US Army Corps
of Engineers
North Central Division

GREAT LAKES LEVELS

UPDATE LETTER NO. 74 5 SEPTEMBER 1991

PRECIPITATION ON THE GREAT LAKES

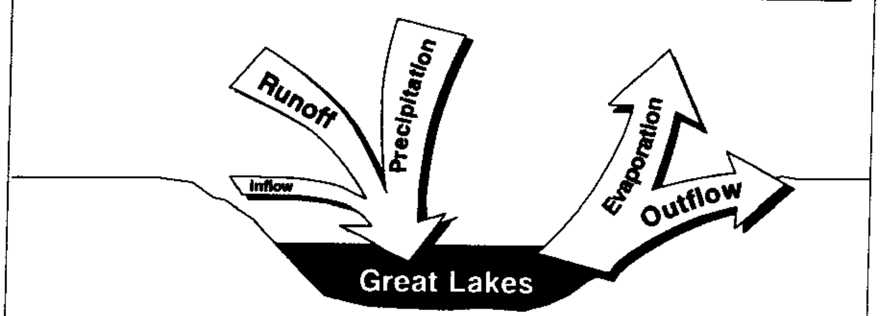
In last month's Update Letter No. 73, the feature article, "Forecasting Great Lakes Water Levels," presented the methodology used to prepare the Corps of Engineers' "Monthly Bulletin of Lake Levels for the Great Lakes." As you may recall, precipitation, or lack of it, was shown to be the predominant factor in the makeup of the net basin supply, and in turn a strong influence on water levels. Figure 1 shows the hydrologic factors that affect the Great Lakes water levels. It also shows the relative magnitudes (in percent) of hydrologic budget factors for each lake. It is noted, of course, that the runoff is a portion of the precipitation that falls on the land drainage area. Figure 2 illustrates the annual precipitation, net basin supplies, and water levels for 1980-1989, for the Lakes Michigan-Huron basin. Precipitation comes in many forms; the most common is rain, but it also comes in the form of snow, hail, and condensation. Most of us take precipitation for granted. However, when extremes of wet or dry conditions occur, people's lives can be dramatically impacted. For example, in the 1930s and, more recently, in the 1960s, extended periods of very little precipitation---drought conditions---caused record low water levels in the Great Lakes.

Inputs (Percent of Total)

LAKE	INFLOW	PRECIPITATION	RUN-OFF
Superior	5	55	40
Mich.-Hur.	30	35	35
Erie	80	10	10
Ontario	80	5	15

Outputs (Percent of Total)

LAKE	EVAPORATION	OUTFLOW
Superior	40	60
Mich.-Hur.	30	70
Erie	10	90
Ontario	5	95



Hydrologic Factors Affecting Great Lakes Water Levels

Figure 1. Great Lakes hydrologic factors and relative magnitudes in percent.

Additional evidence of the effect of extreme precipitation conditions was apparent in the mid-1980s. Following successive years of above-average precipitation in the early part of that decade, a period of extreme rainfall throughout the entire Great Lakes basin occurred in 1985. This led to record-breaking high levels on all the lakes except Lake Ontario, beginning in 1985 and ending in early 1987. In the aftermath of these high levels, it became evident that the control of man over the levels and outflows of the Great Lakes is limited when compared to the predominating effects of "Mother Nature." Following 5 consecutive months of above-average precipitation on the Great Lakes basin, in November 1986, the trend was finally reversed and carried into 1987, with 8 consecutive months of low precipitation. During this period, precipitation on the Great Lakes basin was 25 percent below normal; also in the summer of 1987, some of the lakes had record or near-record evaporation rates. This resulted in a steep decline in lake levels.

By the end of December 1987, Lake Superior had dropped 4 inches below average, and Lake Ontario reached its average level. Although Lakes Michigan-Huron, St. Clair, and Erie were above their long-term averages, they had tumbled to levels well below the record highs of 1986.

