Lake Champlain-Richelieu River Basin
Understanding past floods to prepare for the future

WHAT YOU NEED TO KNOW

International Lake Champlain-Richelieu River Study Board

March 2020

MAKING DECISIONS TO PREPARE FOR FUTURE FLOODING

The record-setting spring 2011 flood in the Lake Champlain-Richelieu River basin was a call to action. What can be done to prepare for and reduce flooding in the future? This is a question for state, provincial, and national governments in Canada and the United States, as well as for the communities affected by flooding.

- Should physical structures such as weirs and channel improvements be built to control the flow of water in the lake and river?
- Are better forecasts needed to predict when and where floods will occur?
- Would flood response plans help communities better prepare for floods?
- Would natural approaches, such as restoration of wetlands, be useful in reducing flooding?
- Should measures be taken to discourage further development in areas vulnerable to flooding?

To determine the best approaches, communities and governments need to understand the causes of floods and the impact they have on people and the environment.

This booklet contains highlights from the report *The Causes and Impacts of Past Floods in the Lake Champlain-Richelieu River Basin*, released by the International Lake Champlain-Richelieu River Study Board in February 2020.

It is intended to share key findings from the report to build public awareness of these issues.

Read the full report, available from ijc.org/en/lcrr

INTERNATIONAL LAKE CHAMPLAIN-RICHELIEU RIVER STUDY

The Lake Champlain-Richelieu River basin spans 23,900 square kilometres or 9,277 square miles. About 84% of the basin is in northeastern New York and northwestern Vermont, in the United States, and 16% is in Quebec, Canada.

To more fully explore the causes, impacts, risks, and solutions to flooding in this basin, the Canadian and US governments asked the International Joint Commission in 2016 to conduct a long-term study, and in 2017 the study was launched.
The primary focus of the study is to investigate measures to reduce the impacts of flooding in the future. However, there is a lack of data to help governments and communities understand the causes and impacts of flooding and the costs. An additional focus of the study is to fill these gaps in data. The study will issue its final recommendations in 2022. It is governed by a study board of US and Canadian experts, and it includes a public advisory group. Public engagement, including engagement of Indigenous Peoples in the basin, are important components of the study. Such engagement helps to ensure that organizations and individuals in the basin better understand the study's objectives and activities and have an opportunity to provide feedback.

INTERNATIONAL JOINT COMMISSION

Canada and the United States created the International Joint Commission because they recognized that each country is affected by the other's actions in lake and river systems along the border. The two countries cooperate to manage these waters and to protect them for the benefit of today's citizens and future generations. The IJC approves projects that affect water levels and flows across the boundary, and it investigates transboundary issues and recommends solutions.

For more information, visit ijc.org/en/lcrr

2011 LAKE CHAMPLAIN-RICHELIEU RIVER FLOOD

In the spring of 2011, the Lake Champlain-Richelieu River basin experienced the worst flooding ever recorded – shattering records for the past 100 years.

Damage to homes, businesses, and farms due to flooding has been estimated at more than US$82 million (all figures in US 2018 dollars), with damage being greatest in Quebec:

- more than $67 million in Quebec
- more than $11 million in New York
- more than $4 million in Vermont

People living in the basin in both Canada and the US had to cope with this damage as well as displacement and disruption of their lives.

The flood also had serious repercussions for the environment, altering the habitat of some species at risk, disrupting natural food chains, and spreading invasive species.

CAUSES

Why did the flood have such unprecedented, wide-ranging impacts? The report finds that several factors combined to produce extreme flooding.

Flooding in Saint-Jean-sur-Richelieu in May 2011
Credit: Ville de Saint-Jean-sur-Richelieu

Flooded agricultural field in Vermont - Spring 2011
Credit: Lake Champlain Basin Program

SNOW

During the winter, snow accumulated in the high terrain of the Adirondack Mountains in New York and the Green Mountains in Vermont. A heavy snowpack, coupled with warm rains, rapidly added large volumes of water to Lake Champlain in the spring. In early 2011, the snowpack was at record levels, because snowfall had been the third highest total since 1883.

TEMPERATURE

The mean monthly temperatures from February to June were at or above average, leading to rapid melt of the snowpack in the mountains.

