US Army Corps
of Engineers
North Central Division

# GREAT LAKES LEVELS

Update Letter No. 82 May 4, 1992

## New Water Resources Management Technologies

Great Lakes' researchers and resource managers are applying modern technologies to monitor the hydrology of the Great Lakes and to evaluate the impacts of fluctuating water levels. Computers are processing satellite images and mapping shoreline characteristics and land use impacts along the shores. In addition, airborne sensor packages, equipped with specialized computers, are being used to map snow and soil moisture conditions across the drainage basins of the lakes.

The satellite and airborne data collection and processing systems are collectively called "remote sensing." The computerized mapping systems are frequently referred to as "geographic information systems," or simply as GIS.

### Satellite Remote Sensing

Satellite pictures of the Great Lakes region are referred to technically as "images" (see Figure 1). Images are collected regularly from several different satellites, some as often as twice daily. Coverage of the total Great Lakes-St. Lawrence River drainage basin is accomplished using a set of polar-orbiting satellites,

**Figure 1. Satellite Picture of the Great Lakes Region**

managed and maintained by the National Oceanic and Atmospheric Administration (NOAA). These are useful for mapping the snow cover over the Great Lakes basin, ice cover on the lakes, and water temperatures at the lake surfaces.

Snow cover mapped from the NOAA imagery is used to monitor the timing and degree of spring snowmelt for water supply to the lakes. Satellite images of the ice cover are used to monitor ice build-up; adverse conditions could cause flooding due to ice jams in the connecting channels. The lake water temperature measurements derived from the NOAA imagery are input to computer models which simulate and forecast evaporation rates for the lakes.

Other satellite data are collected less frequently, but with a greater level of detail. These include images that are obtained from the U.S. LANDSAT earth resources satellites, or from the French SPOT satellites. Coverage of portions of the Great Lakes from these satellites, however, is only repeated every 9 to 18 days. The LANDSAT and SPOT images are frequently processed for the Great Lakes region to map land use and land cover patterns, to monitor sediment distribution patterns, and to identify pollution sources.

Several Federal government agencies and many state universities in the Great Lakes region have remote sensing computer systems. The Detroit District, U.S. Army Corps of Engineers, at Detroit, Michigan, (USACE), has such systems and a trained staff who process satellite data on a regular basis. The Environmental Protection Agency (EPA), in Chicago, Illinois, and in Duluth, Minnesota, also have systems for processing satellite imagery.

Additionally, Federal agencies involved in these activities include the NOAA and the U.S. Navy, who operationally map ice cover conditions. The U.S. National Weather Service (NWS) and Environment Canada's Atmospheric Environment Service also generate satellite maps of snow cover and water surface temperatures.

**Figure 2. An Airborne Gamma Radiation Snow Survey**

## Airborne Remote Sensing

Airborne surveys of snow and soil moisture conditions have been conducted over the Lake Superior drainage basin every winter since 1983-84. These surveys are conducted by the NWS in cooperation with the USACE and Environment Canada.

The surveys are conducted from low-flying turbo-prop aircraft, using a gamma radiation sensing package (Figure 2). The airborne gamma radiation snow survey technique was perfected in the early 1980s. The methodology uses the fact that extremely low levels of gamma radiation are naturally emitted from the soil. At these levels, gamma rays are not harmful to humans. They are measured using highly sensitive sensors mounted in aircraft, flying at an altitude of about 500 feet.

When snowpack covers the ground, the natural emissions of gamma rays are reduced or "attenuated" by moisture in the snow. Repetitive measurements of the gamma ray emissions provide a direct measure of the water content of the snowpack or soil.

The winter airborne surveys over the Lake Superior drainage basin are usually conducted in mid-March, during the time of normal peak snow accumulation. These measurements are quickly processed on the plane and broadcast across the NWS communication networks to users. The USACE receives the data and evaluates the snow conditions versus long-range averages. This information is provided to the International Lake Superior Board of Control of the International Joint Commission (IJC), for their use in determining future water supplies.

Similar airborne measurements have been made by the NWS over the Lake Ontario drainage basin during the last three winters. A network of flight lines over the Lakes Michigan, Huron, Erie, and St. Clair drainage basins have also been developed. Snow and soil moisture surveys over these basins will be conducted whenever heavy snowfall require detailed evaluation.

## Geographic Information Systems (GIS)

A GIS is a computer system used to store, manipulate, analyze, and display various types of information, which are referenced to map coordinates.