One interesting characteristic of the climate of the Great Lakes region is the relatively small spatial and seasonal variation in precipitation. Figure 3 shows that the average annual precipitation does not vary a great deal from basin to basin, with the upper lakes receiving slightly less precipitation than the lower lakes. Most of us have heard variations of the phrase by Thomas Tusser, "Sweet April Showers Do Bring May Flowers." Many people believe that we receive much more rain in the spring than the rest of the year. Figure 4 illustrates that the opposite is true; while precipitation begins to increase from winter lows in the spring, the amount of rain received in the Great Lakes basin does not generally peak until early fall.

Over-lake precipitation represents a large and immediate supply of water to the Great Lakes, since about one-third of the Great Lakes basin area is lake surface. The effect of rainfall on the land areas is related to the relative wetness of the basin at the time of occurrence. If the land is very dry, a large portion of the rainfall will remain on the land portion of the basin to recharge inland lakes and ground water storage. If the land is very wet, a greater percentage of the rainfall enters the Great Lakes and at a much faster rate. Snowfall is stored on the land and becomes the major contributor of water to the lakes in the late winter and early spring. At present, there are no continuous measurements taken of precipitation over the lakes, although the few measurements which are available indicate that it is slightly more than over the land areas. To obtain estimates of over-lake precipitation, measurements of precipitation at land stations on or near the lake shores are extrapolated to represent values estimated over the lake surfaces.

The provisional monthly precipitation presented at the end of this update is an estimated value over both the land and water portions of the Great Lakes basin. Provisional values for precipitation on each of the Great Lakes basins