PRECIPITATION

Record-breaking precipitation continued into the spring, with rainfall in March 46% above normal levels of 5.9 centimeters (2.3 inches), in April 174% above normal levels of 7.3 centimeters (2.9 inches), and in May 213% above normal levels of 7.0 centimeters (2.8 inches). In total, 51 centimetres (20 inches) of precipitation fell in these three months.

WIND

Strong and persistent winds from the south caused water levels to rise at the north end of the lake and become lower at the south end. This caused waves that eroded shorelines along Lake Champlain. When winds died down, standing waves rocked back and forth from end to end of the lake, a phenomenon called “seiche.” During a 67-day flood period in spring 2011, there were eight separate wind events that pushed up the northern lake elevation by 7.6 to 21.3 centimeters (3 to 8.4 in).

GEOGRAPHY

The huge volume of water in Lake Champlain drains through the narrow Richelieu River, which is shallow at the outlet of the lake. The Richelieu River only drops 0.3 meters (about 1 foot) over its first 37 kilometers (23 miles). Thus, the record high lake levels in spring 2011 quickly led to flood levels in the river, and river flooding persisted for weeks as the lake slowly drained.

Richelieu River near Saint-Jean-sur-Richelieu
Credit: Environment and Climate Change Canada

ALTERATIONS

Humans have raised water levels in the lake and river by changing the Richelieu River and the use of land around both the lake and river. The Chambly Canal opened in 1843 alongside the Richelieu River to allow boats to bypass rapids near Saint-Jean-sur-Richelieu. It was widened from 1970 to 1973. Earlier IJC studies estimated that widening the canal caused an increase in Lake Champlain water levels between 3 and 10 centimeters (1.2 to 4 inches). A more recent study found that canal widening is responsible for half of the 30 centimeter (nearly 1 foot) increase in the lake level since the 1970s. The remainder of the rise in lake level is due to increased rainfall. In addition to the canal, other structures have affected the flow of the Richelieu River such as “eel cribs” (to catch eels) and bridge piers that intrude on the river.

Over the years, many wetlands that would have held floodwaters were drained for farming or filled for buildings and roads. Streams flowing into Lake Champlain were straightened and dredged, causing the water to flow more rapidly and forcefully. Berms were built along rivers to prevent them from overflowing. This eliminated many floodplains that used to take up floodwaters. Towns built near the lake and river contribute to flooding, as rainwater flows over asphalt and concrete instead of being absorbed by the soil.

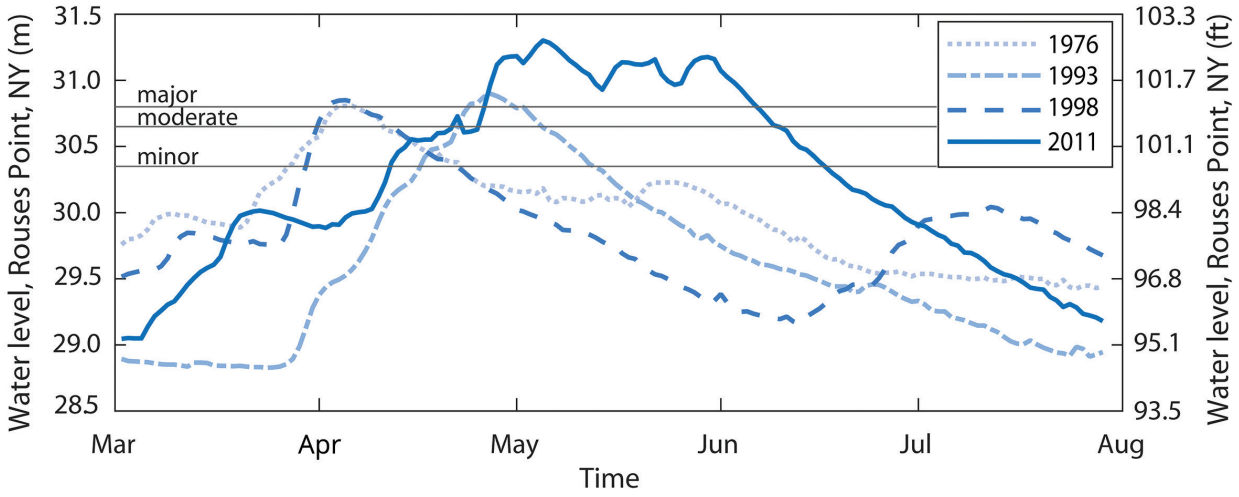
FUTURE FLOODING

What is the risk that a "flood of the century" could happen again?

