

# A Current Issue: Erosion of the Banks of the St. Lawrence

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### SUMMARY

Since 1998, Environment Canada has been monitoring the erosion of the banks of the St. Lawrence between Lake Saint-Louis and Lake Saint-Pierre. Wave action from passing ships was a well known influencing factor. Now, new factors such as freeze-thaw cycles and the deflocculation of marine clays have turned out to be very important. It looks as if fluctuations of water levels in the river play a determining role in amplifying or reducing the influence of these three factors.

### INTRODUCTION

#### Riverbank erosion: A natural phenomenon influenced by human action

Erosion of the riverbanks comes from the action of many physical, chemical and biological factors, which sometimes act simultaneously. Table 1 summarizes the principal causes of this erosion.

Previous studies have estimated that 440-km of the total 1600-km shoreline of the freshwater St. Lawrence are eroding.



Verchères Station showing caved-in banks in spring

Tableau 1. Principaux facteurs de l'érosion des berges dans le secteur fluvial

#### Naturally Occurring Factors

- Currents (flow)
- High waves produced during storms
- Water runoff due to storm surges or snow melt
- The nature of the soil and the slope of the riverbank
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- Ice movement in spring
- Freeze-thaw cycles

#### Factors linked to human activities

- Variations in the water level caused by water control structures (dams, embankments, canals, etc.)
- Deforestation of the shorelines
- Impact of the wakes of ships and pleasure craft
- Agriculture, livestock grazing and ploughing close to riverbanks

Table 1. Principal factors causing erosion of riverbanks in the fluvial sector

### HOW DO SOME OF THESE FACTORS IMPACT EROSION ?

#### Deflocculation

The soils in the study sector comprise clays from the Champlain Sea. When these clays are dried, they become very hard and cracked. Then, when they are rehydrated, the blocks of clay break into tiny clay flakes.



T=0 T=60 min T=90 min

#### Deflocculation of a block of clay in the presence of fresh water of the St. Lawrence

#### Freeze-thaw cycles (gelifraction)

Processes linked to freezing (cryogenic processes) as well as the freeze-thaw cycles (gelifraction) are important factors causing erosion, mainly in fall and spring. In fall, freezing creates polyhedrons, which fall to the base of clay cliffs.

In spring, when temperatures rise, water flows into cracks in the clay face. When the temperature drops, ice forms in the cracks. This process hollows out the clay face and creates overhangs that collapse. The face is left smooth and vertical (gelifraction).



Riverbank face smoothed by gelifraction on Varennes Islands

#### Wakes of passing ships and boats

Wakes caused by shipping are often considered to be one of the main causes of riverbank erosion. Studies of the force of the waves and currents after ships have passed show that the speed of currents increases from 20 cm/s to close to 100 cm/s. In certain cases, in addition to the increase in current, breakers beat on the banks. Results of tests undertaken in tanks show that the clay from the Champlain Sea resists the increase in speed rather well, but it is much less resistant to the breakers hitting the banks. It should be noted that when the water level is very low, waves do not reach the river's banks. A voluntary speed reduction program has been applied since fall 2000 by the shipping industry



The action of waves from passing boats on the banks of Verchères Islands.

#### Water levels

Fluctuations in water levels have a great influence on the three factors mentioned above. If low water levels are prolonged, clay dries and can disaggregate; on the other hand, waves from ships do not reach the banks. The freeze-thaw cycles have a greater impact when water levels are low, because the emerged part is more exposed to bad weather.

