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GREAT LAKES MONTHLY HYDROLOGIC DATA[1]

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ABSTRACT. Accurate hydrologic data (over-land precipitation, over-lake precipitation, runoff, lake evaporation, net basin supplies, connecting channel flows, diversion flows, beginning-of-month lake levels, and changes in storage) are required for simulation, forecasting, and water resource studies on the Laurentian Great Lakes and their basins. This report is an update of an earlier report presenting Great Lakes monthly hydrologic data (Quinn and Kelley, 1983). It has been expanded and revised to include all available data through 1990 and to reflect improved computational techniques. The data and a program for combining the data are available separately.

1. INTRODUCTION

Accurate hydrologic data (over-land precipitation, over-lake precipitation, runoff, lake evaporation, net basin supplies, connecting channel flows, diversion flows, beginning-of-month lake levels, and changes in storage) are required for simulation, forecasting, and water resource studies on the Laurentian Great Lakes and their basins. In 1983, the Great Lakes Environmental Research Laboratory (GLERL) published a report (Quinn and Kelley, 1983) compiling monthly values of these data through 1980 in a single source. This report serves as an update to the 1983 report by providing additional data through 1990 and revising some data to reflect improved computational techniques. We also provide files of all of the tables in this report as well as some derived quantities and FORTRAN software for computing additional derived quantities. As in the previous report, numerous sources are involved so the period of record for the data will vary.

As in the preceding report, all hydrometeorological data are uncorrected for gage errors or systematic measurement biases (such as precipitation gage undercatch). Data are averaged spatially and temporally without regard to their relative quality, except that obvious errors of two types are trapped: 1) all daily minimum and maximum air temperatures that improperly match are regarded as missing data (i.e., minimum exceeds maximum), and 2) all air temperature or precipitation data that exceed range limits are regarded as missing. These range limits are, for the U.S. side, -60°F to 115°F for air temperature and 0 to 10 in for precipitation; for Canada, they are -53°C to 43°C for air temperature and 0 to 25.4 cm for precipitation.

2. THE PHYSICAL SYSTEM

The Laurentian Great Lakes contain 23,000 km^3 of water (about 20% of the world's fresh surface water) and, with their surrounding basins, cover 770,000 km^2 in the United States and Canada; see Figure 1. Their surface areas comprise about one-third of the total basin area. The basin extends over 3,200 km from the western edge of Lake Superior to the Moses-Saunders Power Dam on the St. Lawrence River.

[1] GLERL Contribution No. 902

Figure 1. -- Location map for the Laurentian Great Lakes.

The water surface cascades over this distance more than 182 meters to sea level. The most upstream, largest, and deepest lake is Lake Superior. The lake has two interbasin diversions of water into the system from the Hudson Bay basin: the Ogoki and Long Lake diversions. Lake Superior water flows through the lock and compensating works at Sault Ste. Marie, Michigan and down the St. Marys River into Lake Huron where it is joined by water flowing from Lake Michigan through the Straits of Mackinac.

Another interbasin diversion takes place from Lake Michigan at Chicago. Here, water is diverted from the Great Lakes to the Mississippi River basin. The water from Lake Huron flows through the St. Clair River, Lake St. Clair, and Detroit River system into Lake Erie. From Lake Erie the flow continues through the Niagara River and Welland Canal diversion into Lake Ontario. The Welland Canal diversion is an intrabasin diversion bypassing Niagara Falls and is used for navigation and hydropower production. There is also a small diversion into the New York State Barge Canal system which is ultimately discharged into Lake Ontario. From Lake Ontario, the water flows through the St. Lawrence River to the Gulf of St. Lawrence and the Atlantic Ocean.

Lake Superior and Lake Ontario are the only regulated lakes in the system. Their regulation is conducted under the auspices of the International Joint Commission (IJC) and its Boards of Control. The criteria, or guidelines, for the regulation of these two lakes are set forth in Orders and Supplementary Orders of Approval issued by the IJC. Regulation plans which strive to satisfy these criteria have been developed and are incorporated in hydrologic routing models maintained by the U.S. Army Corps of Engineers and Environment Canada.