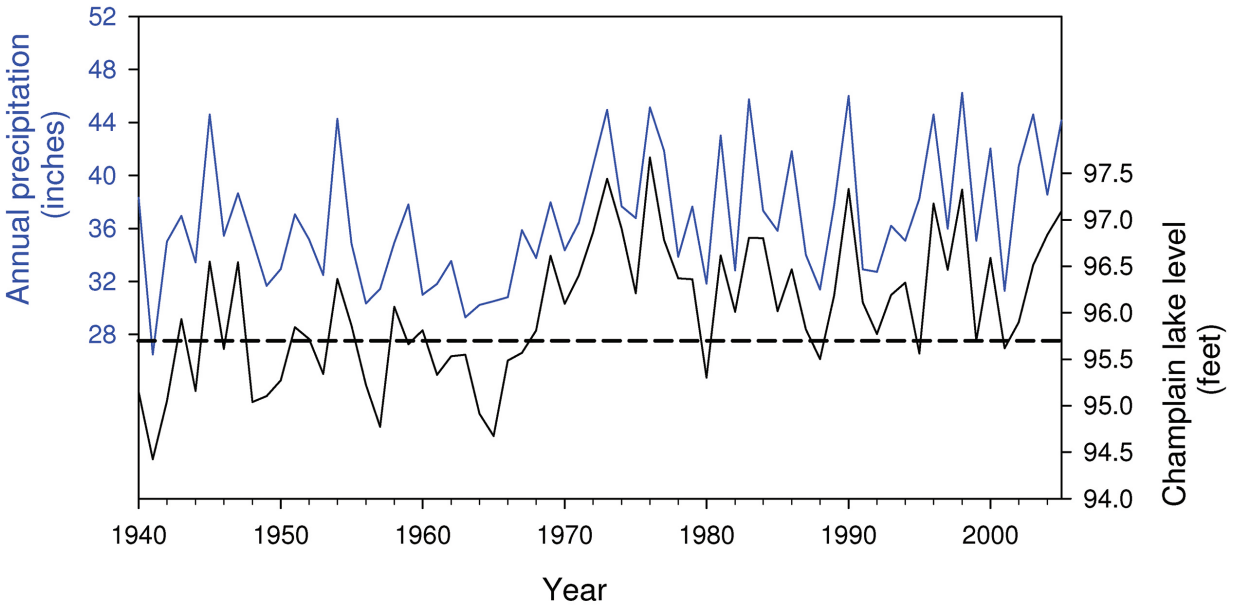
Seven of the 10 highest lake levels ever recorded have occurred since 1975. Most of these floods were caused by heavy precipitation and snowmelt in the spring, like the spring flood of 2011. However, some floods –such as the infamous 1927 flood and the August 2011 flood – were caused by tropical storms later in the year.

The levels of Lake Champlain rise and fall with annual precipitation, as can be seen in the graph. The lake has risen above its long term average level (dotted line) since the 1970s. In fact, studies show that temperatures have warmed and precipitation has increased in the basin over the last century. These trends show why action is urgently needed to proactively plan and take action to mitigate changing weather patterns and alterations on the land in order to minimize the impacts of future flooding.

Floods reaching major flood level, Lake Champlain from 1976 to 2011



Precipitation and mean lake levels of Lake Champlain since 1940.
Source : Stager and Thill (2010)



Impacts: The spring 2011 flood was a "flood of the century," demonstrating the many effects of severe flooding.

HOMES & MORE

Homes, other buildings, and roads were flooded. About 1,310 homes were damaged in New York and Vermont, and more than 2,500 in Quebec. It is estimated that more than 100 bridges and roads were damaged in Quebec. Flooding in the basin led to the inundation of low-lying roads, causing transportation disruption and isolating or threatening to isolate individuals and some communities.

AGRICULTURE

Much of the area bordering Lake Champlain and the Richelieu River is farmland. Many crops were lost directly because of the long duration of flooding, and crop yields were down because of heavy rains. In New York and Vermont, 7,740 hectares or 19,000 acres were affected, and in Quebec, more than 2,500 hectares or 6,177 acres were flooded.