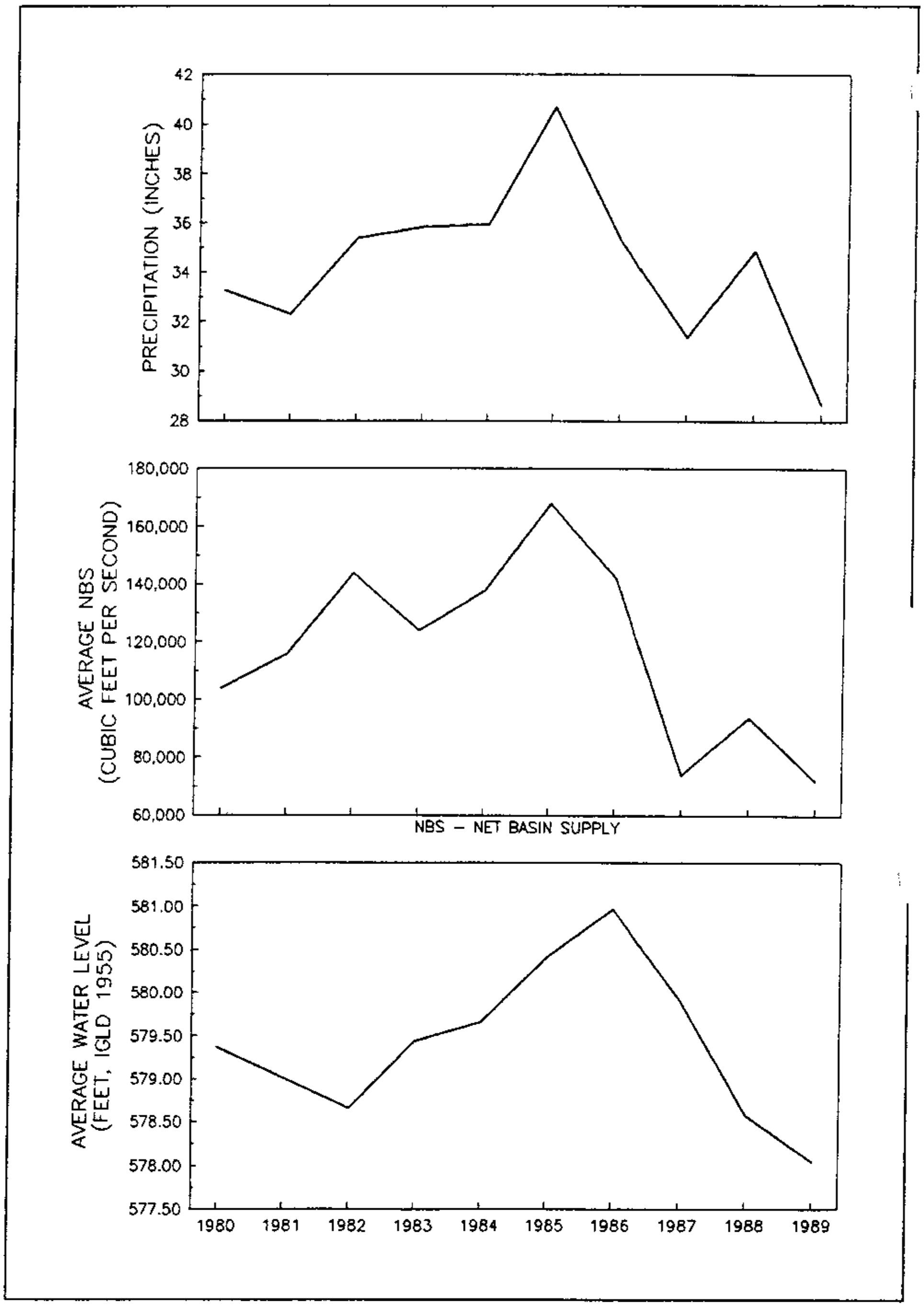


Figure 2. Comparison of annual precipitation, net basin supplies and water levels (1980-1989) for Lakes Michigan-Huron basin.

are computed by the Great Lakes Hydraulics and Hydrology Branch, Detroit District, U.S. Army Corps of Engineers, from certain key data (44 stations) supplied at the end of each month by the National Weather Service and the Canadian Meteorological Division. The National Ocean Service (NOS) computes the final precipitation values based on as many stations as obtainable (up to 2,421). The method used by each agency is basically the same. Provisional values are computed from the precipitation recorded at selected sites around the Great Lakes. The numbers for each of the lakes are as follows: Lake Superior, 7; Lake Michigan, 13; Lake Huron, 13; Lake Erie, 7; and Lake Ontario, 8. Some sites are used for more than one basin. These sites were selected because they are representative of the basin, and also data from these sites are available daily through the National Weather Service.

The method used to compute basinwide precipitation is basically the same for agencies in the U.S. and Canada. That is, the monthly total precipitation at each of the selected sites is weighted as a percent of the basin total. The weight, or percent, used for each site is computed based on the area of the basin and the location of the site within the basin. Figure 5 is an illustration of this weighting for Lake Michigan basin. Table 1 is a sample calculation of provisional precipitation for Lake Michigan basin in July 1991.

The amount received at various locations across a basin can vary greatly depending on the speed, path, and pattern of the weather systems. During the summer, storms can be a very local phenomenon, releasing large amounts of water on one side of town and little or none across town. Hence, there is not always uniform distribution, and the weighed estimates can be in error-- especially when only a few gages are available.

Table 1
Lake Michigan Basin
Precipitation Weighting, July 1991

SITE	WEIGHT	PRECIPITATION JULY (INCHES)	WEIGHTED CONTRIBUTION TO JULY LAKE MICHIGAN TOTAL (INCHES)
MARQUETTE, MI	0.04	5.40	0.2160
GREEN BAY, WI	0.20	4.16	0.8320
MILWAUKEE, WI	0.07	4.34	0.3038
CHICAGO, IL	0.04	1.32	0.0528
SOUTH BEND, IN	0.07	1.32	0.0924
GRAND RAPIDS, MI	0.06	6.24	0.3744
MUSKEGON, MI	0.10	3.31	0.3310
ESCANABA, MI	0.14	5.63	0.7882
HOUGHTON LAKE, MI	0.03	4.43	0.1329
JACKSON, MI	0.04	NOT AVAILABLE	
LANSING, MI	0.03	2.41	0.0723
PELLSTON, MI	0.05	3.95	0.1975
TRAVERSE CITY, MI	0.11	NOT AVAILABLE	
SUBTOTALS	0.98		3.3933
WEIGHT ADJUSTED FOR MISSING STATIONS	0.83		
TOTAL*		4.09**	

