National Climate Impacts

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This project ended in 2001

Overview

To help prepare the nation for climate variability and change, the US Global Climate Research Program, in cooperation with the Office of Science and Technology Policy (OSTP), has engaged in a comprehensive planning effort to implement a national assessment process. These efforts began in early 1997 with a series of regional workshops, and have included a National Forum, intensive sessions of team leaders and advisory bodies, and extensive discussions among federal agencies, the science community, stakeholder communities, and the interagency committee for global change research. These efforts have contributed to the development of a comprehensive plan for the National Assessment to involve 20 regions, 5 sectors, and a synthesis, all led by teams of scientists, managers, and other stakeholders who are committed to understanding the nation's vulnerabilities and to identifying the most rewarding ways of responding to future change.

A Synthesis Report, as well as regional and sectoral volumes, will be published in January 2000. However, the National Assessment has been conceived as an ongoing process to continue beyond the publication of the first reports, eventually also dealing with other global change-related issues.

The National Assessment has been designed with a multi-pronged approach involving regions, sectors, and an overall synthesis. These different elements will provide perspectives from multiple scales and for different audiences.

Regional Assessments: 20 regional assessments will focus on the issues of most importance at the regional level across the United States. Each began with a scoping workshop involving an average of 100 regional participants in a dialogue about perspectives and priorities related to global change for that part of the country. Each workshop is being followed by a minimum of three activities: (1) quantitative analysis of 2-3 key issues; (2) continuous engagement of regional stakeholders; and (3) publication of a report in a common format. Many regional assessments will go beyond this scope in holding additional meetings or publishing multiple products for different audiences.

Sectoral Assessments: Sectoral assessments will focus on issues that are national in scope and related to the goods and services on which people, society, and the economy depend. The first phase of the assessment will focus on five sectors: agriculture, water, human health, forest, and coastal areas and marine resources.

National Synthesis: A Synthesis Report will integrate key findings from the regional and sectoral assessments and will address overarching questions related to implications over the next 25 and 100 years. The water resources assessment team, chaired by GLERL, will assess the impacts of the climate scenarios for the Upper Great Lakes region on the water resources sector.

2001 Plans

The results of model scenarios developed by applying perturbation differences and ratios to observed daily climate data will be complemented by another method. Daily data output from the general circulation models (GCMs) of climate will be adjusted by differences and ratios that bring the present values, on the mean, into agreement with observations. This method will carry the changes in mean of climate variables as simulated by the GCMs, and will also take account of changes in the temporal variability in those variables.

2001 Accomplishments

The spatial resolution of General Circulation models is quite coarse, they are unreliable in their representation of interannual variability on regional spatial scales, and even more unreliable with respect to accurately representing non-stationarity in the characteristics of their variability over time. Therefore, the idea of assessing the effects on Great Lakes Basin water resources of changes in climate variability due to increased greenhouse gases was set aside. 2001 was a year of reporting out. In addition to finalizing a lengthy journal article, conference papers were prepared and presented at the conferences of Societas Internationalis Limnologiae and the American Fisheries Society. Other presentations were at public meetings held in Chicago and Milwaukee by the Great Lakes Regional Assessment team, intended for an audience of policymakers and media representatives. The results of our study, showing reductions in mean lake levels over periods of several decades, coupled with the current shorter-term drop in lake levels, created much media attention, and Drs. Quinn and Lofgren were quoted in Time Magazine, Midwest Living Magazine, the Milwaukee Sentinel, the Chicago Tribune, and several other regional newspapers. This project is officially closed as of the end of FY 2001, but continued work on many of these questions is likely to be of interest to the International Joint Commission's Lake Ontario and Upper Great Lakes Studies.

2000 Plans

Hydrologic Scenario Development: Data on precipitation, air temperature, wind speed, cloud cover, and humidity will be taken from the GCM grid points and distributed on a 1 km grid throughout the Great Lakes basin and adjoining areas in Wisconsin and Minnesota. If monthly data is provided, a similar procedure will be applied as used in the 1980's EPA impact study and the recent IJC levels reference study. This procedure uses monthly ratios applied to existing climate data sets and allows the assessment of mean changes in the hydrologic variables but not changes in variability. These data sets will be applied to GLERL's Great lakes Advanced Hydrologic Prediction suite of models and ice cover models to assess impacts to Great Lakes water supplies, lake levels, ice cover, and tributary river flows. The 1 km data sets will also be provided to other sector teams for their studies.

