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Great Lakes Update

Short Term Water Level Changes On the Great Lakes

It is a well-known fact that water levels of the Great Lakes change in three distinct patterns; short term (storm induced) changes lasting several hours to a few days; seasonal changes with higher summer levels and lower winter levels; and changes over long periods of time. This is evident when examining long-term hydrographs. Periods of high, low and near average water level conditions have been experienced since recording of Great Lakes water levels began in the middle 1800s. Prior to the Great Lakes network of gauges, there is historic evidence pointing to changes in water levels over periods of several decades.

Several factors can lead to short term water level changes. Short-term fluctuations are often larger in magnitude than long-term changes. This article will examine factors causing these fluctuations, including wind and barometric pressure changes and ice jams.

Wind Setup and Seiche

Powerful storms containing strong winds are common in the Great Lakes region, especially in the late fall. These "Gales of November" can have dramatic influence on water levels that may last over a period of a few hours to several days.

When a strong, sustained wind blows over a relatively long section of lake surface, the water will be pushed in the direction of the blowing wind, called a set-up. See Figure 1.

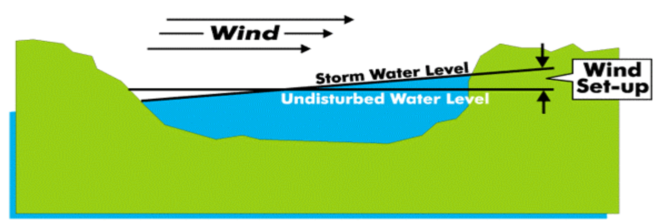

Figure 1: Lake profile showing wind set-up

The prevailing wind in the Great Lakes basin is west-southwest in orientation, meaning it most commonly blows from the west-southwest to the east-northeast. Due to its orientation and shallow western end, wind commonly affects Lake Erie's water level most dramatically, but all of the Great Lakes can experience effects due to the wind.

Lake Erie's longest west to east fetch of water extends from Toledo, OH to Buffalo, NY. The fetch of a lake can be described as any section of open water where a blowing wind would not interact with any land mass. During wind events it is not uncommon to see water level differences of over ten feet between the gauge locations near Toledo and Buffalo. Meanwhile, the water level near Fairport, OH, nearly halfway between Toledo and Buffalo stays nearly constant as the lake surface tilts around its central point.

A very strong storm system moved slowly through the Great Lakes region on October 24-26, 2001. The southwest gale-force winds (between 39 and 54 mph) and storm-force winds (over 55 mph) roared right up the axis of Lake Erie, from Toledo, OH toward Buffalo, NY. Figure 2 shows the lake surface "set-up" in response to the strong winds. The water level difference between Buffalo and Toledo neared 10 feet during the early morning hours of October 26, 2001. The wind began veering westerly then northwest on the 26th allowing the water levels to return back to normal elevations.

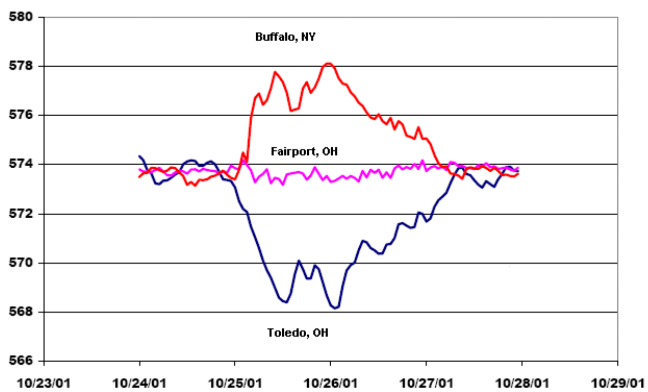

Figure 2: Lake Erie October 24-28, 2001

When the water begins to return back to normal, several oscillations can occur, known as a seiche, (pronounced sayshe). The water essentially sloshes back and forth until all the energy is dissipated. Another more recent event occurred in November 2005. In fact, 3 major setup events occurred during the month. Notice the pronounced seiche preceding the second event. See Figure 3.