The hydrologic cycle of the Great Lakes basin and meteorology determine water supplies to the lakes. Runoff comprises a significant part of the Great Lakes water supply, particularly during the snowmelt season, late March through early June. Because the lakes are so large, lake precipitation and evaporation are of the same order of magnitude as runoff. On a monthly scale, precipitation is fairly uniformly distributed throughout the year. Lake evaporation typically has the greatest effect on water supplies during the winter months as dry air and warm water result in massive evaporation. Condensation on the cool lake surface from the wet overlying air occurs in the summer. Net groundwater flows to each of the Great Lakes are generally ignored. Net supplies (runoff and precipitation less evaporation) typically reach a maximum in late spring and a minimum in late fall.

3. PRECIPITATION DATA

We present monthly estimates for over-land and over-lake precipitation for each of the Great Lakes in Appendices A and B, respectively. Due to the quality of the available station data, estimates were derived in three ways, corresponding to the available periods of record for different segments of the historical time series. Data prior to 1930 (1918 for Lake Superior) were computed by the Lake Survey District of the U.S. Army Corps of Engineers and by the National Ocean Survey. Data for 1930-1947 (1918-1947 for Lake Superior) were computed at the Great Lakes Environmental Research Laboratory (GLERL) from monthly station values. Data for 1948-1990 were computed at GLERL using daily station data. The methodology for each period is briefly described below.

The Lake Survey District of the U.S. Army Corps of Engineers, and later the National Ocean Survey, computed monthly precipitation estimates for data earlier than 1930 with an areally weighted "district" approach (Quinn and Norton, 1982). Monthly over-land precipitation data begin in 1882 (Superior), 1883 (Michigan), 1883 (Huron), 1900 (St. Clair), 1882 (Erie), and 1883 (Ontario). Districts (large areas) were designated and divided into sub-districts (smaller areas). Arithmetic means for each sub-district were computed from all stations chosen for that subdistrict. The sub-district values were areally weighted to compute district precipitation. Over-land values were computed by areally averaging district values. Over-lake values came from the use of nearshore stations. Monthly over-lake precipitation data begins in 1900 for all lakes.

Quinn and Norton (1982) computed 1930-1947 monthly precipitation by using a modified Thiessen weighting approach. They areally weighted monthly station data on a 5-km grid to calculate each monthly value. Each grid square, belonging to the basin or lake, was evaluated to find its nearest station; the relative counts for each station within the basin or lake were used as Thiessen weights to areally combine station values for the basin or lake. All available stations within 25 kilometers of the basin were used, and the weights were recomputed for each month as necessary.

We computed 1948-1990 monthly precipitation from all available daily data from stations in the basin or within approximately 0 - 30 km of the basin, depending upon station density near the edge of the basin. The distance was chosen to assure that we obtain the same non-zero Thiessen weights as if no stations were eliminated. Station data for the U. S. were obtained from the National Climatic Data Center (1987), and station data for Canada were obtained from the Atmospheric Environment Service (1981). We then used Thiessen weighting (Croley and Hartmann, 1985) similar to the above, but defined for a 1-km grid and recomputed every day for all watersheds within the basin and the lake. The basin watersheds were defined by the U. S. Geological Survey and the Water Survey of Canada. We constructed daily over-land basin precipitation by areally weighting the areally-averaged daily precipitation for each watershed and summing over the days in each month. We also constructed total monthly over-lake precipitation by summing the areally-averaged daily values for the lake surface.

4. RUNOFF DATA

We computed watershed runoff estimates, in Appendix C, by using streamflow records from major rivers, available from the U.S. Geological Survey (Showen, 1980) for U.S. streams and the Inland Waters Directorate of Environment Canada for Canadian streams (Inland Waters Directorate, 1980). Complete years of historical daily runoff data begin in 1908 (Superior), 1910 (Michigan), 1915 (Huron), 1935 (St. Clair), 1914 (Erie), and 1916 (Ontario). Daily runoff values provided by these agencies were summed for each watershed within a lake basin. The runoff was extrapolated over ungaged areas; between 22% and 43% of the Great Lakes basin remains ungaged (Lee, 1992) and runoff error potential exists. Weights were assigned to each non-overlapping streamflow gage by dividing its drainage area by the watershed area. Daily watershed runoff estimates were computed by summing all daily station values in the watershed and then dividing by the sum of their weights, to extrapolate for ungaged areas.

Daily lake basin runoff estimates were computed in a similar manner by summing the watershed estimates, for which there were data available, and then dividing by the ratio of the area of those watersheds to the total basin area. Monthly basin runoff was computed by simply summing the daily basin runoff estimates for all days in each month.