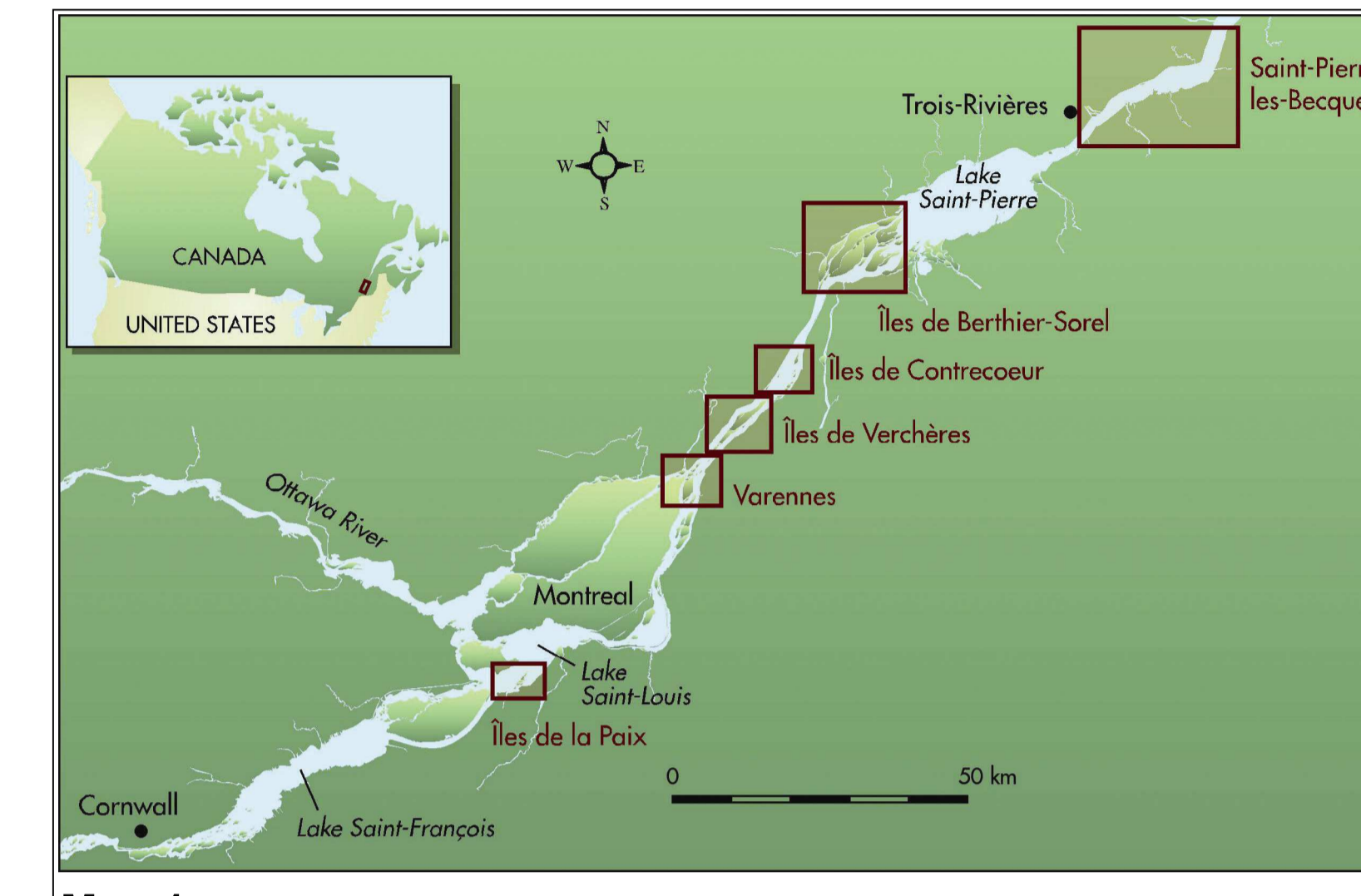
When water levels remain high, submerged clays do not deflocculate because they have not dried. However, waves from ships reach and erode the banks. Freeze-thaw cycles only impact above the frost line, and gelifraction is less severe when water levels are higher.



Surface soils collapse after gelifraction of clay faces

#### Methodology

- More than 100 measuring stations spread out along five sectors of the St. Lawrence between Lake Saint-Louis and Saint-Pierre-Becquets are visited by Environment Canada and the ZIP (area of prime concern) committees (see map 1).
- Three visits are made each year: one in April after the ice has melted; a second in August; and a third in November, just before freeze up.
- These allow identification of the causes (wave action from passing ships, freeze-thaw cycles, variation in the water level and other factors).
- Explanatory panels have been installed for people who live along the river and those who use the islands.



Map 1 Location of study sectors

#### Results

Annual results obtained from 58 stations since 1998 show that riverbanks in the study sectors have undergone more erosion in 2006–2007 than in any other year monitored (see Figure 1); in all sectors of the river, the rate of retreat of the riverbanks has doubled at the majority of stations. Some sectors, such as the navigation channels for pleasure boats at Berthier-Sorel, where erosion is normally minimal have also seen their banks recede.

Winter erosion (from November to April) represents two-thirds of all erosion recorded over the past two years of study. In 2005–2006, the rate of erosion was the same throughout the year.