BUSINESS

Many businesses were impacted, with campgrounds and marinas most affected. In Quebec, ten of the 18 marinas suffered losses of about $2.6 million CAN in material damages and more than $7.4 million CAN in revenue losses. Five of the ten marinas surveyed experienced losses between 20 and 50 percent of their normal revenues.

EROSION

Flooding and high waves eroded shorelines in areas not usually exposed to water. Aerial photos show large sediment plumes near many shorelines. Erosion was worst where there were steep banks with little vegetation, lawns extending to the shore, or an adjacent sea wall.

Shoreline erosion at Isle La Motte, Vermont, in spring 2011
Credit: Lake Champlain Basin Program

SECURITY

Over forty communities were directly affected by the spring 2011 flood. More than 1,600 residents were forced to evacuate in Quebec, and the American Red Cross provided emergency response aid to flood evacuees in New York and Vermont. People faced health risks from mold in wet buildings and dangerous electrical hazards. In many areas, drinking water was contaminated. Quebec drinking water suppliers had to increase their treatment efforts to ensure safe water. Health authorities in Vermont and New York issued boil-water advisories that affected thousands of shoreline residents and businesses. While the flood did not result in any deaths, stress due to displacement and losses of homes, farms, and businesses affected many residents.

ENVIRONMENT

The Lake Champlain-Richelieu River basin is home to many plant, fish and wildlife species, including several species at risk, such as the copper redhorse (an endangered fish) and the Eastern spiny softshell turtle. While ecosystems in the basin are adapted to occasional floods, extreme flooding like that in spring 2011 can alter or even destroy spawning grounds for fish and nesting sites for marsh birds and turtles. Fish became trapped in pools created by the flood. Unable to return to streams, rivers or the lake, many fish died. The flood upset the normal food cycle, and spread invasive species, including fish (alewives) and plants (phragmites, purple loosestrife, Japanese knotweed, Eurasian watermilfoil, curly leaf pondweed, and water chestnut). Eroded sediment and phosphorus runoff from fields later caused large blooms of dangerous cyanobacteria in Lake Champlain.

WHAT OPTIONS EXIST TO PREPARE FOR AND RESPOND TO FLOODS?

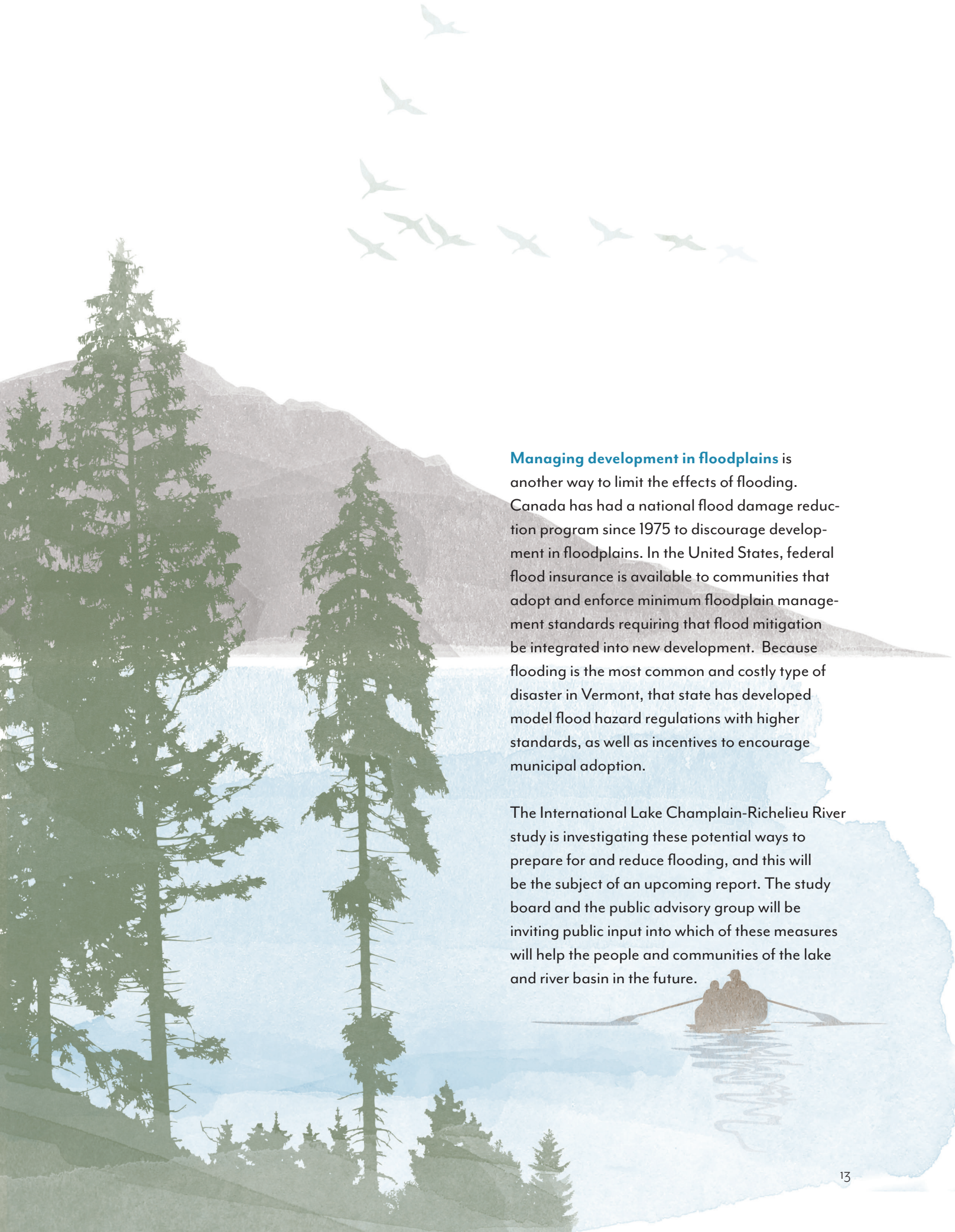
Over the past 100 years, many methods to reduce or cope with flooding have been discussed, but the spring 2011 flood was a wake up call to increase our preparation for future flooding.