Water Management Assessment: An assessment will be undertaken of the potential impacts of the changed climate on Great Lakes water management. Impacts on various stakeholders will be analyzed and potential options for future Great Lakes water management strategies for Lakes Superior and Ontario will be suggested. The Buffalo District US Army Corps of Engineers will serve as the lead for this effort.

Ground Water Supply Impacts: A study will be undertaken to assess the potential impacts of climate change on a municipality which draws it drinking water from groundwater

supplies. The city of Lansing, Michigan has been selected as the site to apply an evapotranspiration model along with the USGD Modflow model to determine impacts of changes in the groundwater table and aquifer storage due to the changes in precipitation and evapotranspiration and the potential problems that would cause the municipality. The USGS will serve as the lead for this effort.

2000 Accomplishments

Analysis of the annual-mean effects of greenhouse warming on Great Lakes Water Resources is complete. Portions of this project involved coordination with the Climate Impacts Group of Environment Canada, the Buffalo District of the U.S. Army Corps of Engineers, and the Lansing Office of the U.S. Geological Survey. Additionally, results from this work have been passed on to other research groups for their studies on possible impacts on lake-effect storms, lake ecosystems, lake shipping, and other dimensions of climate change impacts.

Analysis of seasonally-varying effects of greenhouse warming on Great Lakes Water Resources is nearly complete.

1999 Plans

An assessment of the climate change impacts in the Upper Great Lakes region on the water resources sector will be conducted as part of the ongoing National Assessment. The water resources assessment team, chaired by GLERL, will address the following major components.

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Water Management Assessment: An assessment will be undertaken of the potential impacts of the changed climate on Great Lakes water management. Impacts on various stakeholders will be analyzed and potential options for future Great Lakes water management strategies for Lakes Superior and Ontario will be suggested. The Buffalo District COE will serve as the lead for this effort.

FY 1999 Accomplishments

As part of the U.S. National Climate Change Assessment, estimates were made of changes in net basin water supply (precipitation plus runoff minus lake evaporation) for the drainage basin of the Laurentian Great Lakes due to the influence of increased greenhouse gases. Data generated by general circulation models from the Canadian Climate Centre, CGCM1,

and the Hadley Centre, HadCM2, were used to make adjustments to observed data for temperature, precipitation, cloud cover, relative humidity, and wind speed. The adjusted and unadjusted data were then used to drive a system of rainfall/runoff, lake evaporation, hydrologic routing, and water management models for the Great Lakes system to assess hydrologic and water management changes. The HadCM2 scenarios are seen to be much wetter and cooler than those derived from the CGCM1 The climate scenarios presented here depict a wide range in levels and flows for the Great Lakes in the 21st century. The CGCM1's drier, warmer climate indicates a major lowering of water levels over the next 30-90 years. Flows in the connecting channels are reduced by from 25 - 33% relative to the base period. Possibly the most notable difference between these results and previous climate change studies is the timing of the change in lake levels and connecting channel flows. Most of the other recent studies looked at the impact on the basin of a doubling of carbon dioxide in the atmosphere (Mortsch and Quinn, 1996; Chou,1999). This study predicts similarly dramatic declines in water levels and flows as soon as 2030, at least according to the CGCM1 model.

A much different future is portrayed by the HadCM2 scenarios. The model predicts a slightly warmer and wetter climate that results in higher lake levels and slightly higher connecting channel flows as compared to the 1954-1995 base period. Since the high water levels of 1985-86 set records on all the lakes, approximately 30-80 centimeters above average, the effects of high water levels are still very fresh in our collective memory. The higher levels predicted by the HadCM2 are well within this range.

An interest-based regulation model developed for Lake Ontario and the St. Lawrence River (Eberhardt, 1994) was run on all five climate scenarios examined here (4 climate scenarios plus the Base). The model uses ten interest-satisfaction relationships and attempts to maximize the collective satisfaction of all interests that use the resource, thus determining the optimum outflow for Lake Ontario. The interest-based model failed on all of the CGCM1 model scenarios because none met the minimal requirements for hydropower. The model was able to evaluate the wet conditions forecast by the HadCM2. Although the levels are high, causing difficulties for most interests, the satisfaction values are fairly acceptable for the 2030 scenario. The satisfaction values are averages over the entire 42-year period (compared to a base of 1954-1995). Extremely high levels were experienced for just a few of those 42 years; the discomfort felt by riparians was offset by the high satisfaction scores of the hydropower and commercial shipping sectors. The model failed for the 2090 scenario due to excessively high supplies.