The U.S. Great Lakes shoreline GIS mapping is being developed by the Detroit District and North Central Division of the

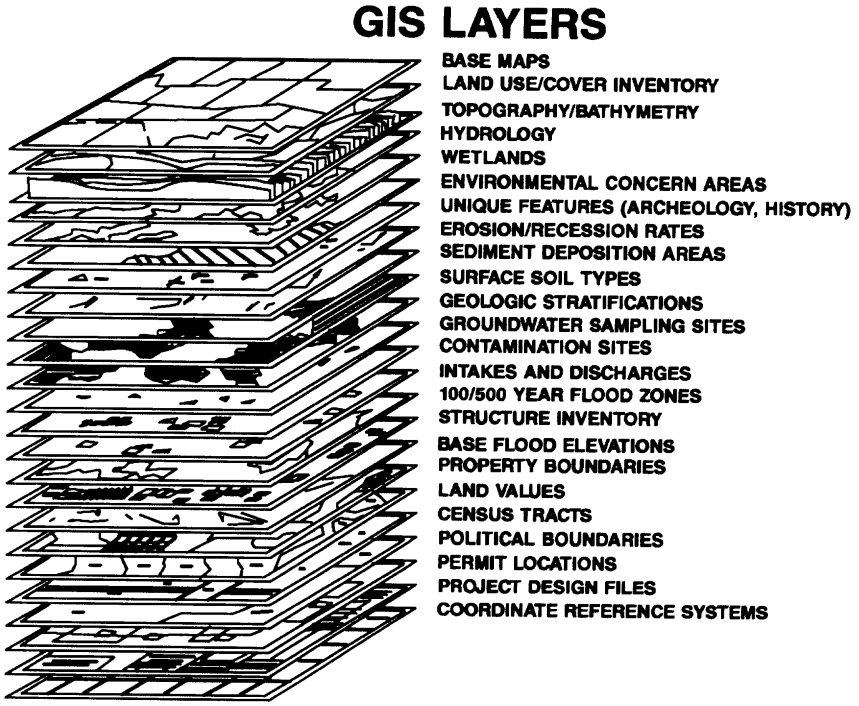


**Figure 3. Typical GIS Layering**

USACE to support the current IJC Levels Reference Study. The Levels Reference Study is evaluating alternative water level regulation, land use management, and crises response measures to alleviate the adverse consequences of fluctuating Great Lakes water levels.

The GIS for the U.S. shoreline is structured so that different types of information on shoreline characteristics, land use patterns, flood and erosion information, and economic values can be stored "on top" of each other (Figure 3). This approach can allow researchers and managers to ask complex questions of the data and to get detailed answers in a picture format.

For instance, an individual could ask a hypothetical question such as, "How many structures (homes) are within the existing 100-year flood zone in Township Pleasant View, and how much flood damage would occur if the existing flood zone was enlarged due to a 1-foot increase in water levels?" Or, just the opposite, "How much flood damage could be prevented in Township Pleasant View if the water level extremes were 1 foot lower?"

The GIS can allow these complex queries, because all of the information is referenced to geographic locations. This referencing is technically referred to as "map coordinates."

The GIS is being developed to store information on base maps of the U.S. shoreline counties and townships. The base maps include roads, rivers and streams, political boundaries, shorelines,

