Water Resources Management Decision Support

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Overview

The Great Lakes Environmental Research Laboratory (GLERL) participated in planning and consequent research activities of both the International Joint Commission, in their ongoing study of Lake Ontario-St. Lawrence River levels and flows regulation, and the board of the International Coordinating Committee for Great Lakes Basic Hydraulics and Hydrology Data. As GLERL identified component research projects, they defined them separately; but house overall planning activities in this project. GLERL uses their Advanced Hydrologic Prediction System (AHPS) in aspects of this work. Recent work included planning on the IJC's Hydrology and Hydraulics Technical Working Group for the Lake Ontario study, evaluating forecast methodologies on the Great Lakes, assisting Hydro Quebec in making climate change impact assessments in the Ottawa River basin complementing earlier GLERL studies, assessing climate change impacts in the Great Lakes based on the latest global circulation model (GCM) scenarios, maintaining GLERL's AHPS both in-house and at other agencies, and constructing a web interface for accessing products, documenting software, and methodology improvements. This project continued GLERL's efforts on the H&H TWG, the board of the CCGLBHHD, and other international boards as well as the ongoing development and maintenance of GLERL's AHPS.

2004 Accomplishments

Participated in planning as part of the International Joint Commission's five-year effort (2001-2005) to construct and implement "The Study for Criteria Review in the Orders of Approval for Regulation of Lake Ontario-St. Lawrence River Levels and Flows." Also participated in research efforts as the planning identified them. Served as the US cochairman on the Hydrology and Hydraulics Technical Working Group (H&H TWG). We met with the study Board to update them on H&H TWG accomplishments and coordinated with the Plan Formulation and Evaluation Group.

Developed metadata for all of the H&H TWG US products to date (databases and data sets, reports, and result summaries, produced over the preceding three years of the study). The group was required to create metadata by using the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata (FGDC-STD-001-1998) for the FGDC metadata standard. Metadata for all of the H&H TWG products to date were necessary to complete project requirements and were developed by joint US-Canadian efforts this year. The US completed the effort for the US products and turned it over to the Canadians for the Canadian products, since their fiscal years overlap.

Acted on the 6-member board (3 US and 3 Canadian) of the International Coordinating Committee for Great Lakes Basic Hydraulic and Hydrologic Data. We met in May 2004 in Burlington and November 2003 in Niagara Falls.

Continued maintaining the use of GLERL's Advanced Hydrologic Prediction System (AHPS) and its graphical user interface (GUI) for making hydrology outlooks both in the office and in the field at five locations. This year GLERL acquired the coordinated Great Lakes Routing and Regulation Model and began modifications of it, the AHPS, and the AHPS GUI, in preparation for integrating them.

Accomplishments

GLERL interpreted the latest GCM results over the Great Lakes in hydrological impact estimates for changed climates. These estimates are for use by the IJC's five-year study (2001-2005) of Lake Ontario-St. Lawrence regulation in assessment of candidate regulation plans. We extracted, and supplied to Hydro Quebec, GCM output changes between a baseline period of 1961-1990 and the future 30-year period of 2040-2069. We adjusted historical meteorology data for the Great Lakes basin with the GCM climate changes (see Figure 1) while Hydro Quebec and the Ministère de l'Environnement did the same for the Ottawa River basin. We used a base climate (observed data) time series over 1950-1999 to define the reference suggested by the IPCC of 1960-1990. We simulated Great Lakes hydrology with AHPS to estimate net water supply scenarios for each lake under each climate scenario. Hydro Quebec and the Ministère de l'Environnement did the same for the Ottawa River basin by using the appropriate hydrology and management models. Finally, GLERL, Hydro Quebec, and the Ministère de l'Environnement combined their estimates for further use by the IJC in their study of Lake Ontario-St. Lawrence River regulation.

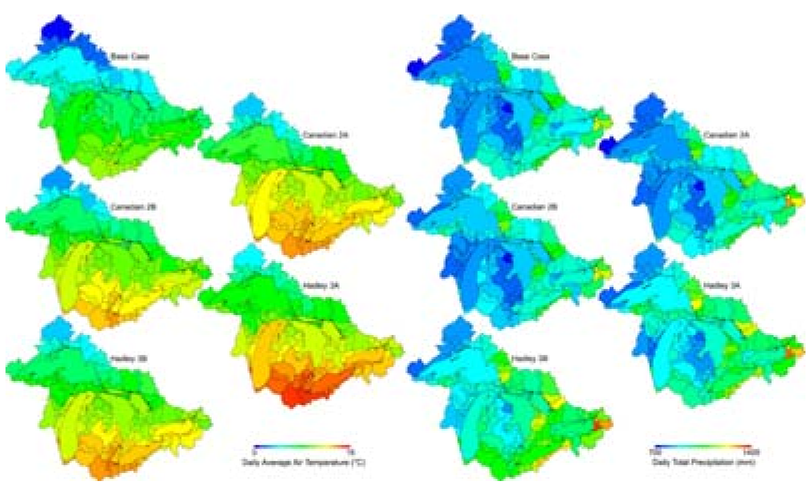

Figure 1: *Maps of average daily temperature and total precipitation in the Great Lakes basin*

GLERL also completed their part of the project: Hydrological Information and Forecasting Integration for the IJC Lake Ontario-St. Lawrence River Study. The US Army Corps of Engineers linked hydrology and hydraulic variables to identified Lake Ontario-St. Lawrence River regulation decision variables and matched them with appropriate scale model forecasts.