The earlier methodology for computing the runoff values (Quinn and Kelley, 1983) differs from our methodology in the handling of missing data. Quinn and Kelley (1983) used data from upstream gages to fill in missing data. We did not fill in missing data, but rather removed any stations with missing data from the computations for those days that data were missing. This effectively makes a station's drainage area part of the ungaged area of the subbasin, and the normal area extrapolation is used with no further adjustments required.

We wish to note that, as in the previous report, the Ogoki diversion flow is indirectly included in our runoff estimate for Lake Superior. It cannot be separated from measured runoff at Lake Superior since it is added upstream, in Lake Nipigon, and its timing obscured by routing through Nipigon and connecting channels to Lake Superior. The Ogoki diversion is about 0.8% of Lake Superior runoff.

5. LAKE EVAPORATION

Monthly evaporation estimates (appendix D) were derived from daily evaporation estimates generated by the Great Lakes Evaporation Model (Croley, 1989a,b, 1992; Croley and Assel, 1994). This is a lumped-parameter surface flux and heat-storage model. It uses areal-average daily air temperature, windspeed, humidity, precipitation, and cloudcover. These data are sufficiently available since 1948 (1953 for Georgian Bay), and 2 years are used for model initialization. Over-land data are adjusted for over-water or over-ice conditions. Surface flux processes are represented for short-wave radiation and reflection, net long-wave radiation exchange, and advection. Atmospheric stability effects on the bulk transfer coefficients are formulated and used with the aerodynamic equation for sensible and latent heat surface fluxes.

Energy conservation and superposition mixing are used to account for heat storage in the lake. The effects of past heat additions or losses are superimposed to determine temperatures at all depths. Each past addition or loss is parameterized by its age and allowed to mix throughout the volume accordingly. Mass and energy conservation are used to account for ice formation and icepack decay in the lake.

These relations are solved simultaneously through iterative determination and use of water surface temperature and ice cover. The model was calibrated to give the smallest sum-of-squared-errors between model and actual daily water surface temperatures observed by satellite during the calibration period of generally 1979-88 and smallest sum-of-squared errors between model and actual daily ice cover during the calibration period of 1958-88. Statistics compiled over independent verification periods agree well with the calibrations. The models were also assessed partially by comparing model evaporation with water balance derivations for 1951-88. Low annual residuals resulted.

Turnovers (convective mixing of deep lower-density waters with surface waters as surface temperature passes through that at maximum density) occur as a fundamental behavior of GLERL's thermodynamic and heat storage model. Hysteresis between heat in storage and surface temperature, observed during the heating and cooling cycles on the lakes, is preserved. The model also correctly depicts lake-wide seasonal heating and cooling cycles, vertical temperature distributions, and other mixed-layer developments.

Comparisons between model results and actual data include 23 years of daily aerial and satellite observations of water surface temperature on all lakes, 8 years of bathythermograph observations of depth-temperature profiles on Lake Superior, and 1 year of independently-derived weekly or monthly surface flux estimates on Lakes Superior, Erie, and Ontario (2 estimates). The daily lake evaporation estimates were summed over all days in each month to calculate monthly lake evaporation.

6. NET BASIN SUPPLY

The water supplies to a lake, referred to as the net basin supplies (NBS), are defined in terms of their components as:

$$NBS = P + R - E \qquad (1)$$

where P is over-lake precipitation, R is basin runoff to the lake, and E is lake evaporation. (Note: since Lake Superior runoff indirectly includes the Ogoki Diversion, NBS values reported here include the Ogoki diversion on Lake Superior.) Over-lake precipitation values were used to compute the values in Appendix E, but GLERL often uses the over-land precipitation as the best estimate of over-lake precipitation (see section 6.2). NBS have also been computed indirectly by both the U.S. Army Corps of Engineers and Environment Canada as a residual in a water balance:

$$\Delta S = NBS + I - O + D \qquad (2)$$

where ΔS is change in lake storage computed from lake-level changes, I and O are inter-basin inflow and outflow through a natural channel, respectively, and D is inter-basin diversions into the lake. Equation (2) ignores thermal expansion, consumptive use, and groundwater.

Lake evaporation is estimable from 1950 (1955 on Lake Huron), since wind speed and humidity data exist only since 1948 (1953 on Georgian Bay) and 2 years are used for model initialization. Thus, NBS from equation (1) from 1950 (1955 for Lake Huron) are reported in Appendix E. Residual NBS, from equation (2), depend on connecting channel flows and water level data, which exist preceding January 1900. Residual NBS are not presented here, but a computer program is available separately for computing them in a variety of manners.

