Lake Champlain – Richelieu River Flood Study

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Extended Abstract

The Lake Champlain-Richelieu River (LCRR) basin is a large international watershed in southern Québec and northern New York and Vermont. It is a geographically diverse basin which covers an area of about 9,277 square miles, and has a deep lake surrounded by the Adirondack Mountains to the west and the Green Mountains to the east. About 84 percent of the basin is in northeastern New York and northwestern Vermont, and 16 percent is in Québec. The total population of the basin is about 1,015,000. The basin is very vulnerable to flooding, with major floods occurring in 1927, 1976, 1983, 1993, 1998 and 2011. A combination of topography and climate makes the LCRR basin naturally prone to extended periods of flooding. The steep mountain slopes of the upper basin, high winter snowfall amounts, the flow regime of the upper Richelieu River, strong winds and large waves, and the frequency of heavy spring rainfall are all key drivers of flooding in this basin. The spring snowmelt is the dominant hydrological event of the year, when nearly one-half of the annual streamflow can occur within an eight-week period. There are also instances of severe summer and fall floods, though these are more likely to be shorter flood events driven by individual storms or sets of storms rather than the longer-duration floods that typically occur in the spring. The primary hydraulic control for the watershed is the Saint-Jean shoal, which is located in a narrow section of the Richelieu River downstream of Lake Champlain. This shoal has been modified over time by adding additional fill material, further constricting the flows. The Chambly Canal is another key structure that was built downstream of Lake Champlain to facilitate navigation past a series of downstream rapids.

In the spring of 2011, the region experienced flooding well beyond anything experienced in the almost 200 years that records have been maintained. This flooding was primarily due to a combination of an above normal snowpack, and warm spring rains. Lake Champlain's water levels reached 102.5 feet above sea level, exceeding the previous historical maximum level of 101.3 feet. The Richelieu River rose above flood stage for more than two months. Many farms, and an estimated 4,000 homes along the Richelieu River in Québec, and along the shoreline of Lake Champlain were damaged. More than 40 communities were directly affected, and thousands of residents needed to be evacuated. Flood damages were estimated at more than $141 million, with almost 80% of the damages occurring in Canada, and 20% in the United States.

The catastrophic 2011 flood prompted the governments of Canada and the United States to investigate ways to mitigate the flooding issues. They worked through the International Joint Commission (IJC), which is responsible for approving projects that affect water levels and flows across the border between the U.S. and Canada, and for investigating transboundary issues and recommending solutions. In the spring of 2012, the governments of Canada and the United States asked the IJC to draft a plan of study to examine the causes and impacts of the 2011 flooding and develop possible mitigation measures. Subsequent mandates led to the development of tools and static floodplain maps, and the establishment in 2016 of the Lake Champlain – Richelieu River Study Board, which oversaw the LCRR Flood Study. This study was an international collaboration involving more than 100 individuals with a wide range of expertise. There was also extensive involvement of the public throughout the study, and review

by an independent review group. The study work included activities such as collecting data, developing tools, and creating static floodplain maps. A final report documenting the study was completed in August 2022.

Study Approach

A study framework was adopted that considered two primary goals and four themes. The first goal was focused on reducing the impacts of flooding by reducing high water levels. This considered moderate structural measures (Theme 1), or watershed storage options (such as enhancing wetlands) to reduce inflows to the lake (Theme 2). It should be noted that the IJC directed the LCRR Study board not to consider major structural works such as damming of the river, and instead to focus on "moderate structural works." These moderate structural measures included things like constructing weirs, excavating shoals, and diverting water through a canal. The second goal was focused on reducing vulnerability to high water levels and building flood resiliency through improved flood response (Theme 3) and floodplain management (Theme 4). Climate change and assessing the social, economic, and political acceptability of potential recommendations were also key considerations of the study.

Several innovative tools and approaches were developed and applied in the study. These included high-resolution modeling and advanced information technology. Specific tools developed include a new: (1) digital elevation model, (2) hydrologic model, (3) two-dimensional hydrodynamic model, (4) water balance model, (5) integrated social, economic, and environmental system, and (6) collaborative decision support tool.

Recommendations

The LCRR Study Board made many recommendations for actions that could be taken to mitigate the flooding issues. These are summarized below based on the four major themes of the study, and on the topic of climate change.