Structures to regulate water flow, such as dams and weirs, were recommended after past severe floods. A dam was built during the 1930s in the Richelieu River at Fryer Island just downstream of Saint-Jean-sur-Richelieu. However, the dam was never operated or used to regulate water flow.

A gated structure on the Richelieu River to control flow in the basin was recommended by a body of the IJC in 1975 but due to environmental concerns no public consensus was reached.

Flood retention using "nature-based" approaches to store water in natural areas before it enters the lake or river has also been considered and, in some places, implemented, but to a limited extent. These approaches include reforesting areas, restoring wetlands, building water-retention ponds, and using farmland to store flood water temporarily. Vermont and New York state governments and the US federal government provide technical help and funding to restore damaged wetlands and protect existing wetlands from conversion. The Quebec government passed a law in 2017 requiring no further net loss of wetlands.

With today's weather technology and research, sophisticated systems for **flood forecasting**, warning, and response are possible. The idea is to forecast the flood and issue warnings in advance, so that residents can prepare. Many communities in the floodplain have plans in place to respond to floods, but with current information, are not able to effectively prepare for them. Improved forecasts would enable communities not only to respond, but to plan and prepare effectively. During public consultations in 2018, residents were interested in having tiered flood-danger levels, with suggested actions for each level of danger. They also mentioned that unreliable telephone and Internet service in many rural areas must be taken into account in planning emergency responses.



Managing development in floodplains is another way to limit the effects of flooding. Canada has had a national flood damage reduction program since 1975 to discourage development in floodplains. In the United States, federal flood insurance is available to communities that adopt and enforce minimum floodplain management standards requiring that flood mitigation be integrated into new development. Because flooding is the most common and costly type of disaster in Vermont, that state has developed model flood hazard regulations with higher standards, as well as incentives to encourage municipal adoption.

The International Lake Champlain-Richelieu River study is investigating these potential ways to prepare for and reduce flooding, and this will be the subject of an upcoming report. The study board and the public advisory group will be inviting public input into which of these measures will help the people and communities of the lake and river basin in the future.