GLERL provided simulated net basin supply forecast time series from their AHPS (see Figure 2) as components in the Corps integration of new meteorological observed and forecast products and weighting technology. GLERL's representative met with the rest of the board of the International CCGLBHHD in planning and organizing activities of its subcommittees.

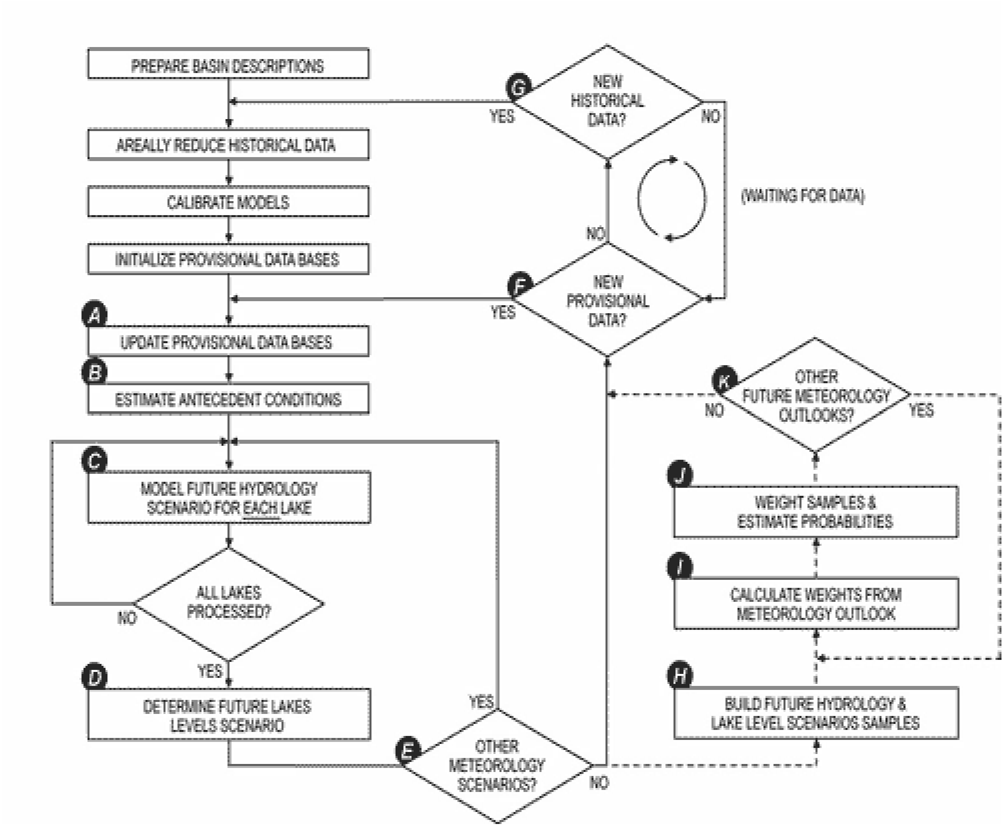

Figure 2: *Overview of Great Lakes Advanced Hydrologic Prediction System*

GLERL maintained, supported, and improved their AHPS and made minor bug fixes for Environment Canada's use of AHPS in the interface between AHPS and Lake Ontario regulation for end-of-year forecasts. They corrected a date mismatch between AHPS and the weighting program (used to incorporate NWS probabilistic meteorology forecasts) for all users of AHPS and continued assisting agencies in making AHPS operational in their offices. GLERL also continued their AHPS operations in house daily to present extended probabilistic hydrologic outlooks on all of the Great Lakes and their basins.

Products

Croley, T.E. II. 2006. Using climatic predictions in Great Lakes hydrologic forecasts. ASCE Task *Committee Report on Climate Variability, Climate Change, and Water Resources Management*. Garbrecht, J., and U. Lall (Eds.). American Society of Civil Engineers, Arlington, VA, 164-185.

Madenjian, C. P., T. O. Hook, E. S. Rutherford, D. M. Mason, T. E. CROLEY II, E. B. Szalai, and J. R. Bence. 2005. Recruitment variability of alewives in Lake Michigan. *Transactions of the American Fisheries Society* 134:218-230.

Croley, T. E., II, 2003. *Great Lakes Climate Change Hydrological Impact Assessment, IJC Lake Ontario-St. Lawrence River Regulation Study NOAA Tech. Memo. GLERL-126*, Great Lakes Environmental Research Laboratory, Ann Arbor, Michigan, 84 pp.

