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Great Lakes Update

Great Lakes Water Level Data Collection

Water levels of the Great Lakes and connecting channels are important data for basin wide management of Great Lake resources. The collection and analysis of Great Lakes water level data is a paramount task of the Detroit District of the U.S. Army Corps of Engineers, the National Oceanographic and Atmospheric Administration and the Canadian Hydrographic Service. Methods for collecting this dataset are mostly automated and the data are often available in real time. This article will discuss the methods for collecting these data as well as their many uses.

The Great Lakes basin (Figure 1) is the largest fresh water system in the world, containing close to 20% of the world's fresh water. Because the lakes are a bi-national waterway, both the United States and Canada have a vested interest in the water levels of the lakes and connecting channels. The connecting channels are the rivers that connect the lakes to one another, including the St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers.

Figure 1: The Great Lakes basin

Water levels need to be monitored because they are always changing. Changes in the hydrologic cycle, or the movement of the earth's water, are the main factors when studying the fluctuation of water levels. In the recorded past, there have been periods of above, below and near average water levels. Water levels can also fluctuate over shorter time periods due to ice cover and meteorological phenomenon.

Reading Water Levels

There is a common misconception when viewing water levels on the Great Lakes. Often people think of the number as a depth, when it is in fact a surface elevation. All water levels of the Great Lakes are shown referenced to the International Great Lakes Datum of 1985 (IGLD 85). IGLD 85 has its zero-base near the town of Rimouski, Quebec, Canada. Rimouski sits near the mouth of the St. Lawrence River and is at approximate sea level. If a water level is shown to be 577.5 feet, it is 577.5 feet above the zero-base near Rimouski, not 577.5 feet deep.

Water depth can be calculated using a water surface elevation, the chart datum or low-water datum (LWD) for the associated water way and a current navigation chart for the area in question. LWD is the benchmark by which all Great Lake navigation charts are based. Simply take the difference of the elevation and the LWD and then add or subtract that difference to the depth shown on the navigation chart.

A Multi-Agency Effort

The United States Army Corps of Engineers (USACE), the National Oceanographic and Atmospheric Administration (NOAA) and the Canadian Hydrographic Service (CHS) all collect, analyze and use each others Great Lakes water level data. For example, the USACE and Environment Canada (EC) use several of NOAA’s 54 water level gages and several of CHS’s gages to coordinate official water level statistics and forecasts. These include long-term averages and maxima and minima. The location of the gages is based on coordination between each agency. The goal is to provide a good coverage of each Great Lake, including bays and channels.

Data Collection

Prior to satellite links, water level data were collected using labor intensive methods. Simple staff gages were primarily used before the advent of data recorders. A staff gage is a vertical staff graduated in appropriate units, similar to a ruler, which is placed so that a portion of the gage is in the water at all times. Observers read the water level off the staff gage. Later, data recorders allowed measurements to be taken on a more frequent basis. A paper tape ran through the recorder and a hole was punched at a determined time interval. The distance between the punches was used to calculate a level. Both the staff gage and punch tape methods required a person to go out and either read the staff or collect the tape.

Current data collection methods are mostly automated. At the gage location, several pieces of equipment are necessary to ensure accurate and timely data collection.

Most water level gages are housed in a simple box shelter (Figure 2) or a larger gage house (Figure 3) to protect the sensitive measuring and recording equipment from the outside environment. A pipe with an intake near the bottom is extended into the water at a selected location. The intake is situated near the end of the pipe so that the water level inside the well is the same as the level of the outside body of water. The pipe is secured to the shore and to the bottom of the water body. A pipe or larger sump well is used to calm the water and is commonly referred to as a stilling well. Its purpose is to negate the effects of wave action near the gage location.

Figure 2: USACE Water level gage

Figure 3: NOAA Gage house at Alpena, MI

The electronic equipment in a gage house depends on what data types are collected at a particular site. A site where just water level is collected will have only a few components (Figure 4), where a station that collects meteorological data will be much more elaborate.