Water balance errors can result in significant differences between NBS estimates computed from equations (1) and (2). Table 1 summarizes a comparison of the two monthly NBS series over an evaluation period of August 1982 through December 1988. While correlation is good, there are large differences between the component and residual methods for all lakes, as reflected by the bias and root mean square error (RMSE) statistics. On all lakes, the RMSE is about one third of the standard deviation of component NBS. On Lakes Superior, Michigan, Huron, and Erie, the bias is about one tenth of the mean component NBS, and on Lake Ontario it is about 4%. Comparison plots of average seasonal characteristics of NBS from both methods (Lee, 1992) reveal little difference in the timing of the seasonal maximum and minimum, but reveal significant differences in the monthly means during the late summer and fall months. Annual comparison plots (Lee, 1992) show the residual NBS are consistently lower than the component NBS throughout the evaluation period used here for Lakes Superior, Michigan, Huron, and Ontario. This agrees well with the bias in Table 1. The differences in Table 1 are also due to inconsistent application of equations (1) and (2) on Lake Superior; see section 6.3.

Table 1. Comparison of Residual with Component Monthly NBS over the evaluation period (August 1982 - December 1988).

	Superior	Mich-Huron	Erie	Ontario
Mean Component NBS (mm)	75	87	63	162
Mean Residual NBS (mm)	68	78	70	156
Standard Deviation Component NBS (mm)	64	60	98	108
Standard Deviation Residual NBS (mm)	63	66	102	118
RMSE (mm)	23	20	27	33
Correlation	0.94	0.96	0.97	0.96
Bias (mm)	7	9	-7	7

6.1 Residual Method Errors

The differences between residual and component NBS largely result from residual errors in the water balance of equation (2). These include errors in estimating change of storage, inter-basin inflows, outflows, and diversions, and errors in ignoring thermal volumetric changes, consumptive use, and groundwater. The change in storage on a lake is computed from the difference between the beginning-of-period and the end-of-period water levels (Lee, 1992). Both are estimated with 2-day averages of spatial means. Average estimates of instantaneous values and remnant short-term fluctuations cause errors in estimates of storage change and, ultimately, NBS. Croley (1987) evaluated errors in storage change for Lakes Superior and Erie and found the largest error in fall and winter months, when storm activity is most frequent.

Lake outflows are determined by direct measurement (Lakes Superior and Ontario), stage-discharge relationships (Lakes Michigan, Huron, and St. Clair), or a combination (Lake Erie) and are generally considered accurate within 5%. However, small outflow errors can result in large errors in residual NBS. Quinn and Guerra (1986) have shown that a 5% error in the Detroit or Niagara River flows can result in a 34% error in the residual NBS of Lake Erie. Errors in outflows estimated for Lakes Michigan, Huron, and St. Clair may exceed 5% during ice jams, since ice retardation must often be estimated. Other sources of large errors in flow estimation include flow reversals on the Detroit River during seiche activity on Lake Erie, past dredging activities in the St. Clair River, and negotiated changes in flow rating equations.

Omissions in equation (2) further contribute to error in residual NBS estimation. Ignoring thermal expansion or contraction of the lake water body can result in a 100% error in monthly residual NBS (Meredith, 1975) on each lake. This difference is largest for June through November, when the lakes heat storage increases and then declines. Quinn and Guerra (1986) verified this in a Lake Erie water balance. Ignoring the total consumptive use [about 2,850 cfs in 1989, (Great Lakes Commission, 1991)] will affect residual NBS (computed for the entire Great Lakes basin) as much as omitting the Lake Michigan diversion; they are about the same magnitude. Groundwater contributions to the Great Lakes are generally taken as small (Great Lakes Basin Commission, 1975) and conveniently ignored since they are unknown. However, any groundwater errors are directly reflected in the residual NBS estimation. While no residual net basin supplies are presented here, they may be computed from equation (2) from changes in storage (computed from lake levels), interconnecting channel flow rates, and basin diversions; these data are presented here in following sections. They may be used with available software to compute residual net basin supplies in a variety of manners.

