FLOODING IN THE MASSAWIPPI BASIN DURING THE 20TH CENTURY

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RÉSUMÉ

L'histoire des inondations dans les Cantons de l'Est québécois n'a jamais été étudiée en détail. Cet article relate l'histoire des inondations dans le bassin hydrographique de la rivière Massawippi au 20^e siècle d'un point de vue journalistique, archivistique et physiographique. Les données proviennent de plusieurs journaux locaux, en particulier du Sherbrooke Record, des photos d'archives réunies par le Centre de recherche des Cantons de l'Est, des mesures faites de la physiographie du bassin et des données climatiques fournies par Environnement Canada. L'analyse de ces divers types de données révèle qu'il y a eu des inondations dans le bassin de la Massawippi à 65 des 100 dernières années. Ces inondations ont causé des dommages aux infrastructures gouvernementales, des inconvénients et des pertes d'ordre personnel ainsi que des pertes commerciales, particulièrement dans le secteur agricole. Certaines preuves indiquent une augmentation possible de la fréquence des inondations vers la fin du siècle. La partie inférieure du bassin, Lennoxville et le sud de la ville, est le secteur qui a été le plus souvent touché.

ABSTRACT

The history of flooding in the Eastern Townships of Quebec has never been studied in detail. This article describes the history of flooding in the Massawippi Drainage Basin throughout the 20th century, from a newspaper media, archival and physical geographic perspective. The data are derived from a number of local newspapers, particularly the *Sherbrooke Record*, from archival photographs collected by the Eastern Townships Research Centre, from measurements of the basin's physiography, and from climate data provided by Environment Canada. Analyses of these various forms of data have shown the Massawippi Basin has experienced floods in 65 of the 100 years of the past century. These flood events have caused damages to government infrastructures, personal inconvenience and losses, and private business losses, especially in the agricultural sector. Some evidence points to a possible increase in the frequency of flood events toward the last part of the century. The lower part of the basin, at and south of Lennoxville, has been inundated with floodwaters most often.

Introduction

People living in the towns and rural areas of the Massawippi Basin, including Lennovville. Continue of the Massawippi Basin, including Lennoxville, Coaticook, North Hatley, Stanstead, Aver's Cliff and points in between, have become used to the arrival of the spring flood event. A Thursday, April 19, 1900 account taken from The Sherbrooke Daily Record accurately portrays the familiarity with this frequent event:

"FLOOD IS HERE

The spring freshet is now on in earnest. The rain of Monday was the beginning. Since then the water has been steadily rising and yesterday afternoon passed the capacity of the river channel and overflowed the banks...Below the city on both sides of the river, the highways are flooded and teams can only pass by fording...The road between Lennoxville and Huntingville is submerged...Those who have watched the progress of the spring floods for many years past predict a record breaker this year." (p. 1)

During the 20th century (defined here as the ten-decade period 1900–1999), rivers in this basin went on to overflow their banks in 65 out of the 100 years, during 95 separate events. Unfortunately, the history of flooding in this region of southern Quebec is not well documented. The purpose of this paper is to provide a descriptive account of flood events that occurred in the Massawippi Basin during the 20th century. Based on newspaper reports from The Sherbrooke Record, The Townships Sun, La Tribune and The Montreal Gazette, and information provided by Environment Canada, the Lennoxville-Ascot Historical and Museum Society, Musée du Seminaire de Sherbrooke and the Eastern Townships Research Centre, a geographical history of these events will be provided. The timing and location of the flooding, causes of floods, and reactions of the media will be presented. Using climate data provided by Environment Canada, comparisons between the timing of historical floods and climate Normals for the period 1888-1990 will be made. This study is a detailed historical analysis building on, and expanding, the short history of flooding in the Massawippi Basin presented by Jones (1999), the only recent publication available on this subject for the study area.

The study area includes all terrain drained by the Massawippi River and its tributaries (Fig. 1). The basin has a total area of 1670 km², a quasi-circular shape and the terrain is one of rolling hills with an overall slope to the north. Principal tributaries include the Coaticook, Moes, Ascot (Salmon), Tomifobia and Niger Rivers. A total of



Figure 1: Flood Location Map

over 2000 km of stream channels exist within the Massawippi Basin, however most of these channels are relatively short, less than 4 km in length. The only extensive water body that interrupts stream channel flow in the basin is Lake Massawippi. Smaller water bodies, including Lakes Lyster and Averill, and Norton and Little Averill Ponds are located at the periphery of the basin, acting as water collection points for streams. All streams follow the regional slope running in a generally north-south direction, eventually coming together as the Massawippi River, which discharges its volume into the St. Francis River at Lennoxville.

