitation was also fairly high in November and December in this scenario, which was accompanied by very high runoff during these months as well. The next month, in January the wetter conditions continued, but then from February through the spring drier conditions encompassed the region.

In the scenario in which the basin receives similar NBS to what was experienced in 1977 and beginning of 1978, water levels for Lake Superior would be above record high levels in September and October and again between December and February. Lake Michigan-Huron would experience water levels above record high levels for 9 out of the next 12 months, with records occurring in the first 3 months (July to September). Lakes St. Clair would see record high levels in 8 out of the next 12 months, while Lake Erie would experience record high levels 11 out of 12 months, starting in August through June.

1930-31 Scenario

The 1930-31 scenario (brown solid line) depicts water levels if NBS for the next 12 months were similar to what occurred during the rest of 1930 and first half of 1931. This scenario is characterized by a dry July to September. Precipitation would be generally below average across the basin in each of the three months (Jul-Sep). Record low Great Lakes basin precipitation occurred in August of 1930, when just 1.14 inches of rain fell. The Lake Superior basin also experienced monthly record low precipitation in August, while Lake Erie set a record low for precipitation in July of 1930. Precipitation continued to be generally below average for the rest of the calendar year. The generally drier conditions would continue into the next year and cause water levels to continue to decline in this scenario.

In this scenario that has similar NBS over the next 12 months as was seen in 1930-31, water levels across all of the lakes would experience large seasonal declines and smaller than normal seasonal rises in the spring. On Lake Superior, water levels would fall below LTA levels between April and June. On Lakes Michigan-Huron, St. Clair, and Erie, water levels would remain above average, but follow the bottom part of the gray range indicating some of the driest conditions in our historical record.

1976-77 Scenario

The 1976-77 scenario is shown with the brown dashed line and was developed using historical NBS data from July 1976 to June 1977. The 1976 NBS scenario is also characterized by dry conditions between July and September. Between July and November of 1976, Lakes Superior and Michigan-Huron received below average precipitation in each month leading to a very dry summer and fall. The Lake St. Clair and Erie basins experienced below average precipitation in August and November, but closer to average precipitation in September and October. These drier conditions also led to decreased runoff during the summer and fall. Summer temperatures were near average, but a near record cold fall season led to increased evaporation during this time. Going into the following year conditions were near average, with the exception of March being significantly wet and May, which was very dry.

In the scenario in which the basin receives similar NBS to what was experienced in 1977 and beginning of 1978, water levels would again experience large seasonal declines. Lake Superior's water levels would fall below LTA levels by October. On the other lakes water levels would remain above average, but would again be toward the bottom of the gray shaded area that represents some of the driest conditions in the historical record.

Climatic Outlook for July 2020

The recent 1-month climate forecast updated by the Climate Prediction Center shows a likelihood of above normal temperatures for the month of July. The forecast for precipitation in July indicates the likelihood of below normal precipitation for most of the Great Lakes basin. The seasonal three-month outlooks for temperatures in the late summer and early fall (July, August, & September) indicate a likelihood of above normal temperatures throughout the Great Lakes basin. The seasonal three month

outlook for precipitation shows generally equal chances of above, below, or normal precipitation, with some areas in the southern portion of the basin showing above normal precipitation. One of the climatic factors that influences the outlooks are teleconnections, such as the El Niño Southern Oscillation (ENSO). Currently, ENSO neutral conditions exist, which occurs when sea surface temperatures in the eastern and central equatorial Pacific Ocean are near average.