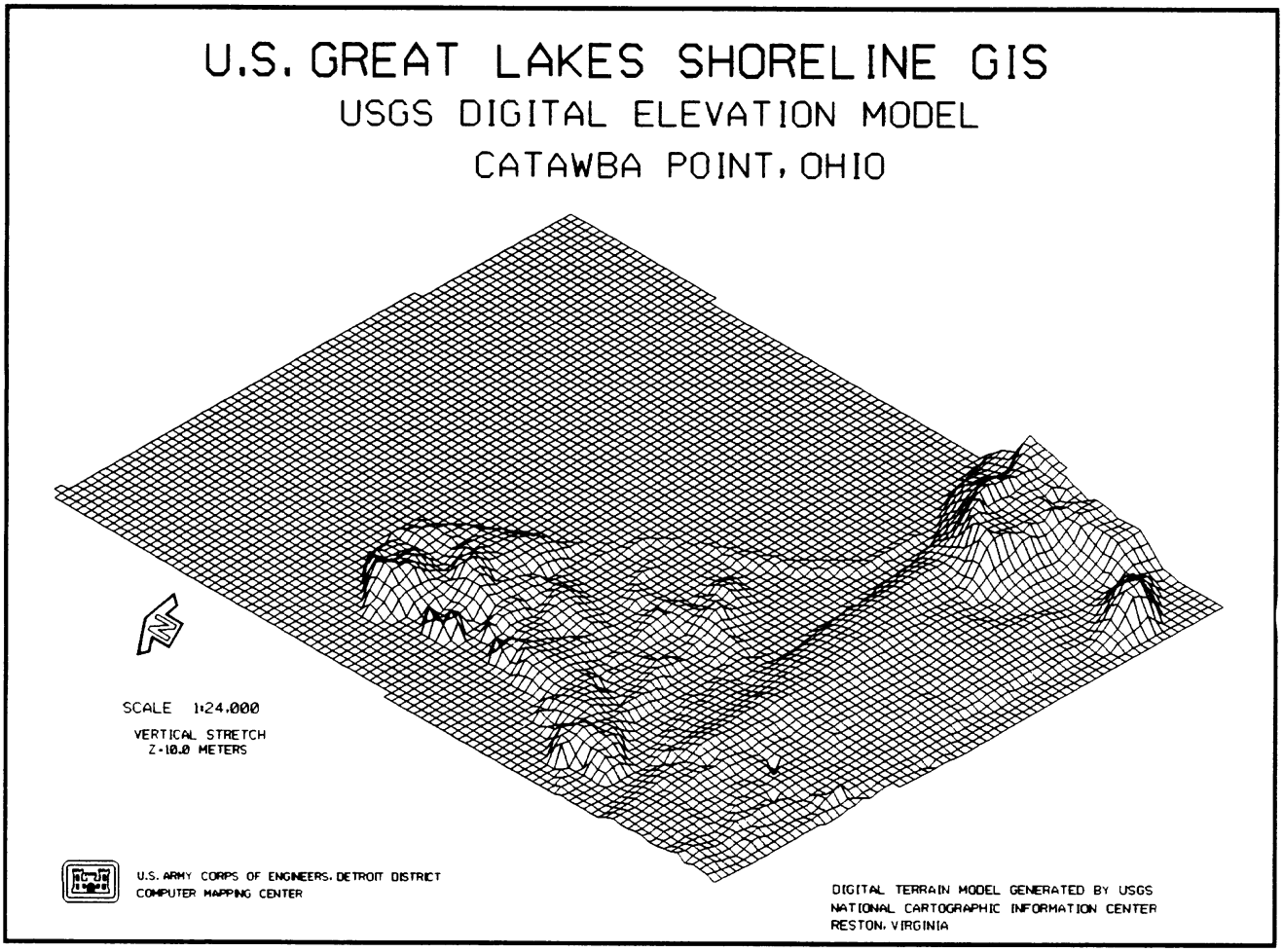


**Figure 4. U.S. Great Lakes Shoreline GIS**

and detailed map coordinate information.

Information on shoreline characteristics, such as the slope, the composition of the soil and number of protective structures in place, are stored in the GIS. Other information on historic erosion and recession rates and long-term recession limits are also included.

Land use information is stored for all shoreline counties and townships. This information generally covers all areas from the shoreline inland to approximately 1.5 miles. The land use data are broken into 52 different categories (e.g., single family residential, multifamily residential, commercial, industrial, etc.).

Additional land use information on historic changes (last 10 years) and projected future land use patterns are also being added to the GIS. The land use trend information is useful for determining future damages that could occur under existing or modified lake level regulation scenarios.

The GIS is being created to also include detailed information on the elevation changes of the shoreline, known as "terrain data." The terrain data being entered in the GIS will be capable of generating, at a minimum, 1-foot contour intervals. Detailed terrain data in the GIS are presently limited to only about 5 percent of the total U.S. shoreline. This is due to the large cost and time requirements needed to input this information. As time proceeds, more and more terrain data will be entered for future applications of the GIS.

The U.S. Great Lakes shoreline GIS is being created to consolidate a diffuse body of physical, environmental, and economic information. The GIS is designed to take full advantage of all available data.

Use of the GIS will provide opportunities for refining Great Lakes modeling of both coastal and riverine conditions. The GIS could be used for other applications, such as sediment distribution studies, flood and erosion impact assessments, and risk assessments for coastal zone development. Further uses of the GIS could also include detailed analyses of the effects of water level management on critical natural habitats, such as wetlands and fish spawning areas.