Theme 1 (Structural Measures)

It was determined that a modest amount of flood reduction could be achieved by returning the hydraulic conditions at the Saint-Jean shoal to a more naturalized state. This would be on the order of 4 inches on Lake Champlain, and 6 inches on the Richelieu River downstream of Lake Champlain (at Saint-Jean-sur-Richelieu) for an event like the spring 2011 flood. Drought water levels could also be improved. This could be achieved by removing some flow-impeding fill materials, in addition to selectively excavating the shoal that constricts the river, and by installing a submerged weir in the area upstream of the shoal. It is estimated that this would reduce the average annual flood damages by about $2.5 million. If desired, additional flood reduction could be achieved by also making modest water diversions through the Chambly Canal. This additional measure would lead to a total peak water level reduction of 6 inches on Lake Champlain, and almost 8 inches on the river downstream of Lake Champlain for an event like the 2011 flood. It is estimated that this would reduce the average annual flood damages by an additional $200,000 (for a total annual flood reduction of $2.7 million). It was also recommended that the IJC encourage the governments to implement a binational governance mechanism to oversee the implementation and operation of any structural solution the governments may decide to pursue.

Theme 2 (Watershed Storage)

It was determined that a modest amount of flood reduction can also be achieved by continuing to protect existing wetlands along Lake Champlain and the Richelieu River. These wetlands are estimated to reduce the peak water level by 6 inches on Lake Champlain, and 5 inches on the Richelieu River for an event like the spring 2011 flood. It was also determined that without creating a very large area (250 square miles or greater) of new wetlands, there cannot be significant additional flood reduction along the shoreline of Lake Champlain and the Richelieu River during major flood events. Therefore, it was recommended not to pursue a new strategy for acquiring land and creating new wetlands as a way to reduce flooding. However, it was recognized that wetlands reduce local tributary flooding, support biodiversity, and have other important environmental benefits. Consequently, the governments were encouraged to not only continue to protect existing wetlands, but also to restore wetlands and create new ones where possible.

Theme 3 (Flood Response)

It was recommended that all of the weather and hydrological information generated by the agencies responsible for flood forecasting (National Oceanic and Atmospheric Administration (NOAA, in the US) and Environment and Climate Change Canada (ECCC) and the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC, in Canada), be made available to and used by the respective agencies responsible for the production and dissemination of flood forecast, guidance and warnings. It was also recommended that collaboration between these agencies continue to be enhanced so that all available forecast data and related information are shared in real time operations. The goal of this is to ensure that the official forecasts on each side of the border are of the highest possible quality, and are well coordinated.

It was also recommended that improved modeling and forecasting tools developed during the LCRR Flood Study should continue to be maintained, because they can greatly aid flood response planning. They could possibly extend the forecasting horizon, and provide new products that could be beneficial to the basin stakeholders. This includes data on water set-up, wave, flood extent and depth, and their consequences. This information could be used to determine things like road closures, social vulnerabilities, and economic impacts. The governments were also encouraged to incorporate the improved modeling, forecasting, and risk assessment tools into their ongoing operations by March 2023 if possible. The LCRR tools, supporting data and documentation should be transferred to appropriate agencies in Canada and the US by no later than March 2023. Finally, it was recommended that simulations of various flood scenarios and related maps produced during the study be made available to basin stakeholders by March 2023 in order to support flood preparedness.

Theme 4 (Floodplain Management)

It was recommended that the governments be encouraged to make the best use of the LCRR Flood Study's analysis of best practices related to flood risk mapping, risk communication, floodplain management, and flood insurance. These practices include: (1) enhancing flood risk mapping for targeted audiences (including updating and adding more details to existing flood risk maps), (2) developing flood risk communication campaigns designed for specific target

audiences within the basin, (3) considering floodplain occupancy in terms of resiliency (including land use strategies that avoid, accommodate and retreat from flooded areas, updating and strengthening the enforcement of land use regulations based on flood risk, and restricting development in high-risk flood zones), and (4) exploring and/or expanding flood insurance (including further investigation of the state of flood insurance in the watershed and promoting an insurance arrangement that shares financial liability for flood damages). Finally, it was recommended that the governments be advised that the benefits of flood water level reductions should be maintained with adaptive land use planning and floodplain management, particularly constraining land use in areas protected by structural solutions and potentially reconnecting floodplains.

This presentation will describe the study process, the new models and tools that were developed to evaluate flood mitigation measures, and the key conclusions and recommendations.

References

International Lake Champlain and Richelieu River Study Board (ILCRRSB), 2022. Lake Champlain-Richelieu River Flood Study Final Report. International Lake Champlain - Richelieu River Study. A Report to the International Joint Commission.