Flood Characteristics

Both climate and geomorphology are important influences in flood creation. The spring thaw or freshet, as it was termed at the beginning of the century, is usually accompanied by heavy rains, increases in temperature leading to quickly melting deep snowpacks and/or river ice jams. Any of these factors may produce a flood event, however when these conditions act in concert they produce enough water to deliver an event with disastrous consequences. Environment Canada provides the average annual precipitation for Lennoxville, for the years 1888 to 1990, as 104 cm; 80 cm of it is rain and 24 cm (water equivalent) of snow. July and August are the wettest months with 108 cm and 119 cm of precipitation; January and February are the driest months with 67 cm and 59 cm of precipitation (Fig. 2). Total snow cover normally peaks at the end of February, at 33 cm; March is the month with greatest snow melt, normally leaving only 8 cm on the ground at the end of the month.

The normal average temperature provided by Environment Canada for the 1888 to 1990 period for Lennoxville is 5.3°C (Fig. 3). The greatest average temperature drop occurs between November and December: 1.0 to -7.1°C; the greatest rise is between March and April: -2.9 to 4.8°C. In both cases the threshold freezing point of 0 °C is crossed. In the latter case this produces important water, in terms of



Figure 2: Contributions of Rain and Snow at Lennoxville (Source: Environment Canada, 1998)



Sigure 3: Temperature Trends at Lennoxvill (Source: Environment Canada, 1998)

flood potential, to stream channels through the melt of most of the snowpack. In addition, the late March/early April period is when any existing river and/or lake ice breaks up and begins to float downstream, producing the potential for ice jams. At this time of year the ground remains partially frozen and/or water-saturated, reducing meltwater infiltration into the soil and increasing runoff to the nearby streams.

Important geomorphic factors influencing flooding include the strong regional northward slope, the relatively large basin size, short lengths of most channels, high bifurcation (channel splitting) ratios, and the basin's circular shape. All of these factors influence an immediate response to rainfall and snowmelt events: movement of water through the basin is rapid, and a quick delivery of water to the basin outlet at Lennoxville results (Jones 1999).

Floods, simply, are the result of the addition of too much water for the stream channel to hold at a specific time. They occur in the study area in three types: regional floods, flash floods and ice jam floods. Regional floods are usually seasonal, often occurring when winter or spring rains along with melting snow provide the river basin with too much water too quickly. The frozen ground at this time of year increases runoff by hampering infiltration. Note, however, that extended rainy periods during warmer times of the year can create saturated soil conditions, thereby causing additional rain to runoff directly to stream channels and exceed their capacity. Both winter/spring and summer regional floods are often associated with slow-moving low pressure frontal systems; summer events may be related to nearby tropical storms or hurricanes.

Flash floods are rapidly occurring events, often hitting within minutes or hours with no warning. They cause immediate rises in stream water levels and high velocity water movement. Factors that contribute to flash flooding include the rainfall intensity, rainfall duration, soil conditions, and topography and slope of the drainage basin. Areas with impermeable surfaces, such as towns and cities, are particularly susceptible because of the lack of water infiltration and excessive runoff. Hilly or mountainous areas are vulnerable due to the steep slopes, relatively thin soils and reduced vegetation cover; steep slopes often funnel the water into narrow valleys where it becomes a danger to all in its path. Extreme soil erosion often creating debris flows, and damage to transportation and communication corridors, are typical results. Although a flash flood can occur at any time of year, the majority occur during the summer months.

Ice jam floods take place on frozen, or partially frozen, streams. Rising flood waters break up the ice into floes of various sizes. The larger pieces jam and accumulate at constrictions in the stream channel such as dams, bridges, log booms and shallow riffle sections. The jams create an obstruction across the channel, causing even more ice to accumulate and completely or partially block the flow of water. Water upstream of the jam rises rapidly, flooding the adjacent floodplain. After the jam breaks the water stored behind it is released and acts somewhat like a flash flood to places downstream. The energetic floodwave carries large blocks of ice at high velocity, increasing the potential for serious damage to any structures. Spring is the normal time for ice jam floods to occur.