* Adjusted for missing stations and accounted area of the basin.
** 4.09 = 3.9333/0.83

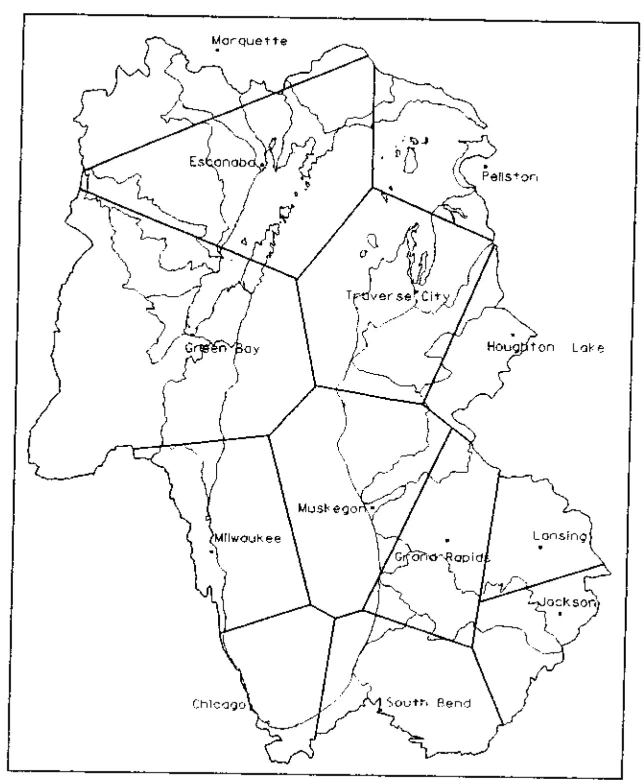


Figure 5. Lake Michigan basin area subdivision.

Table 2
Great Lakes Hydrology

PRECIPITATION								
	AUGUST				YEAR-TO-DATE			
BASIN	1991*	AVERAGE**	DIFF.	% OF AVERAGE	1991*	AVERAGE**	DIFF.	% OF AVERAGE
Superior	2.2	3.2	-1.0	69	20.4	19.5	0.9	105
Michigan-Huron	2.1	3.1	-1.0	68	21.2	20.6	0.6	103
Erie	2.8	3.2	-0.4	88	21.0	23.6	-2.6	89
Ontario	2.8	3.1	-0.3	90	22.8	22.9	-0.1	100
Great Lakes	2.3	3.1	-0.8	74	21.2	20.9	0.3	101

LAKE	AUGUST WATER SUPPLIES***		AUGUST OUTFLOW[2]	
	CFS[1]	AVERAGE[3]	CFS[1]	AVERAGE[3]
Superior	35,000	101,000	77,000	84,000
Michigan-Huron	-24,000***	55,000	189,000	195,000
Erie	1,000	-12,000***	206,000	207,000
Ontario	-1,000***	8,000	260,000	253,000

* Estimated (inches) ** 1900-89 Average (inches)
*** Negative water supply denotes evaporation from lake exceeded runoff from local basin.