6.2 Component Method Errors

There are, of course, errors associated with the component method of estimating NBS. These include errors in estimating precipitation, runoff, and evaporation. Over-lake precipitation estimates can be different, depending on which land-based meteorologic stations are used and how lake/land precipitation ratios are determined from short-term studies. For the Great Lakes, where lake effects on nearshore meteorology are significant and the drainage basins have relatively low relief, the use of all available meteorologic stations throughout the basin may be less biased than the use of only nearshore stations. GLERL often estimates over-lake precipitation from over-land precipitation which is, in turn, measured throughout the basin and Thiessen weighted (Croley and Lee, 1993). Direct measurement of over-lake precipitation may be possible in the future with the implementation of the Next Generation Radar (NEXRAD) as part of the National Weather Service modernization program.

Likewise, there are errors in evaporation modeling. While the model agrees well with monitored water surface temperatures, ice cover, temperatures measured at depth, and estimated thermodynamic surface fluxes, there are no evaporation measurements to compare. However, even though there are significant differences in monthly component and residual estimates of NBS, they agree well over the long term; this indicates the long-term evaporation estimates, at least, are reasonable. Based on our review of the sources and magnitudes of errors in the computation of NBS, we believe that actual NBS are determined more accurately now by estimating all components directly, instead of as a water balance residual.

6.3 Ogoki Diversion Inclusion

Some diversion into Lake Superior is measured before it enters the basin even though it passes through regulated Lake Nipigon before it enters Lake Superior. This is because the timing and amount of diverted water from Lake Nipigon cannot be separated from its natural flow. Likewise, diversions from Lake Michigan, in equation (2), include actual withdrawal from the lake and redirected lake drainage (International Joint Commission, 1985), even though only lake withdrawal should be used. Both cause errors in the NBS estimates.

Users of this data are cautioned to note that the Lake Superior runoff to the lake, and hence Lake Superior net basin supply, include the Ogoki diversion, since it cannot be separated from the measurement at the lake. Users of this data should omit separate Ogoki diversion data in a water balance with this data. Table 1 compares Lake Superior component net basin supplies, with the Ogoki diversion included, to residual net basin supplies, with the Ogoki diversion removed (albeit crudely by subtracting values reported at the basin divide rather than values at the lake edge). By adding the Ogoki diversion back to the residual net basin supplies, the removal is reversed. The comparison between component and residual net basin supplies, both with the Ogoki diversion included, is more meaningful. Then, the *Mean Residual NBS* in Table 1 for Lake Superior becomes 71 mm; the *Standard Deviation Residual NBS* becomes 64 mm; the *RMSE* drops by 2 mm; the *Correlation* is unchanged; and the *Bias* drops by 3 mm.

7. CONNECTING CHANNEL FLOWS

The connecting channels of the Great Lakes system consist of the St. Marys, St. Clair, Detroit, Niagara, and St. Lawrence Rivers. Historical flows in these channels are presented in Appendix F. The basic reference for the St. Marys, Detroit, and St. Clair River flows was the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data (1988). The reference for the Niagara River flows was the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data (1976). The flow data for the St. Lawrence River were obtained from the Levels and Flows Work Group (1969). Updated values for the St. Marys, Niagara, and St. Lawrence Rivers were obtained from the Detroit District of the Army Corps of Engineers.

8. DIVERSIONS

Data for the Long Lac-Ogoki, Chicago, and Welland diversions were obtained from the Levels and Flows Work Group (1969) and updated by the various responsible U. S. and Canadian agencies and international boards and committees. They are presented in Appendix G. Note that the Chicago diversion includes water that would have gone into Lake Michigan as streamflow runoff, but is now discharged into the Mississippi River basin. The diverted area of the basin has already been removed from consideration in our runoff estimates for Lake Michigan. Using this diversion data in a water balance with the runoff data presented here would double count (negatively) Chicago runoff. That is, runoff to Lake Michigan does not include Chicago runoff to the lake, but Chicago runoff is included as a diversion from the lake. The user of this data will need to account for this if performing water balance calculations. The diversion values do not accurately reflect the amount of water removed from the lake, but are significantly higher. Through discussions with the U.S. Army Corps of Engineers in Chicago (Kiel, personal communication, 1993), we determined that it is not possible for us to separate the components for most of the period of record. The numbers are, therefore, presented as supplied to us.

Additionally, in late 1992, the U. S. Geological Survey performed a verification of the rating curve used to compute flows through the Chicago diversion. The USGS found that the flows were actually much higher than indicated by the equations which were used during the period October, 1985 - December, 1990. Accordingly, data for this period is presented from the revised values supplied by the U.S. Army Corps of Engineers, derived from the USGS acoustic current meter at Romeoville, Illinois.