Figure 3: Lake Erie November 2005

Rapid fluctuation in barometric pressure can also cause water level seiche. In the Great Lakes region, a fast moving cold front may trigger a seiche due to barometric pressure. Low pressure will reside ahead of or east of the front, while rapidly rising pressure exists behind or west of the front.

Ice Jams

The formation and break-up of ice cover on the Great Lakes can also bring about short-term water level changes. This is most evident on the St. Clair River, connecting Lake Huron to Lake St. Clair. During extended periods of sub-freezing temperatures, an ice bridge forms at the foot of Lake Huron, in Port Huron, MI. An ice bridge is a section of continuous ice cover, extending from one shoreline to another. When temperatures rise and the ice bridge begins to break up, large chunks of ice break off and flow down the St. Clair River.

The delta of the St. Clair River is made up of several very narrow channels. Ice flow moving down the river can become stuck in these channels, resulting in an ice jam. Ice jams can slow or completely stop the natural flow of the river. The result of ice jams on the St. Clair River can lead to major flooding upstream from the jam and very low water levels downstream of the jam in Lake St. Clair.

Ice jams can cause significant flooding of near river communities and disrupt navigation on the associated waterways. In 1984 a major ice jam formed on the St. Clair River near Algonac, MI.

The following paragraphs contain material from the *Record St. Clair River Ice Jam of 1984* by Jan A. Derecki and Frank H. Quinn, part of the *Journal of Hydraulic Engineering, Vol. 112, No. 12*, December 1986.

During December and January of 1983-1984, frigid temperatures lead to a large build up of ice on Lake Huron. Temperatures warmed in February and returned to frigid during March. The temperature fluctuations led to the thawing and refreezing of the ice bridge at Port Huron. As of the end of March, the southern third of Lake Huron was iced over.

With the opening of the navigation season on March 26, 1984, ships contributed to the break-up of the ice bridge and persistent northerly winds helped push the ice downstream. The result was one of the largest and longest lasting ice jams on record. The duration of the jam was 24 days (April 5-29, 1984) and the maximum divergence of the water level between the Algonac gauge and the St. Clair gauge was close to 5 feet. These gauges are only 17 miles apart and have a naturally occurring difference of about 1.6 feet. During the ice jam, the inflow of water to Lake St. Clair was reduced by 50%, leading to a 2-foot decline in the lake's water level. See Figure 4.

During the jam, navigation was nearly halted in the area. Lake St. Clair and the Detroit River were nearly ice free and became holding areas for vessels awaiting transit through the St Clair River. The Lake Carriers Association, a Cleveland, Ohio based firm, reported estimated losses of $1,700,000 per day due to shipping delays during the ice jam.

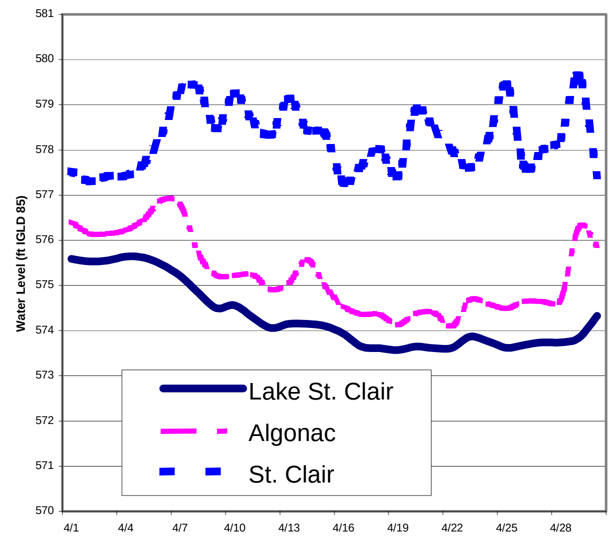

Figure 4: Water Levels During Ice Jam of April 1984 (NOAA)

When conditions are right for an increased chance of ice jams, the Army Corps of Engineers, the United States Coast Guard and the National Weather Service continuously monitor water levels and ice conditions. Models are run during the winter and early spring months in order to get a feeling of when ice may become a problem. A newly installed web-camera located at Algonac, MI will enable easy viewing of the St. Clair River. The web cam can be viewed by visiting the following website.

https://webcam.crrel.usace.army.mil/stclair/

The National Ice Center's website contains various ice charts and can be viewed at the link below.

http://www.natice.noaa.gov/products/gl-ches/index.htm

Current Lake Level Conditions

With the summer boating season rapidly approaching, attention turns to the latest water level forecasts, which contain predictions through the upcoming summer season.