The basic setup has a float connected to a measuring tape that is lowered into the well. The float will sit on the water surface, while the other end of the tape is held in place by a counter weight. The tape is then hooked around a wheeled data encoder. As the water level in the well fluctuates, the float moves up and down with it. The wheel then turns with the measuring tape and a measurement is taken. A data collection platform (DCP) is connected to the encoder and the DCP stores the data.

All of the United States gage locations have antennas that link the station to NOAA's Geostationary Operational Environmental Satellite (GOES) network and Global Positioning Satellites (GPS). The GOES system relays all of the collected data from the gage to a central processing location, where it will be made ready for public dissemination. The GPS link ensures an accurate depiction of latitude and longitude. Other equipment recording data at some gage locations include wind speed and direction, air and water temperature and precipitation sensors as well as a barometer to measure atmospheric pressure. All of the equipment housed at the gage location is usually powered by a single battery which is kept charged using exterior solar panels.

Figure 4: Water level gage setup

Data Analysis

The U.S. Army Corps of Engineers is tasked with calculating lake-wide mean, monthly mean, long term average, and maximum and minimum water level statistics. The period of record for the long term statistics goes back to 1918. Great Lakes water level data does exist back to the 1860s, but the statistics prior to 1918 were based on a single or master gage on each lake. This method did not give a water level that was representative of the entire lake surface. All current statistics are based on data which dates back to 1918. A multi-gage method has been used to calculate lake-wide mean water levels since the early 1990s. For example, 5 gages are used on Lake Superior. They are located at Duluth, MN, Marquette, MI, Point Iroquois, MI, Thunder Bay, Ontario, Canada and Michipicoten, Ontario, Canada. Each day all of the measurements at these locations are averaged to compute the lake wide daily mean. All of the lake wide daily means then are averaged at the end of the month to compute the monthly mean water level. The *Monthly Bulletin of Lake Levels for the Great Lakes,* which this article supplements, is based on monthly mean water levels for each lake.

Who uses the data

Fluctuating water levels and changing weather conditions play a critical role in many uses of the Great Lakes and in the connecting channels. Great Lakes freighters have sophisticated systems on their bridge that monitor water levels and weather conditions in the near real time. This system, called NOAAPORT, is made available by the National Oceanographic and Atmospheric Administration (NOAA). With the PORTS system aboard, a captain can view water levels along the journey and at the final destination to make critical decisions about how much cargo can be safely loaded.

Electric power companies also look at water levels for the purpose of hydroelectric power generation. Higher water levels generally indicate higher water flow and an increased production capability. On the other hand, lower water levels may mean decreased power generation.

Shoreline property owners concerned about erosion and flooding also pay close attention to water levels. In some instances, high water can damage shoreline protection like seawalls and cause significant beach erosion. Low water on the other hand can lead to a much larger beach, often exposing new aquatic vegetation and muddy bottomland. Launching boats and gaining access to channels can also become problematic during periods of lower water levels.

Ice Jams

Ice flows in the connecting channels can pose a threat to navigation and shoreline property owners, especially in the late winter and early spring. These ice flows can become stuck in narrow channels and completely stop the natural flow of water. USACE maintains 5 water level gages on the St. Clair River, and can often pinpoint the location of an ice jam using water level data. If there is a sudden drop in water level at one location, while the water quickly rises at an upstream location, ice may be blocking the flow of water. Web cameras at Algonac, MI and Fort Gratiot, MI also assist the ice monitoring mission. These web cameras can be viewed by visiting the following website.

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

Viewing water levels

Several websites display both historical and near real time Great Lakes water levels. For monthly means and other historical statistics on a lake wide basis, please visit the U.S. Army Corps of Engineers Detroit District Homepage at http://www.lre.usace.army.mil/glhh

For real time United States water levels and meteorological data at specific locations visit http://glakesonline.nos.noaa.gov/

For Canadian water level data visit http://www.meds-sdmm.dfo-mpo.gc.ca/meds/Home_e.htm