9. BEGINNING-OF-MONTH LAKE LEVELS

We computed the beginning-of-month lake levels, in Appendix H, by using the same methodology used to compute the values published in the 1983 report (Quinn and Kelley, 1983). See Quinn (1975a,b), Quinn and Derecki (1976a,b), Kelley (1976), and Quinn et al. (1979). A minimal set of Thiessen polygons were constructed and used without further modification. Missing station data were filled in by various techniques by using nearby gages so that Thiessen weights never required recomputation due to missing data. Networks changed only when new stations became available or old stations were discontinued.

The values in this publication are reported in IGLD 1985 datum. The 1983 report (Quinn and Kelley, 1983) used the IGLD 1955 datum. We do not have access to the station data prior to 1973 in a computer-readable form, so we did not recompute the values prior to 1973. We simply computed lake-wide conversion factors (from IGLD 1955 to IGLD 1985) based on the networks employed and the conversion factors for the individual gages in each of the networks. The conversion factors were then applied to the IGLD 1955 values. The IGLD 1955 to IGLD 1985 conversion was unavailable for Pte. Petre, Ontario, so it was estimated by the average of those at Cobourg, Ontario and Kingston, Ontario. We recomputed the values from 1973 to 1990 by using the actual IGLD 1985 gage data. Our network was the largest network used by Quinn et al. (1979). In those instances where a station from that network had been discontinued, we recomputed the network weights.

The beginning-of-month level for a gage is defined as the level at 12:00:00 a.m. (midnight) on the first day of that month. Since this value is generally unknown for practical reasons, it is standard practice to compute the value by averaging the daily mean level for the last day of the previous month with the daily mean level for the first day of the current month, when both are available. When one or both of the daily mean values are unavailable, several alternative methods for filling in the missing data are available. We used the following methods, listed in order of preference, to estimate the beginning-of-month lake level (BOM) from daily lake level i days after the beginning of the month, L_i:

$$
\begin{aligned}
BOM &= 0.50\ L_{+0} + 0.50\ L_{-1} \\
&= 0.67\ L_{+0} + 0.33\ L_{-2} \\
&= 0.33\ L_{+1} + 0.67\ L_{-1} \\
&= 0.75\ L_{+0} + 0.25\ L_{-3} \\
&= 0.25\ L_{+2} + 0.75\ L_{-1} \\
&= 0.50\ L_{+1} + 0.50\ L_{-2} \\
&= 0.60\ L_{+1} + 0.40\ L_{-3} \\
&= 0.40\ L_{+2} + 0.60\ L_{-2}
\end{aligned}
\qquad
\begin{aligned}
BOM &= 0.50\ L_{+2} + 0.50\ L_{-3} \\
&= L_{+0} \\
&= L_{-1} \\
&= L_{+1} \\
&= L_{-2} \\
&= L_{+2} \\
&= L_{-3}
\end{aligned}
\qquad (3)
$$

These alternatives were sufficient to compute the beginning-of-month level at each gage for each month.

10. CHANGES IN STORAGE

Monthly changes in storage for each lake, presented in Appendix I, were computed by multiplying the difference between two consecutive beginning-of-month levels (as determined by Thiessen weighting) by the area of the lake in Table 2. Changes in storage were then converted from volumes into average rates by dividing by the number of seconds in the month. Leap years were taken into account.

11. DATA AVAILABILITY

All data in Appendices A-I and a FORTRAN program for computing residual net basin supplies are available on a companion diskette. The program clarifies the inclusion of the Ogoki diversion in component net basin supplies and (optionally) in residual net basin supplies. Inquiries should refer to this report and be addressed to:

Publications
NOAA, Great Lakes Environmental Research Laboratory
2205 Commonwealth Blvd.
Ann Arbor, Michigan 48105-1593
U.S.A.

The contents of the diskette are also available via anonymous ftp from ***ftp.glerl.noaa.gov*** and ***http://www.glerl.noaa.gov***.

Table 2. Coordinated Great Lakes Drainage Areas (Coordinating Committee, 1977).

	Superior	Michigan	Huron	St. Clair	Erie	Ontario
Lake Area (sq km)	82,100	57,800	59,800	1,170	25,800	19,000
Land Area (sq km)	128,000	118,000	134,000	15,700	61,000	64,000
Basin Area (sq km)	210,000	176,000	194,000	16,900	86,800	83,000

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