## For Further Information

For further information on Great Lakes satellite and airborne remote sensing or geographic information systems, please contact the following:

Chief, Geographic Data
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Great Lakes Hydraulics and
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Detroit District,
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## Levels Reference Study

The Levels Reference Study Board met on April 22, and held a joint meeting with the Citizens Advisory Committee on April 23. Progress Review Meetings will be held with the public on May 12, in Toledo, Ohio, and on May 27, in Burlington, Ontario. The next Study Board meeting is scheduled for June 22-23, in Montreal.

## Demonstrations of Sediment Cleanup Technologies

This summer, there will be a series of demonstrations of technologies for remediation of contaminated sediments conducted at areas of concern around the Great Lakes in the U.S. and Canada. Technologies include equipment for dredging, pretreating, and treating contaminated sediments. Most of these demonstrations are being conducted by the U.S. Environmental Protection Agency under the Assessment and Remediation of Contaminated Sediments (ARCS) program, and by Environment Canada under the Great Lakes Cleanup Fund. The Corps is supporting the USEPA at several of the ARCS demonstrations. A schedule of the upcoming demonstrations is shown in Table 1. An in-depth article on the ARCS program will be presented in next month's update.

**Russell L. Fuhrman**
**Brigadier General, U.S. Army**
**Commanding General and**
**Division Engineer**

Table 1. Schedule of Great Lakes Sediment Remediation Demonstrations

| Site | Technology | Agency | Tentative Dates |
|---|---|---|---|
| Sheboygan,WI | Bioremediation | USEPA | Apr 92/Dec 93 |
| Saginaw, MI | Physical separation | USEPA | May 92 |
| Toronto, ONT | Cable arm dredge<br>Soil washing | Env Can<br>WTC | May<br>May/June |
| Gary, IN | Chemical extraction | USEPA | June |
| Toronto, ONT | Metal removal | WTC | June/July |
| Buffalo, NY | Dredging equipment | USACE | July/August |
| Collingwood, ONT | Pneumatic dredge | Env Can | July/August |
| Ashtabula, OH | Thermal extraction | USEPA | August |
| Hamilton, ONT | Cable arm dredge | Env Can | August |

Points of contact for more information:

| | |
|---|---|
| Great Lakes Program Office, USEPA | Steve Garbaciak (312) 353-0117 |
| Buffalo District, USACE | Tom Kenna (716) 879-4268 |
| Environment Canada | Ian Orchard (416) 973-1089 |
| Wastewater Technology Center (WTC) | Craig Wardlaw (416) 336-4692 |

# Great Lakes Basin Hydrology

The precipitation, water supplies, and outflows for the lakes are provided in Table 2. Precipitation data include the provisional values for the past month and the year-to-date and long-term averages. The provisional and long-term average water supplies and outflows are also shown.

**Table 2**
**Great Lakes Hydrology[1]**

| PRECIPITATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BASIN | APRIL | | | | YEAR-TO-DATE | | | |
| | 1992* | AVG.** | DIFF. | % OF AVG. | 1992* | AVG.** | DIFF. | % OF AVG. |
| Superior | 3.0 | 1.9 | 1.1 | 158 | 6.8 | 7.1 | -0.3 | 96 |
| Michigan-Huron | 2.9 | 2.5 | 0.4 | 116 | 8.6 | 8.5 | 0.1 | 101 |
| Erie | 3.8 | 3.1 | 0.7 | 123 | 11.2 | 10.4 | 0.8 | 108 |
| Ontario | 3.7 | 2.8 | 0.9 | 132 | 11.6 | 10.6 | 1.0 | 109 |
| Great Lakes | 3.1 | 2.5 | 0.6 | 124 | 8.8 | 8.6 | 0.2 | 102 |

| LAKE | APRIL WATER SUPPLIES*** | | APRIL OUTFLOW[3] | |
|---|---|---|---|---|
| | CFS[2] | AVG.[4] | CFS[2] | AVG.[4] |
| Superior | 146,000 | 149,000 | 77,000 | 69,000 |
| Michigan-Huron | 296,000 | 286,000 | 182,000[5] | 182,000 |
| Erie | 87,000 | 66,000 | 219,000[5] | 203,000 |
| Ontario | 110,000 | 93,000 | 244,000 | 249,000 |

*Estimated (inches) **1900-90 Average (inches)
***Negative water supply denotes evaporation from lake exceeded runoff from local basin.

[1]Values (excluding averages) are based on preliminary computations.
[2]Cubic Feet Per Second [3]Does not include diversions [4]1900-89 Average (cfs)
[5]Reflects effects of ice/weed retardation in the connecting channels.

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

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