Flood Locations

The principal locations of floods in the Massawippi basin are shown on Figure 1 (cf, Jones 1999). All of these locations are susceptible to flooding primarily because of their low elevations, less than 150 metres above sea level. Secondarily, Locations 1 and 3 are areas of major river confluence; ice jams are influential at Locations 1, 2 and 3. At Location 1 bridges over the Massawippi River and the confluences of the Massawippi with the Moes and Coaticook Rivers are key points of channel constriction, and water and ice build-up. At Location 2 a dam present immediately downstream of Lake Massawippi provides a constriction point. The confluence of the Moes and Ascot Rivers is a location of water build-up and flood potential, as is the confluence of the Massawippi and Niger Rivers at Ayer's Cliff, Location 3. Location 4 at Stanstead is the least flooded one, simply being an area of low elevation. Location 5 represents a highly meandering reach of the Coaticook River. Each meander bend provides a possible point of water build-up and overflow. Between each bend are riffles, stretches of the river with bottom sediment accumulation causing shallows, and thus areas where the potential for ice jamming and channel overflows is increased.

Flood History

Other than Jones (1999) there are no studies or records kept of flood events in the Massawippi drainage basin. Therefore, it is necessary to compile a history of flooding from an analysis of local print media. Newspaper accounts have the advantage of easy accessibility and using several sources increases the chance of a flood event being recorded for inclusion. One major disadvantage of this research method is the propensity for newspapers to cover only major events, overestimate damages and, occasionally, confuse flood damage with erosion damage (Kreutzwiser and Gabriel, 1992). The possibility of the newspapers utilized in this study covering only major events is low; the ones used are local newspapers that attempt to report all local events, large or small. Additional, general information on the flood history of southern Quebec came from government publications and web sites (e.g.: Andrews, 1993; Environment Canada: http://www.cmc.ec.gc.ca/climate/normals), the Lennoxville-Ascot Historical and Museum Society, the Musée du Seminaire de Sherbrooke and the Eastern Townships Research Centre.

Spring floods (March to May), caused by a combination of snowmelt, rain and ice jams, are by far the most common type occurring in this part of the Eastern Townships. March and April are the two most common months for flooding, with 63 of the 95 separate flood events that have occurred in the 20th century in the Massawippi Basin occurring during these two spring months, 42 of them in April (Fig. 4). (Note: In this study individual events are defined as those occurring at least three days apart.) These floods also, as a rule, tend to be the most destructive floods on record.

Of the fifteen most significant flood events in the basin during the 20th century (Table 1 on page 118), twelve occurred during March and April. Table 1 provides information on the Date of the



Figure 4: Flood Events By Month

flood event, the Principal Causal Factors, the flood's General Location and Newspaper Media Comments. (Note, on Table 1 floods caused by multiple factors are termed "Composite.") The fifteen significant flood events are those which, based on archival information, caused the highest amounts of damage to infrastructures and larger disruptions to transportation and communication. Three of the most destructive were the events of March 6-8, 1979, April 17-19, 1982 and April 16, 1994. In each case flooding occurred due to a combination of heavy rain, massive snowmelt and ice jams (ie, Composite events). Bridges were damaged, farms flooded and livestock lost, people evacuated from their homes, roads closed. Location 1 (Fig. 1), at and upstream of Lennoxville was usually hit hardest: Bishop's University, built on the floodplains of both the St. Francis and Massawippi Rivers, suffered extensive flood damage, as did the Beaulieu and Wera farms located on the floodplain, or "flats," south of town.

Floods are not restricted to the spring season; winter thaws and summer thunderstorms add to the flood hazard. December, January and February have seen a total of 23 flood events over this 100-year period. Unseasonably warm temperatures causing snowmelt and heavy rains usually produce these floods. Ice jams often exacerbate the flood hazard during these months. One significant event occurred on January 10, 1935 when a composite flood caused heavy



Plate 1: Bridge Removal at the Moes River (Source: Eastern Townships Research Centre, Graphic Material Collection, P020 79-31-36, Flood at Moes River, 1943)

damage in the Coaticook area. Roads were closed, a bridge destroyed and farms inundated with flood waters (Table 1).