Croley, T. E., II, 2003. Weighted-climate parametric hydrologic forecasting. *Journal of Hydrologic Engineering*, ASCE, 8(4):171-180.

Croley, T. E., II, 2003. Weighted Parametric Operational Hydrology Forecasting*. Proceedings, World Water & Environmental Resources Congress 2003*, June 23-26, 2003, Philadelphia, Pennsylvania (Ed. P. Bizier, P. DeBarry), Environmental Water Resources Institute, American Society of Civil Engineers, Washington DC, 10 pp., Compact Disc.

Croley, T. E., II, and C. L. Luukkonen, 2003. Potential climate change impacts on Lansing, Michigan ground water. *Journal of the American Water Resources Association*, AWRA, 39(1):149-163.

Croley, T. E., II, 2002. Improving hydrological forecasts for IJC Lake Ontario-St. Lawrence River study, *Final Report to Hydrology and Hydraulics Technical Working Group on Project 2: Review of Great Lakes Forecasting Methodologies,* Great Lakes Environmental Research Laboratory, Ann Arbor, 58 pp.

Croley, T. E., II, 2002. Evaluation of NOAA Climate Outlooks in Extended Great Lakes Water Levels Forecasts. *Proceedings, Conference on Water Resources Planning and Managemen*t, May 19-22, 2002, Roanoke, Virginia (Ed. D. F. Kibler), Environmental Water Resources Institute, American Society of Civil Engineers, Washington, DC, 10 pp., Compact Disc.

Croley, T.E., II, 2001. Climate-biased storm-frequency estimation. *Journal of Hydrologic Engineering*, ASCE, 6(4):275-283.

Croley, T. E., II, 2001. Climate change scenario development for IJC Lake Ontario - St. Lawrence River study, *Final Report to Hydrology and Hydraulics Technical Working Group*, Great Lakes Environmental Research Laboratory, Ann Arbor, 2 pp.

Croley, T. E., II, 2001. Climate-Biased Decisions Via Partial Historical Sampling. *Proceedings, World Water & Environmental Resources Congress, Bridging the Gap: Meeting the World's Water and Environmental Resources Challenges* May 20-24, 2001, Orlando, Florida (Eds. D. Phelps, G. Sehlke), Environmental Water Resources Institute, American Society of Civil Engineers

CD Rom/Online Products

Climate change impact results (Great Lakes Climate Change Hydrologic Impact Assesment I.J.C. Lake Ontario-St. Lawrence River Regulation Study, NOAA Tech. Memo. GLERL-126) are available from GLERL and from the study's Hydrologic and Hydraulic Technical Working Group. They include 19 overwater variables (minimum, maximum, and average air temperature, precipitation, humidity, cloud cover, windspeed, incident radiation, reflection, net longwave exchange, latent and sensible heats, net surface heat exchange, stored heat, ice cover, surface water temperature, evaporation, runoff from the basin, and net basin supply) defined over the seven lake surfaces of the Laurentian Great Lakes. They also include 10 overland variables (minimum, and maximum air temperature, precipitation, soil moisture storage, groundwater storage, surface moisture storage, snow moisture storage, total moisture storage, evapotranspiration, and runoff to the lake) defined over the 121 watersheds comprising the Great Lakes drainage basin and aggregated over the seven lake basins. These variables are presented as both daily and quarter-monthly values defined over 30 year periods for five different climate scenarios: the present (1961-1990) and four future (2040-2069) climate change scenarios (derived from two Canadian general circulation model runs, CGCM2A and CGCM2B, and from two Hadley model runs, HADC3A and HADC3B, representing, respectively, extreme conditions of warm and dry, not as warm but dry, warm and wet, and not as warm but wet)

Four files are available:

1. HADCM230.TXT [HADCM2 for the three 30-year scenarios (2025, 2055, and 2085) for the seven variable changes for the twelve months of the year],
2. CCGCM130.TXT [CCGCM1 for the three 30-year scenarios (2025, 2055, and 2085) for the seven variable changes for the twelve months of the year],
3. HADCM220.TXT [HADCM2 for the three 20-year scenarios (2030, 2050, and 2090) for the seven variable changes for the twelve months of the year], and
4. CCGCM120.TXT [CCGCM1 for the three 20-year scenarios (2030, 2050, and 2090) for the seven variable changes for the twelve months of the year].

Updated Derivative Outlook Weights Software, a special-purpose GUI, for using probabilistic meteorology outlooks to make derivative outlooks. Accompanied by complete updated documentation in a self-installing file.

An archive (ZIP) file is available with the Linear Programming Solution executable program application and 18 example problems. The program’s use, input requirements, and output interpretation are documented within the GUI of the program. In addition, all code is available in modules for building similar applications if desired.

Tutorial notes: Making Probabilistic Hydrology Outlooks from Probabilistic Meteorology Outlooks