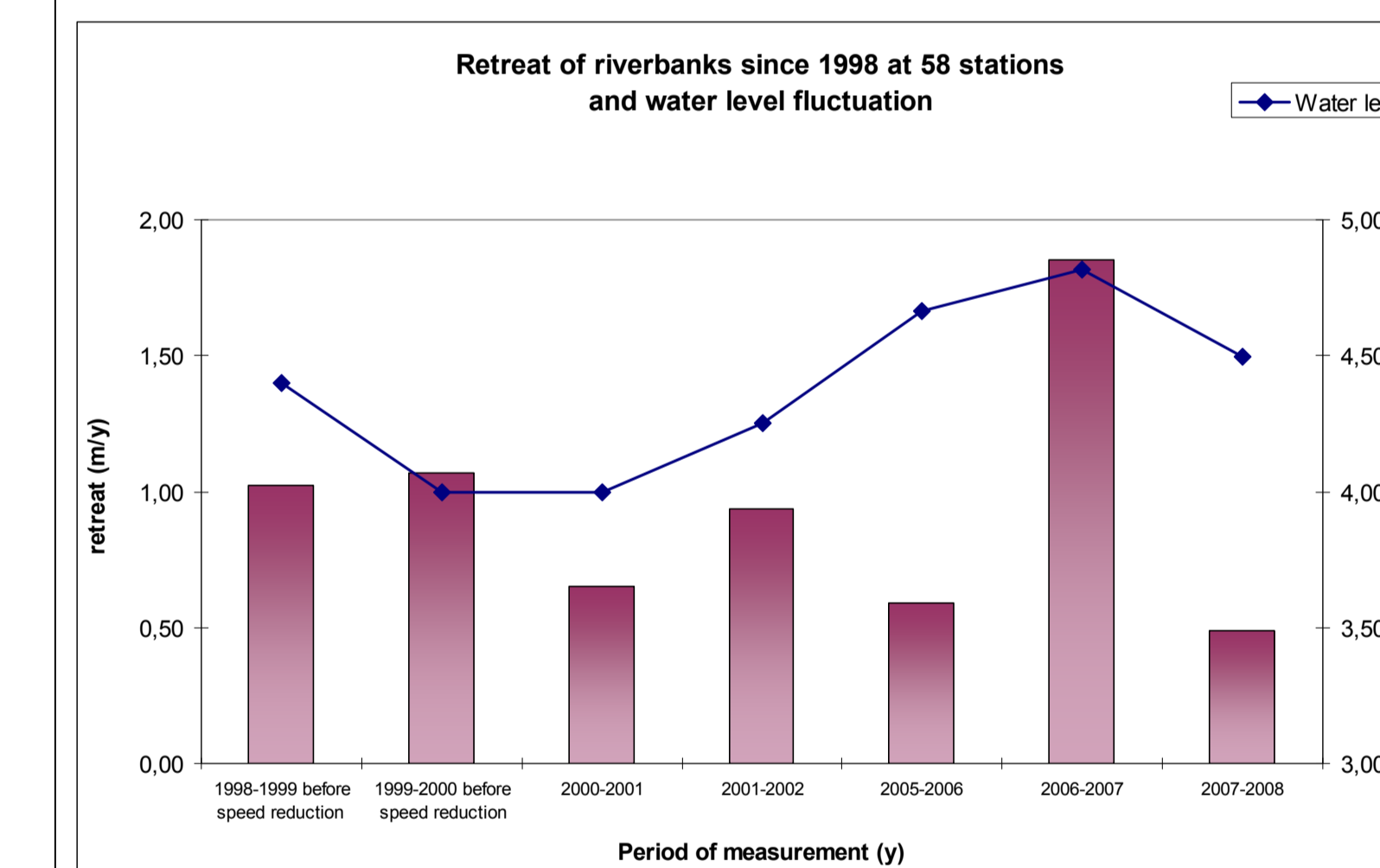


Figure 1. Retreat of riverbanks and average water levels

#### Discussion

##### What happened?

Measurements of the retreat of the riverbanks at different periods of the year have clarified the importance of certain factors, such as the dispersion of the clays and the influence of freeze-thaw cycles. It has been shown that retreat of the riverbanks provoked by freeze-thaw cycles is one of the main erosive factors. More than 65 percent of the erosion was produced during winter over the two last years of the study. Because water levels were low during the summers, there was no erosion.

When water levels have been very low over a long period, the extent of clay deflocculation, although difficult to quantify at this time, is also one of the main causes of erosion. Such a situation brings about a greater concentration of suspended matter in the water. These concentrations are clearly higher in fall, after a long period of drought and low water levels. As has been shown, clays disaggregate when the water level rises. In the 2007 spring flood, even though the maximum water level was above that in the fall, less suspended matter was measured, because clays had not dried out during the winter.

#### Concerning wave action from passing boats

Measurements in the field have shown that very high water levels result in less erosion, because waves provoked by ships break on the summits of islands and not on their shores. When water levels are lower over a long period, deflocculation of clay becomes, for this type of hydrological condition, the main cause of the erosion.

#### Conclusion

Even if the 2006–2007 period was remarkable in terms of the retreat of the shoreline, St. Lawrence bank erosion falls within the range of historical values. Continued monitoring of erosion at the same sites and during the same period will not only allow us to better understand factors governing erosion, but also to find out whether the 2006–2007 period represents an isolated case.

As this activity continues, the participation of communities and other government partners becomes very important in order to take into account other erosion-monitoring activities, to enlarge the area monitored and to increase knowledge specific to individual sectors of the St. Lawrence River.

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Île aux Bœufs, Verchères April 2006



Île aux Bœufs, Verchères April 2008