The summer months of June to August have experienced a total of six events occurring during the century. These are what are termed flash floods, initiated by intense summer thunderstorms, and usually taking place on steep slopes. Where the ground is unstable and/or barren of vegetation, severe erosion and debris flows have occurred during these events. June has seen two of the most destructive events of the century (Table 1). During two consecutive years, 1942 and 1943, heavy rains produced flash floods. These two days saw some of the heaviest rain recorded for the Massawippi Basin in history; property damages were high, transportation corridors were disrupted and low-lying farms inundated. Plate 1 is a photograph of a bridge located at the Moes River where the bridge was removed by the 1943 flash flood. In addition, steep slopes on Montjoie were heavily eroded causing small debris flows that added to the disruption of local roads.

Autumn is seldom a season for flooding. Only two 20th century events are documented for the months of September, October and November. These occurred after unusually intense rainstorms caused flash floods. Occasionally, like the September 20, 1999 event, the nearby passing of a hurricane, in this case Hurricane Floyd, was blamed for the heavy rain.



Figure 5: Flood Events Per Decade

As mentioned above, there has been a total of 95 flood events documented in 65 of the years of the 20th century. There has been no decade free of floods. There has been a slight increase in the reporting of these events in the latest part of the century (Fig. 5). The early decades, with the exception of the 1930s when there were 12 events, normally experienced six to eight events per decade. The decades with the fewest flood events were the 1950s and 1960s when only six events occurred in each decade. The 1970s saw this number rise to 11, followed by 12 in the 1980s and the highest number of events (17) in the last decade, the 1990s, partly because of one unusually hazardous year, 1996; in that year seven different events were reported. These data and the trend they seem to show are, without question, preliminary and require much more detailed study in order to prove that a definite trend to an increase in flood events over time is occurring.

Summary

An analysis of the history of flooding in the Massawippi Drainage Basin during the 20th century has revealed a number of interesting facts. It has been shown that flood events were, as expected from anecdotal evidence, frequent and occasionally destructive. Flood costs included infrastructure damages to communication and transportation corridors, economic disruption and losses on agricultural lands, personal inconvenience related to evacuations and personal losses related to floodwater and stream sediment inundations of homes, and business losses due to service disruptions and direct floodwater damages.

Also, there is some evidence that flood events have increased in number toward the last part of the century, however the information supporting this contention is not detailed. This apparent increase may be simply related to improved reporting techniques by the local newspapers. It may be related to an increase in winter snowfall accumulations and large spring rainstorm events; further investigation of climate data is necessary in order to verify this statement.

It has also been shown that, although flooding occurs throughout the Massawippi Basin, the area near and immediately south of Lennoxville is the site of most flooding. Here the floodwaters from the entire basin accumulate, the topography is flat, with an extensive floodplain and bridges occur which can create ice jams. Much of the damage associated with the flooding of the Lennoxville area is economic damage of local farms located on the floodplain south of town.

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TABLE 1 SIGNIFICANT FLOOD EVENTS OF THE TWENTIETH CENTURY MASSAWIPPI DRAINAGE BASIN, QUEBEC

Date	Principal Causal Factors	General Location	Newspaper Media Comments
1913			
March 24–28	Composite	Throughout Basin	massive damages throughout Townships; log boom on Coati- cook River at Dixville broken; Coaticook River overflowed its banks in all low areas; evacuations in Lennoxville; meadows near Compton flooded; general flooding due to ice jams, mas- sive snowmelt and heavy rain
1935			
January 10	Composite	Coaticook	heavy flood damage; Coaticook to Norton Rd. flooded; ice jam at electric light plant dam; piers of George White bridge on same road washed away (3 km above Dixville); farm lands flooded along road
1936			5
March 13	Composite	Coaticook/ Lennoxville	flood dangers are a grim reality in Townships; warm weather; rain; ice Waterville/jams; lives threatened; heavy damage; rivers took heavy toll in property damage; floods forced many families to leave homes
1942			
June 15	Rain	Throughout Basin	heavy damage, bridges carried off; 214 mm rain in 3 days; towns hit hard, property damage; Coaticook appeals for gov't assistance