1 Cubic Feet Per Second 2 Does not include diversions 3 1900-89 Average (cfs)

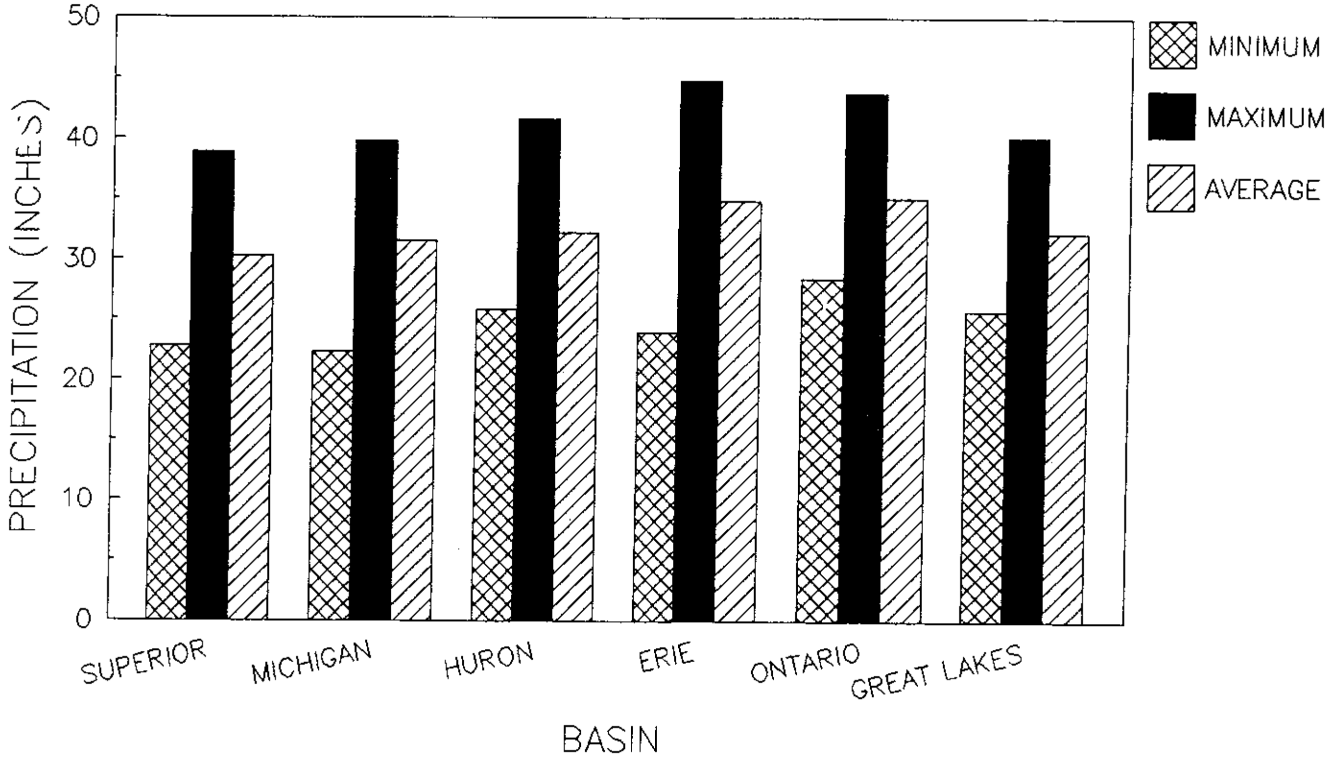


Figure 3. Great Lakes basin's annual precipitation (1900 - 1989).