INTERNATIONAL
LAKE CHAMPLAIN-RICHELIEU
RIVER STUDY BOARD

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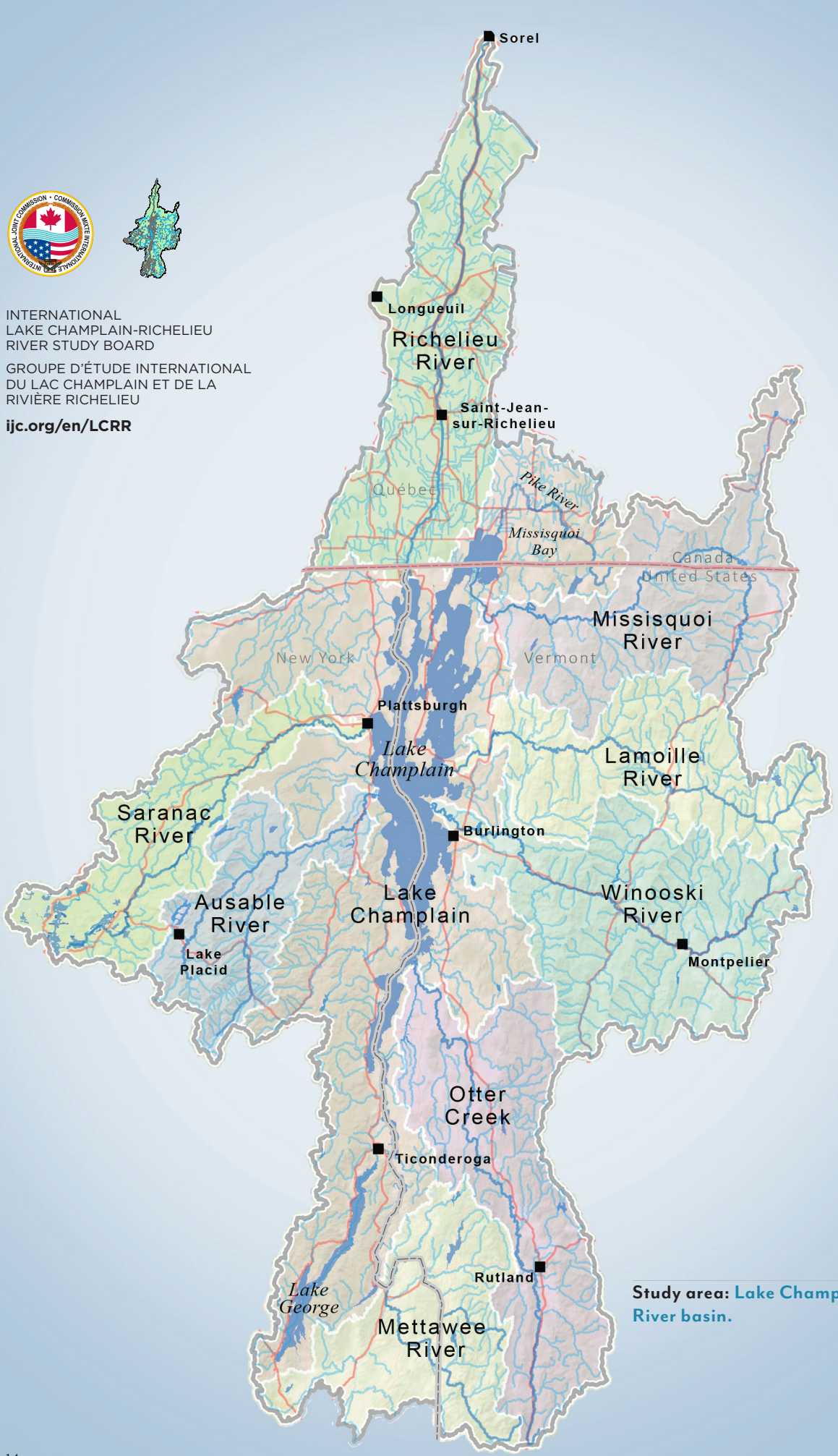

Study area: Lake Champlain-Richelieu River basin.

STAY CONNECTED. BE ENGAGED.

The IJC is committed to engaging the public during the study through:

- public and stakeholder outreach meetings
- news, fact sheets and updates on its website ijc.org/en/lcrr
- an electronic bi-monthly newsletter, the Current

WANT TO STAY CONNECTED?
Do you have a question for the Lake Champlain-Richelieu River Study Board? Email us at lcrr@ijc.org and we'll do our best to answer it.

ONLINE
Visit us at ijc.org/en/lcrr and sign up to receive study news, such as notices of public meetings, reports, fact sheets, and other publications

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