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1943			
June 15–16	Rain	Throughout Basin	highways closed; temperature 4 – 9°C; heaviest 24 hour rain- fall in 20 th century (103.6 mm); 5-day rain (June 12–16): 141.5 mm; transportation and farm properties hit badly; Lennoxville District was severely affected; more rain than in flood of 1942
1960			
April 19	Composite	Lennoxville	farms south of town flooded; at Bishop's University Cookshire road acts as a dike, turning the football field into a pond; water in front of McGreer crept to one-third of the way to the front door; Optimist playground, basements in Little Forks flooded
1964			
March 6	Composite	Lennoxville	rain on March 5 th and ice jams: Little Forks, St. Francis and Col- lege Sts. flooded; several cellars flooded; no evacuations; large ice chunks obstructing roads; turnoff linking Hwy 5 with Capelton flooded
1974			•
April 3–5	Composite	Throughout Basin	¼ mile ice jam at Bower Bridge; Bower Bridge washed down- river; roads flooded; small bridge removed at Route 5 by ice; low lying areas (under 165 m) flooded; Routes 5 and 22 flooded

Date	Principal Causal Factors	General Location	Newspaper Media Comments
1979			
March 6, 7, 8	Composite	Throughout Basin	had serious flooding: ice jams built up; flooding of fields and Highway 147; flooding caused closure of l'Esperance and St Jacques roads; farms on Stanstead Highway evacuated; tem- peratures dropped, slowing flooding; flooding caused closure of Highway 147 at Highway 143; Capelton Road closed due to ice jam on Massawippi floodplains to Eustis; cranes and crews save Capelton Bridge from ice jam; Beaulieu Farm evacuated, including cattle; Fairview Railway Bridge under 20 cm of water; Moes River carried away a bridge, cutting off a Road near US border; Capelton Road closed; Vaillancourt and St Jacques roads closed from Moes River flooding; haven't seen floods like this since 1948
1982			
April 17, 18, 19 Composite		Throughout Basin	very heavy rain overnight; massive snowmelt and rains led to flooding; all local rivers flooded; lake ice behind dam lifted onto RR bridge, causing a large ice jam, which eventually broke, flooding the Ascot River floodplain; severely flooded: Bishop's University tunnels, Nicoll's Building, and Centennial Theatre flooded; dozens of tributaries overflowed their banks due to warm weather and heavy rains; Beaulieu Farm lost 149 prize Holsteins; ~1 m water on Little Forks St.; reasons for flooding: extensive rainfall, higher temperatures, record snow- falls which didn't thaw until March

1987			
April 1	Composite	Throughout Basin	Little Forks Street closed, Optimist Park flooded; MacDonald and Brother roads are flooded; Massawippi River is unstable due to volatility of Coaticook, Moes, Ascot Rivers; spring thaw peaked, water flowing into low lying areas
1989			
March 30	Composite	Throughout Basin	Little Fork Street in Lennoxville flooded to knee depth; High- way 108 closed due to ice blocks on road; Beaulieu Farm flooded badly. Niger River went over banks at Bacon's Bay near Ayer's Cliff
1992			
March 12, 13	Composite	Throughout Basin	ice jam caused Coaticook River to flood fields and roads; Ascot River rose 3.1 m due to ice jams; Magog and Massawippi Rivers swollen, Coaticook and Massawippi Rivers overflowed; Highway 108 closed
1994			
April 16	Composite	Throughout Basin	worst flooding since 1974; 1000 people evacuated; Bishop's University students evacuated to Bishop's College School; Beaulieu and Wera farms flooded; Bacon's Bay and Hatley West; flooded, Niger and Tomifobia River kept Lake Massawip- pi high; heavy rain on April 16 th (water rose 15 cm in 45 min- utes); higher than normal winter snowfall; destruction of wetlands blamed, especially in Bacon's Bay area near Ayer's Cliff; worst flooding: Capelton Road (Ascot River), North Hat- ley, Bacon's Bay, Magog Township near Cherry River; flood waters high on Tomifobia River, Lake Massawippi, and Mas- sawippi River during the week

Date	Principal Causal Factors	General Location	Newspaper Media Comments
1998 March 31, April 1	Composite	Throughout Basin	flooding caused closure of many roads: Drouin Road in Comp- ton Station, Route 116 between Danville and Shipton, Fuller Road in Hatley, Boynton Road in Ayer's Cliff; Highway 108 closed; hydro station wiped out by floods as banks were erod- ed; historic covered bridge severely damaged; residents must boil water; trains unable to run because Klinck Road was