Snow water equivalent (SWE) is a major contributor to the Great Lakes' annual period of seasonal rise. This is especially true on Lake Superior. SWE is the water content obtained from melting accumulated snow. The National Weather Service (NWS) provides airborne snow survey data to the Army Corps of Engineers on an annual basis.

This year the SWE across the Lake Superior basin is 40% higher than average. See Figure 5. This total was largely helped by a major storm system that impacted the region during the week of March 12.

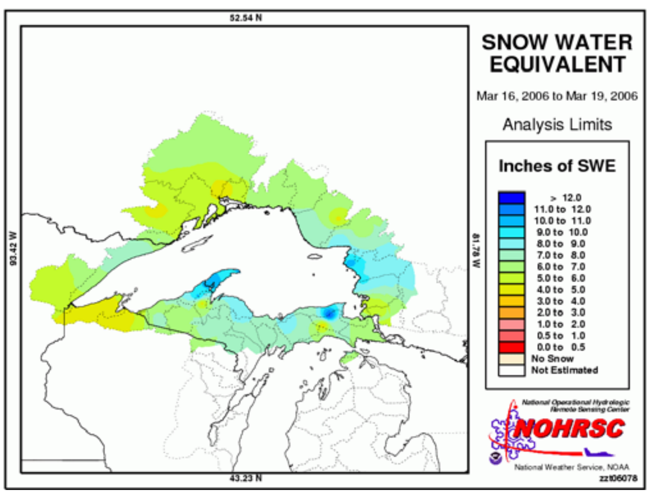

Figure 5: 2006 SWE

Above average SWE is often a good indication that water levels will be higher in the spring and summer months. However, SWE is not the sole variable needed to have higher water levels. During the Spring, rainfall combines with snow melt runoff to drive the lakes' rises. Looking back to 2005, SWE was above average, but drought conditions set in during the spring and summer months. Consequently the Great Lakes all peaked earlier than average.

The latest long-term predictions provided by the Climate Prediction Center of the NWS call for the chance of wetter than average conditions this spring and early summer for most of the Great Lakes basin. See Figure 6.

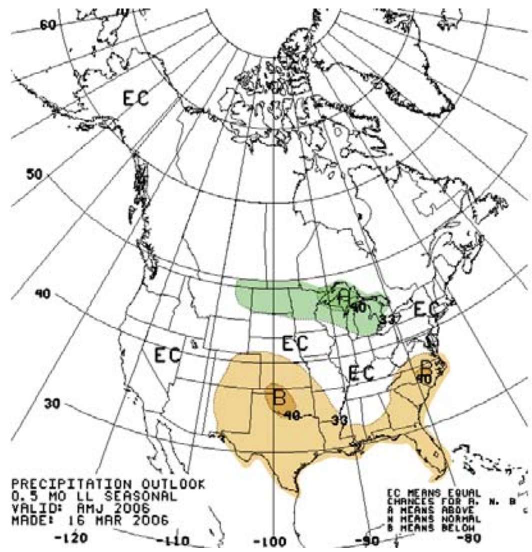

Figure 6: April/May/June Precipitation Outlook, CPC

Latest Forecasts

Lake Superior's water level is expected to be similar to the summer of 2005. With a very wet scenario, Lake Superior's may approach its long-term average water level (LTA) by June.

When compared to last spring, the water level of Lake Michigan-Huron is forecasted to be lower during the remaining spring months. The lake is expected to climb above chart datum in April and be slightly higher than last year during the late summer months.

Lakes St. Clair and Erie will remain slightly lower than last year throughout the next 6 months. Lake Ontario will remain similar to last year during the same period.