These research results are documented in a 5 page summary which will be part of a report to congress and 1 proceedings paper for the AMS which is listed in the publications section of the report.

Products

Publications

Mortsch, L., H. Hengeveld, M. Lister, B. Lofgren, F. Quinn, M. Slivitsky, and L. Wenger, 2000: Climate change impacts on the hydrology of the Great Lakes–St. Lawrence system. *Canadian Wat. Resour. J*., 25, 153-179.

Lofgren, B. M., F. H. Quinn, A. H. Clites, R. A. Assel, A. J. Eberhardt, and C. L. Luukkonen, 2001: Climate change impacts on Great Lakes Basin water resources. *J. Great Lakes Research*, in press.

Croley, T. E., II, F. H. Quinn, K. E., Kunkel, and S. J. Changnon, 1998. Great Lakes Hydrology Under Transposed Climates, *Climatic Change* 38:405-433.

Kunkel, K. E., S. J. Changnon, T. E. Croley II, and F. H. Quinn, 1998. Transposed climates for study of water supply variability on the Laurentian Great Lakes, *Climatic Change* 38: 387-404.

Quinn, F.H., Croley, T.E., Kunkel,K. and S.J. Changnon. 1997. Laurention Great Lakes Hydrology and Lake Levels under the Transposed 1993 Mississippi Flood Climate. *J. Great Lakes Res*. 23(3):317-327

Lee, D.H., T.E. Croley and F.H. Quinn. 1997. Lake Ontario Regulation Under Transposed Climates,*Water Resources Bulletin*, 33(1), 55-69

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Lofgren, B. M., F. H. Quinn, A. H. Clites, R. A. Assel, and A. J. Eberhardt, 2000: Water resources. Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change, P. Sousounis, ed. University of Michigan, Atmospheric and Oceanic Space Sciences Dept., Ann Arbor, Michigan, 29-37.

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Quinn, F. H., and B. M. Lofgren, 2000: The influence of potential greenhouse warming on Great Lakes hydrology, water levels, and water management. Proceedings, 15th Conference on Hydrology, American Meteorological Society Annual Meeting, Long Beach, CA, 9-14 January, 2000, 271-274.

Quinn, F. H. 1999. The potential impacts of climate change on Great Lakes water resources, a review. Proceedings, Specialty Conference on Potential Consequences of Climate Variability and Change to Water Resources of the United States. American Water Resources Association. 311-314, Atlanta Georgia.

Quinn, F.H. 1998. The Impacts of Recent Climate Change on the Hydrology and Water Resources of the Laurentian Great Lakes. Proceedings of The Second International Conference on Climate and Water. Espoo, Finland. 17-20 August 1998. 729-737.

Quinn, F. H., and L. D. Mortsch, 1997. Assessing potential impacts of climate change and variability on the Great Lakes-St. Lawrence Basin; a binational approach. Paper 97-Ta121.01, Proceedings of the Air and Waste Management Association's 90th Annual Meeting, Toronto, Ontario, June 8-13.

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Quinn, F. H., and B. M. Lofgren, 2001: Assessment of climate change effects on Laurentian Great Lakes water resources. Societas Internationalis Limnologiae XXVIII Congress, Melbourne, Australia, 4-10 February 2001.

Lofgren, B. M., 2001: What could happen to Great Lakes levels over many years?. Great Lakes Water Levels Workshop, US Environmental Protection Agency, Chicago, IL, 30 March 2001.

Quinn, F. H., 2001: Great Lakes water management under a changed climate. Great Lakes Water Levels Workshop, US Environmental Protection Agency, Chicago, IL, 30 March 2001.

Sousounis, P. J., and B. M. Lofgren, 2001: How will climate change affect weather patterns and lake levels in the Great Lakes region? Climate Change and Water Ecology Workshop, US Environmental Protection Agency, Milwaukee, WI, 15 June 2001.

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