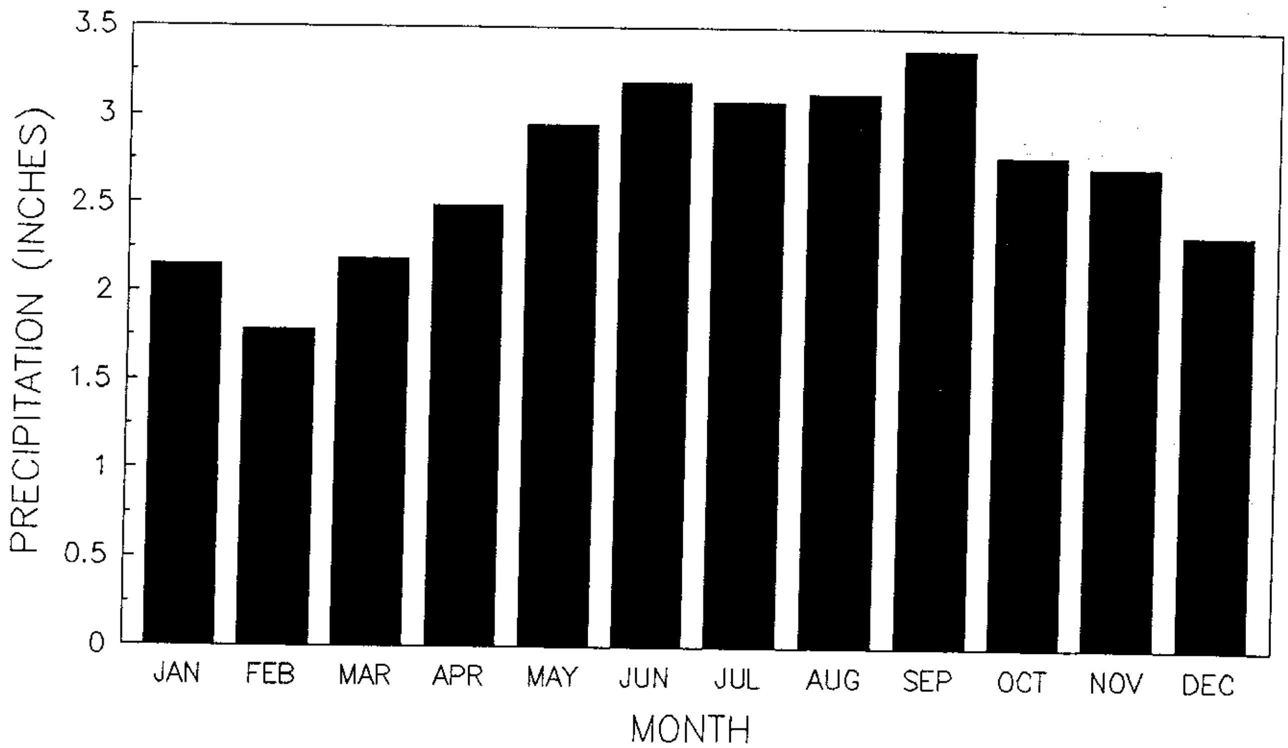


Figure 4. Great Lakes basin's precipitation seasonal variation (1900 - 1989).

Great Lakes Basin Hydrology

The level conditions on the lakes are shown in graphical and tabular form in the bulletin. This includes the actual levels for the past 1-2 years as compared to the record (1900-1990) maximum, minimum, and average levels; a forecast plot for the next 6 months; and a table of the past month's actual level compared to a year earlier and the record (1900-1990) average, maximum and minimum levels.

The precipitation, water supplies, and outflows for the lakes are provided in Table 2. For the precipitation, this includes the actual for the past month and year-to-date, as well as a comparison to long-term average. The water supplies and outflows shown are the actuals for the past month and a comparison to the long-term average.

IJC Levels Reference Study

The next meeting of the Citizens Advisory Committee and the Study Board will be held in conjunction with the IJC's Biennial Water Quality Conference, as described below.

The IJC Biennial Water Quality Conference will be held at the Grand Traverse Resort in Traverse City, Michigan, from September 29 through October 2, 1991. Those interested are cordially invited to attend. To register, please contact the following:

Ms. Rita Kerner
International Joint Commission
2001 S. Street, N.W.
Washington, D. C. 20440
(203) 673-6222

The conference provides a forum for public, elected, and agency officials; scientists; policy makers; and special interest groups to discuss the health of the Great Lakes.

Jude W. P. Patin

Jude W. P. Patin
Brigadier General, U. S. Army
Commanding General and
Division Engineer

For Great Lakes basin technical assistance or information, please contact one of the following Corps of Engineers District Offices:

For NY, PA and OH:
Colonel John W. Morris
Cdr, Buffalo District
U.S. Army Corps
of Engineers
Buffalo, NY 14207-3199
(716) 876-5454, Ext. 2201

For IL and IN:
LTC Randall R. Inouye
Cdr, Chicago District
U.S. Army Corps
of Engineers
River Center Bldg. (6th Flr)
111 N. Canal Street
Chicago, IL 60606-7206
(312) 353-6400

For MI, MN, and WI:
Colonel Richard Kanda
Cdr, Detroit District
U.S. Army Corps
of Engineers
P.O. Box 1027
Detroit, MI 48231-1027
(313) 226-6440 or 6441